Nursery Evaluation Of Different Grafting Techniques For A Sustainable Viticulture Using 99 R And 5 Bb Rootstocks

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Abstract: With an increasing interest for environmentally sound viticulture in sustainable agriculture, the selection of concrete cultivar and/or rootstocks as well as convenient grafting technique interactions become more important. Therefore, the aim of the present study was to evaluate different grafting methods in terms of nursery production. Italia cultivar was grafted on one year old 5 BB and 99 R rootstocks by cleft, omega and chip-budding in glass house. Grafting methods were comparatively evaluated on rootstocks separately with respect to certain factors that determine the degree of compatibility between scion and rootstock. Bud break and shoot emergence commenced earlier in chip-budded grapevines than those of other grafts. Shoot length, shoot diameter and the number of leaves per shoot were significantly higher in chip-budding. The highest percentages of graft final take were also obtained from chip-budded grapevines with the values of 80.0% and 66.7% for 99 R and 5 BB, respectively. Overall, chip-budding method would be recommended to apply when the grafting of rooted grapevines was considered.

Introduction

Grapevine rootstocks have been bred to provide resistance to improper soil condition, diseases or environmental problems. Among such problems, phylloxera (*Daktulosphaira vitifoliae* Fitch) is a worldwide pest of grapevines. North American *Vitis* species can tolerate this pest and can provide varying degrees of prevention of such soil-borne problems. Thus, selection of concrete rootstock for certain area should be based on an array of criteria such as soil characteristics of vineyard, rooting ability, genetic potential in vine vigor, usefulness in grafting and scion/stock compatibility (Galet, 1979; Cass *et al.,* 2002). Grafting combines two separate plant pieces, a scion wood (the cultivar desired for fruit production) and a rootstock (portion of the vine serves as its root system). The practice of grafting onto disease-resistant stocks now extends to a variety of horticultural plants. However, mistakes in any stages of grafting can result in serious problems difficult to compensate.

Several factors may affect the success of grafting such as hormonal application, cold treatment of the cuttings (Alley, 1978; Roux, 1988), time of grafting (Celik & Odabas, 1998) and environmental conditions (Baydar & Ece, 2005). By studying certain conditions on grafting of grape, it was concluded that the characteristics of the rootstock and graft types are the main factors for success of grafting (Schaefer, 1982; Sivritepe & Turkben, 2001). In many cases, producers need to change the original variety to adapt to changing market demands is feasible. For such condition, grafting is more economical when applied properly than replanting because replanting can take up to five years to replace a vineyard. On the other hand, grafted vines take only two to three years to achieve full production because an established vine is used for this technique. In some cases, reasonable crop will be produced in the year after grafting.

The selections of concrete cultivar and/or rootstocks as well as convenient grafting techniques have been increasing interest for environmentally sound viticulture in sustainable agriculture. This study was designed to evaluate the graft success of three grafting methods using 99 R and 5 BB rootstock varieties.

The Study

This study was carried out at the Department of Horticulture, Faculty of Agriculture, University of Selcuk in Konya TR, under glasshouse conditions equipped with heating system. One year old, potted (12 x 25 cm polyethylene tubes) plants of 5 BB (*V. berlandieri x V. riparia*) and 99 R (*V. berlandieri x V. rupestris*) were selected on the basis of freedom from diseases and unity in vegetative development, in dormant season. At the beginning of March, around two weeks before for bud break, Italia cultivar was grafted onto the rootstock using three grafting types; (1) cleft budding with approximately 5 cm long single node cuttings, (2) grafting by omega technique using approximately 5 cm long single node cuttings, and (3) chip-budding type. All of the grafts were performed on the 14th March. For omega graft, plants were cut leaving about 15 cm rootstock trunks and disbudded. After grafting, chip and cleft budding grafts were wrapped to the rootstock while omega grafts were wrapped in parafilm wax. Wax was applied as a dip covering the scion and graft union. Melted wax was maintained at a constant temperature of 55 to 65 °C. Waxed scion cuttings were dipped in tap water to cool. Grafting combinations were replicated 3 times, comprising a total of 27 grafted plants. Grafted plants were grown under glasshouse conditions with 50% shade for the duration of the experiment. Cultivation conditions such as irrigation, weed control, and pruning of any shoots emerging from rootstocks, were performed for all plants as standard cultivation practices. Plants were grown having main shoots by cutting the lateral shoots. When the shoot elongation was near to cease, twenty-seven grapevines were measured for each grafting method of each combination, dividing into three replications.

In order to evaluate the effects of grafting methods on grafting success, the following parameters were examined as illustrated by Celik (2000), Celik *et al.* (1992), Sabir & Agaoglu (2009).

- Phenological stages (woolen stage, bud break, shoot emergence): These investigations were carried out with daily observations and the dates were recorded when 50% of plants in a replicate reach to the related stage.
- Callus formation rate (0-4 scale): A scale ranging from 0 to 4 was used (0=no callus, 1=25%, 2=50%, 3=75% and 4=100% callus formation on graft union surface).
- Graft success rate (%): Percentages of grafted vines that have an adequate callus formation on the surface of the graft union.
- Shoot length (cm): The length of the scion shoot was measured by a meter with a sensitivity of 1 mm.
- Shoot diameter (mm): It was obtained by using a digital compass by measuring between 4th and 5th nodes.
- Leaf number: Average number of leaves on scion shoots.
- The final take percentage (%): Percentage of grapevines that have an adequate or all-around callus ring formation on the surface of the graft union.

The original data are given as percentages of investigations in the tables. Analysis of data variance was performed with SPSS 13.0 software program. The least significant difference (LSD) were calculated at the level of $P<0.05$. Rootstock varieties were evaluated separately in order to compare the grafting techniques.

Findings

Effects of different graft types on phenological stages of Italia grapevine cultivar were shown in Table 1. Phenological dates were designated when the 50% of grafts belonging to each replicates reach to relevant stage. Woolen stage dates among the grafts were between 24th and 29th March for omega grafts of both rootstocks. However, bud-break dates of chip-budding grafts were noticeably earlier than others. On the other hand, bud break and shoot emergence dates of omega grafts delayed, possible because of parafilm used for only omega graft type. Differences among graft types by means of phenological stages would also be arisen from different callus formation aptitudes of the rootstock used, as stated before several researchers (Celik & Agaoglu, 1979; Celik & Odabas, 1998; Sabir & Agaoglu, 2009).

	Graft type	Woolen stage	Bud break	Shoot emergence
Italia/99 R	Cleft	29.03.	08.04.	10.04.
	Omega	24.03.	09.04.	13.04.
	Chip-budding	28.03.	04.04.	08.04.
Italia/5 BB	Cleft	29.03	08.04.	10.04.
	Omega	24.03.	09.04.	13.04.
	Chip-budding	29.03.	05.04.	09.04.

Table 1. Effects of different graft types on date of phenological stages of Italia scion

During the graft union process, callus, undifferentiated cells that bind the scion and rootstock together (Deloire, 1981), is formed in varying degrees depending on grafting type and rootstock callusing capacity. The grade of callus formation at graft union point is an important factor determining the compatibility level between scion cultivar and rootstock (Yavas & Fidan, 1991; Celik, 2000; Sabir & Agaoglu, 2009). In 99 R rootstocks, grafting methods did not significantly affect on callus formation rate (*Fig. 1*). Actually, callusing degrees were eventually high in all the graft types. On the other hand, significant differences were observed among graft types in 5 BB. This case is well adjusted with the findings of Cangi *et al.,* (2000) who reported that the callus formation between graft components was mostly established by rootstock, depending on grafting method and cultivation conditions.

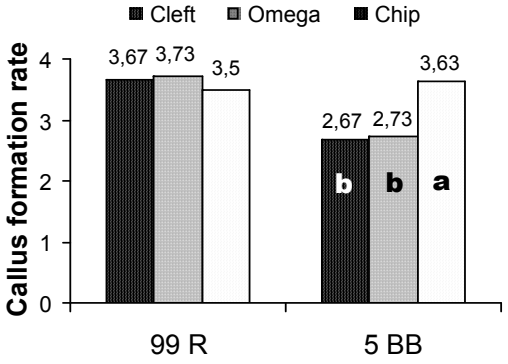

Figure 1. Effects of different graft types on callus formation rate (Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

Graft success rate (%) was similar to callus formation rate, and was not affected by graft methods in 99 R (*Fig. 2*). Whereas, chip-budding method resulted in the highest rate of graft success (73.3%), while cleft and omega graft techniques displayed similar results (53.3 and 56.7 %, respectively) in 5 BB rootstock.

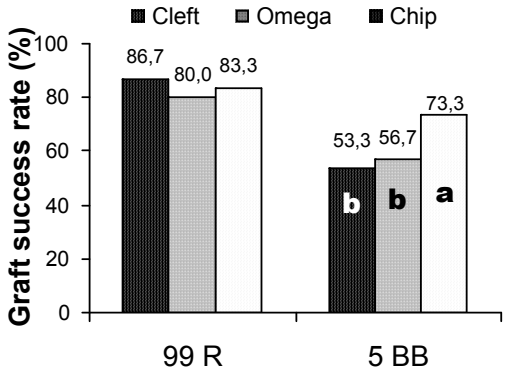

Figure 2. Effects of different graft types on graft success rate (%; Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

As presented in *Fig. 3*, different grafting techniques had significant effects on shoot length (cm). Chip-budding always provided the elongation of the highest shoots in 99 R (60.2 cm) and 5 BB (58.3 cm) rootstocks while, on the other hand, the shoot lengths of cleft and omega grafted plants were similar. Increments of shoot elongation in chip-budded plants in this study might be related with the early bud break and shoot emergence status of relevant grapevines.

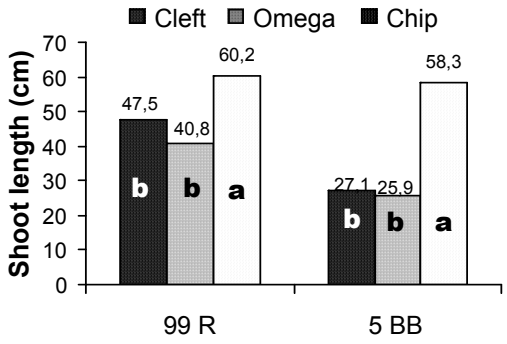

Figure 3. Effects of different graft types on shoot length (cm; Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

Shoot diameter (mm) of Italia scion significantly differed among different graft types in rootstocks (*Fig. 4*). The chip-budding method that promoted the shoot development yielded the thickest shoots with 6.52 and 5.87 mm for 99 R and 5 BB rootstocks, respectively.

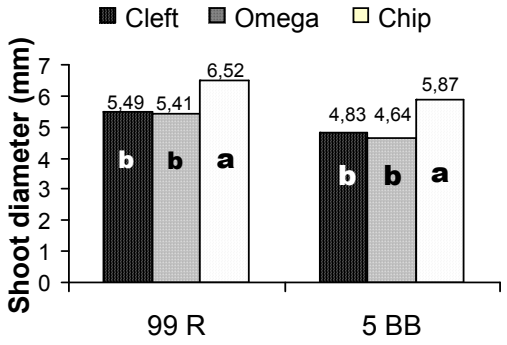

Figure 4. Effects of different graft types on shoot diameter (mm; Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

Grafting methods significantly affected the number of leaves per shoot in both rootstocks (*Fig. 5*). Resembling to the shoot length observations, chip-budding provided the highest leaf numbers in 99 R and 5 BB rootstocks with means of 24.5 and 22.5 leaves per shoot. Different levels of shoot developments observed in this study along with certain literature investigations (Alley *et al.,* 1980; Celik, 2000) reveal that graft types, as well as genotypic aptitude, have fundamental impacts on graft success.

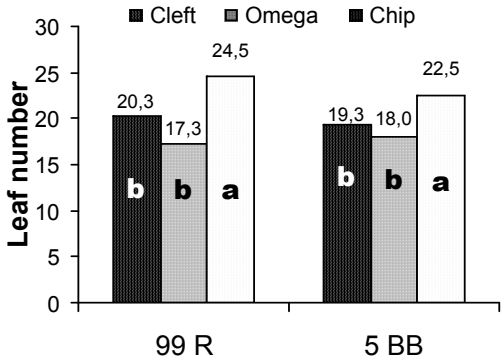

Figure 5. Effects of different graft types on leaf number per shoot (Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

For both of two rootstocks, the percentages of graft final take were higher in chip-budded plants with the rates of 80% and 66.7% for 99 R and 5 BB, respectively than those of other grafts although such differences were insignificant in 99 R (*Fig. 6*). Studying with different scion/rootstock combinations, Celik & Odabas (1998) compared the effects of grafting time and different methods on success of grafted grapevine production by grafting under nursery condition. According to their findings chip-budding, in most cases, provided better results by means of graft take percentage and first grade grafted grapevine plantings.

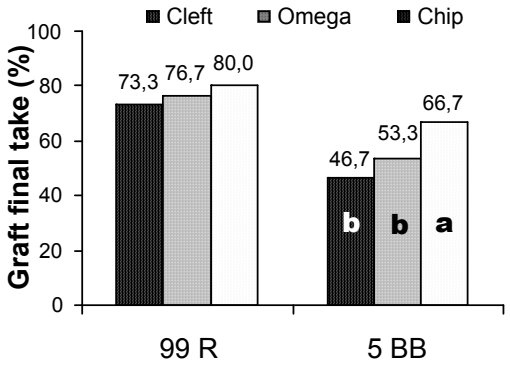

Figure 6. Effects of different graft types on graft final take percentage (%; Numbers, the averages of three replicates, followed by different letters are significantly different and each rootstock was analyzed independently).

Conclusions

According to the overall investigations of the present study, chip-budding yielded the best results in most cases. Therefore this grafting technique could be recommended to perform when the grafting of rooted rootstocks was considered under greenhouse nursery conditions. Besides this, in open area, temperature fluctuations that cause swelling and shrinking, disrupting the cells connecting stock and scion can lead to failure of the graft union. Chip-budding in most cases is much easier and faster than other grafting types because of the reduced surface area exposed and shorter healing time as reported before by several researchers. It should be further noted that grafting should be completed as early as possible, because the vines may not harden off properly, leaving them susceptible to winter damage, in especially areas where winter coldness affects the vine viability.

Acknowledgement

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Banana - A Very Profitable Crop for Subtropical Conditions

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Abstract: Bananas have been cultivated economically for a long time in subtropical regions of Turkey where production and productivity per hectare have significantly increased due to the adoption of protected cultivation. Protected cultivation of banana began in the 1980's in Anamur and Bozyazi, Mersin. In the 1990s this system became more popular. Today, a similar trend is underway in Mediterranean costal strip. Approximately 4300 ha of banana are grown in Turkey, of which over 2500 ha is grown under protected cultivation. The average yield per ha is about 20-30 tonnes under open-field and 60-70 tones under protected cultivation. In 2008, the total banana production of Turkey was 210.115 tones but domestic consumption of bananas in Turkey exceeds supply and hence bananas are imported. Local importers pay very high custom duties (over 100%) for imported bananas and because of that, banana retail prices remain high which makes local banana production a very profitable enterprise.

Introduction

Banana growing areas of the world are mainly situated between the Equator and latitudes 20 ^{o}N and 20 ^{o}S. Climatic conditions in these areas are mainly tropical, with relatively small temperature fluctuations from day to night and from summer to winter (Robinson, 1996). On the other hand, banana can also be grown in subtropical areas. We may show that Western Australia, South Queensland, South Africa, Israel, Taiwan, Spain (The Canary Islands), Egypt, Morocco and parts of Brazil and Turkey for subtropical condition (Galan Sauco et al., 2004). Banana plantations are situated between the latitudes 20^{o} and 30^{o} many of subtropical area. But in Turkey, banana plantations are situated at 36^{o} latitude. Nevertheless banana has been grown economically in Turkey for over a century. At present, the total banana growing area of Turkey has reached up 4300 ha (Anonymous, 2009) of which more than 2500 ha are under protected cultivation. In 2008, the total banana production of Turkey was 210.115 tons (Anonymous, 2009). As local demand (domestic consumption) for bananas are nearly 400.000 tons. Therefore, Turkey has to import nearly 200.000 tonnes bananas from overseas. Local importers pay very high custom duties (over 100%) for imported bananas, as such banana retail prices remain high, which makes local banana production a very profitable enterprise.

The main climatic constrain in Turkey like other subtropical regions are wide temperature fluctuations between day and night, low and high temperature extremes in winter and summer respectively and also rainfall is not sufficient in some months. Due to the low temperature, protected (greenhouse) cultivation has gained popularity in recent years in Turkey. In Turkey, protected cultivation of banana began in the 1980's in Anamur and Bozyazi, Mersin and in the 1990s this cultivation type gained popularity. Presently a similar trend is underway in Erdemli, Mersin; Alanya, Gazipasa (flat region), Finike, Kumluca, Antalya and Iskenderun, Hatay.

The objective of this study was to evaluate the cultivation and constrain constrains of banana in Turkey.

Banana Growing under Open-Field and Protected Conditions

Banana growing areas in Turkey are located in the Mediterranean costal strip. Planting occurs in the North part of the mountain to protect from wind damage. Bananas have been grown in Turkey in both open-field and protected cultivation (plastic greenhouse). Anamur and Bozyazi in Mersin are the main protected cultivation areas. On the other hand, banana has grown in Alanya and Gazipasa, Antalya both open-field and protected cultivation. Average mean yearly minimum/maximum temperatures in the open-field cultivation and under the protected cultivation are 10/30 °C and 11/35 °C, respectively. Yearly average relative humidity for both conditions is over 60%. Shading powder was applied during the summer season to protect plants and fruits from sunburn damage under protected cultivation.

Growing Conditions and Cultural Practices

In Turkey, the greenhouse structure is made of round iron poles and 6.5 – 7 meters high at the top and 5-6 meters below the gutter and covered with plastic. Generally, the greenhouse is not heated in all locations. The greenhouse cost approximately 10-15 Euros/m^2 (without a plastic cover). However, banana plants bear fruits the same year after planting and the production costs outlays are recovered within a few years.

'Dwarf Cavendish' is the most common cultivar for open-field. But 'Grande Nain' and 'Azman' (local cultivar) are the most widely planted cultivars for greenhouse conditions. Plants are planted in March for open-filed condition. However, there are two planting time for protected cultivation (February and September). When the plants are planted under open-field, the first ratoon crop is not so productive. But the plants produce very good bunch in the first ratoon crop under protected cultivation. While suckers are used for open-field cultivation, tissue culture plants are used for protected cultivation. Plant spacing is 2.5 x 2m (2000 plant per ha) in open-field conditions, and 3 x 1.8 m (1850 plant per ha) in protected cultivation (Gubbuk and Pekmezci, 2004). Single line is preferred than double line. But after the second ratoon crop, the plants are increased 2100 or 2200 plant per ha both cultivation systems. The soil pH was slightly alkaline, lime content was medium, texture was loam, and organic matter content was between low and medium (Köseoğlu et al., 1985). Organic manure is applied at about 50 to 60 kg per plant. Fertilizers are applied either by hand around the plant or via irrigation. The main fertilizers are NPK, which are applied at rate of 300, 400, and 1000 g/plant per cycle. Drip irrigation system are used in both cultivation system. Nematodes are the most important pests of banana. There is no Sigatoka and common virus disease in Turkey. Postharvest Technologies including handling and ripening are improve day by day.

Differences between Cultivation Systems

The main differences between both cultivation systems is days from shooting to harvest and yield. Only one crop is produced per year in field conditions, but sometimes two crops are obtained per year under protected cultivation. Days from shooting to harvest were shorter (between 90-120 days) in protected cultivation. Bunch was harvested earlier in protected cultivation than in open-field cultivation. The shorter interval is a great advantage in the subtropical region, especially in the case of frost damage. After mid November, the temperature begins to drop in the cool subtropical climate. Frost damage occurs not only in plants, but also in the fruit. Frost damage can rarely be seen in sucker and fruit in protected cultivation, but not in open-field cultivation.

Average yield per ha is between 25-30 tons in open-field and 50-70 tons under protected cultivation. The harvest time for protected cultivation is between October and January and between December and March for open-field condition. The farmer and retail prices are different in Turkey. The farmer price is between 0.7 and 0.8 Euro per kg. However, the retail price is about 1.5 Euro per kg. Therefore, the income is higher in protected cultivation.

Advantages of Protected Cultivation

There are many advantages in protected cultivation compared to open-field cultivation in subtropical conditions e.g. (a) Reduction of life cycle from planting to harvest (b) Reduction in water consumption (c) Extended duration of temperatures above 20^{o}C (d) Higher rate of photosynthesis (e) Protection against wind and other weather conditions (e.g. sunburn and hail) (f) Increased bunch and finger weight (Galan Sauco et al., 1998). Furthermore, in protected cultivation, chilling injury and low temperature differences do not negatively affect the plants and fruits, as compared to open-field cultivation.

Disadvantages of Open-Field Cultivation

The main constrain of banana growing in Turkey like the cooler subtropics are the greater diurnal temperature fluctuations, and lower night temperatures, insufficient rainfall and wind damage. Furthermore, winter leaf sunburn, underpeel discolouration and growth cessations are typical physiological problems associated with banana production in the subtropics (Robinson, 1996).

Conclusion

The advantage of growing banana under protected cultivation under cool subtropical conditions is that the yield and the quality are higher, compared with open-field cultivation. Therefore, higher yields increase the economic prospects of banana cultivation in the subtropical regions.

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The Sustainability of Agricultural Activities and Its Effects on Inland Waters and Living Areas

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Abstract: Residues of some medicals and fertilizers used in agricultural areas can reach to some receptors through some processes such as irrigation and surface waters. These natural receptors are rivers, lakes and seas. The materials coming from agricultural areas have more destructive effects on the lakes and rivers since these are smaller. The most pronounced pollutants coming from agricultural areas to rivers and lakes are pesticides and fertilizers which are known as a source of nitrogen and phosphor. Chemicals in some areas where pesticide were used are mixed into rivers and lakes through that way and reach to water habitats and organisms. On the other hand, this causes to increase organic ratio, eutrophication and for ecological balance to be destroyed.
Pathogens are transmitted to surface waters with human and animal wastes and then these contaminated surface waters threat human health. An important amount of pathogens is distributed to receptors through use of wastewaters for irrigation. In order for this negative effects to be removed, in order to save rivers and lakes, wild irrigation must be stopped, the direct approach of wastewaters into the rivers and lakes must be prevented, the use of fertilizers and pesticides must be controlled, mechanical and biological war must be strengthened. The sustainable ecological living areas can be constructed by taking the water sources and biological kinds under control with these precautions.

Key words: Agricultural activities, pollution, inland waters, sustainability

Introduction

Drinking water has been less and less for reasons, such as insufficient environmental awareness, fast increasing world population, excessive development of industry and technology. Beside these, pollution of water sources irresponsibly will cause problems unable to be solved (Haviland, 2002; Dağlı, 2005; Akın, 2007).

Increasing demand on the food with increasing population makes that the quality and quantity must be increased. As a result of these demand, the usage of fertilizer and pesticide are increased in time (Huber et al., 2000; Causape et al., 2004). The chemicals used agricultural areas are classified in two groups to be fertilizers and pesticides (Alloway, 1995). They are very important issue since they are toxic, decomposition of them is very difficult, and they can be deposited in living organisms and environment (Egemen, 2006). Pesticides and chemical fertilizers are mixed into rivers which are one of the ecosystems mostly affected from environmental pollution (Huber et al., 2000, Causape et al., 2004; Taş, 2006).

The pollutions caused by agricultural activities are firstly transferred into the rivers and then goes to lakes and seas throughout rivers. It can prevent the development of zoo and phytoplankton which have an important place on the feeding chain of aquatic livings even in the case of the existence of pesticides in trace level in the water (Aguilar et al., 1997).

This pollution is badly affecting not only livings living in pollution but also it can reach human through feeding chain (Yılmaz, 2004). It is important to note that the determination of existence of DDT (pesticide) on the penguins, seal and people living in poles where no pesticides have never been used shows the power of circulation of chemicals used in agriculture over the world (Egemen, 2006).

The harm given by the improper use with the increase of this improper use of pesticides and chemical

fertilizers will have reached to high levels (Öztürk and Tosun, 2004). The production and use of pesticides and chemical fertilizers continue to in crease at present, and it must be taken under control in order to decrease the health and environmental problems (Atasoy and Rastgeldi, 2006).

Agricultural Activities And Pesticide

Since pesticides remain in nature for so long time without decomposition, they have no selectivity on the selected organisms and collected in some parts of food chain, they can cause destructions of some beneficial kinds and ecological balance and appearing of new kinds presenting resistance to these kind of products (Kambur et al., 2005).

It has been well known that pesticides can reach ecosystem of water in several ways. For example, some several medicines can contaminate into water with direct application of pesticides to the buggies during fighting against wild grass in or around the canals of drainage and irrigation or vector insects such as mosquitoes. Some pesticides reach to aquatic plants and insects through the fact that the medicines in some places where pesticides were used mix into to river or ground water by rain water. The pesticides mixture into ground or surface waters have limit values for livings according to some structural properties presented in some receptors. The concentrations exceeding these limit values badly effect the life of livings. The first step of bio concentration mechanisms in aquatic systems is consisted of plankton. An important part of plankton in aquatic habitats consists of algae. Since algae are primary producer, they play a functional role in habitats on which algae exist. Algae which are primary produces in aquatic environment form the base of organic production and they are quite sensitive organisms for physical and chemical changes in an environment where they exist. Algae are key targets for pesticide contaminations since they haw echo physiological similarities (Kambur et al., 2005). The primary production presented by algae forms foundations of whole organic production in aquatic environment. Algae forming the first circle of chain of feeding in waters are organisms which are quite sensitive to the physical and chemical changes in environment where they exist (Round, 1984; Hutchinson, 1967).

Sensitivity of algae, which is an important group in either plankton or benthic organisms in fresh water, is different toxic materials are different. Algae have an important role in determination and improvement of water quality and in rehabilitation of waste water. On the other hand, algae remove some elements such as nitrogen and phosphors, existing in quite large amount in aquatic environment, from environment using them as materials of feeding. Because of this, a change in quality and quantity of algae which is primary produces in aquatic environment cause a whole ecosystem to be destroyed (Turan, 2008).

It has been understood that fishes are harmfully affected from the low level residues of several pesticides mixed into water in several ways and attitudes of fishes are changed. It has also been reported that babies of some kind of fishes are too sensitive to pesticides. The residues of pesticides even in minimal level, in stagnant waters uses up oxygen in water and destroy the feeding environment for fishes (Anonymous, 2004).

The organisms dead by the effects of pesticides are deposited in the bottom of the water by sinking. CO_2 or poison gases raised during the decay prevent aquatic organisms coming near to these areas (Anonymous, 2004). Pesticides transferred to aquatic ecosystems presents some different effects on organisms in receptor environments. These effects cause death of fishes, other vertebrates and in invertebrates and algae to be harmed, and also cause disappear from environment. In addition to this, pesticide residues cause chronic toxicity to be developed by food chain and drinking contaminated water (Turan, 2008). As a result of this, biological variety in ecosystems has been affected. Some increases in the pollutants cause some organisms to be increased too much while cause some organisms to be removed from environment or to be annihilated. Only the types which can tolerate pollution survive. Some damages, which cannot be reversed, appear as a result of destruction of the ecological balance (Kalyoncu et al., 2009).

The gills of fishes first met pesticides and, therefore, the most series damages are taken place on that organ (Heath, 1987). On the other hand, it has some harmful effects on haematology depending on kind of fishes (Shakoori et al., 1991; 1996; Atamanalp and Güneş, 2002a; Atamanalp and Güneş, 2002b; Atamanalp and Cengiz, 2002; Atamanalp and Yanık, 2003). The specimens taken from liver have shown that some histopatological effects beside some changes on the colour and size (Atamanalp et al., 2002). The osmoregulation event which is very important event in either sea or fresh water fishes is badly affected by changes of permeability of the gills and skin (Heath, 1987). Attitudes of fishes exposed to chemicals present some differentiations from others. Especially some changes on the some staminal attitudes, such as feeding and adaptation, may cause the fish to loss health. The problems on the neural system appear to be problems on the central neural system as well as problems on the working systems of receptors (Heath, 1987). Pollutants have different effects in the each of different stages of pregnancy biology depending on the groups belonging to, active material contained, concentration and kind of fishes (Çelikkale, 1991; Heath, 1987; Dhawan and Kaur, 1996; Holcombe et al., 1976). It is well known that the s-triazine compounds, which comprise Atrazine and Terbuthylazine, are usually termed recalcitrant, and especially the first one, due to its asymmetric substituent

groups, is particularly resistant to biodegradation (Varghaa et al. 2005). These two chemicals are furthermore herbicides which affects the photosynthetic electronic transport, inhibiting the algal growth in aquatic environment (Eullaffroy and Vernet, 2003), the primary level of the food web. In addition Atrazine even at low exposure concentrations (5µg l^{-1}) affected significantly aquatic organisms (Steinbergi et al., 1995).

Agricultural Activities And Chemical Fertilizers

When we have looked the harmful effects of fertilizers on environment, it has been thought that mostly nitrogen and phosphors containing fertilizers have given harm on the environment; especially it is well known that it causes the water quality in the watery areas are destroyed as a result of that nitrogen and phosphors containing pollutant are transferred into rivers in anyway and then it also causes eutrophication with increases on the amount of nitrogen and phosphors (Ceran, 2001).

The amount of nitrate mixed into drinking water and rivers through washing out process is increased as a result of usage fertilizers containing nitrogen in high level (Sencar et al., 1993). The compounds containing nitrogen has several effects in the view of water pollution, and the most harmful effect is known to be that of changing oxygen compositions, eutrophication, hygiene on the obtaining of drinking water and toxicity problems (Uslu and Türkmen, 1987).

Approach of phosphor to surface water causes some undesirable effects in aquatic systems as a result of increase in the primary production. Too much increase in green plants and algae in some rich parts in oxygen of water (eutrophication), increase in the blurrily of water, increase in the light input of aquatic macrophytes, not enough oxygen and occurrence of anaerobic conditions as a result of an increase of amount of dead plants in the bottom of water are important factors affecting the quality (Muslu, 1985).

Phosphor components broken up into orthophosphate by aquatic plants are important compositions of food materials. If too much phosphor is loaded, pH value of water and tampon systems are changed (Muslu, 1985). A layer on the water is produced by decreasing surface tension of the water. This layer reduces the transmission of light and oxygen transfer and effect biological activities destructively (Akman et al., 2000). The load of nitrogen and phosphor existing in the environment put pressure on the aquatic ecosystems. Although phosphor has some feeding properties for algae, the extremely high existence in the environment cause some algae to be removed from environment and some of them to be destroyed. This also results with extremely development of taxa tolerating the increase of feeding salts. This change taken place in aquatic ecosystem is not only effective on algae but also destructively affects other living groups (Kalyoncu et al., 2009).

Results And Suggestions

The use of chemical fertilizers and pesticides unplanned and in extremely high amount in agricultural areas affect destruction on all ecosystems. Some cases must be considered before the usage of chemical fertilizers and pesticides in order to completely prevent or minimize the destructive effects.

- It must be note that the pesticides used in agriculture must be easily separable in nature. Beside this, biological fighting methods must be taken over instead of pesticides produced synthetically.

- If applications of pesticide are un-exceptionally necessary, farmers must be educated and trained to apply enough and to avoid over use. The technical and sustainable production with plants, which is more economical and suitable for ecosystems, must be carried out for especially in areas near basins and sources of water.

-It is well known due to the human health and environment that the chemical fertilizers and pesticides used in agricultural areas are important source of pollutants and reaches to aquatic system with surface water. In order for types of kinds in the aquatic systems to be protected, attention must be applied for application of them in suitable time and dose. The effects of chemical components applied on the aquatic ecosystems must be studied and sustainable control must be carried out.

- The ecological agriculture together with advanced agricultural techniques must be applied. Technical and environmentalist agriculture must be carried out for ecological balance to be saved. Some types suitable against diseases and for dried climate must be produced and mechanical and biological techniques for pest management must be developed and then suggested for common use.

- Instead of too much water, enough water applications must be desired, wild and surface irrigations must be left. System must be turned to pressurized irrigation, irrigation time for plants must be determined. Irrigation policies must be put into the agricultural irrigation programs of governments.

- On the other hand, system must be changed from opened system to closed systems. The usage of water and fertilizer applied by farmers must be planned, controlled and sustainable.

- Refinery system for wastewater must be constructed legally in cities. Water and wastewater must be

transmitted through different waterworks and leakages from the system must be minimized. Purified water must be used in green areas and urban agricultural areas.

- Especially the problem of drainage must be solved by completing the foundation of irrigation. The regulation for price of irrigation must be made in the most suitable manner. Economical and efficient irrigation must be supplied and direct-indirect encouragement must be applied.

- More advantageous against erosion, desert condition, dried climate, more environmentalists, sustainable advanced agricultural techniques must be applied.

- As a result, harmful materials reaching to aquatic areas as a result of agricultural activities affect all of livings from algae to fishes living aquatic areas. The importance of agriculture for humanity is unquestionable. But, the aquatic systems are as important as agricultural areas. The chemicals reaching to aquatic areas coming from agricultural areas returns back to people with usage and drinking waters and causes series destructive effects in health. The fresh and clean water sources have gained more importance because of the changes on the global climate. The environmental pollution must be stopped by protecting aquatic ecosystems. The ecology must be kept to be sustainable and carefully followed.

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Effects of Arbucular Mycorrhizal Fungi Applications On Eggplant Seedling Development

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Abstract: The purpose of this research was conducted to determine the effects of arbuscular Arbuscular Mycorrhizal Fungi applications (*Gigaspora margarita and Glomus intraradices)* on seedlings growth parameters of Aydın siyahı, Faselis F_1, Fabina F_1, Topan, Vezir F_1, Kemer, Uzun patlıcan 50896, Uzun patlıcan 50516, Kara patlıcan 50710 and Pala eggplant seedlings grown into the plastic greenhouse in Selçuk University. In results, hypocotil lenght of Aydın siyahı and Kara patlıcan 59710, cothyledone width of Uzun patlıcan 50896, cothyledone length, shoot lenght and diameter of Vezir F_1, number of leaves of Aydın siyahı, shoot fresh weight of Topan and Uzun patlıcan 50516, root fresh weight of Topan patlıcan seedlings were found to be higher than the other eggplant cultivars. In the results of AMF applications, hypocotil length, cothiledone width, cothyledone length, shoot length, number of leaves, root fresh weight had been increased by *G. margarita* applications. Also, *G. intraradices* applications had been increased the shoot fresh weight. In cultivar x Arbuscular Mycorrhizal Fungi interactions, *G. margarita* exhibited better results on the hypocotil length of seedlings of Aydın siyahı, cothyledone width of Uzun patlıcan 50896, shoot length and number of leaves of Fabina F_1, Kemer and shoot fresh weight of Uzun patlıcan 50516, root fresh weight of Topan. Consequently, it was shown that it is necessary to determine the proper cultivar materials and proper Arbuscular Mycorrhizal Fungi rage interactions to get a better success in seedling development of eggplant.

Keywords: *Glomus intraradices, Gigaspora margarita*, eggplant cultivars, seedling development.

Introduction

It is a more realistic approach in terms of environmental health and using natural sources to benefit from the vegetable nutrient elements in an effective way instead of fertilizing with easy-taken nutrient elements to the soil. It is a fact that one of the best ways of benefiting from the unit area is evaluating the microorganism activity of soil. One of the microorganism formations that provide a better benefiting of soil for the plant is mycorrhizal. Until now, it was thought that nutrient elements were taken by only roots. Recent researches have shown that beside roots, vegetable nutrient elements are also mostly taken by fungus types which are called mycorrhizal and produce plenty of hyphe (Ortaş et al. 2000). Researchers searched the effects of three different mycorrhizal fungus, *G.fasciculatum,G. monospromu* and *G. mossea*, under field conditions by inoculating into tomato, eggplant and pepper seedlings. The parameters that they used to measure the effects of mycorrhizal fungus on vegetable development are; vegetable length, shoot fresh weight, total yield, fruit sizes and leaf length. Shoot fresh weight for eggplant with *G. mossea, G. monosporum* and *G. fasciculatum* inoculations showed 47%, 28% and 29% increases, respectively, and total yield of the same plant showed 60%, 43% and 7% increases. The most affective fungus type among the three plant types inoculated to increase the development of the plant is *G. mosseae*. However, *G. fasciculatum* is determined as the most effective fungus in the context of root colarisation of eggplant and pepper plants. Mikorizal trials were conducted on a plenty of vegetable types among horticulture.

Carrot (Smith and Read, 1997), tomato (Demir, 1998), pepper (Türkmen et al. 2005) are some of the examples of these studies. The effects of mikorizal fungi on vegetable types can variable. This effect can be summed up in the following way (Ortaş and Akpınar, 2004). Yield and fruit number increased for the eggplant inoculated by AMF, and meaningful differences appeared among the mycorrhizal types in this increase. Especially, it was determined that the spread of Verticillilum disease the eggplant inoculated by *G.etinicatunium* and *G. margarita* spore were prevented (Matsubara and et al., 1995). According to Şen (2008), a positive effect was observed through the *G.intraradices* application on eggplant seedling shoot length, shoot diameter, number of leaves, shoot fresh weight, shoot dry weight, root fresh weight and root dry weight. All of these studies represent that mycorrhizal is important for plant nutrition.

In this study, the purpose was to determine the effects of mycorrhizal specious (*G. intraradices* and *G. margarita*) on seedling development and growing up of the eggplant cultivar.

Material and Methods

This research was conducted to determine the effects of two *Arbucular Mycorrhizal Fungi* and ten eggplant genotypes and cultivars in the greenhouse which belongs to Selçuk University Silifke Taşucu Vocational High School. Aydın siyahı, Faselis F_1, Fabina F_1, Topan, Vezir F_1, Kemer, Uzun patlıcan 50896, Uzun patlıcan 50516, Kara patlıcan 50710 and Pala eggplant genotypes and cultivars were used as plant materials. The soil mixture used in the trial was supplied with the mixture of garden soil and torf in the ratio of 1:1. Heat and humidity values were recorded data with microlog regularly. According to these records, maximum temperature, average temperature and minimum temperature were measured 30 and 35 ^{o}C, 20 and 26 ^{o}C, 16 and 22 ^{o}C. Relative humidity was measured between 55% and 56%. The soil mixture to grow seedlings was sterilized at 121 ^{o}C in autoclave for two hours. The trial was planned and carried out in the consideration of factorial trial pattern. This researched was designed with the notion of three replications, and in each parcel of the research, there were 10 pots (10 plants) in each plot. Each pot had a 300 ml volume and had no drainage, and pots were filled with soil mixture with was in the ratio of 1:1 soil and torf. The mixture including that had the average 25 spore/g was added in 5 g to each pot in the same dept and at the same time with the seeds. The nutruint solution melted in the pure water was added in 5 ml into each pot only once at the time of sowing. Three seeds were planted into the each pot, and after they grew up, two of them were taken out. Each pot was watered with pure water. Two Arbucular Mycorrhizal Fungi **(***G. intraradices* and *G. margarita*) were applied in the trial. In the control plants, mycorrhiza was not applied. The date of sowing seed which was the beginning of the research was recorded. Hypocotyl length, cotyledon length, cotyledon width, period of real leaf appearance, shoot length, shoot diameter, number of leaves, shoot fresh weight, root fresh weight were determined. Determined research data were analyzed by Minitab program and means compared by Tukey Test.

Results and Discussion

The highest hypocotyls length was found out in Aydın siyahı and Kara patlıcan 50710 cultivar (2.89 mm) among the differences of cultivars in Table 1. The lowest hypocotyls lengths among the eggplant cultivars were assessed as Fabina F_1 (1.87 mm), Vezir F_1 (1.90 mm), and Kemer (1. 95 mm) respectively. When the effects of AMF applications on hypocotyls length were considered, the longest hypocotyls length was found out in *G. margarita* (2.29 mm) and the shortest hypocotyls length was determined in *G. Intraradices* (2.23 mm). The hypocotyls length of Aydın siyahı x *G. margarita* (3.23 mm) interaction was the highest and hypocotyls length of Fabina F_1 into *G. margarita* and *G. intraradices* was the lowest among to the AMF x eggplant genotypes interactions. Consequently Al-Momany (1987) and Türkmen et al. (2008) have got similar results in their researches.

The cotyledon length was observed in Vezir F_1 cultivar (24.71 mm), and this was followed by Kara patlıcan (22.77 mm). The shortest cotyledon length was found in Fabina F_1 eggplant cultivars. The cotyledon length in *G. margarita* (22.55 mm) took the first degree (Table 2). Menge and et al. (1978) appeared to support our studies in their research results.

While the highest cotyledon width among the eggplant cultivar was observed in Uzun 50896 (11.19 mm) eggplant cultivar, the lowest cotyledon width was in Kemer eggplant (7.57 mm). According to the effects of AMF applications on cotyledon width, the highest cotyledon width was detected in *G. margarita* applications (8.58 mm), the lowest cotyledon width, on the other hand, was determined in *G. intraradices* (8.16 mm) (Table 3). Mosse (1981), Harley and Smith (1983) also found similar results with us.

When the effects of AMF applications on real leaves appearance duration were taken into consideration, early real leaves appearance duration was determined in the control group (25.48 days). The longest real leaves

appearance period appeared in *G. intraradices* as 26.59 days. As seen in interaction results, early real leaves appearance was detected in control application with the eggplant cultivar of Aydın siyahı (24.96 days), Uzun patlıcan 50896 (25.16 days), *G. margarita* Vezir F_1 (25.31 days). In the longest *G.intraradices* application, Aydın siyahı was determined as 27.56 days (Table 4). These findings are in accordance with the literature reports which emphasize that proper cultivars specious interaction must be determined in order to get the purposed result in AMF applications (Türkmen et al., 2008, Menge and et al., 1978).

While the highest shoot length among the eggplant cultivars was observed in Vezir F_1 eggplant (18.61 cm), the lowest shoot length, on the other hand, was detected in Topan eggplant as 7.75 cm. When the effects of AMF applications on shoot length were taken into consideration, the longest shoot was found out in *G. margarita* with the length of 12.25 cm, but the shortest shoot length was assessed in the specious of *G. intraradices* with the length of 10.48 cm (Table 5). In the research of Şen (2008), it was observed that the shoot length of eggplant seedlings were between 13.62 and 11.48 cm. Al-Momany (1987) also found the same results.

While the highest shoot diameter among the eggplant cultivars was observed in Vezir F_1 eggplant (5.75 mm), the lowest shoot diameter was detected in Kemer cultivar (3.91 mm). If the effects of mycorrhizal specious on shoot diameter are examined, the highest shoot diameter is detected in the control application as 5.27 mm and the lowest shoot diameter is determined in *G. intraradices* as 4.67 mm (Table 6). Although, Tinker (1980) and Şen (2008) reported that seedling shoot diameters were increased through the AMF applications. According to us, this difference is caused by the differences between the AMF specious and the cultivars.

While the most number of leaves was found out in Aydın Siyahı (7.52), the fewest number of leaves was found out in Uzun patlıcan 50516 (7.08). When the effects of AMF applications on the number of leaves were examined, the most number of leaves was determined in *G.Margarita (*7.64) and the fewest number of leaves was observed in *G. intraradices* (6.87) (Table 7). Şen (2008) recorded an increase in the number of leaves through the *G.intraradices* on eggplant seedlings (4.97), but the number of leaves for the eggplant seedlings on which mycorrhizal wasn't applied, it was found as 3.84. The study results of Harley and Smith (1983) are parallel to our study results.

The highest shoot fresh weight among the eggplant cultivars was remarked in Topan (24.45 g) and Uzun Patlıcan 50516 types (24,45), whereas the lowest shoot fresh length was in Fabina F_1 (17.94 g) and Faselis F_1 (17.93 g). When the effects of mycorrhizal on shoot fresh weight were taken into consideration, the heaviest shoot fresh weight was detected in *G. intraradices* (22.68 g). The lowest shoot fresh weight was found in the control group (17.60 g) (Table 8). Al-Momany (1987) was discovered that the shoot fresh weight for eggplant increased with inoculations of *G.mossea, G.monosporum* and *G.fasciculatum* in the ratios of 47%, 28% and 29%, respectively, and the yield for the same plant increased in the ratios of 60%, 43% and 7%, espectively. Şen (2008) found the increase in terms of shoot fresh weight.

While the highest root fresh weight among eggplant cultivar was remarked in Topan genotype (8.80 g), the lowest root fresh weight was determined in Faselis F_1 cultivar (3.35 g), Uzun patlıcan 50516 (2.91 g) and Kemer (3.04 g) cultivar. When the effects of mycorrhizal on root fresh weight were examined, the harvest root fresh weight was noted as *G. margarita* (6.18 g) and the lowest root fresh weight was determined in the *G. intraradices* group as 4.67 g (Table 9). Şen (2008) obtained the increase in terms of root fresh weight through the application of *G. intraradices.* Onuğur and Demir (1988) concluded that shoot and root fresh and dried weights increased through the AMF applications.

Conclusion

In this research, according to eggplant materials, in the context seedling development change parameters, Aydın siyahı and Kara patlıcan 59710 in terms of hypocotyls length, uzun patlıcan 50896 in terms of hypocotyls width, Vezir F_1 in terms of hypocotyls l length enght, shoot l length, and shoot diameter, Aydın siyahı in terms of the number of leaves, Topan and Uzun patlıcan 50516 in terms of shoot fresh weight, Topan eggplant in terms of root fresh weight were found to be superior cultivar than the others. It was determined that in the context of AMF applications, through the *G. margarita* application hypocotyls length, cotyledon width, cotyledon length, shoot length, number of leaves, root fresh weight increased, the *G. intraradices* application, on the other hand, increased shoot fresh weight. To sum up, it is discovered that it is necessary to determine the proper vegetable materials and proper AMF specious interactions to get a better success in vegetable development of eggplant through AMF applications.

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Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	1,95±0.010**I**	1,84±0.032**m**	1,82±0.011**m**	1,87±0.061E
Faselis F_1	2,13±0.005**gh**	2,01±0.010**j-l**	2,12±0.340**g-ı**	2,09±0.059D
Vezir F_1	1,96±0.005**kI**	2,05±0.005**h-j**	1,70±0.052**n**	1,90±0.158E
Pala	2,04±0.005**ı-k**	2,03±0.010**j-l**	2,03±0.005**j-l**	2,03±0.007D
Kemer	2,02±0.010**j-l**	1,80±0.020**m**	2,03±0.011**j-l**	1,95±0.114E
Topan	2,11±0.015**g-ı**	2,05±0.011**h-j**	2,02±0.005**j-l**	2,06±0.043D
Aydın Siyahı	2,77±0.011**d**	2,65±0.010**e**	3,23±0.041**a**	2,89±0.267A
Uzun patlıcan 50516	2,41±0.011**f**	2,18±0.026**g**	2,44±0.020**f**	2,34±0.123C
Kara patlıcan 50710	2,87±0.011**c**	2,97±0.010**b**	2,84±0.020**cd**	2,89±0.061A
Uzun patlıcan 50896	2,38±0.068 **f**	2,76±0.020**d**	2,67±0.030**e**	2,60±0.173B
Means	2,26±0.324B	2,23±0.393C	2,29±0.473A	

$S\overline{x}_{0.01\ (cultivars)}$ =0.01354 $S\overline{x}_{0.01\ (Mycorrhiza)}$ =0.004282 $S\overline{x}_{0.01\ (cultivars\ x\ Mycorrhiza)}$ =0.01354

Table 1. The effects of AMF applications on hypocotyl length of eggplant cultivars (mm).

Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	21.07±0.1**j-o**	17.33±0.9**p**	20.44±0.0**l-o**	19.61±1.7F
Faselis F_1	20.72±0.3**k-o**	20.35±0.3**m-o**	21.58±0.1**h-m**	20.88±0.6DE
Vezir F_1	25.47±0.3**a**	24.49±0.2**a-c**	24.16±0.0**b-d**	24.71±0.6A
Pala	22.52±0.1**e-h**	20.25±0.0**no**	22.56±0.1**e-h**	21.78±1.1B-D
Kemer	21.11±0.0**i-o**	18.61±0.2**p**	21.46±0.0**h-n**	20.40±1.3EF
Topan	22.41±0.0**f-ı**	21.64±0.0**h-m**	23.32±0.0**c-f**	22.46±0.7BC
Aydın Siyahı	23.08±0.3**d-g**	21.21±0.0**ı-o**	23.29±0.5**c-f**	22.53±1.0BC
Uzun patlıcan 50516	21.72±0.0**h-l**	20.00±0.0**o**	21.81±0.5**g-k**	21.18±0.9DE
Kara patlıcan 50710	23.06±0.0**d-g**	22.20±0.6**f-j**	23.05±0.5**d-g**	22.77±0.5B
Uzun patlıcan 50896	15.96±0.3**q**	24.77±0.7**ab**	23.79±0.1**b-e**	21.51±4.2CD
Means	21.72±2.3B	21.09±2.2C	22.55±1.1A	

$S\ \overline{x}_{0.01\ (cultivars)}$=0.2008 $S\ \overline{x}_{0.01\ (Mycorrhiza)}$=0.06351 $S\ \overline{x}_{0.01\ (cultivars\ x\ Mycorrhiza)}$ = 0.2008

Table 2. The effects of AMF applications on kolitedon length of eggplant cultivars (mm).

Cultivars	Control	*G.intraradices*	*G. margarita*	Means
Fabina F_1	7.46±0.07**n-p**	7.11±0.03**p**	7.71±0.14**k-o**	7.42±0.27G
Faselis F_1	8.61±0.04**e-g**	7.95±0.06**ı-m**	8.42±0.15**f-ı**	8.32±0.30CD
Vezir F_1	9.28±0.06**d**	9.20±0.02**d**	8.860±0.05**d-f**	9.11±0.19B
Pala	8.04±0.01**h-l**	7.36±0.05**n-p**	7.51±0.076**m-p**	7.63±0.31E-G
Kemer	7.67±0.07**l-o**	7.25±0.10**op**	7.81±0.066**l-o**	7.57±0.26FG
Topan	8.07±0.04**h-l**	7.49±0.06**m-p**	8.34±0.055**g-ı**	7.97±0.38D-F
Aydın Siyahı	8.48±0.05**e-h**	7.40±0.07**n-p**	8.17±0.068**g-k**	8.01±0.48DE
Uzun patlıcan 50516	8.62±0.25**e-g**	8.22±0.04**g-j**	8.03±0.104**h-l**	8.29±0.29CD
Kara patlıcan 50710	8.95±0.04**de**	8.62±0.07**e-g**	8.42±0.026**f-ı**	8.66±0.23C
Uzun patlıcan 50896	9.96±0.09**c**	11.03±0.04**b**	12.58±0.52**a**	11.19±1.17A
Means	8.51±0.73A	8.16±1.16B	8.58±1.415A	

$S\ \overline{x}_{0.01\ (Cultivars)}$=0.07348 $S\ \overline{x}_{0.01\ (Mycorrhiza)}$=0.02324 $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza)}$=0.07348

Table 3. The effects of AMF applications on kolitedon width of eggplant cultivars (mm).

Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	25.75±0.1 **c-e**	26.40±0.2**b-d**	25.68±0.1**c-e**	25.94±0.37
Faselis F_1	25.65±0.2**c-e**	27.23±0.2**ab**	25.71±0.1**c-e**	26.19±0.79
Vezir F_1	25.81±0.0 **c-e**	26.37±0.0**b-d**	25.31±0.0**e**	25.83±0.46
Pala	25.39±0.1**de**	25.71±0.6**c-e**	25.40±0.1**e**	25.50±0.40
Kemer	25.41±0.5**de**	25.93±0.1**c-e**	25.64±0.6**c-e**	25.95±0.53
Topan	25.42±0.5**de**	25.93±0.1**c-e**	25.64±0.6**c-e**	25.66±0.50
AydınSiyahı	24.96±0.2**e**	27.56±0.1**a**	25.41±0.6**de**	25.97±1.25
Uzun patlıcan 50516	25.68±0.0**cde**	27.28±0.0**ab**	25.35±0.0**e**	26.10±0.88
Kara patlıcan 50710	25.46±0.0**de**	25.54±0.0**de**	25.67±0.2**c-e**	25.55±0.15
Uzun patlıcan 50896	25.16±0.0**e**	27.25±0.0**ab**	24.99±0.0**e**	25.80±1.08
Means	25.48±0.3B	26.59±0.7A	25.49±0.3B	

$S\ \overline{x}_{0.01\ (Cultivars)}$ = Ö.D. $S\ \overline{x}_{0.01\ (Mycorrhiza)}$=0.0499 $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza)}$=0.1579

Table 4. The period of real leaves appearance in AMF applications of eggplant cultivars.

Cultivars	Control	*G.intraradices*	*G. margarita*	Means
Fabina F_1	12.49±0.46 **gh**	9.47±0.03**I**	9.29±0.03 **I**	10.41±1.5E
Faselis F_1	15.29±0.10**d**	16.44±0.12**c**	15.68±0.07**cd**	15.80±0.51B
Vezir F_1	17.42±0.06**b**	18.06±0.05**b**	20.36±0.19**a**	18.61±1.34A
Pala	10.71±0.07**k**	10.93±0.10**jk**	11.93±0.16**hı**	11.19±0.57D
Kemer	7.71±0.25**no**	6.77±0.04**pq**	8.77±0.13**Im**	7.75±0.87G
Topan	7.33±0.05**o-q**	6.62±0.11**qr**	7.50±0.05**op**	7.15±0.40G

Aydın Siyahı	7.51±0.15**op**	8.41±0.03**mn**	9.55±0.38**L**	8.49±0.91F
Uzun patlıcan 50516	7.04±0.06**o-q**	5.90±0.10**r**	13.31±0.39**ef**	8.75±3.46F
Kara patlıcan 50710	12.67±0.19**f-h**	11.63±0.20**u**	13.49±0.61**e**	12.59±0.87C
Uzun patlıcan 50896	13.06±0.02**e-g**	10.64±0.32**k**	12.63±0.07**f-h**	12.11±1.13C
Means	11.12±3.54B	10.48±3.93C	12.25±3.69A	

$S\ \overline{x}_{0.01\ (Cultivars)} = 0.04$ $S\ \overline{x}_{0.01\ (Mycorrhiza)} = 0.12$ $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza)} = 0.12$

Table 5. The effects of AMF applications on shoot lengths (cm) of eggplant cultivars

Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	4.19±0.02 **no**	3.90±0.13**op**	4.45±0.11**l-n**	4.18±0.25FG
Faselis F_1	5.42±0.07**f-h**	5.16±0.05**h-j**	6.07±0.02**a-c**	5.55±0.41A-C
Vezir F_1	5.55±0.10**e-g**	5.69±0.01**c-f**	6.03±0.02**a-d**	5.75±0.21A
Pala	4.99±0.11**ı-k**	4.78±0.02**j-l**	5.68±0.08**d-f**	5.15±0.41DE
Kemer	4.18±0.03**no**	3.81±0.17**op**	3.74±0.11**p**	3.91±0.02G
Topan	5.26±0.05**g-ı**	4.55±0.05**l-n**	4.68±0.10**k-m**	4.84±0.33E
Aydın Siyahı	6.37±0.27**a**	4.69±0.01**k-m**	4.75±0.04**kl**	5.27±0.83CD
Uzun patlıcan 50516	4.9±0.08**k-m**	3.85±0.12 **op**	4.35±0.30**mn**	4.30±0.40F
Kara patlıcan 50710	6.26±0.07**ab**	4.60±0.01**k-m**	5.39±0.01**f-h**	5.41±0.72B-D
Uzun patlıcan 50896	5.88±0.02**b-e**	5.16±0.03**h-j**	6.11±0.03**ab**	5.71±0.43AB
Means	5.27±5.281A	4.61±0.60 C	5.13±0.81B	

$S\ \overline{x}_{0.01\ (Cultivars)} = 0.06$ $S\ \overline{x}_{0.01\ (Mycorrhiza)} = 0.02$ $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza\ )} = 0.06$

Table 6. The effects of AMF applications on shoot diameters (mm) of eggplant cultivars

Cultivars	Control	*G.intraradices*	*G. margarita*	Means
Fabina F_1	7.23±0.03**j-l**	6.62±0.11**qp**	7.95±0.13**a**	7.26±0.58B-D
Faselis F_1	7.40±0.05**f-j**	6.81±0.07**no**	7.87±0.06**ab**	7.36±0.46AB
Vezir F_1	6.91±0.01**mn**	7.53±0.03**d-h**	7.50±0.05**d-ı**	7.31±0.30BC
Pala	7.31±0.09**ı-l**	6.91±0.01**mn**	7.66±0.03**c-e**	7.29±0.32B-D
Kemer	7.35±0.05**g-k**	6.67±0.04**op**	7.86±0.03**a-c**	7.29±0.51B-D
Topan	7.22±0.02**j-l**	6.58±0.02**p**	7.69±0.02**b-d**	7.16±0.47C-E
Aydın Siyahı	7.60±0.04**d-f**	7.32±0.02**h-l**	7.66±0.01**c-e**	7.52±0.15A
Uzun patlıcan 50516	7.11±0.12**Im**	6.56±0.03**p**	7.55±0.05**d-g**	7.08±0.43E
Kara patlıcan 50710	7.60±0.04**d-g**	6.92 ±0.02**mn**	7.57±0.02**d-f**	7.36±0.33AB
Uzun patlıcan 50896	7.46±0.03**e-ı**	6.74±0.01**n-p**	7.16±0.03**kl**	7.12±0.31DE
Means	7.31±0.21B	6.87±0.31C	7.64±0.22A	

$S\ \overline{x}_{0.01\ (Cultivars)} = 0.03$ $S\ \overline{x}_{(0.01\ (Mycorrhiza)} = 0.01$ $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza)} = 0.03$

Table7. The effects of AMF applications on the number of leaves of eggplant cultivars.

Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	16.16±0.125**I**	18.17±0.186**k**	19.51±0.076**j**	17.94±1.466 E
Faselis F_1	15.61±0.061**I**	20.57±0.064**ı**	17.62±0.026**k**	17.93±2.161 E
Vezir F_1	20.42±0.094**ı**	25.04±0.010**d**	19.23±0.015**j**	21.56±2.655 C
Pala	15.68±0.325**I**	16.38±0.637**I**	17.48±0.425**k**	16.51±0.889 F
Kemer	17.39±0.138**k**	25.16±0.485**cd**	27.02±0.540**a**	23.19±4.438 B
Topan	22.38±0.023**gh**	24.30±0.110**de**	26.67±0.026**ab**	24.45±1.859A
Aydın siyahı	13.98±0.553**n**	23.87±0.107**ef**	24.42±0.068**de**	20.75±5.096 D
Uzunpatlıcan50516	19.86±0.140**ıj**	26.07±0.030**bc**	27.43±0.034**a**	24.45±3.496A
Kara patlıcan 50710	19.28±0.160**j**	22.12±0.046**h**	19.85±0.157**u**	20.41±1.306D
Uzun patlıcan 50896	15.20±0.172**m**	25.13±0.034**d**	23.11±0.036**fg**	21.14±4.544C
Means	17.60±2.647C	22.68±3.192A	22.24±3.824 B	

$S\ \overline{x}_{0.01\ (Cultivars)} = 0.14$ $S\ \overline{x}_{0.01\ (Mycorrhiza)} = 0.04$ $S\ \overline{x}_{0.01\ (Cultivars\ x\ Mycorrhiza)} = 0.14$

Table 8. The effects of AMF applications on shoot fresh weight in eggplant cultivars

Cultivars	Control	*G. intraradices*	*G. margarita*	Means
Fabina F_1	7.50±0.02 **cd**	6.08±0.03**ef**	4.47±0.02 **g**	6.01±1.31CD
Faselis F_1	3.45±0.06 **g-j**	3.15±0.03**h-j**	3.45±0.05 **g-u**	3.35±0.15F
Vezir F_1	6.14±0.01**ef**	4.26±0.01**gh**	6.14±0.01**ef**	5.51±0.94DE
Pala	5.66±0.03**f**	6.51±0.01**def**	6.30±0.01**ef**	6.15±0.38C
Kemer	2.61±0.04**jk**	2.41±0.03 **jk**	4.11±1.31**gh**	3.04±1.03F
Topan	9.33±0.10**ab**	6.79±0.01 **d-f**	10.29±1.0 **a**	8.80±1.65A
Aydın Siyahı	6.98±0.02**de**	3.41±0.06 **g-j**	5.86±0.01**ef**	5.41±1.58E
Uzun patlıcan 50516	2.92±0.07**ı-k**	1.85±0.17 **k**	3.98±0.02**g-ı**	2.91±0.92F
Kara patlıcan 50710	7.49±0.01**cd**	6.24±0.01**ef**	8.96±0.05**b**	7.56±1.17B
Uzun patlıcan 50896	7.52±0.03**cd**	6.01±0.03**ef**	8.30±0.02**bc**	7.27±1.01B
Means	5.96±2.19B	4.67±1.79 C	6.18±2.28A	

$S_{\bar{x}\ 0.01\ (Cultivars)}$ =1.04 $S_{\bar{x}\ 0.01\ (Mycorrhiza)}$ =0.06 $S_{\bar{x}\ 0.01\ (Cultivars\ x\ Mycorrhiza)}$ =0.18

Table 9. The effects of AMF applications on root fresh weight in eggplant cultivars (g).

Effect of Organic and Inorganic Manganese Supplementation in Diets on Performance and Some Organ Weights of Japanese Quails (*Coturnix coturnix japonica*)

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Abstract: This study was carried out to determine the effects of diets containing different levels of inorganic and organic manganese sources on fattening performance and some organ weights of Japanese quails. In this study, 256 one day old quail chicks were fed four levels of inorganic and organic Mn in factorial arrangement design for 35 days. The dietary treatments consisted of the supplementation of the basal diet with 30, 60, 90 and 120 mg/kg Mn supplied from manganese sulphate and manganese bioplex. Dietary Mn sources as a main factor did not effect investigated parameters. But dietary Mn levels had significant effect on all parameters except for feed intake. Supplementation of 60 mg/kg Mn to diets resulted in an increase BW, BWG, liver and pancreas weights, also improved feed conversion ratio.
Keywords: Manganese, performance, Quail

Introduction

Manganese (Mn) is essential for normal bone formation, enzyme function, and amino acid metabolism in poultry (Scott et al. 1976). The utilization of Mn has become an increasing concern because of extremely rapid growth rate of commercial broiler strains (Ji et al. 2006). National Research Council (NRC, 1994) recommended 60 ppm Mn in broiler and quail chicks diet. However, under practical conditions the diets are formulated to contain higher concentrations of Mn to overcome the possibility of its deficiency. This is because of relatively low absorption of dietary Mn in birds (Sunder et al. 2006). Organic Mn sources were more bioavailable than inorganic sources. One of the possible reasons is that there are less chelating or other unwanted reactions with dietary constituent in the gastrointestinal tract for organic mineral complexes compared with those for inorganic minerals (Yan and Waldroup 2006).

Diet supplementation with trace elements of high bioavailability, also known as specific amino acid metal compounds of Mn and Zinc which bind themselves to a specific amino acid show a capacity to increase the immune response and diminish negative effects in turkey and laying hens in respect of these minerals inorganic forms (Menocal et al. 2004). However, according to some research results, the organic and inorganic Mn sources reported no difference in terms of bioavailability (Baker and Holpin 1987, Scheideler 1991).

The aim of the this study to determine the effect of diets containing different levels of inorganic and organic manganese sources on fattening performance and some organ weights of Japanese quails.

Materials and Methods

A 5-wk experiment, 256 mixed sex day-old quail chicks *(Coturnix coturnix japonica)* were used. Four replicate groups of 8 chicks were assigned to each of 8 dietary treatments. The dietary treatments consisted of the supplementation of the basal diet with 30, 60, 90 and 120 mg/kg Mn supplied from manganese sulphate ($MnSO_4$) and manganese bioplex. Dietary treatments were prepared from a corn-soybean common diet without additional Mn contained 21.52 mg/kg. All birds received feed and water *ad-libitum*. Lighting was treated as a 23

h/day. Compositions of nutrients in the diets were adjusted according to the recommendation of NRC (1994; Table 1).

In quails, body weights (BW) and feed intake (FI) were recorded on a pen basis as weekly intervals. Mortality was recorded daily. At the end of the experiment (at five weeks of age), four quails that randomly selected were slaughtered at a processing plant from each replicate and processed, and then the carcass yield were calculated to used warm carcass weight.

A general linear model (GLM) was used for the analysis of variance of the data (Minitab 2000). Significant differences among means were tested by Duncan's multiple range tests. Differences were considered as significant when *P* values were less than 0.05 (Duncan 1980).

Nutrients	***%***
Corn	53.1
Soybean meal (% 47.6 CP)*	41.3
Vegetable oil (7800 kcal/kg ME)*	2.8
Limestone	1.26
Dicalcium phosphate	0.8
Salt	0.3
Vitamin Premix[1]	0.15
Mineral Premix[2]	0.10
Methionine	0.19
TOTAL	*100.00*
Calculated nutrients	
Energy, kcal/kg ME	2901
CP, %	24.06
Calcium, %	0.80
Available phosphorus, %	0.31
Lysine, %	1.32
Methionine, %	0.51
Methionine + Cysteine, %	0.95
Crude cellulose, %	2.25
Manganese, mg/kg*	21.52

* Analyzed value. CP: Crude protein, ME: Metabolizable energy

[1] Vitamin premix (supplied the following per kg of diet): Vitamin A, 12000 I.U; Vitamin D_3, 2400 I.U; Vitamin E, 25.0mg; Vitamin K_3, 4.0 mg; Vitamin B_1, 3.0 mg; Vitamin B_2, 5.0 mg; Vitamin B_6, 8.0 mg; Vitamin B_{12}, 0.015 mg; Niacin, 25.0 mg; Calcium-D-Pantothenate, 8.0 mg, D-Biotin, 0.05 mg; Folic acid, 0.5 mg; Choline Chloride, 125.0 mg.

[2] Mineral premix (supplied the following per kg of diet): Fe, 60.0 mg; Zn, 60.0 mg; Cu, 5.0 mg; I, 1.0 mg; Co, 0.2 mg; Se, 0.15 mg.

Table 1. Composition of basal diet used in experiment (%)

Results and Discussion

The effects of diets containing different sources and levels of Mn on performances are shown in Table 2 and 3. The treatments as the main sources of inorganic and organic Mn were not significantly effect on BW, body weight gain (BWG), FI, feed conversion ratio (FCR), carcass yield, liver and pancreas weight ($P > 0.05$). The diets containing different levels of Mn had significantly effect on all parameters of quails except for feed consumption ($P < 0.05$). The best results of performance parameters, liver and pancreas percentage of BW were obtaining in quails fed with diet containing 60 mg/ kg Mn, but the lowest results of carcass yield obtaining the same diet. The interactions groups in the experiment, the diets containing different sources and levels of Mn had significantly effect on BW and BWG of quails ($P < 0.05$). The highest results of BW and BWG were obtaining fed with diet containing $MnSO_4$ x 60 mg/ kg Mn.

Quail studies on this subject with a limited number of studies but the results are in broilers. Quails and broilers are similar in terms of requirements of Mn (NRC 1994). The results of the experiment, supplemental Mn sources (inorganic and organic) there were no differences. The similar result, Berta et al. (2004) reported that the same level of supplementation of the two Mn sources there were no differences between the Mn concentrations of organs and tissue in broiler chicks. Additionally, these researchers stated that a corn-soybean diet supplemental with levels of 0, 30, 60 and 240 mg/kg Mn from organic and inorganic sources did not significant effect on the BW, FCR in broiler chicks. Collins and Moran (1999) reported that body weight and feed

efficiency were not influenced by supplementary Mn (180 ppm). Also, supplemental Mn did not alter processed carcass weights, yield, or percentage abdominal fat in broilers. Gajula et al. (2010) stated that Mn (60 ppm) as recommended by NRC (1994) was sufficient for broiler performance and bone parameters. The results of this study with the contradiction between the results of previously conducted studies may be due to different Mn levels and animal material.

It is concluded that, 60 mg/kg supplementation Mn to diet is suitable in growing Japanese quails. The number of research interest in this subject is very limited. Therefore, many studies are needed.

Diets	BW, g/bird	BWG, g/bird	FI, g/bird	FCR, Feed/ Gain
Sources				
$MnSO_4$	169.3±2.75	161.0±2.39	524.3±06.41	3.26±0.042
Mn Bioplex	170.1±1.36	161.9±1.36	522.3±05.54	3.23±0.032
Mn levels, mg/kg				
30	$164.4±1.84^{B}$	$156.2±1.79^{B}$	519.5±06.39	$3.33±0.043^{A}$
60	$179.5±3.20^{A}$	$169.3±2.33^{A}$	520.5±07.62	$3.08±0.040^{B}$
90	$166.9±1.87^{B}$	$158.8±1.86^{B}$	519.1±11.57	$3.27±0.055^{A}$
120	$167.9±1.98^{B}$	$161.4±2.55^{B}$	534.0±07.32	$3.31±0.045^{A}$
Sources x levels				
$MnSO_4$ x 30	$160.3±0.73^{C}$	$152.2±0.68^{D}$	515.7±08.77	3.39±0.041
$MnSO_4$ x 60	$185.9±3.71^{A}$	$173.7±2.45^{A}$	532.2±13.16	3.06±0.063
$MnSO_4$ x 90	$163.9±2.36^{BC}$	$155.9±2.37^{CD}$	516.6±16.38	3.31±0.080
$MnSO_4$ x 120	$167.3±1.15^{BC}$	$162.4±3.58^{BC}$	532.9±14.57	3.28±0.058
Mn Bioplex x 30	$168.6±1.96^{BC}$	$160.3±1.84^{BCD}$	523.4±10.35	3.27±0.067
Mn Bioplex x 60	$173.2±2.63^{B}$	$165.0±2.63^{B}$	508.9±10.29	3.09±0.058
Mn Bioplex x 90	$170.0±2.17^{BC}$	$161.8±2.14^{BC}$	521.6±18.77	3.22±0.079
Mn Bioplex x 120	$168.5±4.10^{BC}$	$160.4±4.12^{BCD}$	535.2±06.10	3.34±0.074

$^{A-D}$: Means within a column with unlike superscript differ significantly ($P< 0.05$).

Table 2. Effect of the experimental diets on performance of Japanese quails

Diets	Carcass yield, % of BW	Liver, % of BW	Pancreas, % of BW
Sources			
$MnSO_4$	63.25±0.41	2.05±0.087	0.24±0.019
Mn Bioplex	62.64±0.23	2.02±0.103	0.25±0.009
Mn levels, mg/kg			
30	$64.02±0.37^{A}$	$1.98±0.085^{AB}$	$0.23±0.009^{B}$
60	$61.79±0.37^{B}$	$2.32±0.104^{A}$	$0.29±0.012^{A}$
90	$63.28±0.50^{A}$	$2.01±0.070^{AB}$	$0.24±0.009^{B}$
120	$62.70±0.33^{AB}$	$1.82±0.040^{B}$	$0.23±0.009^{B}$
Sources x levels			
$MnSO_4$ x 30	64.86±0.20	2.00±0.175	0.22±0.005
$MnSO_4$ x 60	61.26±0.56	2.35±0.218	0.29±0.010
$MnSO_4$ x 90	63.58±0.77	2.07±0.111	0.22±0.006
$MnSO_4$ x 120	63.30±0.44	1.78±0.062	0.24±0.019
Mn Bioplex x 30	63.18±0.34	1.97±0.055	0.25±0.016
Mn Bioplex x 60	62.31±0.37	2.30±0.048	0.28±0.023
Mn Bioplex x 90	62.97±0.70	1.95±0.091	0.26±0.016
Mn Bioplex x 120	62.10±0.27	1.86±0.048	0.23±0.009

$^{A-B}$: Means within a column with unlike superscript differ significantly ($P< 0.05$).

Table 3. Effect of the experimental diets on some organ weights of Japanese quails

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Constructed Wetland Filter Use for Controlling Nutrient and Sediment Runoff from Golf Course Developments

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Abstract: Interest in the control of pollution entering into waterways has risen significantly since the last quarter of 20th Century and golf course developments have been identified as areas that use some of the chemical pollutants found in these waterways. Runoff control of pollutants from golf course developments is vital in assuring clean waterway systems for the future. This study investigates the runoff issues that can be related to golf course turf grass systems and their control through use of wetland filters. Three issues addressed in this study are suspended sediment, nitrogen, and phosphorus levels contained in turf grass runoff. Sediment runoff levels were found to be low to moderate for turf grass systems, while nutrient transport in runoff from turf grass areas can become a significant problem. Constructed wetland filtration systems were investigated as one potential method for controlling turf grass runoff. The design and construction of these wetland filters was investigated to determine their potential for filtering runoff from golf course facilities. Data showed that significant levels of runoff sediment and nutrient pollution could be removed if proper design and construction processes are followed.

Information

The game of golf as it is known today originated in the British Isles hundreds of years ago (Love, 2008) and as knowledge of the game spread, it became increasingly popular, and by the early 1900s had begun to experience tremendous growth. Depending on this growth, the importance of the field of turfgrass science was realized, and the associations, such as USGA or EGU, began sponsoring publications and research through the embodied departments or independent organizations (Beard, 2002).

Since the beginning of this process, great steps have been taken to make turf grasses on golf courses the finest of all turfgrass areas. Intensive management practices have resulted in turfgrass areas becoming denser, softer, shorter and greener than previously thought possible. It is needless to say that, for reaching this result, considerable quantities of pesticides and fertilizers are used annually on golf courses throughout the World. The fate of these chemicals can be traced to the creeks, streams, lakes, and groundwater aquifers and the major environmental consequence of these intensive maintenance practices is the potential degradation of adjacent waterways and groundwater aquifers from chemical and nutrient runoff.

Runoff Issues

Runoff can be defined as any surface flow that may occur on turfgrass, soil, or other related surfaces after evaporation, interception, infiltration, plant uptake, and detention storage has been satisfied. Runoff events typically occur after:

- Extended periods of rain in which the soil profile becomes saturated and incapable of storing further water molecules.
- During rain or irrigation events in which precipitation rates exceed infiltration rates of soil.
- On areas with extreme slopes where gravity flow provides a quicker gradient for water movement than soil infiltration.
- On surfaces where soil structure is extremely exposed and compacted so that water cannot readily be absorbed.

These forms of surface runoff are typically the means by which pollutants from golf course developments enter into the waterways and groundwater aquifers. In most cases, sediment runoff is identified as a potential guilty in the pollution of these waterways and aquifers, but more serious problems are posed by the potential eutrophication of downstream lakes and slow-moving water bodies by the nutrients that attach themselves to these soil particles (Balogh et al, 1992).

Turfgrass management practices can have a direct effect upon runoff events and the levels of pollutants that they transport. Nitrogen (N), phosphorus (P), and potassium (K) are the nutrients most widely applied through use of fertilizers on golf course turfgrass areas. Especially, nitrogen (N) and phosphorus (P) are two of the most important nutrients used for the establishment and maintenance of golf course turf. Nitrogen is needed in the largest amount by turfgrass plants. This nutrient is essential for shoot growth, green-up, hardiness, rate of growth and shoot density. Phosphorus is vital to energy transformations in turfgrass plants and is key in turfgrasss establishment, rooting, growth and reproduction (Beard, 2003).

Ideally, all of the fertilizer applied on golf course turf has to be taken up by the plants. But, extended periods of rain, irrigation system malfunction, extreme slopes or extremely compacted soils can cause nutrient runoff into the waterways. It is very crucial to control this kind of runoff from polluting the waterways. According to an USGA-sponsored research, nutrient runoff poses a greater threat to water quality than leaching (Kenna and Snow, 2000) and wetlands provide an effective control of nutrients (Vadineanu, 2005).

Sediment and Nutrient Removal by Wetland Systems

By definition, wetlands are regions that are flooded or saturated by either surface water or ground water often and long enough to support both flora and fauna specially adapted to saturated soil conditions (LaFlamme, 2005). They receive water from surrounding lacustrine systems, precipitation, groundwater and runoff. They act like a giant sponge absorbing water during wet periods and releasing water during dry periods of the year. In addition, wetlands can be considered as the kidneys of the planet since they have the ability to filter out pollutants, transform nutrients and serve as sinks for many compounds (Jordan et al., 1999).

As well as natural wetlands, there exist constructed wetlands. These wetlands are mainly constructed with the purpose of treating wastewater. Constructed wetlands are capable of providing many of the same basic operational benefits of a natural wetland, but with a much greater degree of efficiency and control (Dodson, 2005).

Natural wetlands have been used as convenient wastewater discharge sites for as long as sewage has been collected. But, wetlands constructed for the purpose of treating water have a much shorter history. The worldwide spread of this technology originated from research conducted at the Max Planck Institute in West Germany, starting in 1952 (Bastian and Hammer, 1993; Sakadevan and Bavor, 1998; Verhoeven and Meuleman, 1999) and in the western hemisphere during the 1970s. Implementation of wetland technology has been accelerating around the world since 1985 and now there are many thousands of treatment wetlands across the globe (Kadlec and Wallace, 2009).

Constructed wetlands control water runoff velocities so effectively that they can provide major sinks for suspended sediment. The removal of sediment from golf course watersheds is the first step in providing cleaner water to adjacent ecosystems.

Recently, the use of construction wetlands as a means of reducing NPS pollution has garnered more attention. Constructed wetlands assimilate nutrients at remarkable levels and utilize added nutrients to increase net wetland productivity. The rate at which wetlands are able to assimilate these nutrients is dependent on four basic factors (Bayley, 1985):

- The hydrologic cycle or regime.
- The oxidation-reduction state of the soil.
- The nutrient levels currently in soil.
- The soil organic material content.

If properly designed to satisfy these four factors, the wetland filtration system can be efficient in the removal of nutrient pollutants. However, to be truly effective, constructed wetlands must be carefully designed, constructed, monitored, and maintained.

Guidelines for Constructed Wetlands on Golf Courses

For any constructed wetland filtration system to operate correctly, it must be first sited and designed properly. The design process used by many golf course architects is a viable means of accomplishing this goal. The basic design process involves the following steps: (1) inventory, (2) analysis, (3) design, (4) construction, and (5) management. If these five steps are correctly instituted into the use of wetland filtration systems on golf courses, it will insure the designer of an efficient wetland filter design, effective incorporation into the golf course facility, and the most cost effective wetland filter location.

Inventory

The designers use the inventory process to identify existing site features and site conditions. These features and conditions are important for developing a wetland filtration system.

First of all, determination of the effective drainage area that any wetland system will be filtering is a critical factor in the overall design process. The effective drainage area is the land from which water will runoff into a water body in a typical year. This must be identified for runoff calculation and wetland sizing purposes. Effective drainage area is one of the important parameter of the Rational Method, which is widely practiced in runoff calculation and the formulation is presented as follows (Seçkin, 2004):

$$Q = 0.00277\ C\ i\ A$$

Q = peak flow (m^3/s)
C = runoff coefficient (dimensionless)
i = precipitation intensity (mm/h)
A = effective drainage area (ha)

After calculating the runoff, next challenge is to find out how big a constructed wetland will be necessary to treat the first flush of polluted runoff from the golf course. As well as turfgrass or meadow areas, residential and commercial neighborhoods may also be located in the same watershed as the golf course facility, and may contribute significant nutrient loading levels to wetland filtration systems. Therefore, watershed areas that contain man-made landscapes such as residential neighborhoods, commercial developments or roadway systems must be included in the sizing of any wetland filter. If wetland filtration systems receive excess nutrient loading, the efficiency level of pollutant filtration will drop in significantly.

Soil type and existing site vegetation also needs to be included in this inventory activity. The location of these features is needed to assist in determining the best wetland filtration system location. In addition to these, the golf course's hole routing will play a major role in the location of a wetland filtration systems. Wetlands should be located as amenities to the golf course, thus proper hole location is critical for identifying runoff problem areas and creating strategic golf hole layouts.

Analysis

The location of existing site features and their potential relationship to the golf course and watershed areas is a key element in this process. Environmentally sensitive areas and natural drainage systems must be evaluated and identified so that proper wetland location and integration into the golf course development can occur. Calculation of nutrient removal levels to determine the feasibility of utilizing a wetland filtration system on a golf course development is a key evaluation step in this process. Here, it is important to note that there must be enough water in the wetland to maintain saturated soils and emergent plants. Additional volume within the wetland may be needed if the frequency of runoff will not create continuously moist soil conditions to provide habitat in which emergent plants can flourish (Melby and Cathcart, 2002).

Storage volume and water elevations can be calculated using the following formula (Hammer, D, 1997):

$$\Delta V = V + I - E$$

$$\Delta L = L + \Delta V / A \times D$$

V = volume of storage
I = inputs, E = exports
L = water level or elevation
A = area of the wetlands

D = depth

Design

The design process involves the actual implementation of the site inventory and site analysis information. Once the ideal site is found and the wetland filter size figured, incorporation of the wetlands into the golf course can begin.

Wetland features can serve as excellent hazards on golf course facilities, and the interaction of wetland and golf course correctly can greatly enhance the strategic aspects of the golf course and the enjoyment of a round of golf. These interactions should be diagrammatically highlighted since alteration of the course or wetland may be necessary to achieve the desired results.

Wetland vegetation selection is one of the most vital components of design process. Vegetation plays a vital role in wetlands, as they provide a suitable environment for microbial growth and filtration. The vegetation provides oxygen to the bacteria located in its root zone. It also maintains the permeability of the growth media. The stem and leaves in the water column promote sedimentation and provide a substrate for the growth of beneficial microorganisms (State of Georgia, 2002). In addition, plants add greatly to the aesthetic value of the wetland (USDA, n.d.).

Besides vegetation, many factors should be evaluated and incorporated into the process, when designing a wetland filtration system. Some of the more critical factors are listed below (Mitsch, 1993):

- Utilize the natural energies of the watershed systems.
- Incorporate the wetland system into the existing landscape.
- Provide sufficient buffering from areas, which experience heavy pedestrian or vehicular traffic.
- Design the system for ease of maintenance.
- Orient the wetland filtration system so that the greatest level of runoff flow runs parallel to the wetland.

If these factors are met in the design layout, the incorporation of the wetland filter into the landscape could easily be provided as well as successful filtration of runoff.

Construction

After the site inventory, analysis and design processes have been completed; the site can be directly evaluated for construction purposes. Existing topsoil may be suitable as a substrate base for wetland filtration systems. If the topsoil is not predominantly clay or sand then it will most likely work as an effective rooting base. This soil should be scrapped from the site and stored in an appropriate location for later use. Reuse of this soil will drastically reduce construction costs.

In addition, to protect existing environmentally sensitive areas and to prevent excessive soil erosion into adjacent drainage ways, proper Best Management Practices (BMP) for erosion control must also be instituted before any construction begins.

Wetlands are frequently constructed by excavating, backfilling, grading, diking and installing water control structures to establish desired hydraulic flow patterns. If the site has highly permeable soils, an impervious, compacted clay liner is usually installed and the original soil placed over the liner. Wetland vegetation is then planted or allowed to establish naturally (U.S. EPA, 2004).

After initial plant selection and rough grading of the site, any stockpiled topsoil material can be distributed in the planting zone areas. The best soil for plant establishment is usually a fertile loam or organic soil with a little sand content. Heavy clays should be avoided due to natural settling and compaction, which can make initial vegetation rooting and eventual spreading difficult. The plants should be well established before any wastewater is added to the system. A minimum of 4 to 6 weeks should be allowed for plant establishment after planting before wastewater is added to the wetland (State of Georgia, 2002).

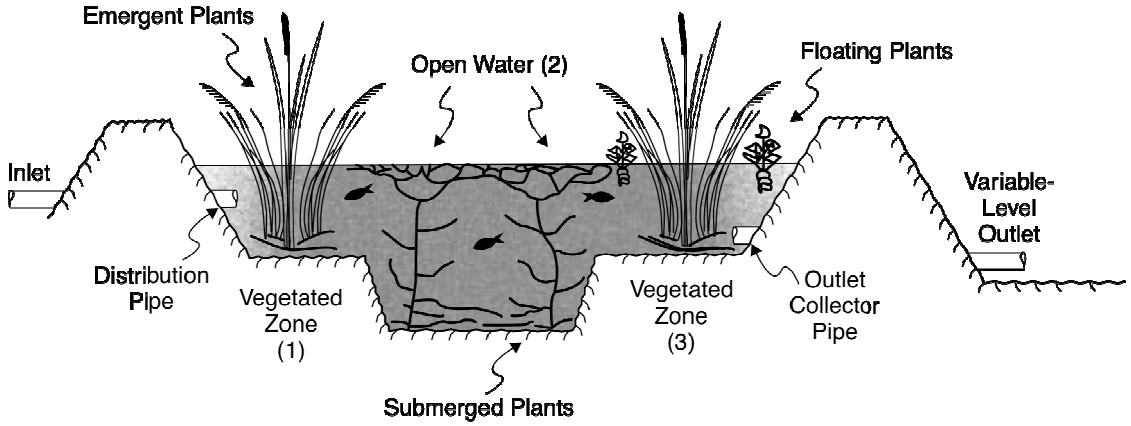

Figure 1: Profile of a free water surface (FWS) constructed wetland (U.S. EPA, 2000).

Management

Wetland management is vital issue for assuring proper wetland filter function. Wetland systems are not capable of establishing themselves within short periods of time. For example, additional vegetation planting may be required to speed plant coverage, replace damaged plants or to try more suitable varieties. Maintenance may also be needed to control the spread of undesired plant species. In addition, inlets and outlets can become blocked with debris, which will require periodic removal. Inlet and outlet structures should be inspected regularly and especially following big storm events (Jones, 1997). Furthermore, proper turfgrass management practices must occur so that the wetland filtration system does not experience extreme sediment or nutrient loading.

Conclusion

Water bodies are important strategical areas on most all golf course facilities. These water bodies can provide the golf course architect with a potentially beautiful amenity to use in creating their golf course design goals. To the player, these can become strategical features that must be negotiated in order to achieve an acceptable score. These water bodies can also act as signatures by which the golf course would be remembered, carrying its influence beyond the property of the facility. In other words, water features have and always will be important features in a golf course development; this includes wetlands.

Constructed wetlands have been implemented as wastewater treatment facilities in many parts of the world and the wetlands used on a golf course have the potential for accepting, storing and filtering runoff from within the course and from neighboring areas. Today, some golf course developments are experimented with wetlands to filter irrigation runoff for reuse on the course, but the environmental significance of this type of use of constructed wetlands is minor at best. Golf course architects and superintendents must do more to insure the safety of the waterways. It is one of the important jobs of every superintendent to insure that the level of runoff is minimized as much as possible. This is where wetland filtration systems become a valuable amenity on golf course developments. It is time that the golf industry makes an effort to support the study and development of methods for controlling runoff from golf course turfgrass systems, so that the future popularity of the game of golf and the health of our environment will be assured.

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Accumulation of Heavy Metals in Some Plants Grown on Serpentine Soils of Mersin, Turkey

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Abstract: The purpose of this study was to determine hyperaccumulator species growing in Findikpinari-Mersin. The soils derived from ultrafamic rocks lead to unusual and sparse associations of flora that are tolerant to extreme environmental conditions such as high heavy metal contents. As the geological structure, Mersin-Findikpinari has rocks containing ultramafic and serpentine, but this site is one of the less studied areas. The 26 specimens of total 755 plants identified systematically from Mersin-Findikpınari in between in 1997-2002 were randomly selected and studied whether hyperaccumulator or not. Twenty six plants collected (members of 26 genera and 8 families) from different sampling locations were analyzed for their total As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se and Zn concentrations using an ICP-MS. A certified reference material (SRM 1573A, SRM 1547) was also analyzed to check the accuracy of the used extraction technique. In the present study, Mn content (548 mg kg-1) of Anthemis aciphylla Boiss. (Asteraceae) was higher than the critical Mn value (300-500 mg kg-1) and Ni content (115 mg kg-1) Crocus graveolens Boiss&Reute (Iridiceae) was higher than the critical Ni value (10-100 mg kg-1) but unfortunately none of the plants studied was hyperaccumulator.

Keywords: hyperaccumulator, Findikpinari-Mersin, serpentine, heavy metal

Introduction

Heavy metal contamination in soil is a global environmental and health safety issue in the world. Remediation of contaminated soils is essential for sustainable soil use. Conventional remediation technologies for soils contaminated with heavy metal cations are generally termed as 'pump and treat' and 'dig and dump' techniques (Chin, 2007). They can be divided into either *in situ* or *ex situ* remediation. The conventional technologies used for *in situ* and *ex situ* remediation are typically expensive and destructive (Prasad and Freitas, 1999). The environmental impact of such technologies can be very high. For example, soil washing methods may render the soil infertile or spread the contaminant, and excavation methods can produce high waste volumes. Additionally, these remediation methods are often limited to small areas and depend on accessibility to the contaminated site (Chin, 2007). The high cost and environmental concerns of conventional remediation technologies has fuelled the need for alternative remediation method. Phytoremediation is one of alternative remediation technologies (Chaney *et* al., 1997; Chin, 2007). Phytoremediation is defined as the use of green plants to remove pollutants from the environment or render them harmless (Raskin *et* al., 1997). The five classes of phytoremediation are outlined below. (i) *Rhizofiltration,* (ii) *Phytostabilisation*, (iii) *Phytodegradation,* (iv) *Phytovolatilisation,* (v) *Phytoextraction* (Chin, 2007). The phytoextraction and rhizofiltration technologies are the most useful branches for heavy metal removal from soil and water respectively. The goal of phytoextraction is to reduce heavy metal levels in the soil to acceptable levels within three to ten years (Huang and Cunningham *et* al., 1996). In order to achieve this goal, plants must be screened and selected for certain attributes. The ideal

plant for phytoextraction would have: (i) a rapid growth rate, even under harsh conditions, (ii) a high shoot biomass (20 metric tons dry mass (DM) ha^{-1} yr^{-1}) (Huang *et* al., 1997), and (iii) a capacity to accumulate or tolerate high amounts of metals in shoots; in the case of Pb, 10,000 mg kg^{-1} (1% DM) (Brooks, 1998). There are three types of metal-tolerant plants which are classified according to their tolerance and accumulation response on soils contaminated with heavy metal cations: (i) *excluders* - restrict metal uptake into roots except at extreme metal concentrations (ii) *indicator plants* - metal level accumulated in the shoot is relative to metal levels in soil and (iii) *hyperaccumulators* – concentrate metals in shoots, regardless of soil metal concentrations (Greger, 1999; Ghosh and Singh, 2005). Metal hyperaccumulator plants comprise species that accumulate (in mg kg^{-1})>10000 (Mn or Zn), >1000 (Cu, Co, Cr, Ni, Pb) or >100 (Cd) in their shoots (Baker and Brooks, 1989; Wenzel and Jokwer, 1999). Initial phytoextraction research began with hyperaccumulator plants, such as *Thlapsi caerulesences* and *Alyssum bertoloni* (Keller *et* al., 2003). Whilst these plants are useful for studying metal tolerance and accumulation mechanisms, their slow growth rate and small biomass may limit their application in phytoremediation (Ebbs and Kochian, 1998). This is because the total amount of metals extracted (a measure of phytoremediation potential) is the product of biomass and tissue concentration (Kayser *et* al., 2000). Of the over 450 plant species which have been identified as hyperaccumulators, about 75% of their have been Ni hyperaccumulators (Clemens, 2001). These hyperaccumulator plants have attracted the interest of plant and soil scientist because of their role in the development of phytoremediation technologies for the treatment of heavy metal contaminated soils, sediments and water resources (Wenzel *et* al., 1999; Lombi *et* al., 2000). For instance, some varieties of *Thlaspi* and ecotype of *Silene vulgaris* have been found to be Cd accumulators; *Larrea tridendata*, a desert inhabitant shrub, accumulates Cu, several wild species of *Sutera* accumulate Cr, and other cultivated species accumulate Cd, Cr and Cu, maize and ambrosia accumulate Pb (Gardea Torresday *et* al., 2004). However, researchers all over the world are searching new plant species susceptible to be used in phytoremediation (Gardea Torresday *et* al., 2004). First, hyperaccumulators are usually specific for one particular metal (Baker and Brooks, 1989), and are adapted to precise climate and soil conditions. Furthermore, they cannot be managed as a conventional crop, have low biomass, and often a short life cycle. Therefore it seems more reasonable to search for non hyperaccumulator plants showing good features for phytoremediation and then transfer biotechnologically traits that make the modified plant even a more powerful tool than natural hyperaccumulators.

Over the last few years on heavy metal tolerance and accumulation studies, the genetic modification approach has gained significant momentum. The goal of genetic modification approach is to develop fast growing, high shoot biomass plants with the metal accumulation traits of natural small biomass hyperaccumulators: 'engineered phytoremediators' (Ow, 1996). The advantage of this technique is the relatively short space of time and selective targeting of genes for improvement. With genetic engineering, plants can be manipulated to accumulate, translocate and tolerate heavy metals, thus creating the ideal transgenic plant for environmental cleanup in the shortest possible time (Pilon-Smits, 2005; Bennett, 2003; Persans *et* al., 2001). For instance, genes can be isolated from metal hyperaccumulators and inserted into fast growing high biomass plant species (Persans *et* al., 2001). It has been suggested that especially phytoextraction would become commercially available if metal removal and tolerance properties of hyperaccumulator plants, such as *Thlapsi caerulescens* (Brown *et* al., 1995; Bennett, 2003) or *Pteris vittata* (Ma *et* al., 2001), could be transferred into fast growing, high biomass producing crop species. For example, most recently, Cd accumulation was enhanced when a metallothionein gene from *Silene vulgaris* L. was overexpressed in the high biomass *Nicotiana tabacum* L. (tobacco) (Gorinova *et* al., 2006).

Ultramafic rocks exposed to heavy tectonic activities usually contain high amounts of serpatine soils in the Earth's crust. Serpentine areas are generally characterized by high levels of heavy metals such as nickel, cobalt and chromium. The soils derived from ultrafamic rocks lead to unusual and sparse associations of flora that are tolerant of extreme environmental conditions such as high heavy metal contents. Serpentine soils, "hotspots" of metallophyte endemics are a rich source of toxic trace elements. There are serpentine soils derived from ultramafic rocks in various parts of the world. Serpentinized rocks are distributed all over the world viz., western north America; Newfoundland, Mount Albert in eastern Canada; Lizard peninsula, Wales and Scotland; north-east Cuba; Portugal; Italy; Balkan peninsula; Turkey; topical far east; Central Brazil; New Caledonia; south east Asia; Philippines; Japan; Zimbabwe; eastern Transvaal Loweveld of South Africa, New Zealand; greenstone belts of western Australia (Proctor and Woodell, 1975; Sequeira *et* al., 1991). Significant exposures of ultramafic rocks and soils are found in many parts of Turkey (Figure 1), although they are not such important features of the geology of the eastern and south-eastern provinces. Notable areas include the central part of the North-west (Kutahya and Balikesir provinces), the South-west between Antalya and Marmaris (Antalya and Mugla provinces), the Amanus Mountains (Hatay and Adana provinces), regions of the eastern Taurus (north and north-east of Mersin) and its extension into the Aladag massif (Nigde and Adana provinces), and numerous areas in a band running generally north-eastwards for several hundred kilometers from near Adana to near Erzincan (Figure 1). Other significant outcrops include several smaller areas near Ankara and in Canakkale province. Soils developed on serpentine rocks cover a large area in Fındıkpınarı (Mersin, Turkey) where there

are a large number of mines (e.g., chromium). Little is known about heavy metal contents of the natural plants grown on Mersin-Findikpinari. Findikpinari is one of the plataeus used as a settlement place and has 1250 m altitude (Orcan *et* al., 2004). Research area is on the Bolkar Mountains which is an interesting place from the point of endemism (Orcan *et* al., 2004). The geological structure of the area is formed upper Crataceous ultramorphic and serpentine. Common soil formations distinguished in the area as follows: brown forest soils, reddish Mediterranean soils and brown calcareous soils (Orcan *et* al., 2004). Koleli *et* al., (2008) reported that the maximum concentrations of metals in 11 soil samples collected from Mersin-Findikpinari (as dry mass) were 909 mg kg^{-1} Cr, 3615 mg kg^{-1} Ni, 246 mg kg^{-1} Cu, 467 mg kg^{-1} Zn, 8.2 mg kg^{-1}Cd and 111 mg kg^{-1} Pb. Koleli *et* al., (2008) to determine hyperaccumulator species growing in serpentine soils in Findikpinari-Mersin, total 123 plant species (members of 23 genera and 15 families) from 5 different sampling locations were collected and analyzed for their total Cd, Cr, Cu, Ni, Pb, and Zn contents using an ICP-MS. The results indicate that four plants species, mainly *Thlaspi elegans* Boiss. and *Alyssum murale* Waldst.& Kit. contained Ni concentrations up to 15693 and 13591 mg kg^{-1} Ni dry matter, respectively. Similarly, *Anthemis cretica* L. and *Sanicula europaea* L. also contained Ni concentrations of 7741 and 4247 mg kg^{-1} DM, respectively. The collected 755 specimens (52 family, 149 genera and 327 species) in Mersin-Findikpinari were identified by Orcan et. al. (2004) in between 1997-2002. Orcan *et* al., (2004) reported that the largest family according to number of the species is *Fabaceae* and the largest genus is *Trifolium* in this area.

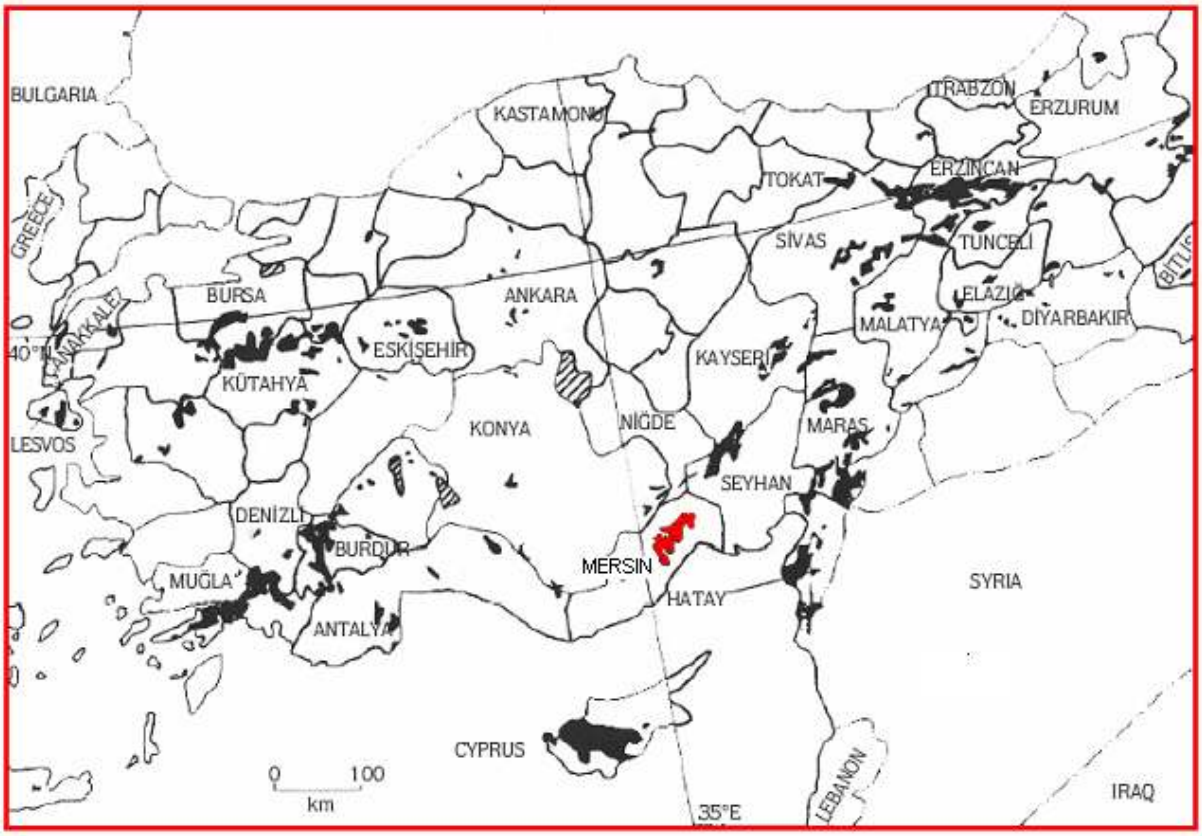

Figure 1: Map of Turkey showing areas of ultramafic geology (in black) and of Mersin-Findikpinari (in red) (from Reeves and Adiguzel, 2004)

The main objective of this study is to evaluate heavy metal accumulation ability of the different plantspecies grown on Mersin-Findikpinari. The 26 specimens from the 755 specimens collected and identified in between 1997-2002 by Orcan et. al. (2004) in Mersin-Findikpinari The plants were randomly selected to evaluate heavy metal accumulation capacity..

Material and Methods

The shoots of identified plants were oven-dried at 70 °C for dry matter amount determination. Dried shoot samples were ground and digested in 2 mL 30% H_2O_2 and 5 mL 65% HNO_3 in sealed vessels of a microwave (MarsXpress) apparatus. Each plant was replicated three times. Arsenic, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se and Zn concentrations were analyzed using an ICP-MS (Inductively Coupled Plasma-Mass Spectroscopy,

Agillent 7500ce). Certified reference materials (*SRM 1573A, SRM 1547*) were also analyzed in order to check the accuracy of the extraction technique used in the study.

Family	Name of the plant	Plant no	Collection site	Altitude, m	Collection date
Asteraceae	*Conyza bonariensis* (L.) Cronquist	689	Purcu surroundings, under forest, rocky places	1350	14.06.1998
Asteraceae	*Crupina curipinastrum* (Moris) Vis.	699	Purcu surroundings, under forest, rocky places	1350	14.06.1998
Asteraceae	*Anthemis aciphylla* Boiss.var. *aciphylla*	85	Cayirbogazi surroundings, waste places, open forest, under forest	1300-1500	20.04.2002
Boraginaceae	*Alkanna aucherana* A.DC.	2	Akarca Guzlesi-Findikpinari, roadside, under forest and open forest	1150	14.03.2002
Caryophyllaceae	*Silene dichotoma* Ehrh. subsp. *dichotoma*	111	Akarca Guzlesi-Findikpinari, roadside, under forest and open forest	900-1150	11.05.2002
Iridaceae	*Crocus graveolens* Boiss. &Reuter	4	Akarca Guzlesi-Findikpinari, roadside, under forest and open forest	900-1150	14.03.2002
Lamiaceae	*Scutellaria salviifolia* Bentham	141	Akarca Guzlesi-Findikpinari, roadside, under forest and open forest	900-1150	11.05.2002
Lamiaceae	*Micromeria carica* P. H. Davis	744	Capurgedigi, surroundings, under forest	1200-1300	28.06.1998
Lamiaceae	*Prunella vulgaris* L.	740	Purcu surroundings, under forest, rocky places	1350	14.06.1998
Lamiaceae	*Lamium garganicum* L. subsp. *reniforme*(Montbret & Aucher ex Bentham) R. Mill	758	Capurgedigi surroundings, under forest and open forest	1200-1300	09.05.1998
Lamiaceae	*Marrubium astracanicum* Jacq.subsp.*astracanicum*	208	Devekoyagi surroundings, under forest and open forest	1800	27.06.2002
Lamiaceae	*Purunella orientalis* Bornm.	741	Findikpinari-Caglarca village, roadside	1300-1400	15.07.1998
Lamiaceae	*Prunella vulgaris* L.	739	Cayirbogazi surroundings, under forest, rocky places, waste places	1300-1500	31.05.1998
Lamiaceae	*Lamium crinitum* Montbret & Aucher ex Bentham.	747	Capurgedigi surroundings, under forest and open forest	1200-1300	09.05.1998
Lamiaceae	*Nepeta nuda* L. *subsp. nuda*	759	Capurgedigi surroundings, under forest and open forest	1200-1300	09.05.1998
Papaveraceae	*Fumaria kralikii* Jordan	72	Cayirbogazi surroundings, waste places, open forest, under forest	1300-1500	20.04.2002
Papaveraceae	*Corydalis solida* (L.) Swartz subsp. *tauricola* Cullen & Davis	775	Findikpinari, under forest	1300-1350	14.03.1999
Poaceae	*Briza humilis* Bieb.	712	Bozon Guzlesi-Findikpinari, roadside, stony, rocky places	1250	01.06.1997
Poaceae	*Poa speluncarum* Edmondson	720	North of the Findikpinari, under forest, rocky slopes	1300-1400	18.05.1997
Poaceae	*Aegilops neglecta* Req. ex Bertol.	722	Bozon Guzlesi-Findikpinari, roadside, stony, rocky places	1250	01.06.1997
Poaceae	*Festuca jeanpertii* (St.- Yves) F. Markgraf subsp. *jeanpertii.*	707	Bozon Guzlesi-Findikpinari, roadside, stony, rocky places	1250	01.06.1997
Poaceae	*Bramus diandrus* Roth	728	Bozon Guzlesi-Findikpinari, roadside, stony, rocky places	1250	01.06.1997
Poaceae	*Festuca pinifolia* (Hackel ex Boiss.) Bornm. var. *pinifolia*	708	Akarca Guzlesi-Findikpinari, roadside, under forest, stony places	900-1150	21.06.1997
Poaceae	*Cynosurus echinatus* L.	713	Bozon Guzlesi-Findikpinari, roadside, stony, rocky places	1250	01.06.1997
Ranunculaceae	*Ranunculus ficaria* L. subsp. *calthifolius* (Reichb.) Arc	5	Akarca Guzlesi-Findikpinari, roadside, under forest and open forest	900-1150	14.03.2002

Table 1: Family, genus, altitude, name of the collected site, and the collection date (from Orcan et. al., 2004)

Findings

Research area is on the Bolkar Mountains which is an interesting place from the point of endemism of Turkey. The collected 26 plants from different sampling locations have 26 genera and 8 families. Different 8 families were Asteraceae (3), Boraginaceae (1), Caryophyllaceae (1), Iridaceae (1), Lamiaceae (9), Papaveraceae (2), Poaceae (7) and Ranunculaceae (1). In the identified 755 plant, the largest family according to number of the species is *Fabaceae* and the largest genus is *Trifolium*. In the tested 26 plants, the largest family according to number of the species is Poaceae (7). Table 1 shows family, genus, altitude, name of the collected site, altitude and collection date of the tested plant samples.

Table 2 shows heavy metal concentrations in shoots of the investigated plant specimens. The highest As (6), Co (10), Cr (46), Mn (548), Se (4) concentrations were *Anthemis aciphylla* Boiss. (Asteraceae). Manganese concentration in *Anthemis aciphylla* Boiss. (Asteraceae) was higher than the critical concentration (300-500) in plants according to Kabata-Pendias and Pendias (1992). *Fumaria kralikii* (Papaveraceae) has higher metal content, except for Cd and Zn, than other plants and higher than normal concentration in plants according to Kabata-Pendias and Pendias (1992). The highest Ni concentration was 115 mg kg^{-1} DM for *Crocus graveolens* Boiss&Reute (Iridaceae) and this value was higher than the critical concentration (10-100) in plants according to Kabata-Pendias and Pendias (1992).

In the future, the identified 755 plants will be studied to evaluate heavy metal accumulation capacity because of the research area is an interesting place from the point of endemism and remediation of contaminated soils is essential for sustainable soil use. New selected metal hyperaccumulator plant may be genetically modify and remediate metal-contaminated soils. But metal hyperaccumulator plants after treatment evaluated as hazardous waste because of the higher concentration of the extracted metals. Therefore, further treatment of this biomass is environmentally necessary.

Family	Name of the plant	As	Cd	Co	Cr	Cu	Mn	Ni	Pb	Se	Zn
Asteraceae	*Conyza bonariensis* (L.) Cronquist	**3**	1	**6**	**24**	**29**	**335**	**40**	15	**3**	137
Asteraceae	*Crupina curipinastrum* (Moris) Vis.	1	1	<bd	1	11	47	3	15	2	179
Asteraceae	*Anthemis aciphylla* Boiss.var. ***aciphylla***	**6**	1	**10**	**46**	**29**	***548***	**67**	16	**4**	84
Boraginaceae	*Alkanna aucherana* A.DC.	1	**3**	1	8	18	88	**35**	**28**	1	79
Caryophyllaceae	*Silene dichotoma* Ehrh. subsp. ***dichotoma***	2	1	**2**	11	16	**235**	**13**	9	2	65
Iridaceae	*Crocus graveolens* Boiss. &Reuter	1	1	**8**	**31**	**21**	**189**	***115***	6	1	104
Lamiaceae	*Scutellaria salviifolia* Bentham	9. <BD	<bd	**4**	**16**	20	67	**79**	13	1	112
Lamiaceae	*Micromeria carica* P. H. Davis	<bd	<bd	<bd	<bd	2	3	1	2	<bd	6
Lamiaceae	*Prunella vulgaris* L.	1	1	<bd	3	**21**	**126**	5	7	1	79
Lamiaceae	*Lamium garganicum* L. subsp. ***reniforme***(Montbret & Aucher ex Bentham) R. Mill	1	1	<bd	4	11	97	**6**	**22**	1	52
Lamiaceae	*Marrubium astracanicum* Jacq.subsp.***astracanicum***	1	1	<bd	7	17	96	**24**	20	1	79
Lamiaceae	*Purunella orientalis* Bornm.	1	<bd	1	3	16	80	**9**	3	1	100
Lamiaceae	*Prunella vulgaris* L.	1	2	1	5	15	**101**	**7**	17	1	207
Lamiaceae	*Lamium crinitum* Montbret & Aucher ex Bentham.	<bd	<bd	<bd	2	12	76	**24**	8	1	58
Lamiaceae	*Nepeta nuda* L. *subsp.* ***nuda***	1	1	<bd	3	12	**158**	**6**	20	1	165
Papaveraceae	*Fumaria kralikii* Jordan	**6**	1	**6**	**26**	**31**	**247**	**30**	**35**	**3**	144
Papaveraceae	*Corydalis solida* (L.) Swartz subsp. ***tauricola*** Cullen & Davis	<bd	1	<bd	3	17	**107**	9	7	1	175
Poaceae	*Briza humilis* Bieb.	1	<bd	<bd	7	11	76	**12**	6	<bd	68
Poaceae	*Poa speluncarum* Edmondson	<bd	<bd	<bd	2	11	67	4	9	1	106
Poaceae	*Aegilops neglecta* Req. ex Bertol.	<bd	1	<bd	4	6	49	**6**	4	1	46
Poaceae	*Festuca jeanpertii*(St.- Yves) F. Markgraf subsp. ***jeanpertii.***	<bd	<bd	<bd	4	18	49	**35**	14	1	60
Poaceae	*Bramus diandrus* Roth	<bd	<bd	<bd	3	10	83	**6**	18	1	45
Poaceae	*Festuca pinifolia* (Hackel ex Boiss.) Bornm. var. ***pinifolia***	1	1	**2**	9	16	**133**	**16**	19	1	68
Poaceae	*Cynosurus echinatus* L.	<bd	1	<bd	2	9	48	**9**	3	1	76
Ranunculaceae	*Ranunculus ficaria* L. subsp. ***calthifolius*** (Reichb.) Arc	1	<bd	**3**	**19**	**24**	**137**	**60**	9	1	92
Asteraceae	*Conyza bonariensis* (L.) Cronquist	<bd	1	<bd	2	18	34	3	6	1	80
	The highest value in plants	**6**	**3**	**10**	**46**	**31**	***548***	***115***	**35**	**4**	207
	The lowest value in plants	1	1	1	1	2	3	1	2	1	6
	Common concentrations in plants*	0.02-7	0.1-2.4	0.02-1	0.03-14	5-20	20-100	0.02-5	0.2-20	0.001-2	1-400
	The critical concentration in the plants*	5-20	5-30	15-50	5-30	20-100	300-500	10-100	30-300	5-30	100-400
	Hyperaccumulation threshold value	1000	100	1000	1000	1000	10000	1000	1000	1000	10000

Table 2: Heavy metal concentrations of the tested plants (As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Se and Zn), mg kg^{-1} DM *Kabata-Pendias (1992)

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Investigation of Temperature Parameter on the Sinterability of Magnesia

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Abstract: A sintering procedure in constant heraus muffle furnace was carried out at an interval of 1600-1900 ^{o}C for 50 min dwelling time and 5 ^{o}C min^{-1} cooling rate to improve the grain growth of magnesia. The effects of temperature on the grain growth and microstructural examination of samples were investigated by using Scanning Electron Microscopy (SEM). The average grain size was also determined separately by an intercept measurement method. According to the findings, crystal size and bulk density were enhanced significantly as a linear relationship with the increasing temperature. For the samples sintered at 1900 ^{o}C, a maximum average grain growth (~100 μm) has been obtained. In this paper, the effects of temperature on the crystal size and bulk density of the treated magnesia and its marketability were evaluated.

Key words: Sintering, grain size, bulk density, purchasability

Introduction

Grain size, impurities, porosity, sintering temperature and practice shape play an important role in controlling many physical, mechanical and chemical properties of magnesia-based bricks (Kingery, 1984, Itatani, Nomura, Kishioka, Kinoshita, 1986, Rice, 1972). It is known that porosity can alter or eliminate the appearance of grain-size control of strength (Itatani, Nomura, Kishioka, Kinoshita, 1986). As grains grow, grain boundaries sweep past many pores, which are then within the grains not at grain boundaries. This commonly results in an additional regular pore shape, which may well decrease stress concentrations.

The size of the MgO crystals within the magnesia grains is critically an important factor in controlling the resistance to corrosive attack of basic bricks (Aksel, Rand, Riley, Warren, 2002). When the size of the crystals increases, a corresponding decline occurs in crystal surface area and open porosity (Aksel, Rand, Riley, Warren, 2002). Furthermore, as the mean MgO grain size increases, the wear rate as a result of corrosive slag attack decreases (Lee, Rainforth, 1994). Magnesia-based refractories with a large grain size (>100 mm) are used comprehensively where the corrosion resistance is required. On the contrary, a high thermal shock resistance in fused magnesia grain requires a fine crystal size and a compromise may be required in applications where thermal shock resistance is important (Williams, Taylor, Soady, 1990) Critical microstructural factors affecting properties and performance of a brick are basically density, grain size, impurities and CaO/SiO_2 ratios (Aksel, Rand, Riley, Warren, 2002).

Currently, researchers focused on the improvement in the resistance of corrosive attack of sintered magnesite with the greatest grain growth. As the grain size increases, the penetration of slag through the grain boundaries can be minimised. The enlargement in grain size leads to a high resistance to fracture and corrosion. To reach the optimum grain size increases the quality and performance of the refractory material, leading to an economical benefit and longer service life for industrial applications in terms of corrosion and thermal shock resistance.

In this study, under optimum test conditions in the literature (Marechal, 1991) such as constant dwelling time (19 min) and the cooling rate (5 ^{o}C min^{-1}), crystal size and bulk density is separately determined according to rising temperature. The role of temperature on the enlargement of grain size and bulk density were also

evaluated by SEM analysis. Furthermore, Crystal size and bulk density, which have a pronounced effect on quality and purchasability, are investigated It is considered that this paper will provide a platform to improve understanding of relationships between microstructure and those parameters, affecting grain size of the sintered magnesite significantly.

Experimental procedures

The magnesite concentrate was provided from Kümas Magnesite Mine Inc, Kütahya. The representative sample was crushed and classified into -5 +3 mm particle size. Mineralogical characterization by X-ray diffraction spectrometry evidenced MgO while main additional minerals were Fe_2O_3, SiO_2, CaO and Al_2O_3. Quantitative chemical analysis of the elements by emission spectroscopy technique revealed that MgO content is 48, 53 % [Table 1].

MgO, %	SiO_2, %	CaO, %	Fe_2O_3, %	Al_2O_3, %	LOI*, %
49.56	0.30	1.10	0.30	0,04	48,70

LOI: loss on ignition* **Table 1. Chemical analysis of magnesite concentrate

A sintering procedure close to industrial situation was performed in the constant heraus muffle furnace at interval 1600-1900^oC for 50 min dwelling time and 5^oC min^{-1} cooling rate [7]. Sintered samples were placed in polyethylene moulds by a mixture of epoxy resin and hardener. Surfaces of samples were ground using progressively finer SiC papers. The polishing of specimens for SEM was carried out using a "Metcom Forcipol 1V" grinder polisher. Chemical etching was then carried out in a HNO_3 and CH_3OH (3:2) diluted solution at room temperature for ~25 min (Aksel, Kasap, Sesver, 2005). Microstructural examination of the regarding samples was carried out using JEOL JSM-6060 SEM. Grain sizes of polished and chemically etched surfaces were then measured from photographs taken in SEM, using an intersecting grain numbers method (Clinton, Freer, 1987). Similar results were achieved by standard lines mean method (Köknal, Eyüboğlu, Özmen, 2008). Average grain size was determined from intercept measurements on the observed plane, by using the following formula:

$$\bar{D} = (n * l)/(Z * M) \quad (1)$$

where $\bar{D}$ is the average grain size, n number of lines, l intersecting grain numbers and M is the magnification unit, taken over 2000 grains and measured on the plane of polish. Supposing for the grain size variables, in order to identify an average grain size, were that the structure consisted of nontextured, equiaxed grains of ordinary polyhedral shape. All the values calculated for each sample were the average value of ~300 measurements of seven SEM micrographs. According to those values, the improvement in grain growth was investigated for each sample based on the effect of temperature. After sintering, bulk density values were measured using the standard water immersion method (Mendelson, 1969). The rise in sintering temperature to 1900^oC for 19 min, using cooling rate of 5 ^oC min^{-1}, resulted in maximum grain growth (~100 μm).

Microstructure of sinter magnesia

Sintering process was carried out in the range temperatures of 1900 and 1600 ^oC. At 1900 ^oC, crystal grains formation ranging from large and coarse to fine have been observed [Fig 1a]. Maximum and minimum crystal sizes have ranged from 20 to 200 μm and average size has also been calculated as approximately 100 μm, utilizing intersection method. At the duration of sintering process, many particles up to 200 μm were formed by the combination of 2 or 3 grains. Though crystal size is differential at 1850 ^oC, relatively steady and homogenous distribution is observed. Locked particles, more than one grain, in range of 120 μm have also been seen [Fig 1b]. Crystal forming at 1800 ^oC sintering temperature show a more homogenous distribution compared to ones formed at 1850 ^oC.

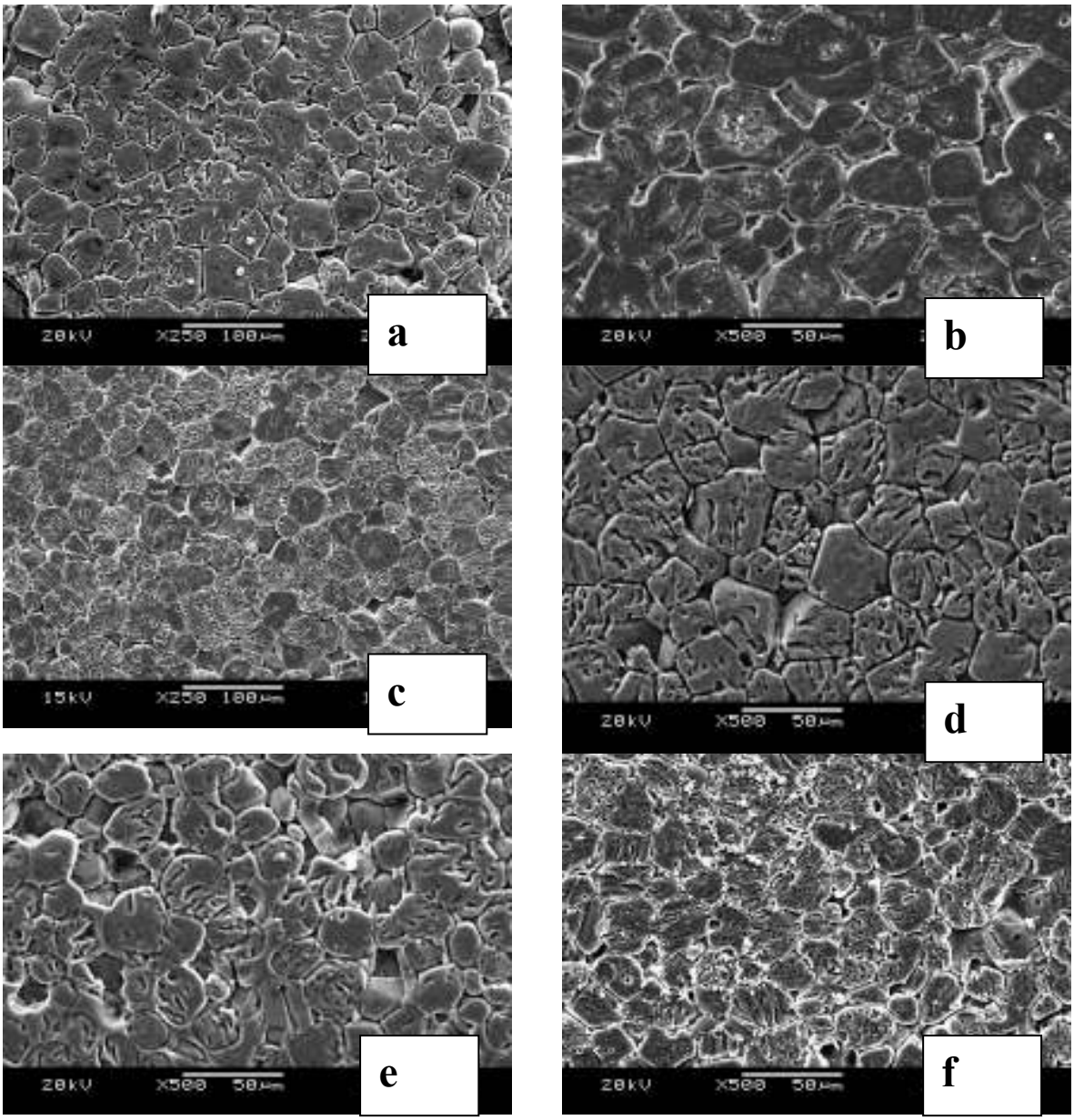

Fig 1. SEM micrographs of sintered magnesia at various temperatures (*a: 1900°C, b: 1850°C, c: 1800°C, d: 1700°C, e: 1650°C, f: 1600°C*)

Associated particles of 120 μm size are also observed at this temperature. Despite the homogenous distribution, there are many finer particles around 17 μm. The average crystal size was calculated as 53 μm [Fig 1c]. At 1700 oC, crystal size varies between 42-25 μm. The average size was calculated as 31 μm. Fewer blocked particles have been observed in this group of tests [Fig 1d]. Maximum and minimum crystal size varies between 35-12 μm at temperature of 1650 oC. The average size was calculated as 23 μm [Fig 1e]. At 1600 oC, sintering temperature maximum, minimum and average crystal sizes were determined as 32, 10 and 17 μm respectively [Fig 1f].

Result and Discussion

It is known that density and crystal contact surface area increase with the increase in the crystal size of sintered magnesia. Refractory materials produced from high quality magnesia have high resistance to acid, moisture and loads at high temperatures (BS 7134, 1989). Product quality is directly affected by crystal size and

bulk density, therefore a small increase in those values can be considered as a big step as far as purchasability is concerned. Therefore, crystal size of magnesia, density, MgO and silica content are important parameters. Magnesia-based refractories with a large grain size (>100 mm) are used extensively where the corrosion resistance is required. In contrast, a high thermal shock resistance in fused magnesia grain requires a fine crystal size and a compromise may be required in applications where thermal shock resistance is important.

In this study, the changes in the crystal size and cast density of magnesia as a function of temperature and the effect of these changes on the purchasability of magnesia were investigated. According to the findings of the study, which are in agreement with the literature (Marechal, 1991, Köknal, Eyüboğlu, Özmen, 2008, Mendelson, 1969, Erdoğan, Yıldız, 1995, Hara, Kusunose, Kenmochi, 1986), crystal size and cast density of magnesia increase with temperature [Fig 2]. Under identical cooling conditions (5 ^{o}C min^{-1}), the temperature dependent increase in the crystal size is clearly linear.

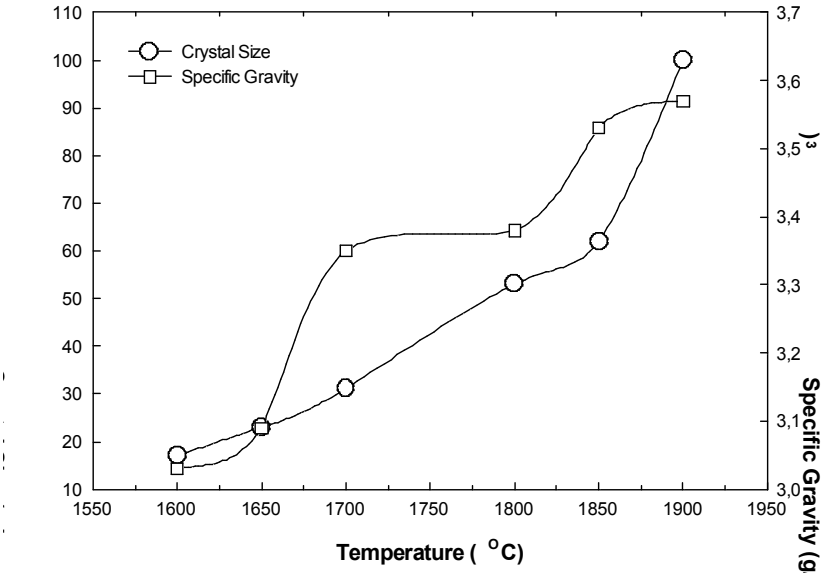

Fig 2. The change in crystal size and density with temperature

The literature shows that density and crystal contact surface area show a parallel increase with crystal size (Köknal, Eyüboğlu, Özmen, 2008). As the particles grow in size, the resulting porosity increase causes an improvement in the resistance of the refractory material to acid and moisture (Kingery, 1984, Itatani, Nomura, Kishioka, Kinoshita, 1986, Rice, 1972). These additional beneficial properties, in turn, raise the saleability of the product. Saleability shows a small improvement with particle size and density; increases with every increase in density, but remains constant after a particle size of 150 microns [Fig 3].

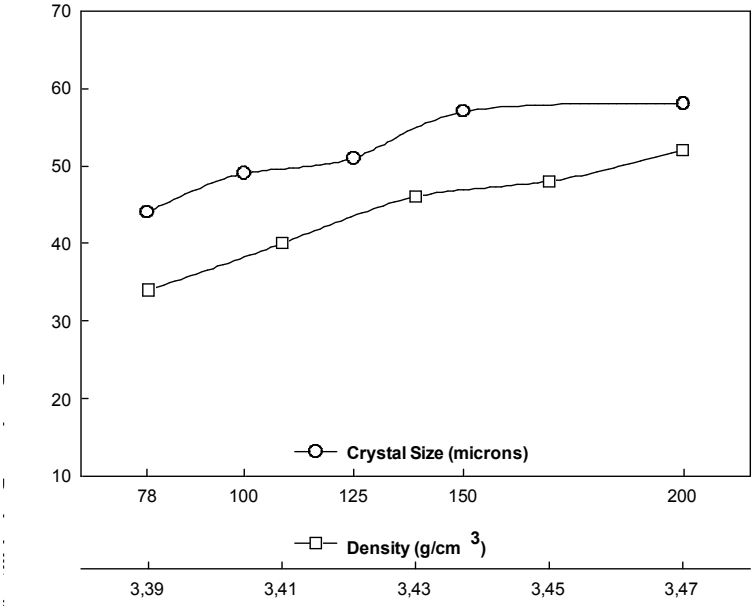

Fig 3. The effect of parameters affecting quality of refractories on purchasability [15]

The quality perception of magnesia has changed with the advances in the refractory materials technology. For example, a magnesia product with a density of 3.36 g/cm^3 was considered high quality; today's specifications expect a density of 3.47 g/cm^3. Considering these facts, it is expected that magnesia products manufactured at temperatures above 1850 ^{o}C should have a strong place in the market.

Conclusion

A high quality sinter magnesia should have a number of specifications such as low B and SiO_2, coarse crystal size, ideal CaO/SiO_2 ratio (~1.86) and high bulk density (>3.40 gcm^{-3}). Magnesia product like this can be easily sold in the market. Under optimum test conditions in the literature such as constant dwelling time (19 min) and the cooling rate (5 ^{o}C min^{-1}), crystal size and bulk density is separately determined according to rising temperature. Saleability of each product is separately evaluated. The results obtained are summarized;

1. The rise in the sintering temperature up to ~1600 ^{o}C improved the densification and gave rise to maximum enhancement in grain size. The values of 17 μm and 3.03 gcm^{-3} at 1600 ^{o}C have risen to 100 μm and 3.57 gcm^{-3} respectively at 1900 ^{o}C.
2. As values of 80 μm, $\geq$3.40 gcm^{-3}, specified for good quality magnesia in the literature, are taken into account 1850 ^{o}C temperature is just about sufficient. At this temperature the bulk density is within the acceptable limits however the crystal size remains below the saleability limit. At lower temperatures (such as 1800 ^{o}C), quality magnesia of required bulk density is obtained. On the other hand needed crystal size can not acquired.
3. At 1900 ^{o}C temperature, saleable quality magnesia (100 μm > 78 μm, 3.57 gcm^{-3}> 3.40 gcm^{-3}) could be obtained
4. According to experiment results, the temperature was subsequently found to be major parameter improving grain growth and specific gravity of magnesite substantially.

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Effect of Marble Dust on Consolidation Characteristics of Clay Soils

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Abstract : The usage of waste materials as an additive material has became widespread, in soil stabilization. This case was positive effects on environment by means of recycling, regains to economy and reducing environmental pollutions. In this study, marble dust had been used as an additive material in clay soil. Marble dust is a waste of the marble industry and despite its recycling in various industries, there is still a significant amount of marble dust left as waste.
In this study, soil specimens were sampled from different locations in the ANS campus of Afyon Kocatepe University. These specimens were mixed with waste marble dust at ratios of 5%, 10% and 15%. Geotechnical experiments were carried out on specimens. Test results shows that marble dust have affected consolidation characteristics of clay soils. Especially, swelling index and consolidation index of specimens were decreased. This decrease is important in point of swelling potential of clay soils.

Introduction

Marble dust is a waste of the marble industry and despite its recycling in various industries, there is still a significant amount of marble dust left as waste. Marble dust has been used as an additive for soil stabilization. Okagbue and Onyeobi (1999) showed that the geotechnical parameters of red tropical soils are substantially improved by adding marble dust: plasticity is reduced by 20 to 33% and strength and CBR increased by 30 to 46% and 27 to 55%, respectively.

The effect of marble dust on the swelling potential of Na-bentonite and Meşelik clays and unconfined compressive strength was investigated by Zorluer (2003, 2006). Specimens were mixed with marble dust at different percentages (3,5,8,10%) of dry soil weight, and compacted at standard proctor compaction energy. For swelling tests, specimens were obtained using oedometer floating ring from compacted mixtures and then tests were carried out with oedometer. Swelling potential reduced from 25.6% to 21% at 5-8% marble dust additive. For compression test, specimens were sampled with coring tube from compacted mixtures. Unconfined compressive tests were performed to these specimens and were cured for 1, 7 and 28 days. At the end of 28 days of curing time, strength increased from 20.1 to 57.3 N/cm^2.

Waste marble dust was used as an additive material by Zorluer and Taspolat (2009) in landfill liner. Mixtures of kaolinite-bentonite were mixed with waste marble dust for design of landfill liner. This process was performed at marble dust ratio of 5%, 10% and 15%. Freezing-thawing tests were carried out in these mixtures. At the end of the tests, it was observed that waste marble dust increased strength of liner in conditions of freezing and thawing.

The objective of this study was to investigate use of marble dust as an additive in clay soils. For this purpose, soil specimens were sampled from 3 locations at ANS campus of Afyon Kocatepe University. These specimens were mixed with waste marble dust (proportions of 5, 10 and 15% dust to dry soil by weight). Index properties of the specimens were determined by liquid limit, plastic limit, sieve, hydrometer and buoyancy analysis tests. Standard proctor and odeometer tests were carried out in these specimens.

Materials

Afyonkarahisar region is known as one of the most important marble production and processing centre in Turkey. Yearly production of marble is about 80,000 m^3 in this region. About 24,000 m^3 marble dust occurs

from this production. Marble dust is minimum sized marble waste that occurs with sawing of marble blocks and plates. This dust is carried by water to sedimentation ponds. Sediment dust is removed from the pond to wasteland, but this forms serious problems for the environment. Waste marble dust is used in very small quantities despite being used in widely variable industries, such as construction, ceramics and cement, paint, agriculture and fertilizer; as a result, a lot of marble dust ends up as waste (2003). The marble dust used in this study, was obtained from a marble processing factory in Afyonkarahisar-Turkey. It was dried and sieved, resulting in marble dust grains smaller than 300 microns. Table 1 are shown chemical compound percentage (%) of marble dust.

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	P_2O_3	K_2O	Na_2O	SO_3	Mn_2O_3	LOI[a]
0.01	0.85	0.04	55.30	0.24	-----	0.20	0.03	-----	-----	43.51

Table 1. Chemical Compound Percentage of Marble Dust (%)

Afyon Kocatepe University Campus area was formed clay. Clay specimens were sampled from three points at campus area. These points were named as BH1, BH2 and BH3. Properties of specimens are in the table 2. Soil classification and definition tests were applied according to the TS 1900 standard.

Specimen	Gs	w_l	w_p	I_p	class
BH1	2,65	59,5	25,6	33,9	CH
BH2	2,72	37,2	20,4	16,8	CL
BH3	2,76	29,4	21,6	7,8	CL
Gs:Specific Gravity, w_l: Liquid limit, w_p: Plastic Limit, I_p: Plasticity index					

Table 2. Geotechnical Properties of Clay Specimens

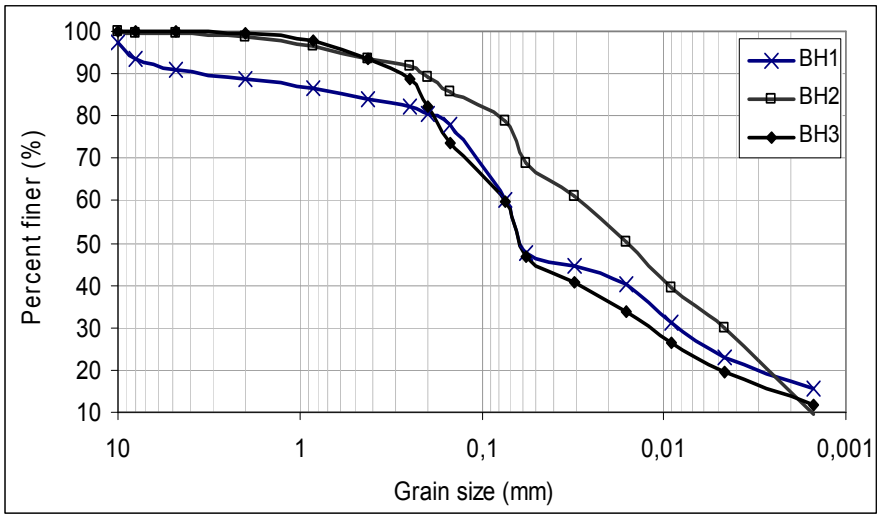


Figure 1. Grain size distribution curves of specimens.

Experimental Study and Results

Standard proctor test was performed on clay specimens. Compaction characteristics of clay soils were determined from this Proctor test. Maximum dry density and optimum water contents were obtained from figure 2. The specimens were mixed with waste marble dust at ratio of 5%, 10% and 15%. These ratios were obtained

from other studies (Okagbue&Onyeobi, 1999; Zorluer, 2003, 2006, 2009). Then, these mixtures were compacted with optimum water content at the standard compaction mold.

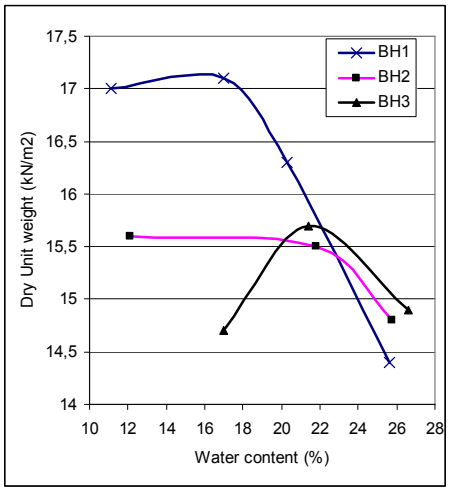
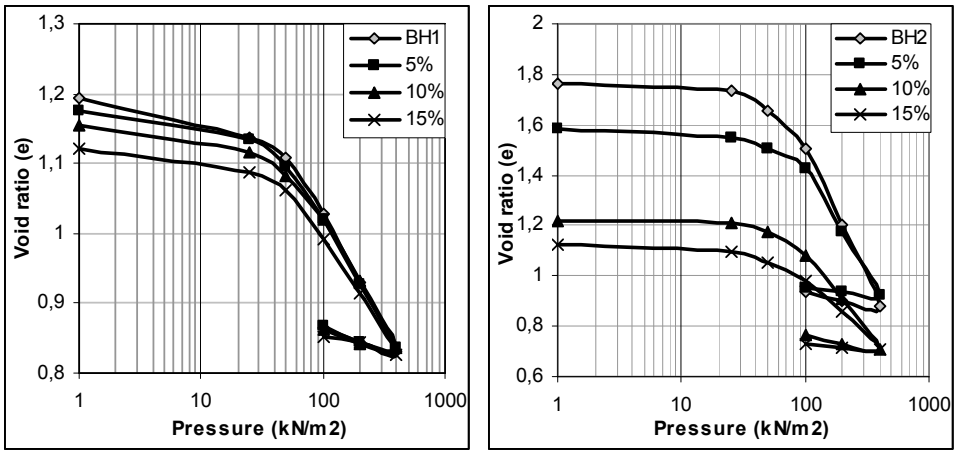
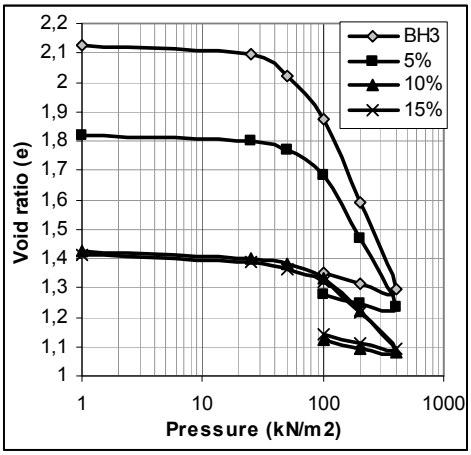


Figure 2. Compaction curves of soil specimens

For consolidation tests, specimens were sampled from compacted mixtures using odeometer ring. Consolidation tests were carried out on these specimens. e-log p graphs were plotted from consolidation tests results (fig. 3 a, b, c). In addition, compression index (c_c) and expansion index (c_e) were obtained from figure 3.



a b

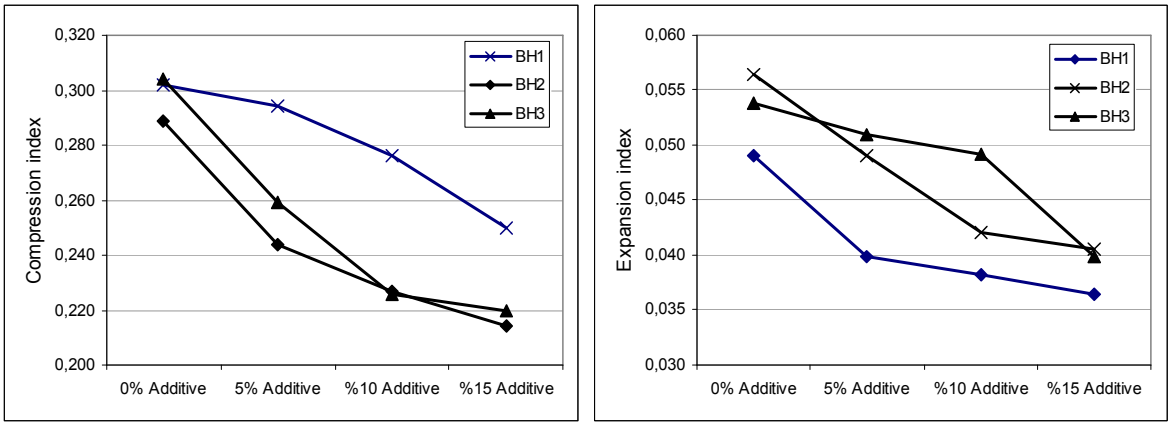


c

Figure 3. (a, b, c) e-log p curves of specimens

Discussion

Compression index (c_c) is the slope of the linear portion of the e-log p plot and dimensionless. It was seen that c_c has decreased with marble dust increasing for all specimens (fig 4 a). For example, this decreasing is from 0,304 to 0,220 for BH3. Similarly, void ratios of specimens have decreased with marble dust increasing (fig 3). Consolidation settlement of soils is fewer when soil voids decreased.



a b

Figure 4. Change of compression and expansion indices with increasing marble dust.

Decreasing of expansion index (c_e) is same with other studies (Zorluer, 2003). The findings show that the expansion index of specimens decreases when the amount of the added marble dust increases (fig 4.b). Therefore, swelling potential reduces when the amount of the added marble dust increases. This case shows that marble dust can be used at stabilization of swelling soils. Also, at the other study of Zorluer (2003), swelling potential was reduced by adding marble dust. Besides, swelling potential values was measured from swell pressure test.

Conclusion

Marble dust affects the properties of clay like strength, swelling potential, freeze-thaw strength. This case was expressed at previous studies. In this study, consolidation characteristic of clay were affected from waste marble dust. Compression index (c_c) and expansion index (c_e) of specimens decreases when the amount of the added marble dust increases. Furthermore, void ratio decreases with increasing of marble dust. This result shows that consolidation settlement reduced when marble dust mixed to clay soil. Use of marble dust in soil stabilization, provide the protection of the environment. In addition, it is gained an economical material for soil stabilization.

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The Effect of Current Density and pH of Cadmium Removal by Electrochemical Processes

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Abstract : Removal of cadmium from synthetically prepared solution using electrochemical processes is studied in the present study. To determine the optimum operation conditions, the effect of several parameters such as current density and initial solution pH have been investigated. Iron electrode was used as electrode materials. Experiments were carried out with different current densities ranging from 0.25 to 1.25 A/m^2. It was observed that the removal of cadmium increases with increasing current densities. The distance of between electrodes was chosen as 5 mm. Initial cadmium concentrations was kept constant at 100 mg/L while other parameters such as current density and initial solution pH were investigated. Cadmium concentration in the solution was determined using Atomic absorption spectrophotometer. The experimentally obtained results were shown that electrochemical processes were achieved to cadmium removal (e.g. 99.99%) from synthetically prepared solution.

Key words: Cadmium, removal, electrocoagulation, electroreduction

1. Introduction

Heavy metals pose a significant hazard to environment and human health. Wastewater generated from cadmium processing is extremely toxic to environment and to humans. Due to their high toxicity, industrial wastewaters containing heavy metals are strictly regulated and must be treated before being discharged in the environment. Cadmium is a toxin of environmental concern. The impact for non-cancer causes includes kidney, liver, and lung damage [1]. It is also classified as a probable human carcinogen for lung cancer. The association of cadmium with hormone-related cancers such as prostate and breast cancers has being actively investigated since the initial implication [2-4]. There is no known function of cadmium in the human biological system. The presence of such foreign metal ion in the human is likely a result of various exposures. In addition to direct exposure from air and drinking water, another potential exposure is to result from crops grown in the contaminated water and soil environment, which transports the metal into food chain where cadmium is accumulated in various parts of crops [5]. Electroplating, nickel–cadmium battery production and disposal, fossil fuels, pigments, fertilizers, certain electronic components are all potential sources of contamination to water [6]. Various methods can be applied to remove toxic metals from industrial effluents [7,8]. These methods include precipitation, co-precipitation, electrodeposition, electrocoagulation, cementation, membrane separation, solvent extraction, ion-exchange,

adsorption and biosorption [9, 10]. Precipitation is most applicable among these techniques and considered to be the most economical. Among these methods, electrocoagulation is particularly interesting. The electrocoagulation has been successfully used to treat oil wastes, with a removal efficiencies as high as 99% [11,12]. A similar success was obtained when treating dye-containing solutions [13–14], potable water [15], urban and restaurant wastewater [16,17] and nitrate or fluoride containing waters [18,19]. In addition, a great deal of work performed in the last decades [20–21] has proved that electrocoagulation is an effective technology for the treatment of heavy metal containing solutions.

This technology delivers the coagulant in situ by anodic dissolution and produces subsequently, iron (or aluminium) hydroxides having a considerable sorption capacity, while the simultaneous cathodic reaction allows pollutant removal either by deposition on cathode electrode or by flotation (evolution of hydrogen at the cathode) [22]. Likewise, during electrocoagulation process, liquid is not enriched with anions and salts content does not increase, compared to chemical metal precipitation [23]. This contributes to production of metallic sludges which are compact using electrocoagulation compared to those generated by chemical precipitation [24,25]. Moreover, electrocoagulation requires simple equipment, small retention time and is easy to operate [26,27]. These characteristics contribute to reduction of operating cost for industrial applications.

In the present work, the efficiency of electrocoagulation in removing cadmium from synthetically solution was reported. The effect of initial pH and current density on the removal efficiency is explored and discussed to determine the optimum operational conditions. Aim of this study is to investigate the effects of initial pH and current density on cadmium removal from wastewater by electrocoagulation method using iron electrodes.

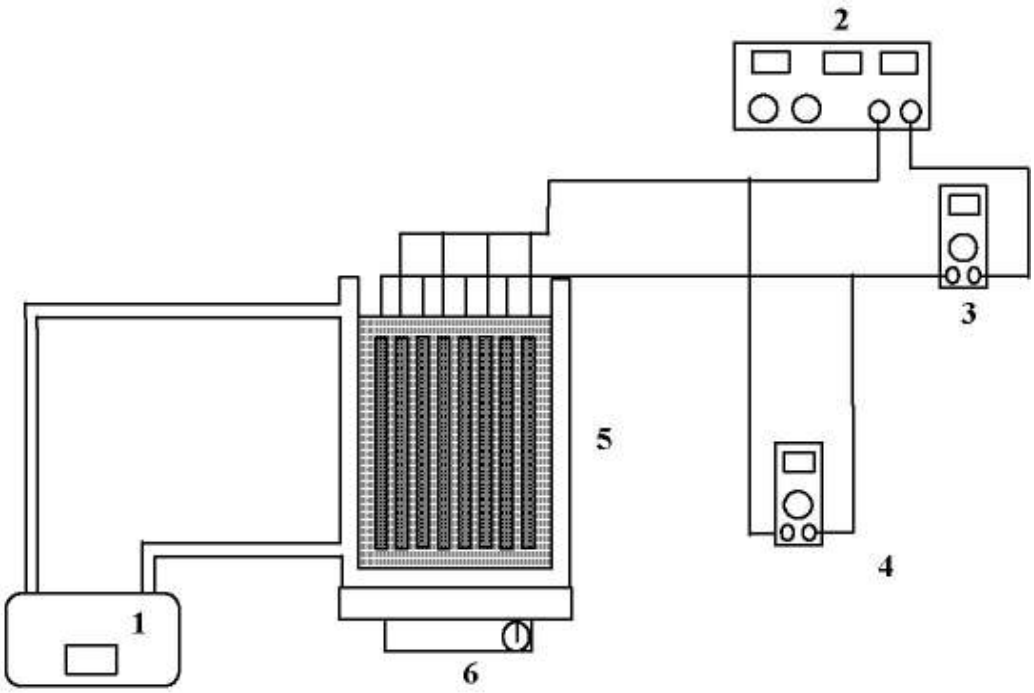
2. Materials and methods

2.1 Materials

Wastewater sample used in the experiments were prepared synthetically using $CdCl_2H_2O$ having 99.99 of purity from Merck. The solution with cadmium concentration of 100 mg/L was prepared by dissolved 0,1796 mg in distilled water and completed with distilled water to 1 L. The electrolyte was synthetically prepared by using analytical reagents and distilled water. A stock solution of cadmium chlorine, 100 mg/l was prepared. The pH of the solution was adjusted to the required value with 10^{-2}M nitric acid and 10^{-2}M sodium hydroxide. All measurements were carried out at ambient temperature approximately (22 ± 1 ^{o}C)

2.2. Experimental setup and procedure

The experimental setup is schematically shown in Figure 1.The EC unit consists of six pair of electrodes made of plate iron with total area of approximately 1000 cm^2 and the gap between the electrodes is 5 mm. Electrodes were connected to a digital DC power supply (Good Will) in monopolar mode. Two digital multimeters (Brymen Bm 201) as ampermeter and voltmeter were used to measure the current passing through the circuit and the applied potential, respectively. The EC unit has been stirred at 150 rpm by a magnetic stirrer. (Heidolp MR 3004 S). The thermostated electrocoagulator is made of plexiglass with the volume of 900 mL. During the experiments, temperature, conductivity and pH of the solutions were measured by a multi-parameter (WTW Multiline P-4 F-Set-3). Reactor was operated in batch and galvanostatic mode. Figure 1.



1.Water Cırculator 2.Digital D.C Power Supply 3.Digital Ampermeter
4.Digital Voltmeter 5.Electrochemcial Reactor 6.Digital Magnetic Stirrer

Figure 1. Schematic diagram of the experimental setup.

2.3. Brief description of electrocoagulation mechanism

Electrocoagulation is based on the in situ formation of the coagulant as the sacrificial anode corrodes due to an applied current, while the simultaneous evolution of hydrogen at the cathode allows for pollutant removal by flotation. This technique combines three main interdependent processes, operating synergistically to remove pollutants: electrochemistry, coagulation and hydrodynamics. An examination of the chemical reactions occurring in the electrocoagulation process shows that the main reactions occurring at the electrodes are:
When iron is used as electrode material, the reactions are as follows.

• At the cathode:

$$3H_2O + 3e^- \rightarrow 3/2\ H_2(g) + 3OH^- \quad (1)$$

• At the anode:

$$4Fe(s) \rightarrow 4Fe_2{+}(aq) + 8e^- \quad (2)$$

• and with dissolved oxygen in solution:

$$4Fe_2{+}(aq) + 10\ H_2O\ (l) + O_2(g) \rightarrow 4Fe(OH)_3 + 8H{+}(aq) \quad (3)$$

• overall reaction:

$$4Fe(s) + 10\ H_2O(l) + O_2(g) \rightarrow 4\ Fe(OH)_3(s) + 4\ H_2(g) \quad (4)$$

2. Result and discussions

The effects of parameters: In the runs, it has been investigated the effects of parameters such as initial pH and current density under the conditions which the reaction time, temperature of solution and stirring speed hold in constant.

The effect of pH: It has been established that the pH has a considerable influence on the performance of electrocoagulation and reduction process. To evaluate this effect, a series of experiments were performed, using solution containing cadmium of 100 mg/L. The effect of pH on the cadmium removal was examined at 3.0, 4.0, 5.0 and 6.0 pH's. Solution temperature of 293 K and stirring speed of 100 rpm were kept constant in the experiments. The results of the experiments conducted to examine the effect of pH are shown in Figure 2.

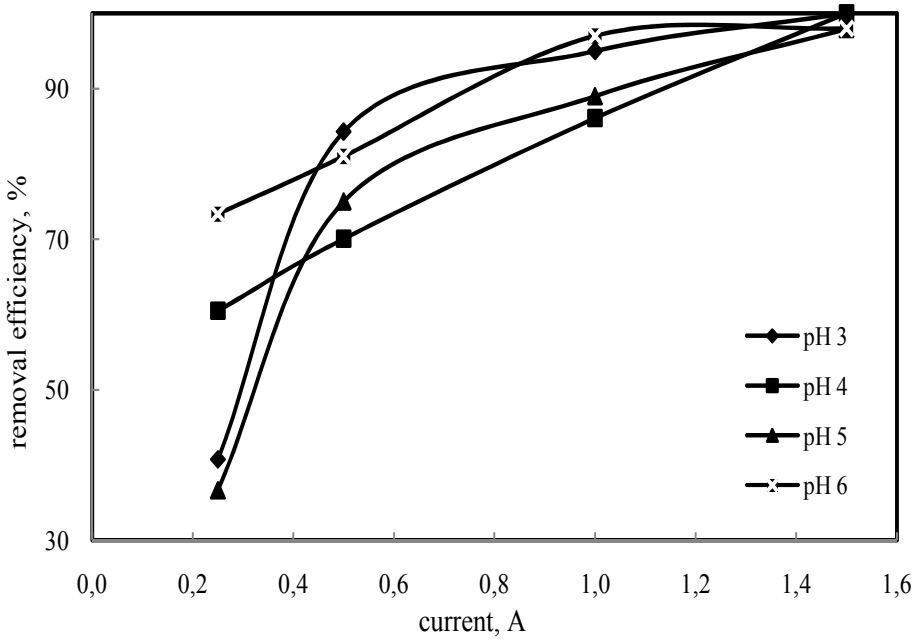


Figure 2. The effects of solution pH on cadmium removal (100 rpm of stirring speed, 293 K of solution temperature and 100 mg/L of initial cadmium removal)

As seen in Figure 2, while there had effects of pH variation on cadmium removal efficiency, the effects of pH variation were not important with increasing current density. At the lower current density, solution pH had effects on cadmium removal efficiency. When cadmium removal was investigated by electrochemical process, energy consumption values obtained in the system. Energy consumption values in the electrochemical reactor related to solution conductivity. The conductivity of an electrolyte solution is a key property. In an electrochemical process, the conductivity determines the cell resistance while the properties of solvent and electrolyte determine their interaction with the electroactive species and thereby influence the electrode reactions. The results obtained for energy consumption were shown graphically in Figure 3.

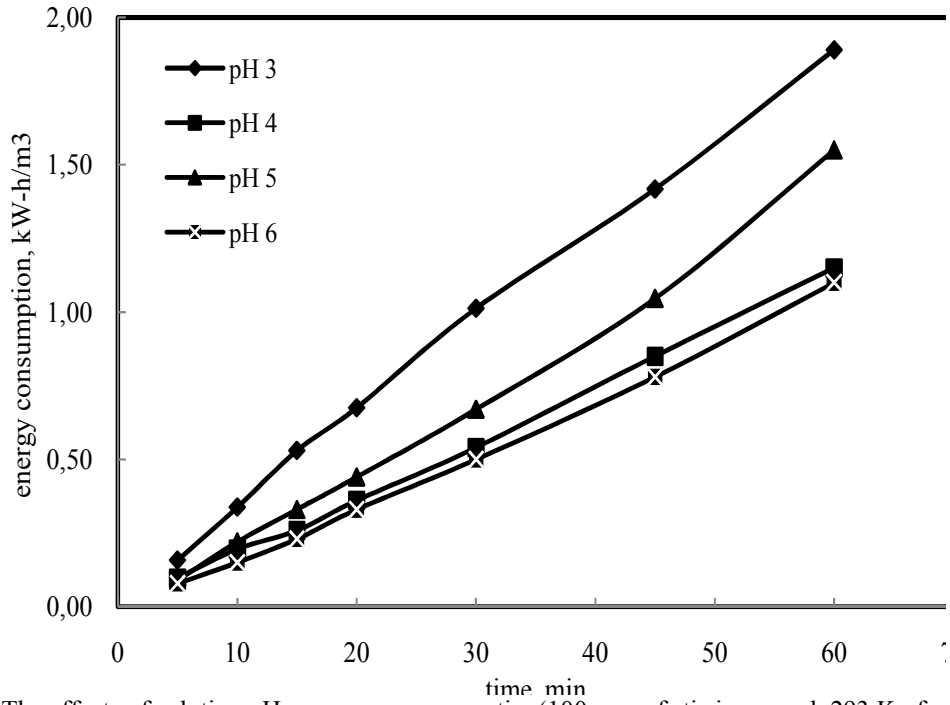


Figure 3. The effects of solution pH on energy consumption(100 rpm of stirring speed, 293 K of solution temperature, 0,5 A of current and 100 mg/L of initial cadmium removal)

The effect of current density: The effect of current density on cadmium removal by electrochemical process using iron plate electrodes was investigated using 100 mg/L Cd^{+2} and pH 5. Effects of current density on system parameters have been analyzed. Variation of cadmium removal efficiency versus time and variation of energy consumption versus time in various current densities with iron plate electrodes is shown in Figures 4-5.

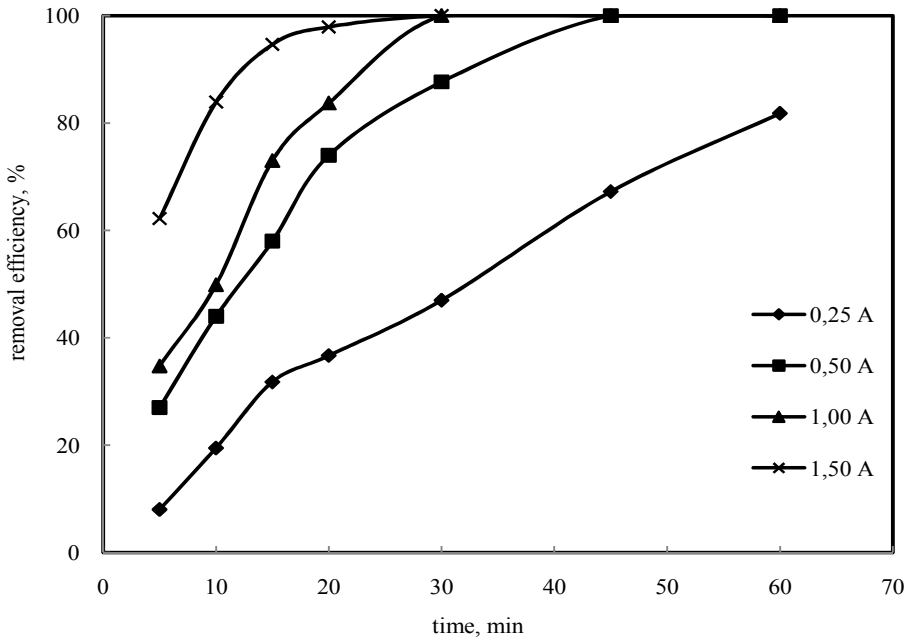


Figure 4. The effects of current on removal efficiency (100 rpm of stirring speed, 293 K of solution temperature, pH 5 of solution and 100 mg/L of initial cadmium removal)

As seen in Figure 4, efficiencies of cadmium removal and removal rate have increased by increasing current density. The removal efficiency depends on the quantity of iron generated, which is related to the time and the current density. It is seen that system energy consumption has mainly increased over a specific current density, respectively.

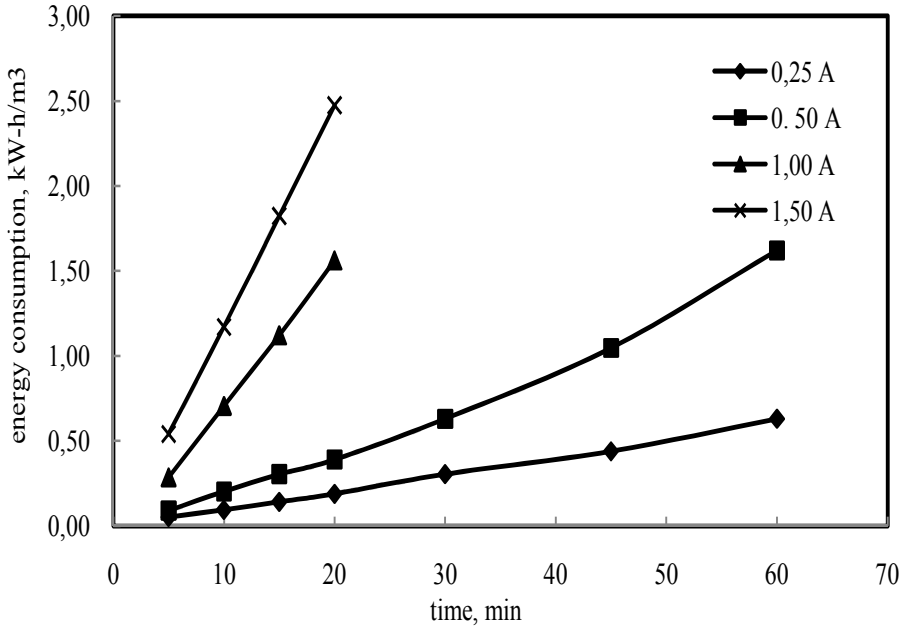


Figure 5. The effects of current on energy consumption (100 rpm of stirring speed, 293 K of solution temperature, pH 5 of solution and 100 mg/L of initial cadmium removal)

Since applied potential have increased by increasing current density**,** system energy consumption has increased. Although potential and current have linearly increased, energy consumption has exponentially increased. Thus, when it has been studied in high current, this state might be taken into consideration. Besides, when it is studied on high potential and current, electrode reactions have taken one's way to secondary reactions from major reactions. Thus, when optimal current density and potential are selected, either high removal rate or low energy consumption might be taken into account.

4. Conclusions

In this study, effects of solution pH and current density on cadmium removal by electrochemical process using iron plate electrodes were investigated and effects of these parameters on system parameters were analyzed. When lower current density was applied to electrochemical process, solution pH must taken into consideration. In the experiments, effects of current density on cadmium removal by electrochemical process were investigated. According to results obtained from the experiments, removal rates and removal efficiencies have increased by increasing current density using iron plate electrodes. But system energy consumptions have increased by increasing current density.

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An Evaluation of Biological Treatment Methods Used in Olive Mill Wastewaters

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Abstract: Olive mill wastewater (OMW) is produced seasonally by a large number of small olive mills scattered in Mediterranean countries. It has a high environmental impact because of the concentration of its pollutant content and the quantity of waste water produced. OMW contains high amounts of organic, inorganic and polyphenols. It affects the water and soil quality, is toxic to plant life, and create odor nuisance when disposed into the environment. The main problem regarding the disposal of OMW is to find an environmentally friendly and economically viable solution. Among the various techniques proposed, biological treatment appears to be convenient from the economic point of view. The biological treatment of OMW is quite difficult since it contains many complex substances, mostly when more easily degradable carbon source is present in the medium. Several biological treatment systems have been examined for the treatment of OMW, resulting in considerable organic load and toxicity abatement. The present work aims to provide an updated review of the current biological methods used in OMW treatment.

Keywords: Olive mill wastewater, OMW, biological treatment, aerobik systems, anaerobic systems

Introduction

Mediterranean countries produce more than 98% of the world's olive oil, which is estimated at over 2.5 million metric tons per year. About 75% is produced in the European Union (EU) (McNamara et al., 2008). Olive oil mills are small agro-industrial units located mainly around the Mediterranean, Aegean and Marmara seas that account for approximately 95% of the worldwide olive oil production (Ergüder et al., 2000). In the olive growing countries of the Mediterranean area (Greece, Italy, Lebanon, Portugal, Spain, Syria, Tunisia and Turkey) olive oil mill effluent production is more than 30 million m^3 per year (Beccari et al., 1996). Olive mill wastes are a significant source of potential or existing environmental pollution in these countries (Bejarano et al., 1992). The difficulties of treatment of olive mill effluents are mainly related to high organic loading, seasonal operation, high territorial scattering, and the presence of organic compounds which are hard to biodegrade such as long-chain fatty acids and phenolic compounds.

Olive oil mill wastewater (OMW) is formed from the water content of the fruit and water used in washing and processes of olive oil extraction. The composition of OMW widely depends on the type of process involved in obtaining the oil. OMW are dark-colored wastes and contain high amounts of many complex substances that are not easily degradable (Borja et al., 1993; Sorlini et al. 1986). Generally, OMW can be treated by conventional biological treatment methods or can be utilized as fermentation raw material for the production of value added microbial products. However, this OMW also contains high concentrations of phenolic compounds which inhibit microbial activity. This makes biological treatment or microbial fermentation difficult (Massadeh and Modallal, 2008).

The uncontrolled disposal of OMW is becoming a serious environmental problem, due to its high organic COD concentration, and because of its high content of microbial growth-inhibiting compounds, such as phenolic compounds and tannins. The improper disposal of OMW to the environment or to domestic wastewater treatment plants is prohibited due to its toxicity to microorganisms, and also because of its potential threat to surface and groundwater (Ramos-Comenzana et al., 1996, Shaheen and Karim, 2007). When OMW are disposed into the environment, they create odor, color and increased oxygen demand in water bodies. They also affect the soil quality and plant life. Therefore, discharge of OMW into receiving media is not permissible unless treatment.

Olive oil production and wastewater generation

The basic steps in production of olive oil are always the same. Batch and continuous processes are the main methods used in the system. The first step in the oil production process is cleaning the olives and removing the stems, leaves, twigs, and other debris left with the olives. The second step is produced olive oil by crushing olives and extracting the oil by stone mills, metal tooth grinders, or various kinds of hammer mills or chemical means (Dalis et al. 1996). The olive paste generally stays under the stones for 30 to 40 minutes. The purpose of crushing is to tear the flesh cells to facilitate the release of the oil from the vacuoles. Mixing the paste for 20 to 45 minutes allows small oil droplets to combine into bigger ones. The paste can be heated or water added during this process to increase the yield, although this generally results in lowering the quality of the oil. The next step consists in separating the oil from the rest of the olive components (Azbar et al. 2004). This used to be done with presses and centrifugation except in old facilities. The oil is then left in tanks or barrels where a final separation. Sometimes the produced oil will be filtered to eliminate remaining solid particles that may reduce the shelf life of the product.

Finally, possible additional processing steps include refining the oil to reduce its acidity and improve flavor by alkali or steam processing; bleaching the oil to reduce chlorophyll, carotenoids, residual fatty acids, and pesticides using kieselguhr, activated carbon, or synthetic silica treatment, and deodorization to reduce odors with the use of activated carbon. The olive oil production processes are summarized in Figure 1.

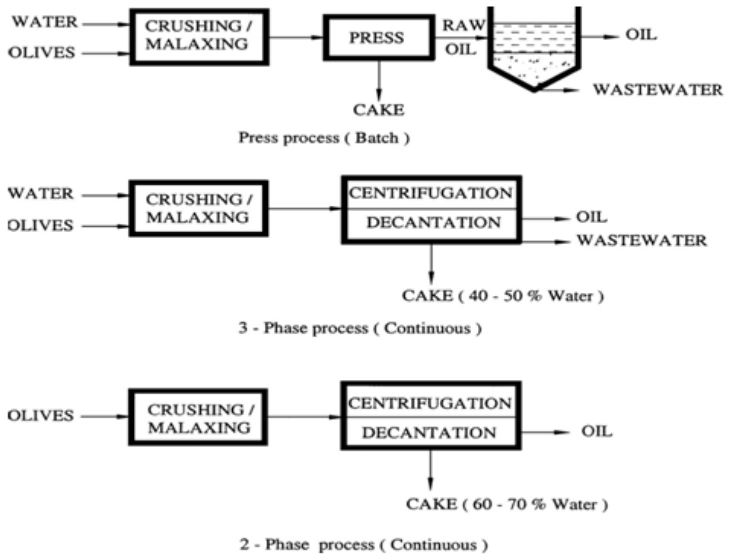

Figure 1. Olive oil production processes (Azbar et al., 2004).

The remaining paste still contains a small quantity (about 2-6%) of oil that cannot be extracted by further pressing, but only with chemical solvents. This is done in specialised chemical plants, not in the oil mills. Olive oil production processes mainly differ in the process water requirements. A two-phase plant involves two phases and much less additional water is used than in the three-phase process. Generally, one tone of olives

yields one/two tones of OMW, according to the oil extraction process used. The continuous process uses about 2 L of water for kg of olives while the discontinuous one requires much less. Although the composition is dependent on the process used, the olive mill wastewater is a stable emulsion constituted by ‘‘vegetation waters’’ of the olives, water from the processing, olive pulp and oil.

Parameter	Conventional press process	Three-phase process
pH	4.5–5.0	4.7–5.2
Total solids, %	12	3
Volatile suspended solids, %	10.5	2.6
Mineral suspended solids, %	1.5	0.4
Suspended solids, %	0.1	0.9
Chemical oxygen demand, g/L	120–130	40
Biochemical oxygen demand, g/L	90–100	33
Sugars, %	2–8	1.0
Total nitrogen, %	5–2	0.28
Polyalcohols, %	1.0–1.5	1.0
Pectin, tannin, %	1	0.37
Polyphenols, %	1.0–2.4	0.5
Oil and grease, %	0.03–10	0.5–2.3

Table 1. Characteristics of Wastewaters (Azbar et al., 2004)

An estimated 10–30 million m^3 of OMW is generated every year from the production of olive oil. The organic fraction of OMW includes sugar, tannins, polyphenols, polyalcohols, pectins and lipids (Capasso et al., 1995). Most of the problems associated with OMW pollution can be attributed to the phenolic fraction. More than 30 different phenolic compounds have been identified in OMW and the types and concentrations of phenolics reported in OMW vary tremendously. In fact, phenolic compounds are responsible for several biological effects, including antibiosis and phytotoxicity (Dalis et al. 1996). The antimicrobial activity is principally due to phenolic compounds such as tyrosol and hydrotyrosol. Another negative property of OMW is its extremely high organic content. Generally OMW has BOD values ranging between 12,000 and 63,000 mg/L and COD values between 80,000 and 200,000 mg/L. These concentrations are approximately 400 times higher than municipal sewage (Al-Malah et al., 2000). As microorganisms present in the environment consume these materials, oxygen will be depleted from the water with adverse effects on the aquatic media. Common disposal practices for OMW include direct discharge into soils or streams and use of evaporation ponds or lagoons. (Al-Malah et al., 2000; Galli et al., 1997).

Biological treatment processes

Treatment processes must be efficient, allow for easy and economical operation in small-scale farm settings, and consider the seasonality and the distribution of olive oil production. Therefore, a variety of biological methods (e.g., aerobic or anaerobic bioreactors, composting) and microorganisms for treatment of OMW have been tested, and reviewed by many researchers to remove the dark coloration, reduce the organic load and remove phytotoxic compounds (Capasso et al. 1995).

Aerobic processes

Aerobic biological processes are commonly used in the treatment of organic wastewaters for achieving high degree of treatment efficiency, while in anaerobic treatment, considerable progress has been achieved in anaerobic biotechnology for waste treatment based on the concept of resource recovery and utilization while still achieving the objective of pollution control (Chan et al. 2009). Using a simple aerobic treatment for OMW is not effective because of the its characteristics. However, biological treatment is possible when a combination of aerobic and anaerobic methods is applied, especially when it is diluted with municipal wastewater.

A number of different aerobic microorganisms have been tested in aerobic processes to treat OMW, including *Bacillus pumilus*, *Arthrobacter* sp., *Azotobacter vinelandii*, *Pseudomonas putida* and *Ralstonia* sp. and various bacterial consortia (McNamar and et al., 2008). Several studies of aerobic degradation of OMW have focused on *A. vinelandii*. For example, Papadelli et al. (1996) isolated a strain of *A. vinelandii* from soil treated with OMW. Eventually, 490% removal of phytotoxic compounds from OMW was achieved using this strain (Ehaliotis et al., 1999; Piperidou et al. 2000).

A number of studies have also utilized bacterial consortia coming from activated sludge, commercial communities, soil, and wastewater. Bioremediation of OMW using aerobic consortia has been quite successful in these studies, achieving significant reductions in COD (up to 80%) and the concentration of phytotoxic compounds, and complete removal of some simple phenolics.

Aerobic treatment has been also carried out in the presence of various strains of fungi such as white rot fungi (including the edible mushrooms *Lentinula* and *Pleurotus*), *Basidiomycetes* sp. and *Aspergillus niger* and several different yeasts. In addition to reduction of COD and removal of simple phenolics, fungi are also effective at reducing coloration of OMW. The different biological treatments lead to very variable reductions in COD and polyphenol levels depending on the performance of the strains selected for use.

Anaerobic processes

The anaerobic digestion is a biological process in which a complex community of microorganisms work in a stable, self-regulating steady state converting waste organic matter into a mixture of carbon dioxide and methane gases (Kaspar and Wuhrmann, 1978; Zeikus, 1980; Gujer and Zehnder, 1983; Speece, 1983; Sterling et al., 2001). Anaerobic treatment is considered as a cost-effective alternative, if compared to aerobic treatment especially for high organic industrial wastewater. Anaerobic digestion has a great number of advantages: low nutrient requirements, energy savings, generation of low quantities of sludge, excellent waste stabilization, production of biogas (methane) without the requirement of pre-treatments of the residues (Kang and Weiland, 1992; Weiland, 1993; Yadvika et al., 2004).

OMW is an effluent of the olive oil extraction process. The large volumes involved, along with the high phenolic content and chemical oxygen demand, cause major environmental problems. However, the seasonal production and high organic loading of OMWs make anaerobic treatment a very attractive option for these wastes. Furthermore, production of much less biosolids (sludge) and biogas as a valuable end product, which may offset the associated treatment costs, further add to the positive aspects of anaerobic treatment (Ergüder et al., 2000). Anaerobic digestion processes produces useful energy and result in a net reduction in CO_2 emissions. Another advantage of anaerobic digestion is that a digester can be started up after more than eight months under non-feeding conditions (Tsonis and Grigoropoulos, 1993), and is thus suitable for the treatment of seasonal wastes such as OMW. The low rate anaerobic sludge blanket type reactor is considered as the most efficient anaerobic reactor for the treatment of OMW.

Anaerobic digestion is usually the basic biological process for OMW treatment since it has many advantages compared to aerobic treatment. These include no aeration requirements, lower sludge production, lower nutrient requirements, the production of methane gas, and the quick recovery of anaerobic systems that have been dormant for a long time (Droste, 1997). The last point is particularly important, as the treatment unit will be without wastewater for about 8-9 months.

In the last decade, most of the research conducted on OMW treatment has been focused on the use and development of anaerobic methods and bioreactors that can remove efficiently the high organic load (Boari et al., 1984; Borja et al., 1992; Hamdi, 1995; Andreozzi et al., 1998) as well as reduce the toxicity of microorganisms-inhibiting materials present in OMW (Paredes et al., 2001). It has been reported that anaerobic bacteria decompose organic materials in a three-stage process emman et al., 1997). In the first stage, anaerobic bacteria degrade complex organic materials into simpler compounds; namely, polysaccharides and polyphenols are converted to their monomers (monosaccharides and phenols, respectively). During the second stage, acetogenic bacteria convert the phenols and the monosaccharide into organic acids, such as acetic, lactic and formic acids and alcohol. Finally, in the third stage, methanogenic bacteria, which are characterized by their sensitivity to pH, convert the organic acids into biogas (a mixture of 60–80% methane and other gases, mainly carbon dioxide).

The presence of compounds toxic to methanogens in OMW appears to be a significant problem for anaerobic digestion of OMW. The presence of phenolics limits the effectiveness of aerobic or anaerobic treatment of this wastewater. Minimising the effects caused by high concentration of phenolics, OMW must be diluted prior to either aerobic or anaerobic processes. Although dilution decreases the concentration of the toxic compounds present in wastewater, making it easier to reach the required standards for the final effluent, it also causes an increase in waste volume, which is not desired (El-Gohary et al., 2009).

A lot of researches were made for the anaerobic treatment of OMW in the literature. Some of them was summarized in here: For example, Boari and Mancini (1990) studied the biological treatment of olive mill effluent wastewater. They studied the effect of sedimentation, coagulation, followed by aeration. They also studied BOD, COD, and suspended solids as main parameters and found that the removal percentage of organics was higher than 90%. Their results using anaerobic digesters showed 70% removal of COD, and more economical operation. Hayek et al. (1996) reduced the COD by 75% using upflow anaerobic sludge blanket (UASB) reactor.

Ergüder et al. (2000) reported that OMWW could be treated anaerobically with high efficiencies (85.4–93.4%) and treatment of 1 L OMWW by anaerobic methods resulted in production of 57.1±1.5 L of methane gas

(i.e. 413 mL of methane gas was produced from degradation of 1 g of COD found in olive mill waste water). Authors concluded that olive mill wastes can be treated under anaerobic conditions leading to production of biogas in significant amounts.

Reductions in COD from 70% to 89% have been reported for anaerobic processes (Borja et al., 1996; Marques et al., 1997; Marques, 2001). In addition to a substantial reduction of COD, Dalis et al. (1996) reported large reductions (475%) in the concentrations of both toxic phenols and volatile fatty acids using a two stage anaerobic reactor with an inoculant obtained from a domestic wastewater facility. In contrast, other studies have reported that the build up of recalcitrant phenolics (e.g., condensed tannins, Zouari and Ellouz, 1996) as well as the presence of long-chain fatty acids (Hwu and Lettinga, 1997) in anaerobic reactors inhibited microbial activity.

Subuh (1999) has conducted anaerobic digestion of OMW using laboratory scale Up-flow Anaerobic Sludge Blanket (UASB) reactor. He proved that removal efficiency of the soluble fraction of COD reached 76% using the UASB. Sabbah et al (2001) have evaluated different techniques for the treatment of OMW including aerobic and anaerobic combined with physical treatment methods. Different types of reactors were checked such as stirred-tank reactor, fluidized-bed reactor, and UASB reactor. UASB has showed a promising technique for anaerobic treatment of OMW.

The anaerobic wastewater treatment processes have been tested for the treatment of olive mill effluents in pilot scales. They have been tested in large scales as well, but only in combination with aerobic processing. A multistage system with first an anaerobic stage and a sequential aerobic treatment stage has been investigated by Steegmans (Steegmans, 1987). Sabbah et al. (2001) found that removal of the phenolic compound and possibly other toxic materials that inhibit the growth of microorganisms using in the primary treatment step contributes significantly on increasing the efficiency of anaerobic digestion.

Anaerobic digestion of unmodified OMW have been concerned with problems such as high toxicity and low biodegradability and acidification of the reactor (Boari et al. 1984; Borja et al. 1992). However, the efficiency of anaerobic digestion was increased when preceded by a pretreatment step. Several treatment methods can be used as pretreatment of OMW such as physical (flotation, membrane seperation, gravitty settling, ultrafiltration, centrifugation, coagulation etc.) and chemical (such as fenton oxidation processes) and biological (aerobic, composting). For example, pretreatment of OMW by previously aerobic fermentation with Aspergillus niger (Martin et al., 1991) and Geotrichum candidum (Beccari et al., 1999) could reduce residence time required for anaerobic process. Selective preremoval of inhibitors such as lipids and poly phenols through lime or lime/bentonite addition followed by phase separation before anaerobic digestion as a chemophysical treatment has been studied (Box, 1983). Similarly, Azbar et al. (2008) compared the methane production in an anaerobic digester fed with either raw or chemically pretreated OMW. They found over 80% increase in biogas production when digesting OMW after chemical pretreatment. Accordingly, it has been concluded that, the anaerobic biodegradability of OMW could be significantly enhanced by chemical pretreatment. El-Gohary et al. (2009) reported that an integrated system consisting of catalytic oxidation using Fenton's in combination with a two stage anaerobic post-treatment (classical UASB followed by hybrid UASB) is recommended for treatment of olive mill wastewater. The use of Fenton's reaction as a primary treatment of OMW enhances the efficiency of anaerobic digestion.

Conclusion

Generation of OMW in the Mediterranean region has a significant environmental impact and the high organic polluted OMW affects the soil, groundwater and watercourses. Besides, the seasonal nature of olive oil production, the geographic dispersion of mills and economic limitations for cost effective treatment all present significant challenges in designing treatment options for OMW. However, OMWis not managed properly, due to the fact that there is at present no reliable management plan. Therefore, a shift in current management schemes is required that focuses on both the sustainable conservation of water resources in the Mediterranean region and on the development of a cost-effective management method for OMW. Overall, the incorporation of biological processes provides some of the most viable options for the treatment of OMW. Effective treatment methods will be resulted in significant reductions in COD, phenolics and color allows safe and economical disposal of OMW onto land or into surface waters.

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Determining The Morphological and Yield Characteristics of Melon (Cucumis melo L.) Landrace From Canakkale-Turkey

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Abstract : This research has been carried out in order to determine some morphological and yield characteristics of melon landrace (Hirsiz kaciran) grown in Canakkale. Research was laid out in randomized block design with four replications and 20 plants in each replication. *Cucumis melo* L. cv. Kırkagac-637 was also used as control cultivar. In addition to fruit and yield charactreristics seed germination tests were also performed. According to data; fruit weight, fruit diameter, total soluble solids of Hırsız Kaciran landrace was found as 1186,15 g, 126,5 mm and 8,4% respectively.

Keywords : Melon, landrace, yield

Introduction

Melon takes part in Cucurbitaceae family is evaluated as cold fruit rather than main foodstuff. Little fruits of melons take an important place in pickle industry. Anotolia, Iran, Afganistan, Middle Asia and Soutwest Asia is admitted as origin centers of melon. Wild types of melons are seen in this region. Melon was taken to the European countries taking from Van region by the Roman missioners (Vural et.al. 2000). Melons are classified up to their fruit shapes, skin colours, flesh colur, fleshe firmness, their aromas and cavity of seeds. Production of melon is approximately 20 millions tonnes in the world and China achieves 6.6 millions tonnes and Turkey takes part in the second line with the 1.8 millions tonnes production in 103.000 hectares area. Melon is produce relatively with local populations and open polinated cultivars while hybrids use in greenhouse and irrigated lands. In Turkey, melon cultivars consists of raund Kırkağaç (60%), elipse Kırkağaç (%30-35) and Yuva-Hasanbey (%5-10). Production of seeds are recieved 37.150 kg in local open polinated and 2.302 kg in hybrids in Turkey in 2007. On the other hand importation of seeds was made 5400 kg in open polinated types and 3288 kg in hybrid types in 2007 (Ünlü et. al., 2007). While mature fruits of melon is consumed freshly, there are also some other source of consuming. They are consuming as ice-cream, consuming as drink mixing with milk, using as essence, consuming in salads as immature, consuming in soups and as brines vegetables, using in diets because of consisting protein and vegetable oils (Anonymous, 2010).

Kaynaş et. al.(2003) carried a study out in order to determine the adaptation characteristics of melon and watermelon cultivars in Canakkale conditions. Types of watermelon used in experiment is 117 F1 and Crimson sweet and 2 melons are Topaz and Altınbaş. They reported that Topaz and 117 F1 cultivars can be suggested to region producers.

Abak (1991), made studies on devoloping melon agriculture in GAP under the circumstance of Şanlıurfa Harran plain. It is painted out the suitable types for locals establishing types, fertility and adaptation in melon.
Sarı et.al.(1994), made studies on effects on production grafted watermelon and melon in Çukurova university. She emphasis on fusarium is seen much more in ungrafted rather than grafted plots and can be seen dramatic increase in growth of fruits with using grafted seedlings .

Küçük et.al.(2002) collected samples from Kırkağaç, Hasanbey and Çinikız cultivars produced in three population in Agean region for melon selection improvement. Firstly Hasanbey population was held and the population which shows different two characters was divided into two groups and two types was asserted as

Hasanbey-1,Hasanbey-2 .Candidates of melons were determined as Kırkağaç-589 and Kırkağaç-637 up to constitutions of fruits in the lines get from Kırkağaç population. Also Çinikız-808 a new type come out from Çinikız population. Hasanbey-1, Kırkağaç-589 and Kırkağaç-637 was register as new types in 1991.

Village populations named as local types or landraces, these wild relatives, old types are not used anymore. Genetics of vegetable sources include genetics knowledge types of one plant in DNA pod and they have the quality of being source for genetic variety. These valuable source is face to be in danger with the pressures of local and the others. Protection of these is a must by the way of taking guarantee to protection of vegetables of future, future of human beings.

10000 years ago, variety of genetics which was seen in the local types carries importance of being protected these types and being used in improvement since it reflects harmony to different local condition at the same time. Types of vegetables must have genetics in order to adapt changing ambient condition.

Genetics of vegetable source are loading because of overusing of the source, genetics introductions, pollution, climate cahanges, loss, decrease, cutting to pieces of the land, development pressure and genetics erosion. Protection of genetics of vegetable source is vegetable source in their countries protects or saves genetics of vegetable source in their countries applying internetional protection strategies. Types of plants are taken under protection either in their nature or out of it in genebanks. Today and the next natural experiments has to be ready for improvements. Using wealth of biology of a country in its own progress and moving it into action needs to be determıned by its wealth. Not paying attention to this and not doing anything for short investments means the same with the destruction of economic potential which can be left the next generations.

Local populations becoming with the effects of natural selection have to be protected in order to provide maintaining agriculture. They have great importent in ecological agriculture. They are quite rich as they contain genetics and cultural specialities. They have many characteristics by the way of quality, resistance to pest and diseases and fertility.

Material and Method

The seeds of Hırsız Kacıran melon population which is produced in small areas by the local producters and consumed by families and being in local bazars in Çanakkale has been used as plant material and Kırkağaç-637 melon cultivar is as a control. Hırsız Kaçıran population was collected by the producers in Kepez county of Çanakkale.

Method

Both seeds were planted directly with randomized block design with 4 replication and 20 plants im each replication. Seeds were sown at 21st of May and each parcel is lay out in 530 m^2. In each replication of 5 plants were left for seed harvest and experiments were on 15 plants .
Before the planting, field have fertilized with manure (4tonne/da) and also 15 kg/daN (NH_4NO_3), 20kg/da P_2O_5 (TSP) and 15 kg/da K_2O (K_2SO_4) applied. At time of flowering and 8 kg/da N added to each parcel. Drip irrigated plants hoed two times before plants have 6-7 leaves.
For plant protection; all plants spreyed with fungucide against fungal diseases. Totaly four harvests done for both cultivars in experiment.

Criteria below was determined during and at the end of experiment.

- The time passing from sowing to harvest (day):
- The time passing from flowering to harvest (day)
- The time between sowing and flowering (day
- Fruit weight (g): weighing by randomly selected 5 plants in each harvest for each replication with digital balance (0,01 sensibility).
- Fruit length (mm): measuring the fruit length by randomly selected 5 plants in each harvest for each replication with strip and digital compass.
- Fruit diameter (mm): measuring the fruit diameter by randomly selected 5 plants in each harvest for each replication with strip and digital compass.
- Total Soluble Solids (%): measuring the TSS by randomly selected 5 plants in each harvest for each replication with hand refractometer.

- Flesh thickness (cm): measuring the fruit flesh thickness by randomly selected 5 plants in each harvest for each replication with digital compass.
- Seed weight (g): weighing the total fresh seed weights of randomly selected 5 plants in each harvest for each replication with digital balance (0,01 sensibility).
- Skin colur: by observation
- Skin (outher layer of pericarp) thickness (mm): measuring the fruit pericap thickness by randomly selected 5 plants in each harvest for each replication with strip and digital compass.
- Yield per plant (g/plant): weighing and added the perivious weight of randomly selected 5 plants in each harvest for each replication with digital balance (0,01 sensibility).
- Yield per decare (kg/da)

Data were subjected to ANOVA test for statistical analysis and "Minitab 13" statistical software was used for statistical analysis. Differences among the averages were tested at P=0.05 significance levels.

For germination test; Germination of seeds were carried out in petri dishes (9 cm diameter) containing two Whatman (No:1) filter paper imbibed with 8 ml of distilled water. Three replicates of 50 seeds were germinated in each seed lot. Seeds were allowed to germinate at 25 ^{o}C in the dark for 14 days. 2 mm radicle protrusion was accepted for as germination.

Cold test was carried out on each cultivars with three replications of 50 seeds were sown 4 cm deep in compost in sandwich boxes and wetted with 50 ml water. Sandwich boxes with lid on were kept at 10 ^{o}C for 7 days in the dark. They were then transferred to 25 ^{o}C and normal seedlings that appeared at the surface were counted after 10 days. High temperature germination test in each cultivar was conducted on three replicates of 50 seeds at 35 ^{o}C by the same way.

Findings And Discussion

Data for yield and some quality parameters can be seen in Table 1.All parameters on yield and yield parameters are found to be significant al 0.05 level. According to analysis; average fruit weight is found as 1186 g in Hırsız Kaçıran and 2336 g in Kırkağaç-637. Yield per plant is occured as 2901,34g and in 6126,60g Hırsız Kaçıran and Kırkağaç-637. Similarly yield on decare are found higher in Kırkağaç (1997kg/da) than in Hırsız Kaçıran (916,5kg/da). As relatively to fruit weight, fruit length and fruit dimeter are also found to be higher in Kırkağaç-637 (216,9 mm and 184,8mm) than Hırsız Kaçıran (134,6mm and 126,5 mm). For consumer demand generally larger melon and watermelon cultivars are less in atrraction. Markets for especially local and domestic bazars public concern is from the moderate sizes. From this point of view local genotype Hırsız Kaçıran landrace has an advantage although it's yield occurs less than the control plant. Total soluble solids ocur as 8,4% and 12,5% in Hırsız Kaçıran and Kırkağaç-637. Hırsız Kaçıran has low total soluble solids that means less sweet than Kırkağaç-637. Normally melon cultivars has total soluble solids between 8-15%. From this point of view it has an alternative choice for the consumers who does not like more sweets even fort he diabetics. Neverthless, flavour of Hırsız Kaçıran is very significant as compare with Kırkağaç-637. Skin thickness is measured as 2,33 mm and 7,28 mm in Hırsız Kaçıran and Kırkağaç-637 respectively. Very low skin thickness is an advantage for the consumers but vice versa a disadvantage for postharvest and transportation. Further studies must be lay out for solving this problem. Flesh thickness is obtained as 2,42and 4,29 cm for Hırsız Kaçıran and Kırkağaç-637.

Cultivar	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	TSS (%)	Seed weight (g)	Skin thickness (mm)	Flesh thickness (cm)	Yield per plant (kg/da)
Hırsız Kacıran	1186 B	134,6 B	126,5 B	8,4 B	41,98 B	2,33 B	2,42 B	2901,34 B
Kırkağaç-637	2336 A	216,9 A	184,8 A	12,5 A	54,51 A	7,28 A	4,29 A	6126,60 A
LSD	215	5,466	2,465	0,3182	3,866	0,3182	0,5032	150,5

Table 1. Statistical analysis results for yield and quality parameters

Days harvest from sowing is counted as 81,25 and 73 for Hırsız Kaçıran and Kırkağaç respectively. Although Kırkağaç reaches maturity approximately 9 days earlier than Hırsız Kaçıran, 81 day can be consider as a medium vegetation for vegetables. Besides this melon is planting as a second crop after wheat in the region. Hırsız Kaçıran can be evaluated from this point also.

Cultivar	Days to harvest from sowing (day)	Days to harvest from floweing (day)	Days to flowering from sowing (day)
Hırsız Kacıran	81,25 A	39,50 A	41,75
Kırkağaç-637	73,00 B	31,00 B	42,00
LSD	3,528	2,054	Ö.D.

Table2. Statistical analysis results for days to flowering and harvest

Skin colour, flesh colour and seed colours of observed fruits from each replacation has been lay out in Table3. Skin colour of Hırsız Kaçıran is mainly white. Skin has slices on the outher layer with green-yellow strips on the slices. Flesh colour at maturity is mainly white but around the seeds colour becomes yellow-orange. Seed colour occurs as light yellow.

Cultivars	Skin colour at maturity	Flesh colour at maturity	Seed colour
Hırsız Kaçıran	Main colur is white Slices have Green-Yellow colour	Main colour is white, seed cavity around is; yellow –orange	Light yellow
Kırk Ağaç-637	Main colour is yellow, have randomly black spots on it	Light green- white, seed cavity around is; orange	Yellow

Table 3. Skin colour, flesh colour and seed colour of Hırsız Kaçıran and Kırkağaç-637

Seed width, seed length, hypocotyl radicula ratio adn 1000 seed weight of tested plants can be seen in Table 4.

Cultivar	Seed width (mm)	Seed length (mm)	1000 seed weight (g)	Hypocotyl/Radicula ratio (H/R)
Hırsız Kaçıran	10,405	4,55	37,3	5,18
Kırkağaç-637	11,825	4,82	41,63	6,72

Table 4. Seed width, length hypocotyl/radicula and 1000 seed weight of tested plants

From the harvested fruits means of a thousand seed weight is calculated as 37,3 g while the seed width and length is 10,404 and 4,55 mm respectively. At germinated seedlings hypocotyl radicula ratio is calculated as 5,118.

Selected fruits before seed harvest, harvested and seeds seperated by hand. Seperated seeds washed under tap water and then dired at incubator until the seed humidity levels reaches to 10%. Standart germination, cold and heat tests performed on the harvested seeds. Results can be seen in Figure 1 and 2.

According to results; standart germination means are 92,5% and 96,5% for Hırsız Kaçıran and Kırkağaç-637. Cold test results are 48,5% and 57% while heat test are 63,5% and 71,5% for Hırsız Kaçıran and Kırkağaç-637 respectively. Hırsız Kaçıran has also moderate tolerance to low and high soil temperatures and it can be grown in a long period during the months (May-October).

Hırsız kaçıran is a local landrace for Canakkale and its province. So it has a well adaptation especially for the region ecological situations. Wheras open pollinated and hybrid cultivars claimed to be more resistant to pest and diseases and also more productive. Landraces are found in areas where crop species first arose through domestification, Turkey also lies within the board region of domestification of several crops. Therefore, there are highly variable domesticated crops as well as landraces with unique characteristics in Turkey. Introducing the new crops, nitrogen fertlizers and increase in commercial trades in agriculture reduce the ratios of landrace productions. Sustainable development requires human beings to raise and improve their quality of life in harmony with and by conserving the balance of ecosystems, they are part of and which supply the fundamental support to sustain their lives. The development of new and innovative policies fort he sustainable use of biodiversity necessitates, foremost, a fundamental revision of national land-use policies and an earnest change in national policies concerning agriculture, animal husbandry, employment and health. In this regard endangered species, endemic species, their ecosystems and natural habitats must be protected. The relationship between species conservation and sustainable development is important for biodiversity. The market prices of endangered species, especially those which are of economic value, are high because of scarcity (Tüzün and Sezer, 2002; Tan,1996). Most of landraces maintain a high level of genetic heterogenity. This will be a key role for the further studies.

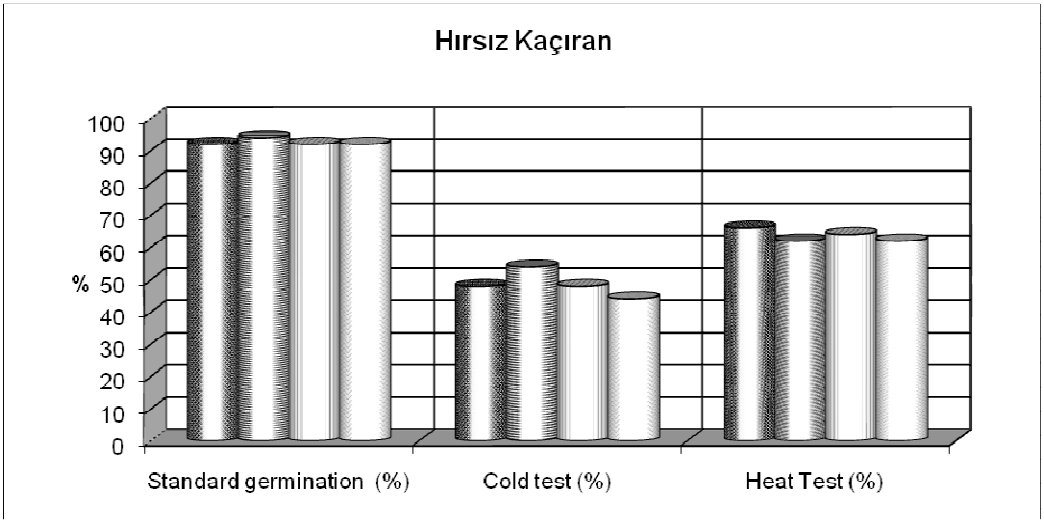

Figure 1. Mean values of germination, cold and heat tests of Hırsız Kaçıran

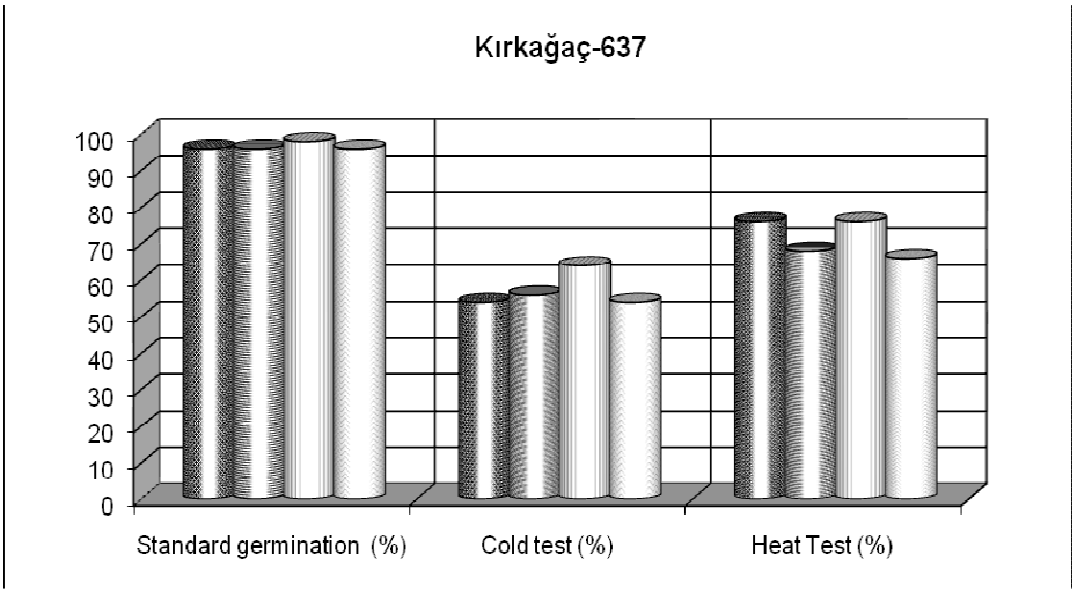

Figure 2. Mean values of germination, cold and heat tests of Kırkağaç-637

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Rural women in terms of education, sustainable development and agricultural Extension in Konya, Turkey

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Abstract: The overall purpose of this study was to examine factors influencing accessibility of women to agricultural Extension services in Konya. The second purpose of the study was to investigate specific needs and interests of women. In basis of the rural development, between the city and countryside, socio-cultural and reaching optimum level of economic differences, rural population to improve themselves in their rural area, in addition to that, the real women's effect on manufacturing and the improvement in social status has not been performed yet. Because, in Turkey, rural development practices are mostly done to improve the basis facilities, canalizing the new technologies to agriculture, modernizing the agriculture to take form to shape the improve the life standard. However, we can also see women in every part of agricultural production. When the criteria of education is taken care that bearer ring the importance of women's status, especially, there exist importance for education services that must be taken to women who live in the rural areas. Increasing in the women's education level, also increase in the participation level of the labor force.
This research used multi-method research approach that combined interviews by the questionnaire, participant observation, focus group interviews, document evaluation. Also, while 11.78% of farms are not in question, now they enforce as producer activities under cover. Rural women need to be informed as education, research, health, family planning, spread for the further generations, to provide them enough income and food secure.

Keywords: rural women, Turkey, Education, Agricultural Extension

Introduction

It examines the specific activities in which women participate, and investigates the way that this participation varies based on factors such as age, marital status, location and household structure. The research finds that women provide an important, and often underestimated, source of human capital for household livelihood strategies. In spite of women participate in household livelihoods in reality; the research illustrates the limited control and decision-making power that women have in agricultural pursuits. Widows enjoy the greatest autonomy; however they are most vulnerable due to inadequate Access to resources and human capital. Agriculture is the very backbone of the central government's plan to foster reconstruction and revitalization of the Turkish economy.

While rural women's contribution to agricultural and livestock production is well-documented, they have little or no access to productive inputs to enhance their economic participation in these sectors. Evidence based on national level data indicates that women's participation in agricultural activities is constrained by the lack of land and other assets [Sathar and Desai (1994)]. Contrary to the general view, women belonging to households that own land or other assets have a higher labor force participation rate than landless women. While landless women are more likely to work as agricultural laborers, however, the demand for wage employment is seasonal; limited to a few activities and certain regions, and their lack of assets to work with excludes any possibility of self-employment. Findings of village level research indicate a wide gap between the technology used by rural women

and the more efficient practices in livestock production, which is attributed to their lack of contact with extension services and to their lack of resources to adopt more efficient methods of livestock care [Haque (1986)]. In agricultural communities the development of viable solutions for dealing with economic, social and environmental problems is placed in jeopardy through numerical shrinkage of this section of the population. Agriculture is still an important activity in country areas, even in the most developed countries. In the southern regions of Europe such as Greece where the economy is distinctly agricultural in character, farming is the most important employment sector in the countryside. The devaluation of farming as a profession and the generally negative stance of young people, particularly young women, towards the prospect of farm employment or integration through marriage into a farming household is already well-documented (Gasson and Errington, 1993; Fonte et al., 1994; Dahlstrom, 1996; Gidarakou, 1999).
There is clearly a strong need to raise women's knowledge of efficient management practices and to facilitate their access to necessary resources. These interventions are essential not only because of their likely beneficial effect on women's economic autonomy, but also to meet the sector's objective of raising farm and livestock production. In agriculture sector, women have been striving the agricultural activities and besides their house-works. Women are drawers in agricultural development for Turkey. If the women who get good education, could be affect her husband and children, she can also be very sensitive about their agricultural environment (Oguz, 2009) This study also described the characteristics of women's farming and conservation groups, their tasks, objectives problems, and proposed solutions, and the content and implementation of Extension programs that promote increased food production and conservation at the local level.

Material and method

The main material that is used in this research is obtained from the questionnaire that is applied to the via inquiry from 50 volunteer women who are in the extent of leader farmer project in 12 village in Konya. Also some secondary data such as reports and statistics were used to facilitate and to support the research. This research is the secondary part of our previous study called as "The Role and the Importance of Women in Agricultural Production in Rural Area of Konya" in 1997 and the inquiry applications were realized in August-September months of 2009. The "judgement sampling" method was used in selecting the villages. Agricultural production techniques, economic structure and distribution of farms were taken into consideration as criteria in representing the village. The women's were selected randomly and those who are willingly and voluntarily cooperate with the researches were interviewed. Farms samples were investigated in 3 separated groups; there were 17 enterprises in 1-50 decare enterprise group, 15 enterprises in 50-100 decare enterprise group and 10 enterprises in 101-+ decare enterprise group. Appropriate computer programs will be used in the analysis of the data. Their levels of satisfaction, relevancy, quantity or quality using a four or five point scale;1=Very Low, 2=Low, 3= Medium, 4= High, and 5= Very High. Additionally, the respondents were asked questions related to their demographic characteristics. These items incorporated b both open-ended and closed type of questions.

Rural women in sustainable Agriculture

Rural and farm women are generally among the most disadvantaged groups of a population, yet they play a key role in agriculture and rural development. The farms of Turkey have obtained a family business and small scale. Day to day, youths are not interesting in agriculture in the developing countries like Turkey. Almost 8 millions employee work in agriculture and about 60% of them are female in Turkey. In agriculture sector, women have been striving the agricultural activities and besides their house-works. Women are drawers in agricultural development for Turkey.
There is widespread agreement that rural women in World play an important role in agriculture (figure 1). From 1950 to 2010 agricultural population are rising in the world and also, share of agricultural population are rising of developing countries.

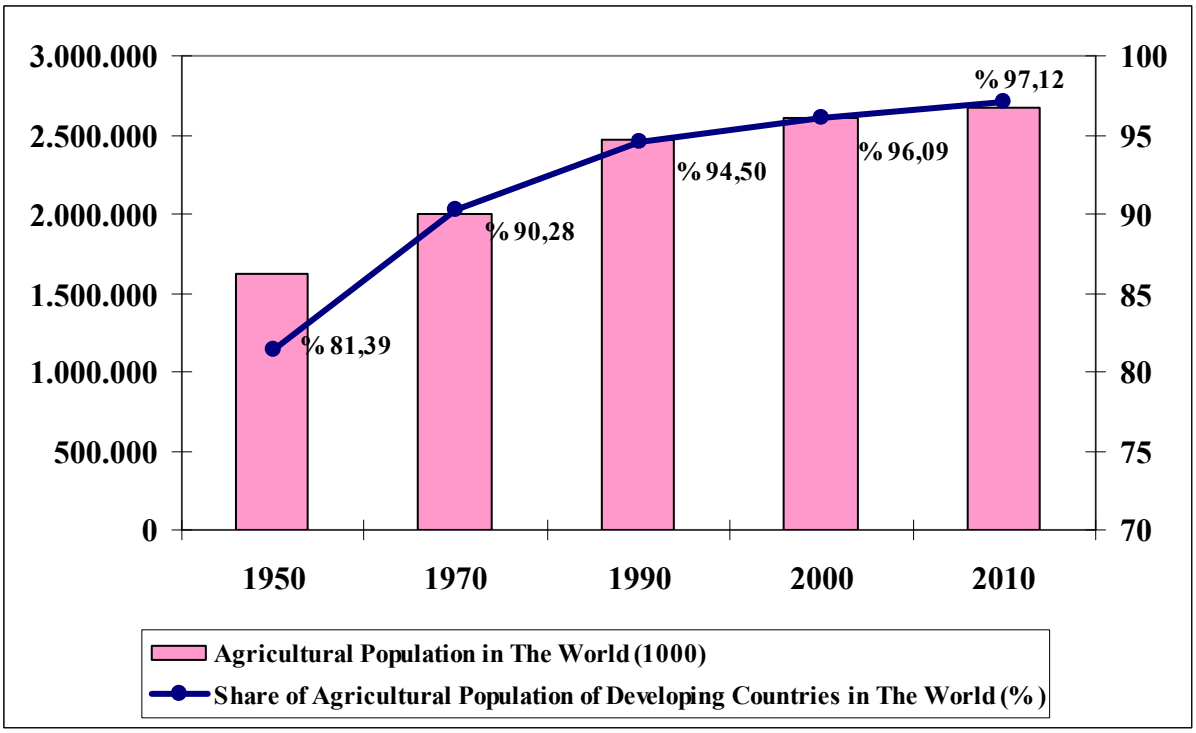

Figure.1 Agricultural Population in the World

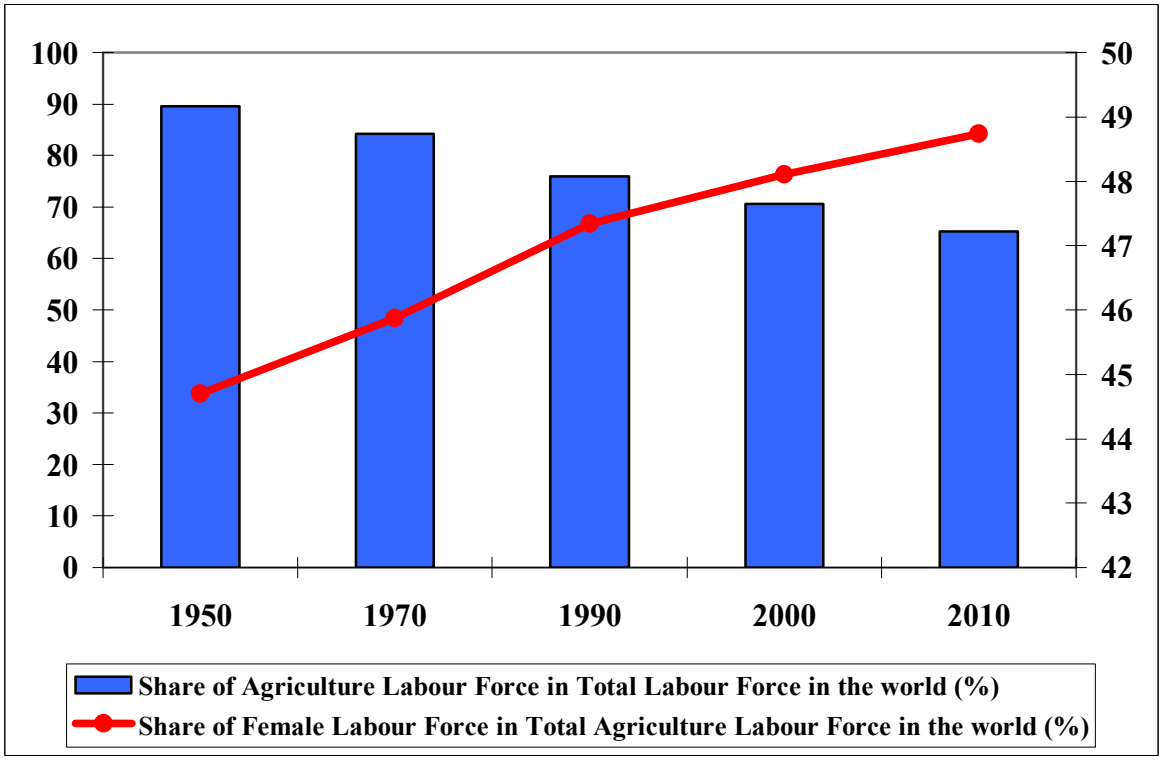

Figure 2. Share of female Labor Force and Agriculture Labor Force in Total Labor Force in the world (%)

We see that the share of agricultural labor force in total labor force in the world. Agricultural labor is decreasing on the 2010 years. But the shares of female labour force are rising in total agriculture labor force in 2010. So far the focus of the Division's programme has been on the data derived from agricultural censuses and

surveys. While these provide an overview of the structure of gender involvement in the agricultural activity, they do not suffice for providing guidance to policy makers to draft programs for agricultural and rural development. Therefore, in the new approach, it is planned to compile data from all sources (agricultural censuses and surveys as well as household income/expenditure surveys) to understand the role of women in the social, cultural and economic development and their impact on income, consumption, nutritional status etc. Thus, in addition to the traditional focus on the collection and compilation of data on status of holder, employment and population dependent on agriculture by gender, the new approach would attempt cross classifications of the attributes by size of holding, income classes etc. as well as establish linkages with income and consumption levels (Oguz, 2009).

The Republic of Turkey occupies a unique geographical and cultural position at the crossroads of Europe and Asia. Turkey has a total land area of 78 million hectares and a population of more than 70 million. About one third of the land is arable, and 26 percent of the population lives in rural areas**.** The active population, work in the rural area of Turkey, is 14 767 000 and women have 61.26% of this population. The population of women work active in the agricultural activities shows an increase from year to year. From the point of this view, the place and importance of the women population in agricultural activities and rural development is understood. In agricultural enterprises in Turkey, the individuals are comprised from 54% men and 46% women whose main work is agricultural activities. Nevertheless the number of unpaid family worker is 5 265 431 and it is conspicuous that 66% of this is formed by women. While the major portions of the workers, who work for ownself, are employer and are paid, is creating by men, the altitude in the number of women as unpaid family worker shows the low degree of importance of women in the rural area. 49% of the workers in Konya whose main work is agricultural activities are women and the ratio of the unpaid family worker is about 59%. On the side of this, 2% of employers and 9% of who works for ownself are formed by women (Oguz, 2008)

In the research area, Konya, the study estimated 52 % of women labor in agriculture (Oguz et al., 1998). Even women has been taking big percentage of farm labor, they are not benefiting from rural development aids, so they are the most effectible gender in poverty. For civilization rural development aids must be reached to the women in rural area and women respect must be increased in developing countries. The women works in agriculture commonly are unpaid workers in Turkey since farm owners are men. In this case, rural development aid must be offered to women in order to establish their own business. The business sustainability is depending on the knowledge on the women in rural social and economical situation. For the woman who is in the rural area of Turkey, being made of manufacture and home works together, lowness of education level and social status, not being provided organization, not having possibilities for working as paid and the presence of legal regulations deficiencies about working as social security are seen as important problems (Yildirak et al., 2003).

Rural women in terms of education

In basis of the rural development, between the city and countryside, sociocultural and reaching optimum level of economic differences, rural population to improve themselves in their rural area, in addition to that, the real women's effect on manufacturing and the improvement in social status has not been performed yet. Because, in Turkey, rural development practices are mostly done to improve the basis facilities, canalizing the new technologies to agriculture, modernizing the agriculture to take form to shape the improve the life standard. However, we can also see women in every part of agricultural production. When the criteria of education is taken care that bearerring the importance of women's status, especially, there exist importance for education services that must be taken to women who live in the rural areas. Increasing in the women's education level, also increase in the participation level of the labor force. In research area, 60.45% of women are literate or graduated from primary school, 34.76% graduated from secondary school or high school, 4.79% are graduated from academy (Table 1).

Farm Size Group(da)	**Literate or primary school**	**Secondary school**	**High school**	**University**	**Total**
1-50	3.57	1.56	0.36	0.20	5.69
51-100	4.00	2.40	0.50	0.50	7.40
101-+	5.60	2.00	0.55	0.30	8.15
Enterprise average	3.53	1.65	0.38	0.28	5.84
Ratio (%)	60.45	28.25	6.51	4.79	100.00

Table 1. The education position (person) and ratio (%) of the population that are more than 6 years old due to the enterprises groups

In research area, 26.18% of women take decisions which are about house work and children, 9.44% of women have an active role in provision of input, 40.40% of women attend in animal husbandry and 23.80 % of women participate the all decisions in the family (Table 2).

Farm Size Group(da)	Decisions only about house works	House works + assurance of input	House works+ purchase of animal	Agree with all decisions
1-50	27.00	16.00	50.00	20.00
51-100	30.00	-	56.00	30.00
101-+	40.00	20.00	33.00	40.00
Farms average	26.18	9.44	40.40	23.80

Table 2. The ratio of attendance of women to the decisions (%)

Women's education is important for not only for her status but also for rural development and sustainability. Because, women who get good education, affect her husband and her children and she can also be very sensitive about the environment. Starting with the air, water and soil pollution, environmental problems that reach the vegetation and vanished of the animals and death of humans, society who faced with such these problems, concern about their future (Işikli et al., 1998). Especially, field of agriculture and animal being must be increased to provide the requirements and agricultural enterprises sustainable in economic way. In addition, women who generate potential force must be educated and made conscious of environmental issues. Because, women take place in production process also take place in consumption process. If agricultural innovations are narrated to the rural area and technical knowledge of technology usage is given to women, most of the environmental pollution will be solved. Because, if knowledge is given to men, it is only informed the men but not to make men conscious of knowledge. However, giving education to the women is helpful to educate the children and partner. But there was no information available on whether or how extension policies and project acknowledged or responded to women's agricultural and conservation groups in research area. Especially, undeveloped and highland areas where poverty level women live and they protect the land to get maximal efficiency, they give importance to variability of vegetable and animal product and they diligently claim these products. Between 2006-2009, intended for the women, within the agricultural spread practices, organic goods such as strawberry, tomato, broccoli production is internalized and working is continued. Also, while 11.78 % of farms are not in question, now they enforce as producer activities under sub-project(Table 3).

Farm Size Group(da)	Greenhouse	Milk dairying	Ewes	Fruit growing	Family grocery
1-50	17.00	37.00	17.00	40.00	27.00
51-100	20.00	33.00	15.00	60.00	38.00
101-+	-	28.00	20.00	56.00	53.00
Enterprise average.	11.78	28.08	14.28	42.80	31.18

Table 3. The activity areas of women enforced in the project extent (%)

Needs of the Rural Women

Women need to be informed as education, research, health, family planning, spread for the further generations, to provide them enough income and food secure. Women's had important needs which could be easily addressed if these needs were clearly understood by the Extension administrators. The most important needs were related to farm-tools, especially those used for soil conservation. Their need farm input such as fertilizers, certified seeds, pesticides, and planting materials. Other needs included farming inputs, assistance in acquiring agricultural loans, and regular Extension training. Especially, the Ministry of Agriculture had given-up on them, and women's were treated as if they were beyond help. If women's economic, social and environmental

conditions were be improved, extension administrators and implementers need to understand women's needs, their work strategies, and the best way to reach them. In addition, there has been no research done on the needs or functioning of women's autonomous farming and conservation groups in Konya.

Rural Women Participation in Extension Activities

Historically, women in Konya have been pivotal in agricultural production and have contributed immensely, individually or collectively, to environmental conservation work. Increased emphasis on cash cropping and male migration out of the rural areas has further accentuated the centrality of women in food production for local consumption.

Gaps between extension services and women producers have also been found to exist in village. Increasingly, women have come to rely on self-help groups to meet their needs. Most mountain village women have had only limited access to services and resources provided by the local state services.

Poor roads and farm credit is a major problem. Farmers were transporting their produce to the nearest market. These problems were supported by the state service. Farm input (strawberry seedling), packet, selling, loans, tools and cash problem were conducted in the project research area during 2006-2009. Female farmers participation in field-days and farm demonstrations was reported to be high compared to other activities. Extension service reported medium participation in village meeting, seminars and show attendance.

Activities	**Degree of Participation**					
	1	**2**	**3**	**4**	**5**	**Total**
Field days	**0**	**5**	**10**	**20**	**15**	**50**
Farm demonstration	**0**	**0**	**15**	**15**	**10**	**40**
Seminar	**0**	**5**	**10**	**15**	**20**	**50**
Shows	**0**	**2**	**10**	**15**	**15**	**40**

Note: 1: very low, 2: Low, 3: Medium, 4: High, 5: Very High

The majority of women have had agricultural based functions related to natural resources as a means of sustainability. This research area had drip irrigation system and marginal soils making it difficult for farmers to farm productively without effective Extension services. On the other hand women involvement in environmental conservation also did not receive meaningful support from extension. A extension programme aimed at raising production through delivery of extension services and credit cannot be effective if it fails to provide the inputs to active participants in the sectors. If women's economic, social and environmental conditions were be improved, Extension administrators and implementers need to understand women's needs, their work, strategies, and the best way to reach them.

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The Greening Desert Of Karapinar: An Example from Turkey

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Abstract: In Turkey, there is an area of 465.913 hectares which is subject to wind erosion. 103.000 hectares of this area is in the Karapınar district of Konya province. The Karapınar district of Konya faced the risk of emigration in the 1960s because of reasons such as that the region was an old lake bed and the climate of the region was extremely hot, soil properties etc. The soils lost their yield capacity, the dunes rose, clouds of dust and sand storms made life difficult for the people living in the area as the result of erosion in that period. Because of these problems, the first studies started in 1962. An area of 160.000 decares was taken under control. As the result of approximately 47 years of improvement practice, which constitutes the topic of this paper, today, activities aimed at research and production are also being maintained in Karapınar.

Key Words: Desert, dune, improvement practice, sand storms, wind erosion.

Introduction

Agriculture is practiced on the 28 million hectares of the 78 million hectares total area of Turkey. The lack of the development of a sustainable agricultural policy and the human effect have caused a decrease in organic matter, resulted in the loss of soil aggregation and the dispersion of soil structure, and also, together with bad climatic effects, caused the occurrence of wind erosion in cultivated areas.

Wind erosion in Turkey is commonly seen within the borders of Konya, Niğde, Kayseri province, which is located in the southern part of Central Anatolia, and Kars province in the east, both of which are areas under the effect of an arid and semiarid climate (Anonymous 2007).

Karapınar county of Konya is located in the most arid region of Turkey with the lowest precipitation; consequently, it is most affected by aridity and desertification. For this reason, the first disaster related to the problems of aridity, climatic change and desertification experienced in our country occurred in this region.

In Turkey, wind erosion is observed as a problem varying from light to severe on an inland dune area of 465.913 hectares. Approximately 70% (322.474 hectares) of this area is located within the borders of Konya province (Anonymous 1975), and 103.000 hectares of this area are located in the Karapınar district of Konya. This area constitutes the 22.1% of the area of wind erosion throughout the country (Yıldırım 1999).

Reasons for the Occurrence of Wind Erosion in Karapınar

In the 1960s, the people living in the Karapınar district of Konya were at risk of emigrating from the region as the result of the wind erosion that occurred in that period. There is an inland dune in the South-Southwest of the district which covers an area of 4000 hectares.

The soils lost their yield capacity and sand dunes occurred as the result of erosion; it was observed that clouds of dust rose and cars on the Konya-Adana Highway were dragged and the paint of the cars was totally or partially damaged. Children could not go to school because of sand storms, machines did not work, and the incidence of ear-nose-throat diseases increased among the people. Winds that cause erosion in this region blow from the South-Southwest, and it was determined that the wind speed reached 110 km/h in the month of March in 1962(Anonymous 2007).

We can list the primary factors that cause wind erosion to be effective in the region as follows:

This region was an old lake bed, therefore, the lake dried and the dunes that were on the base of the lake rose to the surface, the climate of the region is extremely hot and arid, animal husbandry was highly common and excessive grazing was practiced in the pastures, some plants (*Astragalus micracophalus*,*Salvia cryptantha, Verbascum mucronatum*) which the animals did not like but supported the soil were pulled out by the people and used as fuel, pastures were destroyed, the use of disk ploughs which overturned and broke the soil increased erosion in the region where fallow-cereal rotation system was implemented, and the district is located in an active wind zone.

Characteristics of the Wind Erosion Area of Karapınar

Karapınar is located on Konya-Adana Highway and is 95 km from Konya. The population of Karapınar is 31.913 according to the 2007 census. The altitude of the district is 995 m above sea level and its area is 3030 km^2.

***Geological Characteristics*:** In Central Anatolia, there are several sand beds located near Karapınar. The dune systems were altered during the late Pleistocene and Holocene period. The main dune system located in the south of Karapınar was formed as the result of the coastal winds that were caused by the withdrawal of the old lake. The climate changes that occurred during the Holocene period caused the sand to move inland, afterwards, sand movements started as the result of human activity (such as extreme pasturage, becoming poor of soil) (Demiryürek et al. 2007).

***Climate Characteristics*:** The climate of the region is semiarid; summers are arid and hot, and winters are cold and snowy. The large part of the snowfall occurs in January and February. The annual average precipitation is 275 mm, and 40% of the precipitation falls in the months of winter. The average precipitation from July to September is 15 mm. Long term climate values of the study area are given in Table 1. The annual precipitation for 2008 is 232.1 mm (Anonymous 2009).

Climate data	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean Temp. ^oC	-1.8	-0.8	4.2	11.1	14.8	18.7	22.4	22.1	17.2	11.0	5.9	0.4
Max Temp.^oC	19.6	20.5	25.5	31.4	36.0	36.8	41.2	38.4	36.2	33.2	25.3	18.4
Min. Temp. ^oC	-21.4	-26.8	-22.8	-8.0	-2.3	3.1	5.0	4.5	-3.3	-6.4	-15.0	-21.2
Precipitation (mm)	29,9	27,6	28,5	39,6	38,9	25,5	4,6	2,7	7,5	22,6	27,5	39,5
Moisture (%)	78	75	69	62	62	53	48	47	51	63	75	79
Mean wind speed (m/sec)	2.97	3.21	3.36	3.31	2.66	2.92	3.29	3.09	2.46	2.34	2.61	2.86
Wind Max direction and speed (m/sec)	SSW 27.3	SW 29.0	SSW 28.8	SSW 32.7	NNW 23.1	ENE 23.0	NNW 20.2	NNE 28.0	S 32.0	NW 19.8	SSW 21.8	SSW 27.7

Table 1. Long term climate values of the study area (between 1983-2006 years) (Anonymous 2009**)**

In the erosion area of Karapınar, the most important factor that affects erosion is the wind, and the dominant direction of the wind is north-east and south-west. Mean wind speed is between 2.34 - 3.36 m/sec. Stormy days are common and the wind speed reaches 20-32 m/sec on those days (Table 1).

Soil Characteristics **:**Although the soil belongs to the group of alluvial soils which is formed over old lake deposits, colluvial, sierozem and regosol soil groups are also seen in Karapınar, where wind erosion studies are conducted. The soil color of the plow layer is light gray and light brown and the lower parts are pale yellow and white. The soil texture is generally light (loamy sand) in the top soil, and heavy (clay) in lower layers. Soils are rich in lime and potassium and poor in organic matter and phosphorus. Some characteristics of the study area soils are given in Table 2.

Depth (cm)	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Texture Class**	**Field capacity (mm)**	**Volume weight (g/cm^3)**	**pH (1/2.5)**	**EC(mmhos/cm) (1/2.5) 25°C**	**$CaCO_3$ (%)**	**Organic matter (%)**
0-15	68.1	15.1	16.6	SL	23.3	1.10	8.1	0.62	44.7	1.9
15-30	57.2	22.7	20.1	SCL	32.9	1.09	8.1	0.45	48.6	1.6
30-60	31.0	28.0	43.0	C	79.6	1.01	8.2	0.45	53.5	1.5
60-90	16.0	24.4	59.6	C	88.6	1.06	8.3	0.85	54.6	1.3
90-120	12.5	42.3	45.2	SiC	85.7	1.18	8.0	1.10	53.3	1.2

Table 2. Some characteristics of the study area soils (Anonymous 2009)

Studies Conducted to Improve Problematic Areas

The first step taken against erosion in the district was establishing an association with the name "Association for Saving Karapınar from Erosion" in 1959. Afterwards, studies were started by Mülga Topraksu (the Directorate General of Agriculture) in 1962. First, a team was formed of technical personnel and an area of 160.000 decares was taken under control by being enclosed with wire fence.Then, 30.000 decares of this area was assigned to the Armed Forces to be used for military purposes. The remaining 130.000 decares area was divided into four sections based on the problems observed. Soil improvement practices started on this area considering the degree of the problem. Mülga Konya Topraksu VI. Region Management (The Directorate General of Agriculture) maintained its studies continuously for 10 years and when the improvement studies were completed, the area was assigned to Konya Institute of Soil and Water Research Directorate in 1973 to be used for protection control, research and production studies.Today, 43.000 decares of this land is given back to farmers and studies are continued in the 87.000 decares under the control of the government (Yıldırım 1999). The studies conducted on these areas are as follows:

Sand Dunes (Dune Barkhan) Area(40.000 decares): This area is located to the south west of the district 7 km from Karapınar. The size of the area is 40.000 decares. The severest erosion effects were observed in the area in the 1960s. Sand dunes with heights of 41 m, widths of 50 m and lengths of 240 m, which are shaped like the moon and completely look like a desert, have been formed in the area. These dunes are inclined at a rate of 5-17% to the direction of the wind and 20-48% to the other directions. The dunes in this area have the characteristics of moving with the lightest wind. The dunes that move with the effect of the strong winds started to threaten the district by digging up the Ketir Hill, which is covered with 15 hectares of basalt rocks. The improvement study conducted on this area was carried out in two subsequent stages.

a.Physical measures

Construction of Bamboo Screens: First, bamboo screens were constructed on the sand dunes in order to decrease the speed of the wind and prevent the movement of the sand. These bamboo screens were woven with two lines of wires running perpendicular to the blowing direction of the wind leaving parts of 40 cm uncovered at the top and bottom tips. During the fixing process, the screens were supported with wooden posts at every two meters in order to prevent the collapse of the screens with the effect of the wind.

b.Cultural measures

Grassing: After the bamboo screens were constructed and the speed of the wind and the movement of the sand completely stopped, the process of grassing the spaces between the screens started. Weed seeds collected from the pastures around the region were used in grassing the area and also rye (*Secale sp*.) and wheat grass (*Agropyron elongatum*), which are known to be resistant to aridity and hot conditions, were extensively used as crop plants.

Afforestation: After the area between the bamboo screens was grassed, afforestation studies started as a long lasting precaution in order to completely prevent soil movements. Saplings obtained from the nursery gardens established in the area and from other regions were planted and grown between these screens. The types of trees selected for afforestation were oleaster(*Eleagnus sp.*L), acacia(*Robinia pseudeaccacia*), ashen(*Fraxinus sp.*L), elm(*Ulmus sp.*L) and maple(*Acer sp*.L) since they are trees which are resistant to aridity peculiar to the area.

The Active Dune(Barkhan) Area(25.000 decares): There were some plants peculiar to the region which were not eaten by animals and were resistant to aridity on this area, which was known to be a high quality pasture a long time ago. Dunes have accumulated around these plants and formed hills with heights of 0.3-1.2 m and widths of 0.2-2.00 m. The inclination of these hills is 30-60% to the direction of arrival of the wind, and 5-19% to the direction of the wind. These plants are *Salvia cryptantha, Astragalus micracophalus*, *Alhagi camalorum* and *Artemisia sp.* .Such areas were enclosed with wire fences during the implementation of the improvement practices. Following the enclosing process, the existing plants were reproduced through self-pollination and other plants were reproduced through grafting. As the result of the studies, today, the soil is completely covered with vegetation and natural flora has been reestablished.

Flat Soils Sensitive to Erosion(26.000 decares): This area is composed of agricultural lands on which no vegetation exists, and which was formerly used for dry farming and abandoned because of erosion. 14.000 decares of this area are privately owned lands where erosion prevention practices have been successfully performed and the owners have resettled. Agricultural activities are still being carried out on this area under the control of the government. Today, agriculture is performed through band seeding along paths of 40-60 m width vertical to the prevailing wind direction on the 10.000 decares of the remaining land and fallow-cereal rotation system is implemented, as is done under the conditions of Central Anatolia.Approximately 2.000 decares of land has been irrigated and vineyards and orchards peculiar to the region have been planted on the land. This part of the area is used as a demonstration site for fruit production, and there are also nursery gardens and pasture seed production facilities in the area.

Ketir Hill (10.000 decares): Before the implementation of improvement practices, this area was covered with basalt boulders and there were not any trees on the hill. After the erosion studies were conducted and sand movements were stopped, plants such as blackthorn, wild almond and blackberry started to grow on the area. Furthermore, almond seeds (700.000 pieces) were planted on the foot of the hill during the practices. Currently, pine and cedar trees are being planted on the hill.

Current Land Use Planning

The following improvement practices are implemented on the remaining 87.000 decares of land, which is under the government control:

The areas where the problem has reemerged are afforested, practices are performed for the trial of new irrigation techniques, the activity areas of newly drilled wells are widened, and new orchards and sapling production practices are established.

The current status of land use is as follows (Table 3):

Status of Land Usage	Area(decares)
Woodland area	40.000
Basaltic area	10.000
Vineyard, garden, orchards and sampling generation areas	2.000
Nature grass pasture	25.000
Band seeding(dry cultivation)	5.000
Watery cultivation	5.000
Total	87.000

Table 3. The current status of land use(Anonymous 2009)

The plants that were determined in the study conducted on the approximately 30.000 decares of pasture area which is under protection in Karapınar Station of Soil and Water Resources Research Institute are as follows: *Festuca ovina* (29.8%), *Centaurea virgata* (17.6%), *Euphorbia kotschyana* (10,1%), *Alhagi pseudalhagi* (5,9%), *Astragalus microcephalus* (5,0%), *Scabiosa argentea* (4,6%), *Scorzonera cana* (3,4%), *Centaurea urvillei* (3,4%) and several other plants at smaller rates (TAGEM 2007). With these plants, the pasture area has acquired the characteristics of a typical arid climate pasture.

Conclusion

As the result of the studies conducted to prevent the Karapınar District from being moved to another location, the problem has been solved at a cost less than almost a quarter of the moving cost. The project is highly important in terms of presenting the new agricultural techniques to the farmers living in the region and increasing the agricultural value of the land by means of new irrigation wells and canals.

Previously, the project area often caused traffic jams and accidents over an 8 km part of the Karapınar Highway when strong winds blew. All of these problems have been solved as the result of the erosion prevention practices.

A farmer training camp was organized within the project studies and the workers of the farms were trained on irrigated and dry farming. Groundwater surveys that were conducted at the start of the project studies were found to be favorable and the wells drilled based on these surveys were used for sapling production and irrigated farming. Today, the number of wells is over 5000. Beet-wheat crop rotation system has started under irrigated conditions. Animal feed products such as clover and trefoil, vegetables, fruit, even strawberry is produced in the area. A forestland of 4000 hectares covered with trees has been a good shelter for wild animals (such as fox,rabbit, grouse and nightingale) .

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Economic Importance and Using Purposes of Gypsophila L. and Ankyropetalum Fenzl (Caryophyllaceae) of Türkiye

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Abstract: Gypsophila L. is the third biggest genus of Caryophyllaceae family in Türkiye. 55 species of the genus have been growing naturally in our country. 33 of them are endemic and total number of the taxa is 55. *Ankyropetalum* Fenzl is a small genus with 3 species and 1 of them is endemic. It is agreeable that gene center of the both genera is Türkiye. In terms of growing habitats there are large areas in Türkiye. According to importance order East, Central and Southeast Anatolia regions have the biggest number of taxa growing there. *Ankyropetalum* genus distributed only in the Southeast Anatolia and Mediterranean regions and in their intersection areas of Türkiye.

Both of the genera have known as "çöven, çöğen", halvah root and largened root parts or rhizomes are economically very important. Extracts produced from under parts of the plants known as fire extinguisher, gold polishing, silk and cloth cleaner and softener and crispness giving to halvah. These extracts have often used for making liqueur, preparing herbal cheese and making ice cream. Because of giving flavour, crispness and nice odor they generally preferred in food industry.

With different ratios all of the taxa are boron (B) hyperacumulators. For this reason they can be used for destroyed agricultural areas. They can be planted to elevated slopes and hills to control erosion and survive biological diversity. General character of the family is their importance for horticulture. *G. paniculata* is very important for horticulture industry. In the presentation, some information about economic importance of the plants in the light of our observations and literatures were given.

Key Words: *Gypsophila*, *Ankyropetalum,* Economy, Flora of Türkiye

Introductıon

Turkey is known as a gene centre of many economic groups of plants. In Turkey there are 32 genus and around 500 species of Caryophyllaceae family [1-6]. It is reported that the centres of some regions in which the species belonging to the ***Gypsophila*** genus are pervasive are Turkey, Caucasian, the North Iraq and the North Iran; that 75 out of 126 ***Gypsophila*** species in the world are found in this region and that in Turkey there have been found 55 ***Gypsophila*** species in 10 sections [7-8]. In the world ***Ankyropetalum*** genus has 4 species, and 3 of which grow in Turkey. The gene centre of both genus is Turkey.[9].

In general, soaproot is the woody roots of some perennial species of the genera ***Gypsophila*** L., ***Saponaria*** L., and ***Ankryopetalum*** Fenzl, belonging to the Caryophyllaceae family. However, *Saponaria* is not used as soaproot in Türkiye [10].

Turkish Çöven are commonly obtained from ***Gypsophila graminifolia*** Bark. ***G. arrostii*** Guss. var. ***nebulos*****a** (Boiss. & Heldr.) Bark., ***G. eriocalyx*** Boiss., ***G. bicolor*** (Freyn & Sint.) Grossh., ***G. perfoliata*** L.*,* ***G. venusta*** Fenzl subsp. ***venusta*** and ***Ankyropetalum gypsophiloides*** Fenzl. [7, 10]. But such species as ***G.***

ruscifolia Boiss. and ***G. bitlisensis*** Bark. are less preferred. Since 1800s soaproot has been exported from Anatolia (Turkey). The leading ones are ***G. bicolor, G. arrostii*** ve ***A. gypsophiloides*** (Radix Gyspohilae) [11-14]. For nearly 30 years the extraction of Çöven from natural flora has been increasingly continueing in the Eastern and South-east Anatolia [10].

Ankyropetalum Fenzl is represented by 3 species in Turkey. One of these is endemic and the others are not widespread. The genus is essentially pervasive in South-west Asia including Turkey. Regarding the phytogeography the genus grows in the South east of Turkey; that is in Iran-Turan and Mediterranen regions [14, 15]. The species belonging to the ***Ankyropetalum*** genus which is pervasive in Turkey are ***A. arsusianum*** Ky, ***A. reuteri*** Boiss.& Hausskn. (endemic) and ***A. gypsophiloides*** Fenzl. The genus is found in South-east Anatolia and its neighbour countries in borders [1, 14, 15].

The taxa belonging to the ***Ankyropetalum*** and ***Gypsophila*** genus and known and used by the public are generally known by the name "Çöven Otu" . As the ***Ankyropetalum*** genus' members look like perennial ***Gypsophila*** species and as they are distinguished hardly, they are known by the same name and used for the same purposes. In Europe ***Gypsophila*** species are widely known as "Baby's Breath". For the word ***Gypsophila*** "Soaproot" or "Soapworth" words are used. In Turkey these plants are called "çöven otu, çevgen, dişi çöven, tarla çöveni, helva çöveni, şark çöveni" by the local public.

It is reported that the saponins are found in the different parts of the plant in different doses; that they were first obtained by boiled alcohol from the risoms of ***Saponaria officinalis*** and that they are called "saponin" [11]. It is reported that as the roots of Soaproot are obtained from various ***Gypsophila*** species, the saponin amounts in the roots which are used in the trade differs between (4-)10-20(-25) % [22]. Used as Turkish Soaproot, in the ***Gypsophila bicolor*** (Van Çöveni) the saponin amounts have been found to be 20-25 %, in the ***G. arrostii*** var. ***nebulosa*** (Konya, Beyşehir, Isparta Çöveni) 19-22 %, in the ***G. perfiolata*** (Niğde Çöveni) 15-19 % and in the ***G. eriocalyx*** (Çorum- Yozgat Çöveni) 10-14 % [17]. They have found out that in the ***G. paniculata*** the saponins synthesizes only in the roots and then moving through the other parts of the plant and that in dry material there is around 4 % saponin [20]. They report that in the Soaproot originated in Anatolia the amount of raw saponin is 10-25 %; and in their searches on the taxa of ***G. bicolor***, ***G. perfoliata*** var. ***anatolica, G. venusta*** subsp. ***venusta, G. eriocalyx*** and ***G. arrostii*** var ***nebulosa*** which are pervasive in different parts of Turkey the amounts of saponin are respectively 19.58 %, 14.44 %, 12.65 %, 12.39 % and 11.58 % [20]; and the amounts of protein are respectively 8.01 %, 7.80 %, 8.38 %, 8.15 % and 6.92 % [7].

It is stated that in the roots of ***G. paniculata*** with the affect of the enzyme of UDP-Glucuronosyltransferase the synthesis of saponin has been increased considerably and that in order to define the activity of this enzyme which has a versatile role in the plants the ***G. paniculata*** species would be a good model plant [17].

The Production of Soaproot Extract

The roots and risoms of Soaproot

↓

Cut in the form of chips

↓

The first boiling (4-5)

↓

The second boiling

↓

The extract of Soaproot

The extract of Soaproot whose production stages and chemical formule have been shown above is composed of sugar, resin and saponin. Saponins are highly moleculer glycosides which has the characteristic of solution in water and which are widely seen in some plants especially in ***Saponaria***. It keeps the plant from germs and fungus and some species of it increases the nutritional value of plant as well as simplifying the digestion [18].

Where ıs soaproot used?

Its usage in the food industry

It is known that ***A. gypsophiloides*** was formerly exported from Siirt and Batman by caravans and that it is known by such names as " Helva kökü, Çöven otu, Sabun otu, Helva otu" and that it is especially used in preparing a local food called "Siirt sweet". ***A. reuteri*** is called "çöven" by the local public around Gölbaşı (Adıyaman); it is used for animal feding by mixing with straw and it is said that it was formerly used for the purpose of animal feding [9, 11,12].

In the Eastern Anatolia, the roots of some soaproots are used in preparing a local and origional food kind "herby cheese". [8, 13-14]. The use of extract of Soaproot is firstly an obligation in making "tahin helvası (halvah)". Otherwise it is impossible to make the halvah crisp. Apart from halvah, it is utilized for the production of "delight" and "icecream" and also in Thracian region because of its charasteristic of whitening wax and its power to make crisp soaproot is utilized in the "köpük halvah" which has a white and spumy form. Furthermore, in some parts of Turkey while making "hellim cheese" after soaproot is cooked it is added to the brine so that the cheese doesn't spoil [8, 18, 19].

It is stated that the delight obtained by mixing syrup whitened by soaproot extract with pure delight is called "sultan delight" and that the maximum saponin amount should be 0.1 % [7]. The main reasons of why soaproot is most preferred for the halvah production are those; the saponin in the soaproot whitens the sugar wax, saponin softens the sugar and makes like sponge, and it has a function like emulgator by enabling the sesame oil to mix with sugar. In halvah production the amounts used are respectively 52-65 % tahini, 35-48 % sugar, 0.5 % soaproot [17]. In the production of "köpük halvah" soaproot and sugar are boiled in water and added after it takes the wax form. Soaproot water is used in production of "köpük halvah" which is half-liquid and has a little hard stiffness. When adding soaproot water there are two elements to be taken into consideration; firstly, its amount shouldn't exceed the avarage level and second, when adding soaproot the pot should be covered. Otherwise the air absorbed leads to overbubbling. When making "köpük halvah" it can be used about 60- 65 % glycose syrup, 30- 35 % water and 0.01 % soaproot water [18].

Some kinds of ***Gypsophila arrostii*** var. ***nebulosa*** are economically valuable and in Konya and Beyşehir it is called "dişi çöven (female soaproot)" because of its multiplying fast. Roots of the other soaproots known as "erkek çöven (male soaproot)" are not widely used in trade. In their rhizomes there are saponin, resin and sugar. Because they are widely used in production of "tahini halvah" in Turkey and Near East they are called "helvacı çöveni (halvah soaproot)". In some of our cities and in Cybrus in order that the "hellim cheese" which is boiled and made salted does not spoil, soaproot root is added to its water. In Thracia region a white spumy halvah known as "köpük halvah" is produced by soaproot [20].

Its Usage in The Chemistry and hygiene Industry

Soaproots are also used in the manufacturing of Saponin which is a valuable chemical substance [8, 21]. Saponins are components which have pervaded in wide districts, which are in the form of heavy molecular steroidal or triterpenoid glycsides and which have a great biological activity on plants, insects, fungus and microorganisms. Their lower doses helps the plants have roots; however higher doses decreases root growing [7].

As quoted from Çevrimli (1990); it is expressed that because of the negative impacts of alkil and aril sulfanat types of detergants on environmental pollution and human health, the usage of saponin present in ***G. arrostii*** as an active surface substance of detergant will be more benefical, the saponin present in the plant will be easily used as an active surface substance in both extinguishers and soap industry, and that in the plant rhizomes there has been found around 18 % saponin [7].

Because it has a good characteristic of bubbling, soaproot is being utilized for soap, shampoo materials or fabric softener in hygiene industry. In the cool water obtained from the soaproot roots boiled, the silky and delicate fabrics and the other fabrics which are otherwise deteriorated are cleaned. Fabrics or clothes are cleaned by being dipped into the cool water obtained and are kept waiting for a few hours without spoiling their colors and brightness. Moreover, in some regions they are used in order to clean the wool obtained from the animals. [8, 18, 19]. The undersoil parts of ***G. arrostii*** have been used as a cleaner and a removal of stain since ancient times. [21].

Its Usage In Medicine

It is reported that in the antraks vaccine which is against Antraks disease seen among animals and which is produced in Turkey, the saponin amount has been found to be % 0.1- 0.5. It has been found out that saponins

are in the seeds, limbs, leaves, flowers and roots of plants; and that when the plants containing saponin are eaten by animals, the bitter-flavoured saponins have irritated mucosa cells in throat. Such types as ***G. paniculata*** and ***G. arrostii*** are used as a cough and respiration system diseases deterrent besides being used as a myx remover [7]. Soaproot has some features such as urine remover, exudative and myx remover [18]. As for drug, it has a function in some drugs compound when they are brewed because of its characteristics such as myx and urine remover [19].

Its Antimicrobial Effect

It is known that saponin has an antimicrobial effect and it keeps the plants against some insects in soil. Besides this, it is estimated that it has a role of increasing the plant resistance in some parts of plants. It is reported that in the soil in which the plant containing saponin grows there has been found to be saponin in certain amounts and this saponin in the soil has some impacts on some bacteria. It has been found that ***Aquaspirillum dispar*** and ***Aquaspirillum*** spp. soil bacteria have been in great numbers in the roots of ***G. paniculata*** [7]. In the search of ***Gypsophila*** species' antiviral impacts it has been expressed that ***G. arrostii*** var. ***nebulasa***, ***G. bicolor, G. perfoliata*** and ***G. eriocalyx*** species have impacts on ***V. stomatitis*** virus, that they have no impact on ***Parafainfluenza*** **type-1** virus and that the ***G. bicolor*** species has effectiveness against the other viruses (***Poliovirüs*** **tip-1,** ***Herpes simplex*** **tip-1 ve tip-2,** ***Vesicular stomatitis*** **ve** ***Influenza*** $\mathbf{A_2}$**)** except ***Parafainfluenza*** **type-1** virus [7, 22].

Its Usage in Horticulture

Gypsophila species are regarded as one of the most important alternatives of product diversification in the sector of flower cutting. ***G. paniculata*** species used as fresh and dry cut flower attract attention as being one of the most indispensable elements of arrangement and bouquet in domestic market [7, 8].

It has been reported that in Eurasia continent there have been found to be 125 species of ***Gypsophila***, that the most significant of those to be used as ornamental is ***G. paniculata***; that although the plant is perennial it has been grown annual and that because it cannot enable blossoming in short time and because it has no genetic evolution it is more advantagous to multiply it by cutting. It has been expressed that ***G. paniculata*** species has a great importance in the trade of cut flower; that although with the reparation studies the desired plants have been obtained, from these plants whose seeds are cultivated the desired plants will not be able to obtained and that they may have genetic evolution so the plants should be grown with vegetative organs. They have found that in the ***G. paniculata*** species which is used in horticulture their harvest should be done when their petals have exceeded 50 % blossoming, the vase lifespan in plants has reached about 55 days with the blossoms of buds in vase and that during 82 days the flower harvest can be done on plants. In ***Gypsophila paniculata*** species which is used in horticulture in the flower buds, the flowers should be harvested when they blossomed 30 % and so the vase lifespan increases. They have informed that because in coastal regions of Mediterranen the floral deportation obtained in unit area for the production of ***G. paniculata*** will be more it can be advised to cultivate around coastal parts of The Mediterranen Region [7].

Its Usage in Mining

As a result of the studies on natural-growing 4 ***Gypsophila*** species in the district of boron (B) mine in Eskişehir Kırka; it has been observed that ***G. sphaerocephala*** Fenzl ex Tchihat. var. ***sphaerocephala*** and ***G. perfoliata*** have been the first ones which have a characteristics of a potential boron hyperaccumulator. These species grow successfully in concentrations as high total soil boron (8900 mg/kg-1) and suitable soil boron (277 mg/kg-1). As a result of the analysis conducted, it has been found out that in the upper soil parts of the *G. Sphaerocephala* it has contained B in extremely high concentrations (in seeds; 2093 ± 199 SD mg / kg-1; in leaves; 3345 ± 341 SD mg / kg-1), but in roots it has contained far less concentrations of B (51 ± 11 SD mg kg-1). In the respect of Boron amount this has been followed by ***G. perfoliata***. It has been stated that by growing ***G. sphaerocephala*** in the soils which have some signs of high B toxid, vegetative mining can be conducted by hyperaccumulation and the soils containing boron in toxic amounts can be refined by vegetative ways [23]. In this way the agricultural fields in which fertilizers have long been used can be prevented to become barren and during reparation process it will be possible to evaluate the agricultural fields which have become dormant.

Its Other Usages

Apart from these, the cool water obtained from the boiling of soaproot roots is used in the process of whitening gold and treasuers. Furthermore this solution is used as spray in the structure of film emilsion and

extinguishers. It is known that the rhizomes of perennial soaproot sold to Israel from Isparta are used in the production of extinguishers [7, 8, 21].

Pıckıng, dryıng and storıng the plants

Because the subsoil parts of the plants are generally utilized, from just after the precipitation season to the time of plant's fruit; that is between May- July the plants are picked. The local public utilizes its root when its leaves are on land area or when they are in the time of blossoming; they can distinguish ***Gypsophila*** species between others and they can extract its rhizomes by means of such tools as anchor. Because the subsoil parts of the plant are also picked, with an unconscious picking they are endangered. The roots which are picked are cleaned and after washing them, they are dried under sun. In order to dry well and in order to enable some fresh air during this process the rhizomes shouln't be laid down thick. The subsoil organs are brought in bundles and are stored in suitable, dry and moisture free places [19].

It is reported by Anonim (2006) that in the roots of soaproot plant which can be grown in barren and hillside areas there have been foud to be some dryings because of extreme damp; that it is not suitable to harvest them before four years old; that their trade situation should be considered before harvesting and if necessary the product should be waited in the field; that the roots extracted by fork or tractor plough have dried in 2-3 months and from 2.5 kg raw root about 1 kg dry root has been obtained; and that in one decare of field totally 4000-5000 kg dry roots are extracted [7].

The trade of soaproot and ıts standart

There is not a general accepted standart for the roots of soaproot but they can be classified in three different qualities in terms of commercial purposes according to where they grow: those growing in Van-Isparta are of the 1. quality, those obtained from Niğde are of 2. quality and those obtained from Yozgat-Çorum are of 3. quality [19].

In the usage of soaproot in industry, the hemolysis and bubble indexes of them; as for in food industry the bubble indexes are of importance. So, in the quality evaluation these rates should be taken into consideration. Both the bubble and hemolysis indexes of Van (***G. bicolor***) and Isparta-Beyşehir (***G. arrostii***) are high. Also their raw saponozite rates are more than the others.

Species	**Hemolysis index**	**Bubble index**	**% Raw saponozit**
G. bicolor	**6.667- 6.925**	**9.000-10.000**	**20-25**
G. arrostii var. *nebulosa*	**5.295- 6.667**	**9.600-10.034**	**19-22**
G. perfoliata var. *anatolica*	**9.778-10.000**	**4.650 - 5.000**	**15-19**
G. eriocalyx	**3.385- 3.659**	**1.800- 2.000**	**10-14**

Table 1. The Analysis of Turkish soaproot [22]

Isparta-Beyşehir ***Gypsophila*** ***(G. arrostii***) has decreased extremely on the market. There is still Van Soaproot (***G. bicolar***) on market and is sold as being the first quality. The oldest commercial soaproot is this species, so its population has damaged greatly. But this species has been produced in fields (Atabey Plain) by some farmers. Furthermore, Isparta General Directorate of Forestry cultivated about 15-20 kg seeds 3 years ago in order to be a financial support in the future and to enable the continuation of the species generation for Sütçüler and Aksu villagers. The hemolysis index of Niğde soaproot (***G. perfoliata*** var. ***anatolica***) is high but its bubble index and raw saponozit percentage is low. Despite its features similar to 1. quality, it should be regarded as second quality. Çorum-Yozgat G soaproot (***G. eriocalyx)*** is one type of soaproot having the lowest rates. In these respects it should be regarded as the third quality [22].

They are exported to many countries includin Germany, Egypt, Greece at the outset [19]. Between 1989-1996 the avarege annual export of soaproot root was 140 tonnes. In 1997 it decreased to 93.3 tonnes. Today, every year the avarege export of soaproot root from Turkey is about 90 tonnes. In 2004 80000 dollars have been earned from the soaproot exportation for 85 ton. According to the statistics of 2005 92 tonnes of

soaproot roots were exported from Turkey by taking 66 000 dollars in return. In 2006 despite 153 tonnes exportation the income was 61 000 dollars in an unparallel way [7, 24].

Discussion and advices

Six of species growing in Turkey has a high economic value. Besides picking plants in an uncontrollable way from nature, industrialisation and urbanisation, extension of agricultural fields and extreme grazing, tourism, the reparation of barren fields, agricultural struggle and pollution, unconscious forestation and fires are leading factors that threaten the plants in our country [7].

Because many natural plants used in medicine, exported and and used traditionally are constantly being picked from nature, are exported and used in domestic market, they are increasingly disappearing [7].

Soaproot plants have been utilized in medicine, food, hygiene, as ornamentals in parks and gardens, in chemistry industry in order to produce saponin. It has the ability to extinguish the fires, whiten gold, clean silky and delicate fabrics. It also enables cleaning the contaminated soil by removing the boron which is in great amount in our country. They are clened by cultivating ***G. sphaerocephala*** and ***Gypsophila*** species. Also it is possible to make vegetative mining by boron hypercumulation to the upper surface of the plant on soil.

Because they are utilized in many different areas, agriculturalists, food engineers, chemists, pharmacists, landscapists, textile workers and jewellers are all interested in them [7].

In Turkey the general name of ***Gypsophila, Ankyropetalum*** ve ***Saponaria*** species are " çöven ". But some researchers name those whose subsoil parts are economically valuable as "çöven". Regarding this soaproot is the name of a raw material and is an extract obtained from a plant [9].

Turkish soaproot is widely obtained from 6 ***Gypsophila*** (***G. graminifolia*****,** ***G. bicolor*****,** ***G. arrostii*** **var.** ***nebulos*****a,** ***G. eriocalyx*****,** ***G. perfoliata*** **var.** ***anatolica*** **ve** ***G. venusta***) and **1** ***Ankyropetalum*** (***A. gypsophiloides*** species. The gene centre of both species is Turkey [9].

Gypsophila species yielding soaproot, their locations and some properties are as below [25].

G. bicolor (Turkish names: Van çöveni, Tarla çöveni): This species is distributed around Van, Bitlis and Artvin provinces. The rhizomes are hard and difficult to break. Saponin content is 20 %-25 %. This value is higher than that in other soaproot yielding plants. This is the most preferred soaproot, also known as the soaproot of the highest quality.

G. arrostii var. ***nebulos*****a** (Turkish name: Beyşehir çöveni, Konya çöveni): Saponin content is 19%-22%. This is also considered to be of good quality.; This species also has a narrow distribution. Halvah makers in Konya especially use this soaproot.

G. eriocalyx (Turkish name: Çorum-Yozgat çöveni): Grows around Ankara, Çankırı, Çorum, Eskişehir, Kayseri, Sivas and Yozgat provinces in steppe habitats with gypsum. This is an endemic species.

G. perfoliata (Turkish name: Niğde çöveni): Grows around Ankara, Kayseri, Sivas, Erzincan, Konya, Niğde, and Denizli provinces. It is considered to be of 3rd quality.

G. venusta subsp. ***venusta*** (Turkish name: Konya çöveni): Grows around Ankara, Çankırı, Konya, Gaziantep, Urfa, Sivas, Malatya, and Erzurum provinces in stepe habitats or arable fields, and yield soaproot.

G. graminifolia (Turkish name: Başkale çöveni, Dağ çöveni): This local endemic species also grows in Van province, around Başkale.

Three species of ***Ankyropetalum*** genus grow naturally in Turkey; all of them are endemic. However, only ***A. gypsophiloides*** rhizomes are known, with the name "helva (halvah) root" around Siirt province and used as soaproot. ***A. gypsophilloides*** (Turkish name: Siirt çöveni, Helvacı çöveni, Helva kökü): This species grows around Şanlıurfa, Mardin, Gaziantep, Batman, and Siirt provinces. Its roots are collected in Siirt and used by local halvah producers. [12].

Because the roots of these plants are generally used, the harvest time is in March-June months and thus because the plants don't produce seeds they don't enable seeds for the latter year. These plants which are constantly taken from nature both exported and used in domestic consumption and whose economic value is extremely high, are increasingly disappearing and are on the verge of extinction. This problem becomes more important especially when the plants are endemic. Except for the ***G. paniculata*** which is used for cut flower and cultivated, ***Gypsophila*** species which are used for exportation and domestic consumption and some of which are endemic are taken directly from natue. This brings the danger of extinction with itself.

Although economically important, these plants are a source of biological richness in Turkiye. Most of them are endemic species having narrow distributions. Since they are not cultivated but collected directly from nature, populations of these plants in nature deteriorate, their generations diminish or become extinct, and the balance of nature is disturbed. Since only roots and not the aerial parts are collected destruction is an even more important problem. According to some trading companies cheaper soaproot having better quality is being imported from Afghanistan, and re-exported after the extraction of their juices. This soaproot juice (extract) is

sold to halvah producers in Türkiye. So there is no need to collect soaproot in Turkey anymore. Soaproot has been collected for years due to the high unemployment rate in the region, and the demand. In order to preserve these species and also have regular exports, feasibility studies should be conducted and a determined quantity of a given quality should be cultivated. Soaproot should not only be collected from nature and its cultivation should be scheduled. Decrease in collection due to decreasing demand and soaproot imports from Afghanistan are good news. Soaproot imports may stop some day, but soaproot usage will continue and so we should take necessary precautions. Soaproot collection in Turkey should be stopped or at least alternation should be applied to collection areas. Cultivation of soaproot yielding plants, should be studied and encouraged. Standardised extract of soaproot should be prepared. Soaproot yielding other perennial species and their saponin contents should be determined and new soaproot resources should be identified, and their cultivation and marketing possibilities should be studied. Informtions must be given to our puplic to preserve our biological richness [25].

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Ecological Importance of Birds

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Abstract: There are about 10000 bird species in the world. From the poles to the equatorial forests, from the deserts to the centres of the oceans, from the highest mountains to the hearts of our cities, everywhere birds are amongst the most conspicuous forms of animal life.
Of all the animals, birds have been the most well-known classis because human beings have used them for feeding, communication, pollinating plants, and decorate the home, etc. Also, birds are important to some animals for biological control, for example Rodentia.
Birds are important to continue ecologic circle, specially in food chain. For the last three centuries, industrial developments and anthropological effects have degraded habitats and caused the natural balance to deteriorate. Approximately 200 bird species had been affected directly or indirectly from these negative changes.

Key Words: Birds, Ecological importance, Aves, Ornithology.

Introduction

Ornithological research has always a central role in the development of certain aspects of our science. In other words, birds have attracted more than their fair share of our zoological attention. Reasons for this are: 1. most species are diurnal and conspicuous. 2. they can be trapped and marked with leg rings or other tags. 3. because in most species individuals raise their young in discrete nests, their individual reproductive rates can be measured accurately in a way not possible for most other organisms which lack parental care. 4. the huge popular interest that birds engender has given rise to an extensive network of skilled amateur observers (Newton 1995).

Given the significance of birds for conservation planning and environmental assessments, there is a need for a better ecological understanding of the role of avian community structure in conservation decision-making. Thus, they are widely used in conservation and population trends in farmland are one of the 15 'Quality of Life' indicators. In additon, small landbirds in particular have often been proposed as potential indicators for the presence of other unrelated taxa or as environmental change indicators to be integrated into broader monitoring schemes. Furthermore, they are frequently included in evaluation studies for overall biodiversity conservation (Gregory et al. 2004; Kati and Şekercioğlu 2006).

Although bird species have an important mission to continue for ecological balance, 1,012 species are being threatened by threats that habitat loss, human persecution and introduced predators. For example, habitat loss was cited as a source of risk for over 70% of threatened species, whereas human persecution and/or introduced predators were cited in 35% of cases. Overall, twice as many species (54%) were classified as being threatened by either habitat loss alone or human persecution/introduced predators alone than being threatened by both sources together (27%) (Owens and Bennett 2000).

The Role of Birds in Plant Distribution

Birds have a good system for spreading seeds. They eat berries and then when they dispose of their waste, the berry seeds are disposed along with it. Bird feces provide good fertilization for the seeds with which they are dropped, giving seeds very good conditions with which to grow. In addition, a lot of bird species may have been significant browsers of forest vegetation. For example, McEwen (1978) stated a large proportion of forest tree and shrub species had fleshy fruits which were attractive to birds. And also, Godley (1979) stated that birds performed a relatively minor role as pollinators in New Zealand forests and that foliage of all kinds was eaten mainly in late winter, spring and early summer, when fruit was least available.

Because of extensive dietary overlap between different herbivorous birds and the turnover of both bird and plant species through evolutionary time, it is unlikely that particular plant species have evolved adaptations to browsing by particular birds, although evolutionary responses to bird browsing in general are possible. With the extinction of moas and the recent decline of other birds such as kokako and kakapo, browsing by birds no longer has a great impact on forest plants (Clouth and Hay 1989).

The habitat heterogeneity hypothesis is one of the cornerstones of ecology. It assumes that structurally complex habitats may provide more niches and diverse ways of exploiting the environmental resources and thus increase species diversity (Bazzaz 1975).

In most habitats, plant communities determine the physical structure of the environment, and therefore, have a considerable influence on the distributions and interactions of animal species. For example, for bird species diversity in forests, MacArthur & MacArthur (1961) evidenced that the physical structure of a plant community, how the foliage was distributed vertically, might be more important than the actual composition of plant species. Depending on the taxonomic group, the structural parameter of the vegetation and the spatial scale, species diversity might also decrease with increase in habitat heterogeneity. Moreover, effects of habitat heterogeneity might vary considerably depending on what was perceived as a habitat by the species group studied. Structural attributes of the vegetation that constitute habitat heterogeneity for one group might be perceived as habitat fragmentation by another taxonomic group (Tews et all 2004).

Bird Extinction in Habitats

Ecosystem has biotic and abiotic compenents. There is constant interaction between. But, recently, this relationship has been changed negatively. For example, habitat loss is the major factor affecting directly or indirectly the global decline of biodiversity. Being complex to measure directly, biodiversity trends are often monitored as the extent and rate of species extinctions. Therefore, species' responses to habitat loss are a central issue of contemporary conservation biology (Mikusiński and Angelstam 2004).

Critical thresholds for habitat loss have been demonstrated in a wide range of studies using theoretical models. Two kinds of thresholds have been addressed: 1) the fragmentation threshold, which is the amount of habitat below which habitat fragmentation (spatial pattern) may affect population persistence and 2) the extinction threshold, which is the minimum amount of habitat which the population goes extinct (Mikusiński and Per Angelstam 2004).

Owens and Bennett (2000) suggested that different lineages are vulnerable to different mechanisms of extinction, with lineages that are highly threatened by one source usually being relatively secure with respect to the other source. Such results point strongly to the possibility that different ecological factors will be associated with different sources of extinction risk.

Whereas extinction risk via habitat loss was positively correlated with the degree of habitat specialization and small body size but not significantly associated with residual generation time, extinction risk incurred via human persecution and/or introduced predators was correlated with large body size and slow life history but was not significantly associated with variation in ecological specialization. These results confirm the prediction that different ecological factors are responsible for making a lineage vulnerable to different sources of extinction (Owens and Bennett 2000).

The Role of Birds in Agriculture

Agricultural land currently occupies approximately 38% of the planet's land surface, or around half its habitable area (Clay 2004). The modification and management of landscapes to produce food or other agricultural commodities for human consumption represents one of the most severe and widespread threats to global biodiversity (BirdLife International 2004; Foley et al 2005). The distribution of agricultural land is a beter predictor of wildlife threat status than the distribution of people (Scharlemann, Balmford & Green 2005). Agriculture affects natural ecosystems in more diverse ways, including modifications of landscape, soils, and water supply through deforestation, erosion, channeling, flooding, draining, etc., as well as the elimination or propagation of selected species of plants and animals (Steadman 1996).

Agriculture impacts on biodiversity in two main ways. The first is through the clearance of pristine habitats for new planting, with the accompanying pressures of fragmentation of remaining habitats, pollution and disturbance. The second driver of biodiversity decline is the intensification of existing agricultural systems, aimed at increasing crop yields per unit area. This has contributed more to increasing overall productivity of most commodities over the last 30 years than the planting of new land (Donald and Evans 2006).

Birds patterns of behaviour, distribution, seasonal phenology and demography track closely onto the spatial and temporal scales of agricultural change. Foraging, nest-site selection or breeding performance reflect features within the patchwork of agricultural habitats. The pattern of events in the annual farming calendar interact with key events in their own lives such as breeding or migration. Their populations or communities vary in ways that reflect local, regional or international variations in land use or management. The effects of year-to-year drift in their demography means that their population trends match the march of agricultural change. Perhaps most importantly of all, the availability of well-organized and geographically extensive data on bird populations over time has drawn our attention to the major environmental changes that have occurred on agricultural land. When coupled with equally valuable long-term monitoring of land use, these data have special importance in illustrating how ecological trends and agricultural practices are so closely linked (Ormerod & Watkinson, 2000).
The possible ecological effects of changing agricultural practice or land conversion are many. Some arise as a direct consequence of structural or composition changes to vegetation and the associated faunal communities. Others are mediated more subtly, for example through the changing phenology of crops. In addition, a wide array of indirect influences arise, for example through changing predator-prey dynamics or the chemical influences of agro-chemicals on species composition. There are also knock-on effects on other ecosystems, for example downstream or in adjacent bordering areas. Moreover, the major restructuring of land surfaces that accompanies agriculture is one of the principal ways through which the remaining semi-natural habitats are fragmented, with consequences for species' populations and dispersal (Ormerod and Watkinson 2000).

Negative effects of habitat heterogeneity may occur as a consequence of fragmentation, causing the disruption of key biological processes such as dispersal and resource acquisition. However, there is general consensus that not all species in an ecosystem are equally affected by spatial structures, depending on whether they cause heterogeneity or fragmentation (Tews et all 2004).

Birds have been widely used as indicators of agricultural environments, and increases in agricultural intensity have been linked with severe declines in farmland bird populations in Europe, North America, Africa and Asia (Donald & Evans 2006).

Kati and Sekercioglu (2006) determined that there are 10 specialist species that are highly characteristic and strongly dependent on the habitat types they are found in, as they are found in almost all sites of that habitat type and rarely in others.

When distinct ecosystems, such as forests or wetlands, are destroyed, the ecological roles of birds often disappear with them. In many cases, however, bird declines occur independent of habitat loss; exploitation, introduced species, pathogens, fragmentation, and other factors eliminate birds and their services from ecosystems. In fact, half of threatened species are threatened by a factor besides habitat loss. This result is particularly the case for scavengers (100%), piscivores (80%), herbivores (78%), omnivores (76%), granivores (56%), frugivores (53%), and birds that weigh 100 g (73%), all of which, except granivores, are groups significantly more threatened than average. Given the momentum of climate change, widespread habitat loss, and increasing numbers of invasive species, avian declines and extinctions are predicted to continue unabated in the nearfuture. By 2100, we expect 6–14% of all historic bird species to be extinct, 7–25% to be functionally extinct, and 13–52% to be functionally deficient (Şekercioğlu et all 2004).

The Importance of Birds for Biological Conservation

The resulting effect of habitat heterogeneity/diversity on species diversity is subject to the measurement of species diversity. In general, species diversity is a measure of the number of component species and their abundance at a defined point in space and time. On the smallest spatial scale the diversity of animal species measured is the result of individual behaviour, i.e. habitat selection, and of course sampling chance. On larger spatial scales species diversity depends on, e.g. the size of the regional species pool and evolutionary history. Considering these aspects, the measurement of species diversity is always a snapshot and results may vary even for similar habitats. Furthermore, correlations between species diversity and habitat heterogeneity in different locations are subject to equilibrium and nonequilibrium dynamics. For example, if species diversity patterns show year-to-year variations this will have great implications for across-study comparison (Tews et all 2004).

The 'structural extent' can be used when the gradient is characterized by a single variable, whereas 'structural gradients' apply to multivariate gradients. For instance, the structural complexity of the vegetation depends on a variety of parameters like height, coverage and vegetation types. While correlating carabid beetle diversity in a field study to gradients of any one of these variables did not yield significant results, the correlation with the multivariate structural gradient was highly significant (Tews et all 2004).

The ecosystem approach is also the only way to conserve organisms and processes in poorly known or unknown habitats and ecological subsystems. There are many examples from ecological science of the richness of previously unappreciated habitats, such as forest canopies, belowground subsystems, and the hyporheic zones (Franklin 1993).

Habitat reserves are an essential element in any comprehensive program to conserve biological diversity for the foreseeable future. The objective in designing a reserve system is to try to ensure that the reserves are sufficient in number and size and appropriately distributed over the landscape in terms of geography and ecosystem type. Much of the emphasis on reserves for maintenance of biological diversity is appropriate. Native habitats are disappearing at a rapid rate. Saving some pieces has a high priority if we are to retain the species and the processes dependent upon them. In the Pacific Northwest it is highly probable that there are species and processes that depend upon old-growth forest as habitat. Over the short term, existing old-growth forests are our only source of reserves. Hence, decisions about the amount and distribution of late successional forest habitats have high priority (Franklin 1993).

Conclusion

Based on the criteria used by the IUCN, 21% of 9,916 historic bird species are extinction-prone, a category that includes species that are extinct (1.3%), threatened with extinction in the next 10–100 years (12%), and close to qualifying or likely to qualify for a threatened category in the near future (7.4%, near threatened). Extinctionprone birds are not randomly distributed across different functional groups (based on primary diet) or guilds (based on diet and order of food preference). Even though primary diet is not a good predictor of threat status, some functional groups have more extinction-prone species than average: frugivores, herbivores (consumers of nonreproductive plant parts), omnivores, piscivores, and scavengers. Insectivores have slightly fewer extinction-prone species than average. Increased specialization is highly correlated with increased likelihood of extinction, and 41% of bird species limited to one habitat type are extinction-prone (Şekercioğlu et all 2004).

Higher concentrations of extinction-prone birds in certain groups may lead to community disassembly and to more pronounced ecological consequences than one would expect from global aggregated extinction probabilities. There are significant differences in the distribution of extinction-prone species among categories other than diet, such as habitat, region, altitudinal distribution, body mass, clutch size, and evolutionary uniqueness. Island birds are particularly at risk, although this is due to their small global ranges rather than an ''island effect''; in our stepwise regression model with forward selection (4,515 species), compared with ''range size'' alone, addition of ''island status'' was a negligible improvement (Şekercioğlu et all 2004).

Bird extinctions and population reductions in the 21st century may disrupt ecosystem processes and services of potential importance to society. Declines in bird species that are important for a particular ecosystem process service may not necessarily mean a decline in that process service if the populations of other functionally equivalent species increase in response. In addition, avian dispersers and pollinators for some plant communities

have low equivalence, resulting in a high risk of plant extinctions from lost mutualisms. Because highly specialized and evolutionarily unique species are more likely to go extinct, the probability of others taking their place is reduced (Şekercioğlu et all 2004).

Among the bird functional groups that are expected to have more extinctions than average, nectarivores pollinate many plant species and frugivores are important seed dispersers, both of which have important consequences for plant populations and community dynamics. Declines in pollination and seed dispersal as a result of bird extinctions may lead to extinctions of dependent plant species. The former is particularly important in the Austral, New Zealand, and Oceanic regions, where the proportion of bird-pollinated plants is higher than other parts of the world, and, in the case of the latter two regions, most of the presettlement avifauna is already extinct (Şekercioğlu et all 2004).

Little is known about the potential consequences of widespread disappearance of fish eating and scavenging bird species. There is an urgent need to investigate whether ongoing declines in seabird populations may have unanticipated top-down or bottom-up consequences as a result of trophic cascades or significant reductions in nutrient deposition. Because most scavenging birds are highly specialized to rapidly dispose of the bodies of large animals, these birds are important in the recycling of nutrients, leading other scavengers to dead animals, and limiting the spread of diseases to human communities as a result of slowly decomposing carcasses. In South Asia, the combination of extremely rapid crash of vulture populations, highly virulent diseases, and high human population density may cause increases in incidences of anthrax, bubonic plague, and rabies, but this potentially crucial interaction has not been studied. In 1997, 30,000 of the world's 35,000–50,000 rabies deaths took place in India where feral dog and rat populations have exploded after the decline of vultures. Although less threatened than average, insectivorous birds include more extinction-prone species than any other group (Şekercioğlu et all 2004).

Because of their high ecological specialization, many tropical forest insectivores are highly sensitive to habitat fragmentation , and 26% of these species are extinction-prone. Exclusions of insectivorous birds from apple trees, coffee shrubs, oak trees, and other plants have resulted in significant increases in insect pests and consequent plant damage. Natural pest-control services are increasing in importance as invertebrate pests develop resistance to chemicals, and pesticide use is curbed by environmental regulations and consumer trends (Şekercioğlu et all 2004).

Overall, 21% of bird species are currently extinction-prone and 6.5% are functionally extinct, contributing negligibly to ecosystem processes. A quarter or more of frugivorous and omnivorous species and one-third or more of herbivorous, piscivorous, and scavenger species are extinctionprone. Furthermore, by 2100, 6–14% of all bird species will be extinct, and 7–25% (28–56% on oceanic islands) will be functionally extinct. Important ecosystem processes, particularly decomposition, pollination, and seed dispersal, will likely decline as a result (Şekercioğlu et all 2004).

Although much research has been carried out in the field of habitat heterogeneity and species diversity patterns, empirical support is almost restricted to studies of vertebrate communities and habitats under anthropogenic influence. In addition, the measurement of habitat heterogeneity is very inconsistent making across-study comparisons difficult. For example, across-study comparison may include the relative effect of habitat heterogeneity between species groups. Furthermore, there is a significant lack of studies that consider multiple spatial scales and species groups within one ecosystem. This approach, however, is particularly important, as it enables detection of keystone structures that are crucial for maintaining species diversity. Examples from temporary wetlands in agricultural fields and solitary trees in South African savannas have demonstrated that keystone structures may simplify biodiversity conservation by protecting a wide array of species and functional mechanisms at the same time(Tews et all 2004).

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A Research on Heavy Metal Statues in Some Pasture Soil of Antalya

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Abstract: Meadow and pasture resources fulfill many important tasks, besides feature of being a source of feed for livestock production. Being natural balance element, erosion prevention, clean water, air and food production and protection of genetic resources of many plant and livestock organism can be accepted among these.
Because of rapidly growing urbanization, industrialization and tourism, meadow and pasture resources in the Mediterranean region have been polluted with different pollutants. In this study, soil pollution research was done in pastures near intensive industry and tourism region of Antalya. Concentration of Cd, Cr, Cu, Ni, Pb, Zn and Hg elements were analyzed in 12 samples from 3 different pastures as 4 samples from each one.
Results showed us that the concentration of Ni was higher than the limits written in Turkey Soil Pollution Control Regulation. The other concentrations are lower than the limits written in Regulation. This study is a precursor study which shows the needs of other detailed study.

Key words: Pasture, Soil, Heavy metal

Introduction

Meadow and pasture are being one of the important natural richness of a country (Altin et al., 2005). According to last evaluations, nearly half of the land of the earth is taken in to pasture concept and these areas have been accepted as valuable part of the nature and they should be protected as tropic forest (Avcioglu, 1999). Meadow and pastures have important tasks such as protection of soil, protection of genetic resources and using as livestock feed (Avcioglu, 1983). It is known that increasing with industrial activity, energy production, transportation and urbanization is caused to environmental pollution. Environmental pollutants are dangerous to human health, plants and other goods (Hodges, 1977; Biggins and Harrison, 1980).

The most negative effect of pollutants is carrying heavy metals which are toxic and carcinogenic (Lagerwer and Specth, 1970; Linton et al., 1980; Biggins and Harrison, 1980; Sakai et al., 1988). Pb, Cd and Ni pollution are more common in urban areas than rural areas because they are caused by industrial sources. Normally Pb and Cd are not found in plants. Whether if they are found trace amount in plants, it is accepted as a sign of pollutions (Foy et al., 1978). Heavy metals such as Pb, Cd, Ni, Cr are toxic for human and animals (Lagerwerff et al Specth, 1970; Linton et al., 1980). These toxic heavy metals are spread out to environment by industrial activities and emissions of motor vehicles (Biggins and Harrison, 1980; Miller and McFee, 1983; Chow, 1970).
Antalya is one of the provinces which has highest emigration rate in Turkey. This emigration causes to industrialization. In this study, soil pollution of 3 selected pastures which have great role as livestock feed source and near to urban and industry areas.

Material and Method

Ooil samples were taken from 4 stations of each 3 pastures, totally 12 stations. Each sample was formed by mixing 5 samples taken from 100 m^2 representative areas of pasture. Samples were taken from 10 cm depth. Analyses were carried out at Atmosfer Agriculture Analysis Laboratory.

Soil samples were prepared to analyses by sieving them through 2 mm sieves after making them as air dry at laboratory conditions (Jackson, 1967). In soil samples, structure analysis were done by hydrometric method (Bouyoucos, 1962), and water soluble total salt content were done by measuring electricity resistant in sature soil priming (U.S. Soil Survey Staff, 1951). Amount of $CaCO_3$ were analysed by Scheibler calcimeter (Schlichting ve Blume, 1966), organic materials were analyzed by crossing organic C percentage, which were evaluated by fresh burning method, with 1.724 factor (Reuterberg and Kremkus, 1951), total N was analyzed by modified macro Kjeldahl method (Bremner, 1965).

In soil and ash samples, content of some trace elements (Fe, Zn, Mn, Cu, Cd, Co, Cr, Ni, Pb) and heavy metals, which were extracted in aqua regia (HNO_3+HCl), were analyzed at ICP-OES after extraction by aqua regia extraction methods.

Result and Discussion

Analysis results of researched pasture soil are given in Table 1, contents of some useful macro and micro nutrition elements are given in Table 2, results of some heavy metals are given in Table 3, changing of pollutant heavy metals according to each station are shown in Figure 1. Pb content of soil is changed from 1.8 ppm to 13.16 ppm. The lowest Pb content of soil is at the Aşağıoba 3 and the highest one is at the Yağca 1 (Table 3). According to values which were given by Kloke (1980) that shows the Pb pollution of soil (100 ppm), it can be said that there is no Pb pollution at the researched soils (Figure 1).

Nickel contents of soils are changed between 12.76 ppm and 78.25 ppm. The lowest nickel level belongs to Aşağıoba 4 soils and the highest one is belong to Kovanlık 2 (Table 3). According to values which were given by Kloke (1980) that shows the Pb pollution of soil (50 ppm), some researched soil samples nickel contents are higher than Klokes's data. They are also higher that the limits (75 ppm) written in the Turkey Soil Pollution Control Regulation (Figure 1). But according to Regulation, analysis results can be exceeded to this limit, if it is proven scientifically, that they are not dangerous for human and environment at the feed crop cultivated areas.

Cupper contents of soils are changed between 0.7 ppm and 27.63 ppm. The lowest cupper level belongs to Yağca 4 soils and the highest one is belong to Yağca 2 (Table 3). According to values written in the Turkey Soil Pollution Control Regulation (140 ppm) there is cupper pollution at the researched soils (Figure 1).

Station	pH	EC (mmos/cm)	$CaCO_3$ (%)	Organic materials (%)	Total Nitrogen (N), %	Structure %
Aşağıoba 1	6,1	0,7	2,0	0,9	0,10	31
Aşağıoba 2	5,4	0,7	2,0	1,6	0,14	36
Aşağıoba 3	6,1	0,9	2,0	1,0	0,12	35
Aşağıoba 4	6,4	1,0	2,0	1,5	0,10	40
Kovanlık 1	8,1	1,6	16,0	2,7	0,15	64
Kovanlık 2	7,9	1,4	10,0	2,5	0,14	63
Kovanlık 3	7,9	1,3	8,0	2,3	0,13	59
Kovanlık 4	7,9	1,2	9,0	2,3	0,14	63
Yağca 1	7,8	1,7	6,0	4,4	0,27	66
Yağca 2	7,6	1,6	3,0	3,9	0,23	57
Yağca 3	7,7	1,2	5,0	4,6	0,35	65
Yağca 4	7,3	0,4	2,0	4,6	0,25	63

Table 1. Some soil properties of research area

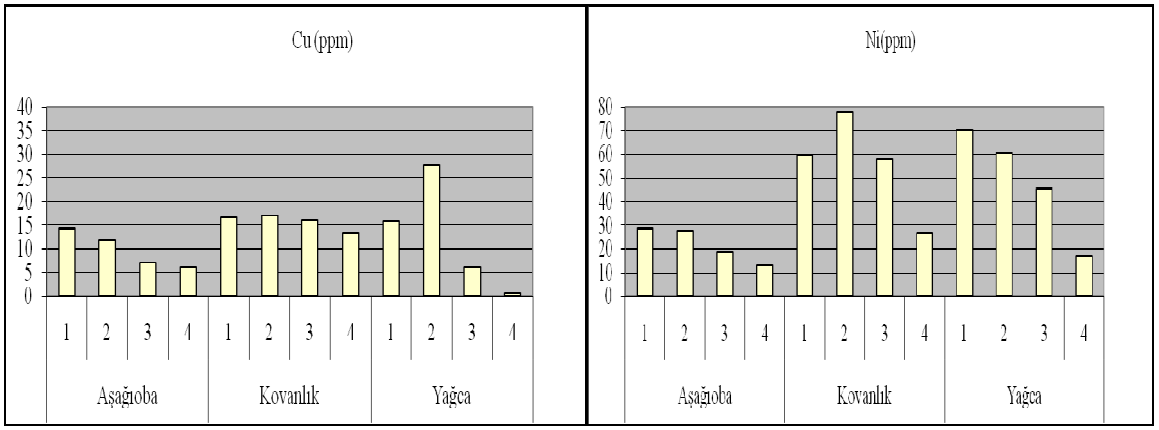
.

Station	P_2O_5 (kg/da)	K_2O (kg/da)	Ca (ppm)	Mg (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Aşağıoba 1	2,15	21,02	1559	249,00	32,4	35,78	0,24	0,87
Aşağıoba 2	6,14	32,40	2250	348,00	71,4	55,74	0,01	1,62
Aşağıoba 3	5,95	56,64	2492	366,00	33,8	29,19	0,24	1,28
Aşağıoba 4	4,08	33,60	3255	417,00	11,8	34,93	0,42	1,69
Kovanlık 1	2,15	41,04	7310	367,00	0,7	0,39	0,68	1,76
Kovanlık 2	0,82	37,44	7518	468,00	1,2	0,08	0,74	1,24
Kovanlık 3	1,88	37,68	6301	339,00	0,6	0,44	0,68	1,20
Kovanlık 4	1,60	40,80	7436	416,00	0,6	0,04	0,53	1,72
Yağca 1	42,73	158,16	7813	358,00	1,0	0,04	0,53	1,66
Yağca 2	3,25	188,16	7975	383,00	1,5	3,88	6,20	1,19
Yağca 3	31,24	206,40	7485	330,00	0,2	2,84	1,53	0,39
Yağca 4	8,34	262,56	6874	434,00	1,5	2,94	6,90	2,43

Table 2. Some useful macro and micro nutrition elements in soil samples

Pasture	No	Heavy metals (ppm)						
		Cu	Ni	Pb	Zn	Bor	Hg	Cd
Aşağıoba	1	14.34	28.62	3.42	5.95	-	-	-
	2	11.83	27.81	-	5.24	-	-	-
	3	7.08	18.65	1.8	3.35	-	-	-
	4	6.02	12.76	5.96	-	-	-	-
Kovanlık	1	16.64	59.65	6.19	31.83	-	-	-
	2	17.13	78.25	6.08	31.01	-	-	-
	3	16.00	58.11	4.44	27.52	-	-	-
	4	13.42	27.11	3.34	5.37	-	-	-
Yağca	1	15.78	70.5	13.16	76.85	-	-	-
	2	27.63	60.75	7.7	147.86	-	-	-
	3	5.97	45.54	2.73	52.17	-	-	-
	4	0.70	17.29	-	33.98	-	-	-

Table 3. Some heavy metals contents of soil samples, ppm



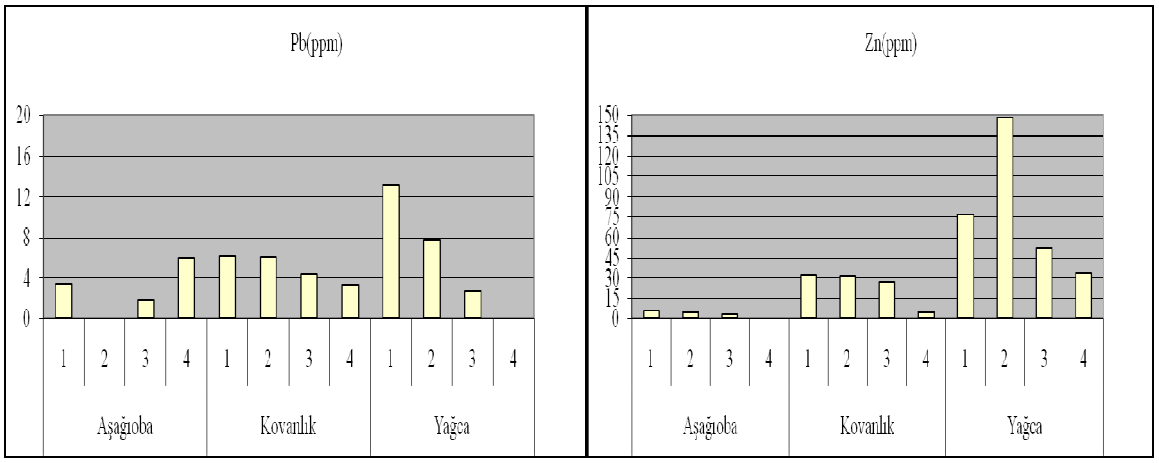


Figure 1.Concentration values of polluted heavy metals according to stations

Amount of Zn contents of soils are changed between 3.35 ppm and 147.86 ppm. Aşağıoba 3 has the lowest Zn level whereas Yağca 2 has the highest one (Table 3). According to values written in the Turkey Soil Pollution Control Regulation (300 ppm) there is cupper pollution at the researched soils (Figure 1).

In this research, Bor, Cd and Hg, which were analyzed in the soils, were not found.

Results

Four elements (Ni, Pb, Cu, Zn) were found for soil pollution at the 3 pasture near to urban areas and industry centers. Heavy metal pollution of soil is now at low levels. But if any precaution does not taken, this pollution level can be increase. For this reason, this initiator research should be considered an than these type of researches should be replicated periodically (once a 3 or 4 year) and results should be taken in to consideration carefully. If it is thought, that large part of livestock feed needs are covered from pastures, pastures should be protected from non-returning soil pollution

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Parameters Affecting Anaerobic Color Removal of Textile Wastewaters: An Overview

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Abstract: Release of colored wastewaters represents a major environmental problem worldwide due to the toxicity, mutagenicity and carcinogenicity of the dyes and their breakdown products. Therefore much attention has been focused on the effective treatment of dyes discharged from the dying and textile industries. The most widely used dyes in industries are azo dyes which require anaerobic and aerobic phases for their complete biodegradation. Color is removed under anaerobic conditions in which azo dyes act an electron acceptor. Further, aerobic conditions are essential for removal of breakdown products which are known resist to biodegradation under anaerobic conditions. Thus using both anaerobic and aerobic stages represents both decolorization and mineralization of azo dyes. Anaerobic stage is the first and the most important phase for color removal, however; decolorization can be affected by so many parameters such as; organic carbon source added, microorganisms selected, dye structure, cycle time, sludge age, and alternative electron acceptors involved. This review article summarizes the results of several research studies dealing with the factors affecting anaerobic color removal efficiency.

Introduction

Increased population and developments in industrialization have resulted in higher use of textile products leading to release of its huge amount of wastewaters to the environment. Actually the main problem related to the textile wastewaters is colored effluents. There are so many types of dyestuffs used in textile industry to give its color to the fabrics Dye is the most difficult constituent of the textile wastewater to treat since they are synthetic and typically derived from coal tar and petroleum based intermediates. It is estimated that almost 10^9 kg of dyes are produced annually in the word, of which azo dyes represent about 70% by weight (Dos Santos et al., 2007). Azo dyes are characterized by nitrogen to nitrogen double bonds (N=N). The major problem associated with the dyes and their breakdown products is their toxicity, mutagenicity and carcinogenicity. Their discharge into surface water leads to aesthetic problems and adversely affecting to aquatic life. To overcome this problem, much attention has been focused on the effective treatment of dyes discharged from the dying and textile industries. There are many reports on the use of chemical and physical methods for color removal (Cooper, 1993; Hao et al., 2000; Dos Santos et al., 2007). The most commonly used chemical and physical treatment methods for dye-containing textile-processing wastewaters are chemical oxidation, chemical flocculation and settling, adsorption, membrane filtration and ion exchange. By these existing physical and chemical color removal methods, color is generally concentrated in the sludge or colored molecules are partly removed. Moreover, formation of large amounts of sludge and economical limitations presents disadvantages of these methods. Alternatively, biological methods are commonly considered to be the most effective treatment applications since they present lower operating costs and improved applicability (Shaw et al., 2002; Lourenço et al., 2001).

It is known that several microorganisms; such as fungi, bacteria and algae; can decolorize many azo dyes (Pandey et al., 2007). In this review we will focus on the bacterial decolorization. Bacterial decolorization applied for textile effluents are based on anaerobic and aerobic treatment. Under anaerobic conditions, azo dyes are readily cleaved generating aromatic amines. The required electrons are provided by electron donating carbon sources which can be glucose, acetate, volatile fatty acids (VFAs). Hence, azo dye acts as electron acceptor and organic matters act as electron donor under anaerobic conditions. Electrons released from oxidation of electron donor directly accepted by azo dyes which results in azo linkage and color removal. Although these process the

remove color of the wide range of azo dyes dyes, they do not completely mineralize the aromatic amines generated in the anaerobic environment with few exceptions (Brown and Laboureur, 1983). However due to the carcinogenic effects treatment of the aromatic amines is essential. It is known that some of the aromatic amines can be biodegraded under aerobic conditions (Brown and Hamburger 1987; Seshadri et al. 1994; Carliell et al. 1995). Combination of anaerobic and aerobic conditions is therefore the most convenient concept for treating colored wastewaters (Haug et al., 1991; Zaoyan et al., 1992; Seshadri et al., 1994; Kudlich et al., 1996; Hu, 1998).

This review article summarizes the results of several research studies dealing with combined anaerobic-aerobic SBRs. Since anaerobic stage is the first and the most important phase for color removal, parameters affecting color removal should be determined to achieve desirable treatment. Therefore, this review study especially presents the problems dealing with anaerobic color removal. Anaerobic color removal can be affected by so many parameters such as; organic carbon source added, microorganisms selected, dye structure, cycle time, sludge age, and alternative electron acceptors involved. Therefore, factors affecting anaerobic color removal efficiency are briefly discussed in subsequent sections.

Factors Affecting Anaerobic Color Removal Efficiency

As mentioned before, anaerobic phase is the first stage of decolorization process starting with the formation of intermediary aromatic amines by reductive cleavage of the azo bond (Walker 1970; Wuhrmann et al., 1980; Haug et al., 1991; Blumel et al., 1998). The schematic diagram of enzymatic dye reduction is depicted in Figure 1. The research papers reviewed are proved that color removal is mainly associated with the anaerobic stage of the SBR, however; contribution of aerobic stage is almost none. Therefore, this review study especially presents the problems dealing with anaerobic phase of SBRs. Since most of the azo dyes can be decolorized under anaerobic conditions, anaerobic biodegradation seems to be nonspecific. Nevertheless; decolorization can be affected by so many parameters such as; organic carbon source added, microorganisms selected, dye structure, cycle time, sludge age, and alternative electron acceptors involved. Therefore, factors affecting anaerobic color removal efficiency are briefly discussed in subsequent sections.

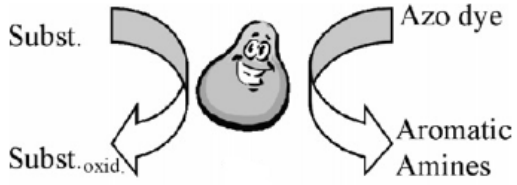

Figure 1. Enzymatic azo dye reduction, adapted from Subst., substrate or primary electron donor; Subst.oxid, products of substrate oxidation (Dos Santos et al., 2007)

Microorganism

In most of the reported processes of azo dye biodegradation, a wide range of organisms are found to reduce azo compounds such as bacteria, algae, and fungi. Azo dyes are generally known to resist aerobic bacterial biodegradation with the exception of bacteria with specialized azo dye reducing enzymes. Bacterial strains which can anerobically reduce azo dyes, cannot utilize dye as the growth substrate, therefore; require organic carbon sources. There are only a few bacteria that are able to grow on azo dyes as the sole carbon source. Aromatic amines resulting from reductive cleavage of azo bond can be used as a carbon and energy source for bacterial growth. Like carbon source, a nitrogen source is also essential for decolorization process with exception of bacteria that can be used azo dyes as a nitrogen source. As reported before, ammonium chloride is the most suitable among all nitrogen sources for SBR studies, since nitrate is believed that it is a better electron acceptor than azo bond (Wang et al., 2008). Based on the previous publications, azo dye can be reduced by azoreductase-catalyzed reduction under anaerobic conditions. But still there is a speculation whether bacterial flavin reductases are responsible for the azo reductase activity observed with bacterial cell extracts. In a published report, it was reported that flavin reductases are indeed able to act as azo reductases (Russ et al., 2000). Bacteria produce extracellular oxidative enzymes which are relatively non-specific enzymes catalyzing the oxidation of a variety of dyes. It was reported that there are so many diverse groups of bacteria playing role in decolorization. It has been also reported that mixed microbial community could reduce various azo dyes and members of the *γ-proteabacteria* and sulfate reducing bacteria (SRB) were found to prominent members of mixed bacterial population by using molecular methods to determine the microbial population dynamics (Pandey et al., 2007).

Dye Structure

It appears that almost every azo compound that has been tested is biologically reduced under anaerobic conditions, nevertheless; though similar conditions were provided, different color removal efficiencies were achieved. This indicates that, dye structure is important when investigating biological color removal by SBRs. It was reported that metal-ion containing dyes can have adverse effect on decolorization efficiency (Chung et al., 1978; Brown and De Vito 1993). It has been also reported that azo compounds with methyl, methoxy, sulpho or nitro groups being less likely to biodegrade than the others with a hydroxyl or amino group (Zimmermann et al., 1982; Claus et al., 2002). Azo dyes with a limited membrane permeability such as; sulfonated azo dyes, cannot be reduced by intracellularly (Stolz, 2001).

Cycle Time

Though cycle time plays an important role in the SBR for the decolorization process, not so many reports are found in literature. The long retention times are often applied in the anaerobic phase of the reactor studies such as 18h, 21h. In several studies, it was reported that there is a positive correlation between the anaerobic cycle time and color removal (Kapdan et al., 2003; Albuquerque et al., 2005). Indeed, in combined anaerobic-aerobic SBRs, since bacteria shifted from aerobic to anaerobic conditions, or vice versa; anaerobic azo reductase enzyme can be adversely affected from aerobic conditions which are essential for aromatic amine removal, thereby resulting in insufficient color removal rate. To investigate the effect of cycle time on biodegradation of azo dyes, Çınar et al. (2008) operated SBR in three different total cycle times (48-h, 24-h and 12-h), fed with a synthetic textile wastewater. The results indicated that decrease in anaerobic cycle time, the system performance on color removal is not adversely affected; on the contrary, both color removal efficiency and COD removal efficiency are slightly improved.

Sludge Age

The sludge retention time (SRT) is known as very important operational parameter for color removal in SBR system. To obtain efficient color removal rate, adequate microbial population is desired. It was reported that 10 days sludge retention time remained insufficient to obtain adequate population, and to ensure the color removal, sludge retention time was increased to 15 day (Lourenço et al., 2001).

Redox Mediators

Since long retention times are often applied in the anaerobic phase of the SBR, it can be concluded that reduction of many azo dyes is a relatively slow process. Reactor studies indicate that however; by using redox mediators; which are compounds that accelerate electron transfer from a primary electron donor (co-substrate) to a terminal electron acceptor (azo dye), azo dye reduction can be increased (Keck et al., 2002; Kudlich et al., 1997). By this way, higher decolorization rates can be achieved in SBRs operated with a low hydraulic retention time (HRT) (Cervantes et al., 2001; Dos Santos et al., 2003). Flavin enzyme cofactors, such as flavin adenide dinucleotide (FAD), flavin adenide mononucleotide (FMN) and riboflavin as well as several quinone compounds such as AQS, AQDS and lawsone have been found as redox mediators (Semde et al., 1998; Cervantes et al., 2000; Rau et al.,2002a; Rau et al.,2002b).Though accelerating effect of redox mediators is proved, differences in electro-chemical factors between mediator and azo dye is limiting factor for this application. It was reported that redox mediator applied for biological azo dye reduction must have redox potential between the half reactions of the azo dye and the primary electron donor (van der Zee et al., 2003). The standard redox potential for different azo dyes is screened generally between -430 and -180 mV (Dubin and Wright 1975).

Alternative Electron Acceptors

Decolorization of azo dyes starts by reductive cleavage of azo bond. Electrons releasing from oxidation of organic compounds in the wastewaters goes through the azo dye and cleaves the azo bond. As anaerobic color removal occurs by the way of reduction of the azo dye which acts a final electron acceptor in the microbial electron transport chain, existing different electron acceptors in anaerobic zone can be assessed as limiting factor for the dye removal. Alternative electron acceptors such as oxygen, nitrate, sulfate and ferric ion; may compete with the azo dye for reducing equivalents, and resulting in insufficient color removals under anaerobic conditions. Electron flow preference as a function of the different electron couples is depicted in Figure 2. Among the electron acceptors involved in electron transport chain, oxygen is the most effective electron acceptor. Anaerobic reactors in full-scale treatment systems are designed as open to the atmosphere. The effect of oxygen entering anaerobic reactors through the surface is generally assumed to be negligible since surface area is small relative to

the reactor volume. Oxygen can get into the anaerobic reactors of waste water treatment plants with the mixed liquor recirculated from the aerobic zone and mixing. The impact of oxygen on anaerobic color removal efficiency becomes progressively larger when it is thought that oxygen is the most effective electron acceptor on the electron transport chain. Researchers have reported that decolorization is significantly affected from the, high-redox-potential electron acceptor, dissolved oxygen. This is because; released electrons by oxidation of organic compounds are preferentially used to reduce oxygen rather than the azo dye. Oxygen has an adverse effect on decolorization under anaerobic conditions, therefore; facultative or obligate anaerobes are necessary for azo dye reduction (Chang and Kuo, 2000). Inhibition of azo reductase activity by oxygen was also reported for Pseudomonas luteola (Chung and Stevens, 1993; Blumel et al., 1998). Indeed, NADH leads to bacterial biodegradation of azo dyes by acting electron donor. In the case of the fact that oxygen is the electron acceptor, the consumption of NADH by oxidative phosphorylation can adversely affect the enzymatic decolorization of azo dye. In a recent study results also suggested that the presence of oxygen inhibits azo decolorization when the dissolved oxygen concentration in the medium was higher than 0.5 mg/L (Xu et al, 2007). This is mainly due to the adverse effect of the molecular oxygen on anaerobic azo reductase enzyme.

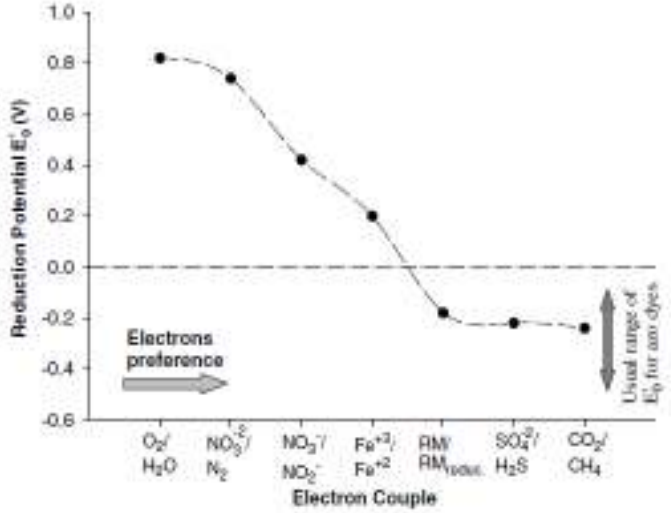

Figure 2. Electron flow preference as a function of the different electron couples, RM and RMreduc are the oxidized and the reduced form of the redox mediator, respectively (Dos Santos et al., 2007)

Among the electron acceptors involved in electron transport chain, nitrate is the second effective electron acceptor. Nitrate is normally found in textile processing wastewaters and generally coming from the salts such as, sodium nitrate which is included in dye baths for the improvement of dye fixation to the textile fibers. Nitrate concentrations used during textile processing can reach 40–100 g/l (Carliell et al., 1998). The importance of nitrate in anaerobic phase of SBR is that nitrate can compete with the azo dye for the reducing equivalents formed and resulting in decreasing decolorization (Carliell et al., 1995; Carliell et al., 1998, Lourenço et al., 2001; Panswad et al., 2000; Wuhrmann et al., 1980). Wuhrmann et al (1980) was reported that azo dye cannot be decolorized until denitrification ends up. Like nitrate, sulfate is also a constitute of textile processing wastewaters. Sulfate is generally added to the dye baths for ionic strength adjustment or it may be formed by the oxidation of sulfur species used in dyeing processes, such as sulfide, hydrosulfide, and dithionite (van der Zee et al., 2003). There are so many reports highlighting different effects of sulfate on azo dye degradation. It seems that in the presence of sulfate, decolorization may be rather stimulated than competitively suppressed (Carliell et al., 1995; Carliell et al., 1998; Panswad and Luangdilok, 2000; van der zee, 2003; Albuquerque et al., 2005). It was reported that when inhibiting sulfate-reducing activity of microbial population in SBR by the addition of molybdate, anaerobic azo dye removal efficiency is decreased. Indeed, since sulfate acts as an electron acceptor under anaerobic conditions, may compete with the dyes for the electrons available, thus causing an adverse effect on the decolorizing process. However; microbial population and sulfate concentration is also important for the reactions taking place during anaerobic phase. High sulfate concentrations are found to adversely affect decolorization unless sufficient amount of substrate is supplied to overcome the negative effects of elevated concentrations of sulfate (Cervantes et al., 2007). Furthermore; when sulfate is reduced under these conditions by sulfate reducing bacteria (SRB); sulfide, which is known as bulk reductant, is generated and can in turn serve as an electron donor. Sulfide generation is found to also contribute to the reduction of azo dyes. It is also reported that cofactors involved during microbial reduction of sulfate such as; cytochrome C3 (-205 mV) and NADH (-324 mV); have appropriate redox potential. Therefore, can channel the electrons to azo dyes.

Meanwhile, the redox potentials with more positive of the dye reduction than the redox potential of biological sulfate reduction (-220 mV) can be accelerated by sulfate. It was also reported articles that ferric iron can act as an electron acceptor under anaerobic conditions in which azo dye reduction occurs. Like sulfate, it was found that addition of ferric iron to the reactor stimulates the azo dye reduction. Indeed, the reactions are dealing with the redox couple Fe (III)/Fe (II) which can act as an electron shuttle for transferring electrons from electron donor to the electron accepting azo dye. Meanwhile, reactions of both reduction of Fe (III) to Fe (II) and oxidation of Fe (II) to Fe (III) facilitate the electron transport from the substrate to azo dye, thus acting as an extracellular redox mediator (Albuquerque et al., 2005).

Primary Electron Donor Type

Since anaerobic azo dye reduction is an oxidation-reduction reaction, a liable electron donor is essential to achieve effective color removal rates. It is known that most of the bond reductions are occurred during active bacterial growth (Nigam et al., 1996). Therefore, anaerobic azo dye reduction is extremely depended on the type of primary electron donor. It was reported that ethanol, glucose, H_2/CO_2 and formate are effective electron donors, contrarily; acetate and other volatile fatty acids are normally known as poor electron donors (Dos Santos et al., 2003; Tan et al., 1999; Pearce et al., 2006). So far, because of the substrate itself or microorganisms involved, with some primary substrates better color removal rates have been obtained but with others no effective decolorization have been observed. Electron donor concentration is also important to achieve higher color removal rates. Since there are so many reactions involved in bioreactor, competition for reducing equivalents by other reactions may increase the required amount of primary substrate. Though in theory the amount of electron donor per mmol monoazo dye azo is 32 mg COD, it was reported in a study that even if 60-300 times higher of the stoichiometric amount is used, more electron donor source is needed (O'Neill et al., 2000).

Dye concentratıon

In several studies, large variations in dye concentrations have been applied in the reactor studies and it was reported that dye concentration may play a role in the decolorization process. In the case of exceeding the reactor's biological azo dye reduction capacity, high dye concentration may adversely affect the dye removal efficiency and COD removal efficiency. Kapdan and Özturk **(2005)** reported that increasing initial dyestuff concentration adversely affect the COD removal performance of SBR. Nevertheless; dye removal rate may be increased by increasing dye concentrations **(**Cruz and Buitron, 2001). Some of the reactor studies have been proved the possibility of azo dye toxicity to microorganisms involved in biodegradation. Though toxicity is related to dye concentration, dye type applied is also important (Luangdilok and Panswad 2000). Metal-complex dyes and reactive dyes are known to have toxicity effect on decolorization process from the literature **(**Libra et al., 2004).

Conclusion

Azo dye containing wastewaters seems one of the most polluted wastewaters which require efficient decolorization and subsequent aromatic amine metabolism. Based on the available literature, it can be concluded that anaerobic- aerobic SBR operations are quite convenient for the complete biodegradation of both azo dyes and their breakdown products. Nevertheless, like the other methods used for biological treatment, SBRs treating colored wastewaters have some limitations. Presence of forceful alternative electron acceptors such as nitrate and oxygen, availability of an electron donor, microorganisms, and cycle times of anaerobic and aerobic reaction phases can be evaluated as quite significant. Though treatment of azo dye containing wastewaters needs combined anaerobic-aerobic phases, microorganisms are subjected to continually alternating anaerobic and aerobic conditions. Thus, it is presumable that anaerobic enzymes involved in the azo dye reduction may be adversely affected from aerobic conditions, as well as aerobic enzymes involved in the aromatic amine mineralization may be adversely affected from anaerobic conditions. Since little is known about the regulations of the enzymes involved in complete biodegradation of colored wastewaters, this approach seems to need advanced investigation to improve color removal and aromatic amine mineralization.

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Parameters Affecting Polyhydroxyalkanoate Synthesis from Wastewaters

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Abstract: Plastics used almost every manufacturing industry are resist to biodegradation. Their persistence in soil for a long time has become a major concern in terms of the environment. This promotes many investigators to search for replacement of non-biodegradable by degradable plastics. Polyhydroxyalkanoates (PHAs), known as a biodegradable plastic produced by bacteria, have received increasing attention due to the difficulties in disposal of plastics. In recent years, researchers have focused on the processes to increase PHA production which involve in biological phosphorus removal (BPR). Normally, BPR can be achieved through anaerobic- aerobic cycling by a group of bacteria known as polyphosphate-accumulating organisms (PAOs). PHA is stored within the PAO as carbon polymers under anaerobic conditions by taking up volatile fatty acids (VFAs), further it is used as energy source and phosphorus uptake under aerobic conditions. The aim of this review is to discuss recent advances in PHA production from wastewaters and parameters effecting PHA production efficiency.

1. Introduction

Plastics which are known to be widely used in almost every manufacturing industry are very much advantageous. Plastics are popular in many durable, disposal goods and as packaging materials. Beside a wide range of benefits, they are not desirable in the environment. Especially, plastics are known as hardly biodegradable even non-biodegradable due to the fact that they mainly have high molecular weights (Reedy et al., 2003). Their persistence in soil for a long time has become a major concern in terms of the environment. This promotes many investigators to search for replacement of non-biodegradable by degradable plastics. An alternative approach to conventional plastics is Polyhydroxyalkanoates (PHAs) which are known as a completely biodegradable plastic produced by bacteria, have received increasing attention due to the difficulties in disposal of plastics (Bengtsson et al., 2008). Additionally, Poly-(R)-3-hydroxybutyric acid (PHB) and hydroxyvalerate (PHV) are among the most common PHA monomers. The chemical structure of the PHAs is shown in Figure1.

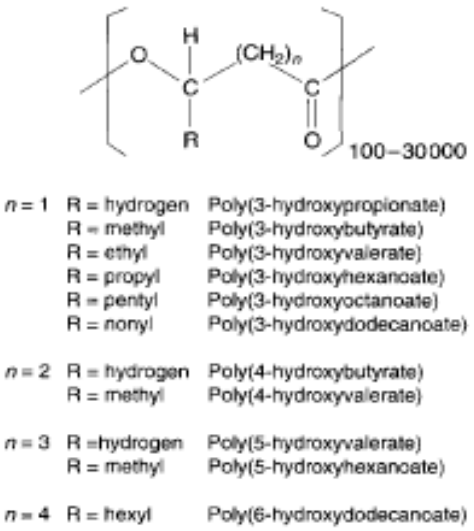

Figure 1. Chemical structure of PHAs (Lee, 1996)

2. PHA Production

As mentioned before, the PHAs are non-toxic, biocompatible, biodegradable thermoplastics that can be produced from renewable resources such as biomass. These biopolymers accumulate as storage materials in microbial cells under stress conditions (Sudesh et al., 2000; Chen et al., 2001; Kadouri et al., 2005). Many gram-positive and gram-negative bacteria are known to be able to synthesize PHAs (Reedy et al., 2003). PHAs can be produced through anaerobic- aerobic cycling by a group of bacteria known as polyphosphate-accumulating organisms (PAOs). Although PAOs are often present in a wide range of aerobic suspended growth cultures, they only have the ability to store large quantities of phosphate when they are subjected to alternating anaerobic and aerobic conditions. PHA is stored within the PAO as carbon polymers under anaerobic conditions by taking up volatile fatty acids (VFAs), further it is used as energy source and phosphorus uptake under aerobic conditions (Figure 2). Under aerobic conditions stored PHA or PHB within the cell is used as energy source for biomass growth, and glycogen synthesis.

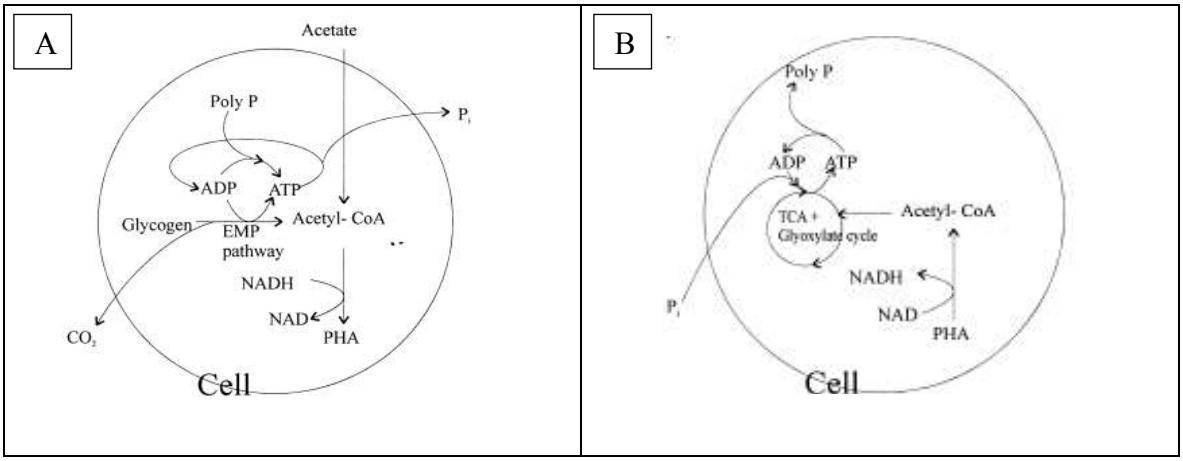

Figure 2. Anaerobic PHA production and phosphorus release (A), aerobic PHA utilization and phosphorus uptake (B) within the cell (Lee and Choi, 1999)

Recently reported research articles have been performed to understand PAO metabolism (Seviour et al., 2003). Acetate has been used almost exclusively as the carbon source in these studies, partially explained by the fact that it is typically the largest volatile fatty acid (VFA) species present in the wastewater treatment plants. Metabolic PAO models for anaerobic acetate uptake and utilization and the subsequent aerobic processes have been proposed. As depicted in Figure 2, anaerobic process is based on fermentation in which poly-P degradation and phosphate release take part. Under anaerobic conditions with acetate as the carbon source, phosphate

accumulating microorganisms can take up acetate rapidly, accumulate PHAs in the cell. The energy for this biotransformation is mainly generated by the cleavage of polyphosphate and release of phosphate from the cell. They consume previously stored intracellular carbohydrate, and release P as a result of utilization of stored poly-P. Thus, wastewater from anaerobic process is rich in inorganic phosphate. In aerobic processes, oxygen is electron acceptor and microorganism use stored PHB as their carbon and energy source.

PAOs are actually known as responsible for enhanced biological phosphorus removal (EBPR) and have a key role with respect to both PHB accumulate within the cell and phosphorous removal. The process is one of the most commonly used and environmentally sounds methods for phosphorus (P) removal from wastewater. As mentioned before, VFAs are preferable substrates for PHA production. Anaerobic fermentation converts various organic compounds to VFAs hence increasing the potential to produce PHA from the wastewater. The composition of the VFAs produced during fermentation will influence the final polymer product. However, the number of literature reports for PHA production with mixed cultures enriched with real wastewaters is limited.

- **PHAs Extraction from the Cell**

Since PHAs are accumulated within the cell, it should be extracted to be able to be used as plastic polymers. However, the extraction of bioplastics from microorganism poses yet a challenge. There are two common protocols used for PHA extraction from bacteria. The first protocol is developed by taking into consideration of solubility in chloroform and insolubility in methanol. Harvested bacterial cells are exposed to warm chloroform to make PHAs soluble. Further, residuals from harvested bacteria such as lipids and other lipophilic components are removed by reflux in hot methanol. Purified PHA production efficiency of this protocol is high. However, requirements of a large amount of hazardous solvent make it not environmentally friendly (Lee, 1996). The second protocol developed for the aim of avoiding organic solvent usage. In this protocol, a mixture of enzymes are used such as proteases, nucleases and lysozymes, additionally to remove proteins, nucleic acids, and cell walls, detergents are used.

3. Factors Affecting PHB Production

In the previous sections the importance of PAOs on PHB production and phosphorus removal from the wastewaters were emphasized. However, their production costs are much higher than the petrochemical- based plastics (Fang et al., 2009). Thus, it becomes inevitable to know parameters affecting PHA production efficiency within the cell such as; microorganisms involved, pH, substrate, solid retention time (SRT), availability of electron acceptors, and temperature. These will be briefly discussed by taking into account the published research articles that focus on increasing the cost-effectiveness of this process.

a. Microbial Population

Determination of microbial population that involve in PHB production and phosphorous removal is one of the most important factor to be able to make the process successful. It has been emphasized in so many articles that there is a competition between two microorganisms, PAOs and glycogen (non-polyphosphate) accumulating organisms (GAOs) respectively. Like PAOs, GAOs are able to proliferate under alternating anaerobic and aerobic conditions but the problem is they do not contribute to P removal hence anaerobic P release or aerobic P uptake cannot be established. This constitutes a major challenge since PHA production without any phosphorous removal cannot be convenient according to discharge regulations. Additionally, the presence of GAOs increase the anaerobic VFA requirements of these plants, thus so many investigators have focused on the ways that minimize the growth of GAOs. Factors affecting GAOs and PAOs competitions can be summarized as:

6. One factor affecting the PHA accumulation is the ratio of organic carbon to P in the influent or the so-called COD: P ratio. In so many studies it was reported that a high COD/P ratio (e.g. 450mgCOD/mgP) in the wastewater feed tends to favorable the growth of GAOs instead of PAOs while a low COD/P ratio (e.g. 10–20mgCOD/mgP) tends to favorable to the growth of PAOs (Oehmen et al., 2007).

7. Effect of pH has been reported in so many research articles. They have found that increase in pH from 6.5-7.5 is favorable for PAOs while is not favorable for GAO. Thus it is possible to eliminate GAOs by increasing pH. In a study performed by Filipe et al., (2001a) has shown that P uptake, PHA utilization and biomass growth were all inhibited by a low pH (6.5), and suggested that a higher aerobic pH (7–7.5) would be more beneficial for PAOs.

8. Effect of temperature is also investigated by so many researches and they concluded that GAOs are inhibited at 10 ºC since PAOs are the dominant microorganisms at low temperature (Carlos et al., 2009). It was also noted that high temperatures (30 ºC) can suppress the proliferation of GAO in which operating conditions for pH is high (>7) and an adequate acetate to propionate ratio (75–25%) is supplied. The experimental evidence obtained thus far suggests that GAOs tend to become stronger competitors with PAOs at higher temperatures.

b. pH

In many studies it was shown that adjusting to pH higher levels results in a higher anaerobic P release (Smolders et al., 1994; Liu et al., 1996; Bond et al., 1999; Filipe et al., 2001b). Kasemsap et al., (2007) found that increasing the pH from 6 to 8 promoted the PHA production significantly. It was also reported in other study that the ratio of anaerobic P release to acetate uptake increase from 0.25 to 0.75 P-mol/C-mol by increasing pH from 5.5 to 8.5 (Smolders,1994). Actually, by adjusting pH GAOs can be eliminated, this is the reason for why so many researchers focus on its effects.

Increase in pH makes the energy requirements for substrate uptake high. When external pH is high, more energy is needed for acetate uptake. This increased energy is generated through an increase in polyphosphate degradation. This scenario has been found ineffective for the acetate uptake, glycogen degradation and PHA accumulation rates of PAOs when the pH is over the range 6.5–8.0 (Filipe et al., 2001b). Nevertheless, this situation is rather different for the GAOs. It was reported that a higher pH results in a higher energy demand for acetate uptake, but negatively affects the ability of GAOs to take up acetate. This is obviously related to the differences between metabolic pathways of the microorganisms. The energy production pathways of GAOs and PAOs are dissimilar since PAOs use the energy required for the substrate uptake from the hydrolysis of poly-P while GAOs from the hydrolysis of glycogen (Smolders et al., 1994; Filipe et al., 2001a,b). That means PAOs have poly-P as an extra energy source as compared to GAOs and they deplete it to meet higher energy demand. In a published report performed by Chua et al.(2003) studied the effect of pH on the PHA content using acetate as the substrate. They found that, through controlling the pH at 6 or 7, the PHA content (less than 5%) was lower than at pH 8 or 9 (25–32%). Like this record, Serafim et al., (2004) was found that polymer yield per substrate and the intracellular PHB content were higher at pH 8 than at pH 7.

c. Substrate

It is a prerequisite to optimize all the fermentation conditions for the successful implementation of commercial PHA production systems. Actually there is a major challenge to reduce PHA production costs. Carbon source has a large impact on production cost of the PHA produced. Hence, recent studies have been focused on reducing costs. The price of the product ultimately depends on the substrate cost, PHA yield on the substrate, and the efficiency of product formulation in the downstream processing.

In so many studies different substrates were used to improve the predictability of the metabolism of both PAOs and GAOs. Acetate has been used almost exclusively as the carbon source. It has been well known that short chain fatty acids like acetate are favorable carbon sources for PAOs. Beside acetate, there are so many carbon sources used in order to investigate PHA production pathway, such as; lactate, propionate, sucrose, glucose, cheese whey, cane molasses, methanol, and hemicelluloses hydrolsate (Quillaguaman et al., 2007; Ahn et al., 2000; Wong and Lee, 1998; Rhu et al., 2003; Hong et al., 2000). Waste materials or industrial by-products can also be used for PHA production. However it was reported that carbohydrates are not directly stored as PHA and they are tend to be preferentially accumulated as glycogen (Dircks et al., 2001; Karahan et al., 2006). PHA production from raw materials requires a previous anaerobic fermentation step for their transformation into volatile fatty acids (VFA). This is the reason why the majority of the studies related to PHA production are based on the use of organic acids. The effect of various substrate costs, the yield on the P (3HB) and production cost are summarized in Table 1.

Wastewater contains a much more diverse mixture of substrates other than acetate and investigations were conducted with other compounds, alone or in mixtures, including: propionate, butyrate, valerate, isovalerate, formate, lactate, malate, pyruvate, glucose, citrate, succinate but glutamate but the metabolism of these organic substrates have not yet been well understood (Wang et al., 2002). Several studies concluded that glucose as sole carbon source led to deterioration of the EBPR process, as glucose promoted the growth of GAOs which do not accumulate polyphosphate and therefore capable of utilizing glucose without the release of phosphate (Cech and Hartman, 1993; Mino et al., 1994; Satoh et al., 1994; Tasli et al., 1997). However, there are also opposite research results where a stable EBPR performance could be maintained with glucose as the major organic substrate, with no appreciable proliferation of GAOs (Carucci et al., 1999; Jeon and Park, 2000; Wang et al., 2002).

Substrate	Substrate Price (US$ kg^{-1})	P(3HB) yield (g P(3HB) (g substrate)$^{-1}$)	Product cost (US$(kg P(3HB))$^{-1}$)
Glucose	0.493	0.38	1.30
Sucrose	0.290	0.40	0.72
Methanol	0.180	0.43	0.42
Acetic acid	0.595	0.38	1.56
Ethanol	0.502	0.50	1.00
Cane molasses	0.220	0.42	0.52
Cheese whey	0.071	0.33	0.22
Hemicellulose hydrolysate	0.069	0.20	0.34

Table 1. Effect of various carbon sources on PHB yield and production cost (Reddy et al., 2003)

In the past, there have been relatively few studies on EBPR systems involving propionate as a carbon source (Satoh et al., 1992,). In recent years, however, the metabolism of propionate by PAOs (Lemos et al., 2003) and its effect on EBPR performance has attracted considerable attention. Several studies have suggested that propionate could be a more favorable substrate for EBPR (Chen et al., 2004; Thomas et al., 2003), likely providing a selective advantage to PAOs over GAOs (Oehmen et al., 2004a, 2004b; Pijuan et al., 2004). In the studies used other single substrates such as lactate, ethanol, and glutamate which can be converted into PHB, very low storage yield has been obtained. When lactate used for carbon source, 0.20 g PHA g-^{1} substrate accumulation was obtained, it was 0.25 g PHA g^{-1} substrate for ethanol, and 0.058 g PHA g-^{1} substrate for glutamate (Dionisi et al., 2004; Doi et al.,1987). Lactate is taken up by PAO cells and converted to propionyl-CoA, using both poly-P and glycogen hydrolysis as energy sources. Poly-P is hydrolyzed to orthophosphate and released from the cells, while glycogen is hydrolyzed to acetyl-CoA and CO_2. Acetyl-CoA and propionyl-CoA are reduced and condensed to form PHA, with the reducing power provided by glycogen hydrolysis. This mechanism is compared to the situation in which acetate is used as sole carbon source in Figure 3.

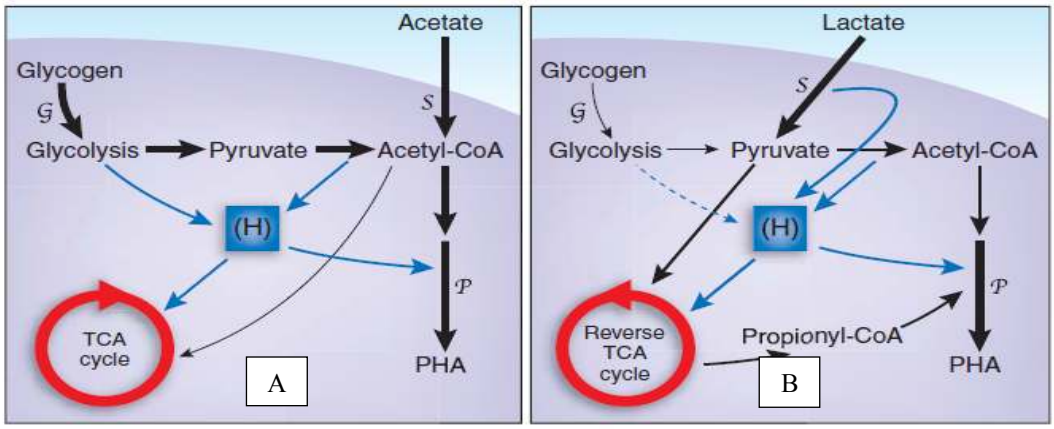

Figure 3. Control of redox balance of different carbon source in PHA production under anaerobic conditions (Mino and Satoh, 2006).

H, reducing power or hydrogen in such forms as NAD(P)H and $FADH_2$;
S, molar amount of acetate or lactate taken up;
G, molar amount of glucose unit in glycogen consumed;
P, molar amount of monomeric units of PHA produced.

In Figure 3, redox balance regulation is depicted which is the key mechanism for anaerobic carbon uptake and hence proliferation of PAOs. Glycolysis via Embden Meyerhof pathway (EMP) and acetate oxidation through the TCA cycle provides the required reducing power for the conversion of acetate into 3-hydroxybutyrate for PHA synthesis (Figure 3A). Mino reported in this study that the ratio S/G/P will be 1:(1/6):(2/3) and 1:0:(4/9) if all reducing power is supplied by glycolysis and by the TCA cycle, respectively. In Figure 3 B, lactate is taken up within the cell as carbon source. By this way, ratio of S/P is increased to 2. During conversion of lactate into acetyl-CoA the reverse operation of the TCA cycle is needed to consume excess reducing power produced.

d. Solid Retention Time (SRT) and Temperature

It is obvious from the published reports that SRT has important impact on PHA production yield for a given organic loading rate (OLR) .Short SRT sludge acquires higher PHA production capability, hence sludge acclimatization with a short SRT may also be preferable for PHA production purpose. This approach is confirmed since the sludge yield under a shorter SRT is higher than that under a longer SRT. So it can be concluded that with a short SRT can supply sufficient amount of sludge for PHA production compared to that with a long SRT. It was found that sludge with a short SRT (3 days) could achieve PHA content about 10% more than sludge with a long SRT (10 days) (Chua et al, 2003). However, it was reported that higher cell growth rates resulted in a lower PHB content higher PHB yields were produced at longer SRT when the cells were growing more slowly (Dias et al 2006). Beun et al. (2000) reported that the PHB yield per substrate and specific productivity were almost constant when vary the SRT from 3.8 to 19.8 day. Dionisi et al. (2001) obtained a relatively constant storage yield in a SRT range of 0.37–3 day.

Temperature also appears to be a factor that has an important impact on the PHA production. It was reported that temperature has actually directly affected microorganism competition which is known as GAO and PAO. In a published report, it was mentioned that a lower temperature decrease the rates of P release/uptake, acetate uptake, PHA oxidation, growth (Brdjanovic et al., 1998). Panswad et al. (2003) found that the rate of P release increased with increasing temperature from 20 to 35 ºC, while the rate of P uptake decreased. Aditionally,it was reported in a study that the increase of temperature from 15 to 35 ºC result in decrease in the yield of PHB on acetate from 0.43 to 0.072 g PHA g^{-1} substrate and a decrease in the specific productivity from 0.12 to 0.060 g PHA g^{-1} cell dry weight h^{-1} (Krishna and van Loosdrecht, 1999). The yield of biomass also decreased with temperature increase. Low temperatures (between 15 and 20 ºC) allow for a less costly process thus increasing the PHA productivity.

e. Availibity of Electron Acceptors

Since anaerobic P release based on fermentation process, availability of electron acceptors, such as; oxygen, nitrate and sulphate, is not desired since this will eliminate the fermentation process. For example availability of nitrate will result in denitrification process and nitrate reduction will take place other than fermentation process in which organic compounds are usually used as electron acceptors. Additionally, it has been observed that aerobic P uptake is inhibited by the presence of nitrite (Kuba et al., 1996). Saito (2004) also reported that the presence and accumulation of nitrite inhibits PAOs, thereby favoring the growth of GAOs. Third et al. (2003) was studied the effect of dissolved oxygen concentration (DO) on PHA production. They found that when oxygen was limited PHA yield was 0.49 g PHA g^{-1} substrate using acetate as sole carbon source. They have found that PHA yield was decreased to 0.34 g PHA g^{-1} substrate under excess oxygen.

4. Conclusion

Polyhydroxyalkanoates (PHA) have gained major importance because of their similar properties to conventional plastics and their complete biodegradability. PHA can be produced from renewable carbon sources, allowing for a sustainable process for the production and use of such polymers. PHA can be synthesized by polyphosphate-accumulating organisms (PAO) under anaerobic conditions from external carbon sources and internal glycogen. Glycogen-accumulating organisms (GAO) are also present in EBPR systems and compete for carbon substrates with PAO. They also cycle PHA and glycogen in a fashion similar to PAO, but GAO do not cycle polyphosphate. Hovewer, much more effort is required in this area to increase the production of bioplastics to successfully replace the non-degradable plastics. Thus the future of bioplastics depends on the efforts towards fulfilling requirements of price and performance. This review shows the parameters affecting PHA production efficiency. Process monitoring and control are important factors for achieving high productivity. Since carbon source has a large impact on production cost of the PHA produced recent studies have been focused on reducing its costs. Besides carbon source, some other factors such as SRT, temperature, pH, availability of electron acceptors in the anaerobic phase are proved to have important affect on PHA production yield. It can be concluded that, low SRT, temperature ranging between 15-25 ºC, pH above 7 can be preferable for higher PHA production efficiency. Indeed, the main challenge regarding the bioreactor operation and control is the development of culture selection strategies of fast growing organisms that have a high PHA storage capacity. It can be recommended to introduce the new metabolic pathways for not only to expand the utilizable substrate range but also enhance the current PHA yields.

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Water Management and Sustainable Development

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Abstract: Water is the basis of life on earth; it is the main component of the environment and an essential element for human life. Water is also fundamental for sustaining a high quality of life and for economic and social development. Human health greatly has been affected by water. But water resources has been threaten by pollution, miss using, and industrialization.
In this paper loads on water resources and water availability depending on factors are analyzed; regions of water scarcity and water resources deficit are discussed. Possible ways of water supply improvement and elimination of water resources deficit in different conditions were argued.

Keywords: Water management; Freshwater; Sustainable development

Introduction

Water is very important resources for sustainable development in human life. Uses of water include agricultural, industrial, household, recreational and environmental activities. The demand of water amount increased six times in 20th century when comparing with 19th century, but during this time the population of word increased only three fold. To know reliable assessment of water storage on the earth is essential but there is complicated problem because water is very dynamic. It is in permanent motion, converting among liquid, solid, and gaseous phases. In addition to the quantitative estimation of water storage, it is necessary to determine the form salt or freshwater and the other formation on our planet.

It is estimated that the earths hydrosphere contains of water, 1,386 million cubic kilometers (km^3). However 97.5 percent of this amount is salt water and only 2.5 percent is fresh water. Most of the fresh water

(68.7 percent) is in the form of ice and permanent snow cover in the Antarctic, the Arctic, and mountainous regions. Fresh groundwater comprises 29.9 percent of fresh water resources. Only 0.26 percent of the total amount of fresh water on the earth is concentrated in lakes, reservoirs, and river systems (Korzoun 1978).

Water storage in the hydrosphere permanently exchange among the ocean, land, and the atmosphere. This exchange is usually called the turnover of water on the earth, or the global hydrological cycle. This cycle is fully replenished according to hydrospheric water, for example 2500 year for oceanic water, 10000 years permafrost and polar ice, 1500 years deep groundwater and mountainous glaciers. On the other hand, water storage in lakes is fully replenished 17 years and in rivers only 17 days. So, river water is of great importance in the global hydrological cycle and in supplying humankind with freshwater. In hydrology and water management, two concepts are very important that are used freshwater storage and renewable water resources.

Renewable water resources include the water yearly replenished in the process of water turnover on the earth. In the process of turnover, both the quantity of river runoff is replenished and its quality is restored. If we could stop the contamination of rivers, then, with time, water could return to its natural purity. It is the river runoff that is most widely distributed over the land and provides a major part of water use in the world. A discovery of the anthropogenic factors that effect change of the quantitative and qualitative parameters of river water, are very important aspects of the water resources appraisal and assessment. Reliable assessment and appraisal of water resources is very important for each country or region and serves as an important prerequisite for all other aspects of the utilization and operation of water resources, and development of measures to protect against depletion and pollution. So each country is responsible water use and assessment their water sources.

There are many research and document about renewable freshwater resources published since the turn of the past century in the different countries of the world. During the last years, the results of global estimations have been published with varying degrees of comprehensiveness (Baumgartner & Reichel 1975; Berner & Berner 1987, World Resources Institute 1996; Gleick 1993 and 1998).

For assess renewable water resources at the global scale it must be;

5. The availability of the long-term observation series;
6. Location of sites on large and medium rivers, uniformly spread across the region,
7. Observations should reflect the river runoff regime, natural, or close to natural.

Also using water was primarily estimated for the countries of the world. Then the values obtained were generalized for large natural-economic regions and continents.

Household Water

The amount of public water use in their home depends on climatic conditions. In many well-equipped cities of the world, water withdrawals equal 300-600 liters per day per person (lcd). By the end of the 20th century, in industrially developed countries of Europe and North America, the per capita urban water withdrawal was expected to increase up to 500-800 l/day. On the other hand, in developing agricultural countries of Asia, Africa, and Latin America, public water withdrawal is 50 to 100 lcd; in individual regions with insufficient water resources, it is not more than 10 to 40 lcd of freshwater per person (Shiklomanov & Markova 1987; Gleick 1993 and 1998).

When calculated the specific water withdrawal is 400 to 600 lcd, and consumption does not usually exceed 5 to 10 percent of total water intake. Water use by populations in cities and rural areas was estimated using population dynamics data (urban and rural) and per capita water withdrawal.

Industrial Water Uses

Generally water in industry is used for cooling, transportation, as a solvent, and as an ingredient of finished products. Mostly water user is thermal and nuclear power generation. They use water mostly for cooling system. Used water in industry withdrawal is quite different not only for individual branches of industry, but also within each kind of production, depending on the technology of manufacturing process. As a rule, in the northern regions, industrial water withdrawals seem to be considerably less than in southern regions with higher air temperatures. Some water is use in recirculation system after used. But new freshwater add to system. The amount of new freshwater intake water supply is insignificant. Extra water intake in most industries it is 5 to 20

percent, reaching 30 to 40 percent in some industries (Shiklomanov & Markova 1987; Margat 1994; Shiklomanov 1997

In the future, most countries will need to continuously increase the transition to circulating water supply systems. Many industries will convert to water-free, or dry, technologies. In some countries and regions of the world, there is a tendency to increase the use of marine waters for industrial purposes.

Agricultural Water Uses

For all the countries and regions in the world, irrigation is the principal water user. At the beginning of the 20 th almost all developed and developing countries initiated intensive irrigation development. This intensive irrigation could provide for the growth of irrigated areas and increased crop production. But this increase in irrigated areas slowed considerably (Postel 1992; Shiklomanov 1997).

The reason of this situation was the very high cost of irrigation system construction, soil salinization, the depletion of irrigation water-supplying sources, and the problems of environmental protection. Also some developed countries, the amount of irrigated lands has stabilized or even decreased.

At the present time, about 15 percent of all cultivated lands are being irrigated. However, the food produced in irrigated areas amounts to almost half the total crop production. Irrigated areas would expand mainly in countries with an extremely rapid population growth and sufficient water and land resources. Water required for irrigation is determined water intake in cubic meters per hectare per year (m^3/ha/year), and returnable waters in percentage of water intake. They depend on general physiographic conditions, serviceable condition of irrigation systems, watering techniques and crop composition. In the irrigation area the returnable water amount is change according to the area and climatic condition. This amount changes between 20-60% percent of total water intake. Therefore, the values of annual water withdrawal vary greatly, from 5,000-6,000 m^3/ha to 15000-17000 m^3/ha, and in individual regions of Africa to 20000 or 25000 m^3/ha. (Shiklomanov & Markova 1987; Shiklomanov 1997; FAO 1995 and 1999).

A considerable water economy can be attained through use of the most efficient modern engineering methods and means of watering (sprinkling, drip irrigation, etc.) that increase crop productivity and decrease irrigation water volume.

The largest water use in agriculture is irrigation. However, quantitatively, the total water contribution to other agricultural uses is insignificant when compared to those for irrigation (approximately, 5 to 8 percent). In estimating future water withdrawals for irrigation, the trend of irrigation to decrease due to improving technological procedures and engineering efficiency was considered.

Solutions to the Water Crisis

* Develop more water sources, while ensuring that environmental and community concerns are addressed;

* Improve water infrastructure, including the installation of low-flow toilets and efficient drip-irrigation systems;

* Improve water-use efficiency

* Update the Clean Water Act and the Safe Drinking Water Act to include new contaminants, and actively enforce the standards already in place

* Price water more accurately, with the understanding that water is a human right and should be subsidized for basic human needs

* Improve and expand public participation in environmental decision-making; and Strengthen water institutions and improve communication between them.

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Work-Scheduling Model for an Open Cast Coal Mine in Turkey with Integer Programming

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Abstract: Tunçbilek Open Cast Coal Mine of Garp Lignite Enterprise (GLI) is located in Kütahya, Turkey and the overburden removal operations are carried out by using Truck/Shovel Systems which is faced with the problem of changing number of trucks due to equipment breakdowns. The maintenance of failed trucks are planned to occur at fixed scheduling days. It is required to determine the operating number of truck drivers for each operating shifts in a weekly planning horizon. A simple Integer Programming model is developed using LINGO software to determine the optimum number of truck drivers required to satisfy the variable number of trucks for each operating shift. The developed model schedules the trucks drivers optimally for each operating shift in a weekly scheduling period.

Introduction

Cyclic staff scheduling problems arise in a variety of service delivery systems including nurses in hospitals, baggage handlers in airlines, operators in telephone companies, etc. Many such systems operate 24 hours a day, seven days a week with demand for services varying in some daily or weekly pattern over each hour of the week. Full-time employees in these service organizations are often assigned to a prescribed 40-hour work schedule (eight hours per day, five consecutive days) each week Staff scheduling or rostering is the process of constructing work timetables for its staff so that an organization can satisfy the demand for its goods or services. It involves a number of hierarchical sub problems including demand modeling, shift design, days-off scheduling, lines of work construction and staff assignment. The first part of this process involves in determining the number of staff, with particular skills, needed to meet the service demand. Individual staff members are allocated to shifts so as to meet the required staffing levels at different times and duties are assigned to individuals for each shift. All industrial regulations associated with relevant workplace agreements must be observed during the process. Days-off scheduling has been extensively discussed in literature in a variety of planning context, including many contributions from the area of nurse scheduling. (Alfares et al., 2007), (Ernst et al., 2004), (Morris, J.G. and. Showalter**,** M. J, 1983), and Baker, (1974) are some of the research papers in this staff scheduling or rostering problems in various fields of applications.

This study is concerned with scheduling the daily truck drivers for a weekly scheduling period at GLI open cast coal mine truck/shovel systems operations in Kütahya, Turkey. In this system, the daily required number of truck driver changes frequently for each working day since the maintenance of trucks and shovels are scheduled for regular inspection days in a weekly planning horizon. It is required to schedule the truck drivers for each operating shift in a weekly planning horizon.

Problem and Background

Tunçbilek Lignite Reserve which is operated by Garp Lignite Enterprise (GLI) is located in Kütahya, Turkey and is one of the most important lignite deposits being in production since 1940's. The overburden removal operations are carried out by using truck/shovel systems with 85-ton and 100-ton trucks and 10 and 20 cu-yd capacity shovels. The open cast coal mine is faced with the problem of changing number of trucks due to regular machinery maintenance. The maintenance of truck and shovel resources are planned to occur at fixed scheduling days. It is required to determine the operating number of truck drivers for each operating shift in a week period. The problem considered in this paper focuses on the days-off scheduling phase of the rostering process, and has been dealt with in the context of open cast coal mine truck/shovels systems. The main concern in days-off scheduling is to determine the off-work days for each staff member over the rostering planning

horizon. The constraints refer to the individual days of the planning horizon and are concerned with satisfying the required daily staffing levels for each shift. In this paper, it is assumed that the required shifts and their staffing levels for each day have been determined prior to the days-off scheduling phase and hypothetical data for a case study are given in (Tab. 1). Each truck driver is scheduled to work for six successive day shifts and is off-work for the following single day. It is also assumed that the scheduling model is developed for a single shift in a day for week duration.

Days-off Patterns x_j		**Required Daily Number of Truck Drivers,** r_i	
Monday	x1	17	r1
Tuesday	x2	13	r2
Wednesday	x3	15	r3
Thursday	x4	19	r4
Friday	x5	14	r5
Saturday	x6	16	r6
Sunday	x7	11	r7

Table 1. Hypothetical Data for Daily Number of Truck Drivers Demanded

Models and Scheduling

Shift and days-off scheduling problems have received much attention in the literature of integer programming approaches to workforce scheduling. A typical managerial use would be to schedule full-time employees to minimize the number of labor hours while satisfying variable workforce requirements of a service delivery system. To satisfy the daily demand for truck drivers shown in (Tab. 1) most efficiently with minimum cost, the optimum number and schedule of truck driver needs to be determined for the open cast coal mine at GLI which currently employs a (6,7) work schedule. The (6,7) work schedule assigns workers to seven day-off patterns with one-single day off per week. The (6,7) days-off scheduling problem can be represented as an integer linear programming model as follows:

$$\text{Minimize} \qquad W = \sum xj \tag{1}$$

Subject to

$$\left(\sum_{j=1}^{7} xj \right) - x_{i+1} \geq r_i \qquad \text{for} \qquad i = 1, 2, 3 \ldots 7 \tag{2}$$

$$x_j \geq 0 \quad \text{and an integer,} \qquad \text{for} \qquad j = 1, 2, 3 \ldots 7 \tag{3}$$

x_j = number of workers assigned to a days-off pattern j ,
(i.e. number of workers off on just day j+1)
r_i = minimum number of workers required on day i,
W = workforce size, (i.e. total number of workers assigned to all days-off patterns)

During the planning stage of operations in open cast coal mining at GLI, a mathematical model is established with Integer Programming method and is used to find answers to truck drivers scheduling and reduce costs. The above formulated days-off scheduling model for determining the optimum number of truck drivers in GLI open cast coal mine truck/shovel systems operations is developed with Integer Programming using LINGO software package very easily and is given in (Fig. 1). (Fig. 2) gives the generated LINGO display of the developed model. (Fig. 3) gives the LINGO model formulation report for scheduling truck drivers.

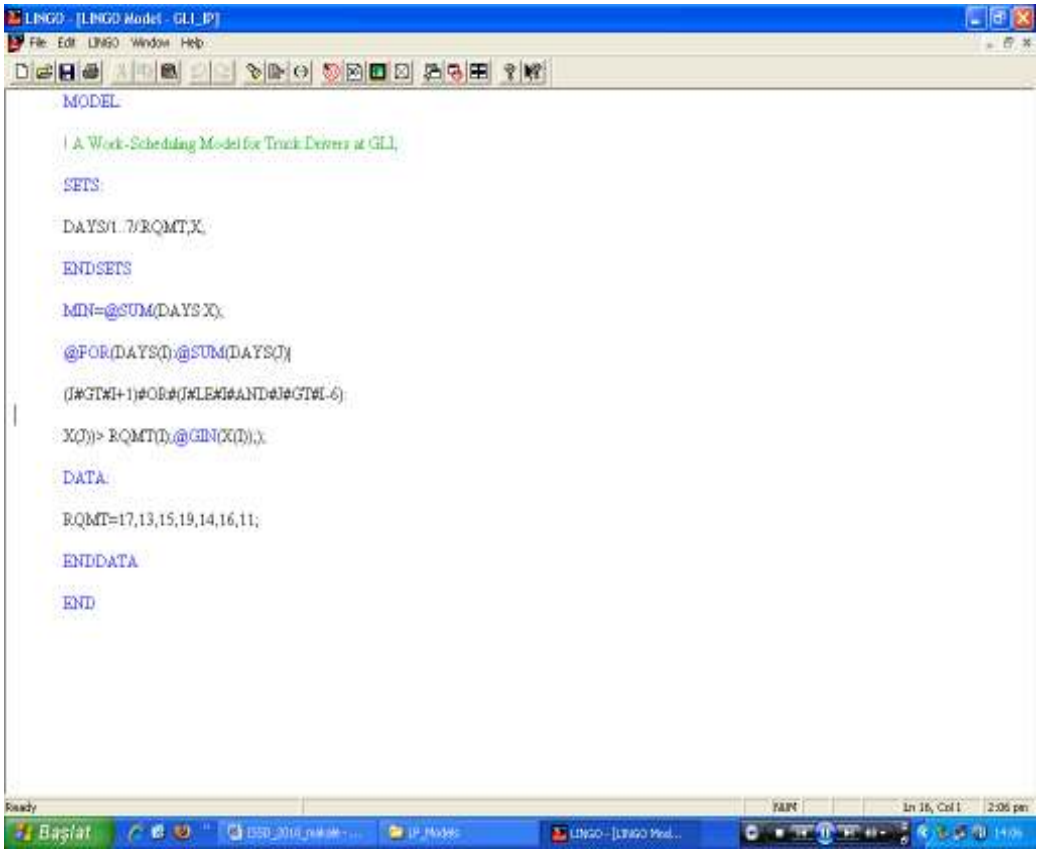

Figure 1: LINGO Model Program for Scheduling Truck Drivers at GLI

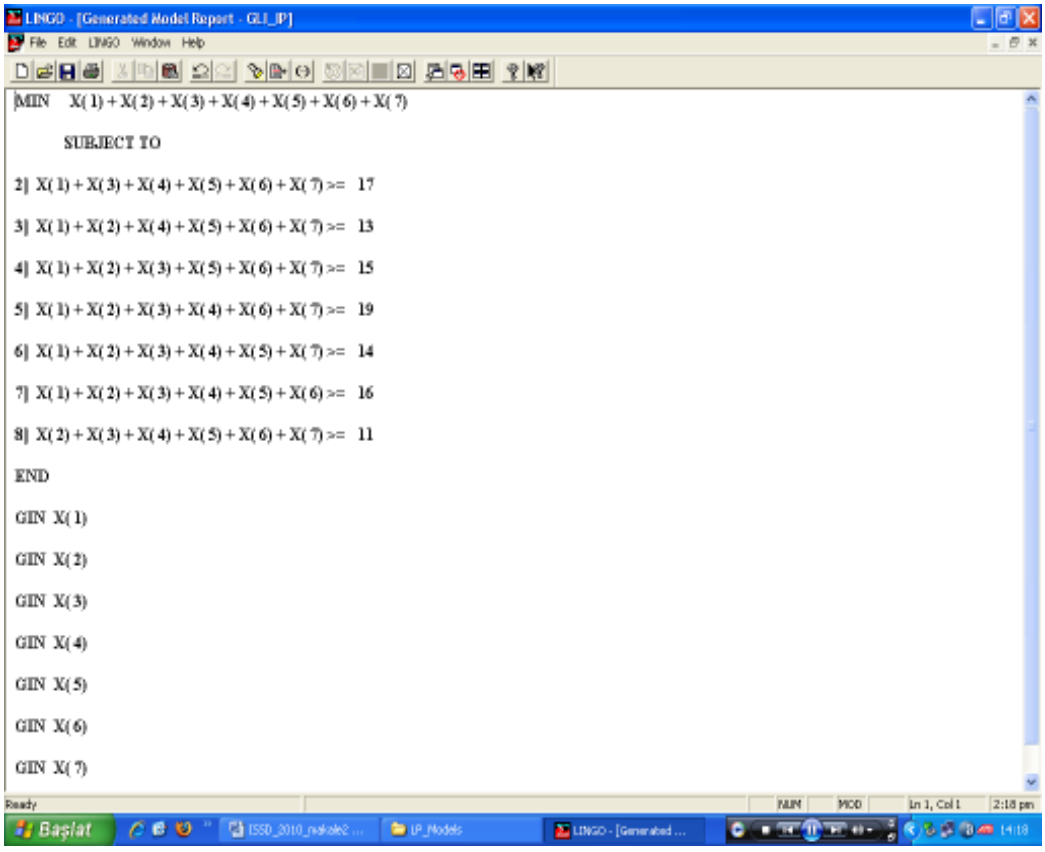

Figure 2: LINGO Generated Model Display for Scheduling Truck Drivers at GLI

LINGO Model Statements

```
1]      MODEL:
2]      ! A Work-Scheduling Model for Truck Drivers at GLI;
3]      SETS:
4]      DAYS/1..7/:RQMT,X;
5]      ENDSETS
6]       MIN=@SUM(DAYS:X);
7]      @FOR(DAYS(I):@SUM(DAYS(J)|
8]      (J#GT#I+1)#OR#(J#LE#I#AND#J#GT#I-6):
9]      X(J))> RQMT(I);@GIN(X(I)););
10]     DATA:
11]     RQMT=17,13,15,19,14,16,11;
12]     ENDDATA
13]     END
14]
        END
```

Figure 3: LINGO Model Formulation Report

As shown in (Fig. 3), Line 3 defines the sets needed to solve the problem. Line 4 defines the days of the week (Monday, Tuesday… Sunday) and associates each with two quantities: the number of truck drivers needed (RQMT) and the number of truck drivers that will begin work on that day of the week (X). Line 5 ends the definitions of the sets. In line 6, an objective function is created by summing the number of truck drivers starting work on each day of the week. Lines 7-9 create for each day of the week the constraint that ensures the number of truck drivers working on that day is at least as large as the day's requirement. For DAY (I), lines 7 and 8 sum the number of truck drivers starting work over the values of J satisfying $J > I + 1$ or $J \leq I$ and $J > I - 6$. For instance, for I = 1, this generates the sum

$$\mathbf{X(1) + X(3) + X(4) + X(5) + X(6) + X(7)}$$

which is indeed the number of truck drivers working on DAY 1 (Monday). Line 9 (in concert with lines 7 and 8) ensures that the number of truck drivers working on Day I is at least as large as the number needed on Day I [RQMT (I)]. Line 10 begins the DATA section of the program. In line 11, the input requirement for each day of the week is inputted.

The Open cast coal mine must ensure that sufficient number of truck drivers is working on each day of the week. For example, to ensure that at least 17 truck drivers are working on Monday, it is required that the constraint [2] in (Fig. 2).

$$\mathbf{X(1) + X(3) + X(4) + X(5) + X(6) + X(7) \geq 17}$$

must be satisfied which does not include X(2) term since it is the number of truck drivers who begin work on Tuesday and they will be off-work on Monday. The constraints [3- 8] must be added to the model for the remaining six days in a similar way to complete the whole off-day patterns. GIN X(I) statements are needed for i = 1,2,…,7 to make all decision variables as integer values since number of truck drivers starting work on any day can be positive-valued integers only.

Results and Conclusions

The objective of this paper is to determine the optimum number of truck drivers workforce for (6, 7) work schedule that satisfies each daily demand with minimum cost. The results of days-off assignments for optimum number of truck drivers determined from LINGO Solution Report are given in (Fig. 4). As it can seen from the LINGO Solution Report, the optimum total number of truck drivers is determined as 19 truck drivers and the number of truck drivers beginning work on each days-off work pattern are as follows:

x1 = 8, x2 = 2, x3 = 6, x4 = 0, x5 = 0, x6 = 0, x7 = 3

An Integer Programming model is developed using LINGO software for determining the optimum number of truck drivers for truck/shovel systems operations to meet the daily work schedule demand at GLI open cast coal mine in Kütahya, Turkey. If there is a future change in daily required number of truck drivers as the mine progresses over time, the LINGO program can easily be modified to determine the required size of truck drivers and the days-off assignments to satisfy the new demands. The developed model is site–specific and can only be used for the given specific mine conditions that prevail. The developed model assumes deterministic equipment breakdowns, which is not realistic for actual operating mines. Stochastic models will be needed to provide more accurate systems performance measures. It is hoped that the developed model to the GLI's open cast truck driver's days-off scheduling problem will provide convenient timetables to improve the efficiency of operations.

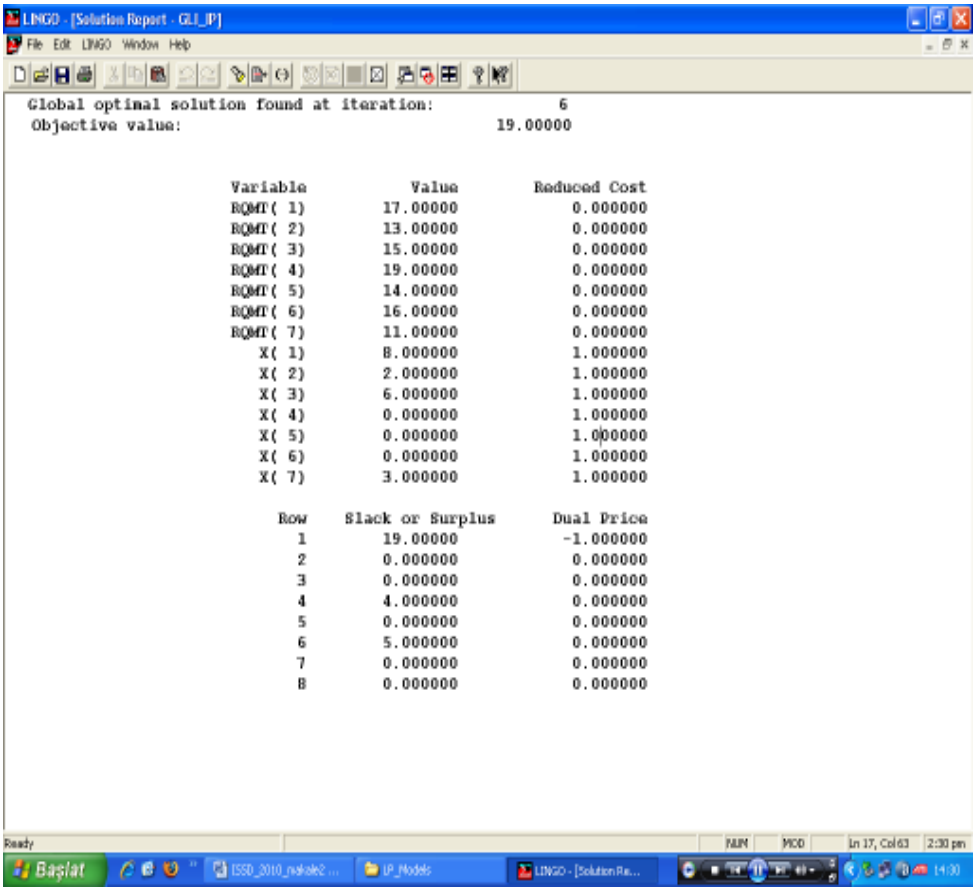

Figure 4: LINGO Solution Report for Scheduling Truck Drivers at GLI

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Recent Developments in Biogas Production from Pulp and Paper Industry Wastewaters

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Abstract: Increase in population and rapid developments in technology have enhanced production capacity in pulp and paper industry and have resulted in formation of huge amount of wastewaters, as high as 6-15 x 10^4 L per ton of paper produced. Depending on the pulping process, wastewaters can have a wide range of various pollutants characterized by biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), toxicity, and dark color. Untreated wastewaters from pulp and paper can be potentially very polluting especially for high COD concentrations which can be reach at 13000 mg/L. Thus a reliable treatment process is needed to reduce any possible impacts of wastewaters on the receiving media. To overcome this problem an environmentally friendly and economically viable treatment technology should be applied. Indeed, high organic content of pulp and paper industry wastewaters make anaerobic treatment a very attractive option for these wastes. Anaerobic processes not only remove the wastewater pollution but also can produce methane gas which is a valuable and renewable energy source. This review evaluates the recent developments of treatment technologies that highlight to practical use and economic availability of biogas production from pulp and paper wastewaters.

1. Introduction

The rapid increase in population and the increased industrialization to meet human requirements have created problems leading to the environmental danger. The pulp and paper industry which is the one of the most important industries produces a wide range of different types of papers we use today such as; channeled carton paper, newspaper, cleaning paper, cigarette paper, and bag paper. Normally paper production can be achieved by the help of so many process steps and each step generates a wide range of various pollutants. Generated pollutants from the wood pulping and production of the paper products have the potential of biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), toxicity, and color (Pokhrel andViraraghavan, 2004). Discharge of these wastewaters without any treatment poses a significant contributor to the environment pollution, such as; organic pollution, scum formation, color problems, loss of aesthetic beauty in the environment, and increase in toxic substances that affects terrestrial ecosystem (Berube and Kahmark, 2001). Thus a reliable treatment process is needed to reduce any possible impacts of wastewaters on the receiving media. Before introducing the applied treatment technologies for these wastewaters, the process of pulp and mill industry and characterization of the wastewaters generated in each step will be discussed briefly. Treatment methods widely used in order to remove the pollution in the process of papermaking will be deeply described in the subsequent sections.

2. Process Description of Pulp and Paper Mill Industry and Generated Effluents

2.1 Pulp and Paper Making Process

Pulping is the initial step of the paper making industry and represents the largest source of the pollution in the whole process of papermaking. The whole process from wood preparation to paper production can be classified into two categories, pulping and papermaking; respectively. Each process utilizes large amounts of waters which are then turn into a wastewater stream. The paper making operation generally consists of two parts. One is stock preparation by treating the pulp to the required degree of fitness and the other is paper making where the treated pulp is passed through continuous moulds/wires to form sheets (Pokhrel andViraraghavan, 2004) (Table 1).

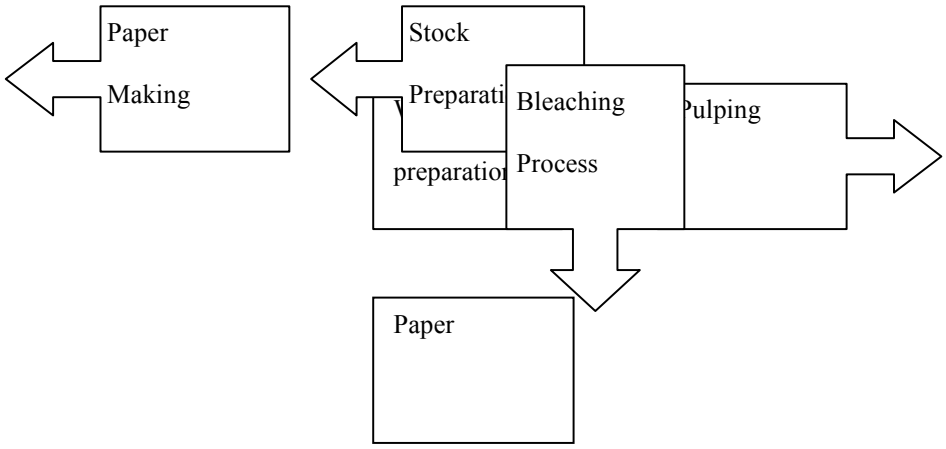

Table 1. Paper Process

Widely used pulping processes are mechanical pulping, chemical pulping and a combination of the two (chemical thermo-mechanical pulping). In the process of mechanical pulping wood is prepared for the subsequent steps by a rotating grindstone in which the fibers are stripped of. When the wood is broken down mechanically, the resulting pulp is known as *groundwood pulp*. Although mechanical pulping efficiency can reach about 90-95%, the quality of the generated pulp is highly colored, and contains short fibers. Additionally, this process does not require chemicals, but the lignin is not removed. In the process of the chemical pulping the wood chips are transformed into fibrous mass by using appropriate chemicals under elevated temperature and pressure in an aqueous solution. The main aim of this process is to remove the lignin by breaking it down and make it soluble (Smook, 1992). This process is performed under two different process, kraft process, and sulfite process; respectively. Kraft process requires alkali conditions in which woodchips are cooked in a solution of sodium hydroxide (NaOH) and sodium sulfide (NaS_2). Differently, in sulfite process woodchips are cooked in mixture of sulfurous acid (H_2SO_3) and bisulfide ions (HSO_3^-) to dissolve lignin (Pokhrel andViraraghavan, 2004). This process makes the wood free from lignin and hemi-cellulose and generated bagasse is used as energy source by burning. Remaining liquor from this step is called as black liquor (Soloman, 2009). In addition, the process in which the wood is first partially softened by chemicals and the remainder of the pulping proceeds with mechanical force is called the chemical thermo-mechanical pulping. By the help of this step, the wood chips are broken down and prepared for the next step.

The bleaching process is used for removal of colored compounds and lignin by chemical agents. In bleaching process chlorine based oxidation agents are used such as hypochlorite, NaOCl, Cl_2, ClO_2, etc. On the other hand there is also oxygen based oxidation agents used for bleaching such as (such as H_2O_2, Na_2O_2, O_3, etc) however their use as not widely as the chlorine based ones. Bleaching by the chlorine-based chemicals cause production of degradation products in which various chloro organic derivatives can be seen. The bleaching process technology and in-mill control is improving continuously. Finally, paper making processes is the last step in which generated pulps is used as paper production including two parts. Initially, a stock is prepared by treating the pulp to meet the required degree of fitness and then treated pulp is passed through continuous moulds/wires to form sheets (Pokhrel andViraraghavan, 2004). In the preparation of stock, pulp is diluted to at least 99% with water also some additives can be used such as optical brighteners and polyvinyl alcohol (Hentzschel, 1998).

2.2 Pulp and Paper Mill Effluent

Due to the diversity of processes and chemicals used in pulping and papermaking operations there is a significant difference between the qualities of wastewaters produced from the both (Billings and DeHass 1971). The major difference between the generated wastewaters is that pulp wastewater contains the dissolved wood derived substances which are extracted from the wood during the process of pulping. Additionally, the other difference between the pulp and paper mill effluents is the color of the effluents. Due to the dissolved lignin, all pulping effluents including papermaking effluents have some discoloration. Actually, lignin is responsible for the mechanical strength of the wood structure and gives the brownish color to the effluents (Leiviska, 2009). Except for the color, pulp and paper mill effluents represent some other pollutants. The sources of pollution and the generated pollutant features are summarized in Table 2. Although the availability of trace elements including heavy metals in the effluents is not mentioned above, there have been published reports on the discharges of metals and other elements from the pulp and paper industries.

Process Description	Wood preparation	Pulping	Paper Making
Features of wastewaters generated in each step	Suspended solids (SS) Biochemical oxygen demand (BOD) Fibers	High pH, Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Adsorbable organic halides (AOX) Volitile Organic Compounds (VOCs) Suspended solids Resins, Fatty acids Dissolved lignin, Carbohydrate, Color, Inorganic chlorine compounds Organo chlorine compounds	Chemical oxygen demand (COD) Particulate waste, Organic compounds, Inorganic dyes, Acetone

Table 2. The sources of pollution and the generated pollutant features (EPA, 1995)

3. Treatment of Effluents

Pulp and paper industry generates large quantities of highly polluted wastewaters. The high water usage, between 20,000 and 60,000 per ton of product results in large amounts of wastewater (Nemerow, 1991; Sinclair, 1990). Normally 150 m^3 effluents are generated per ton paper produced (Ali, 2001). Effluents of the pulp and paper making processes are widely expressed by its brownish color, high COD and high BOD. The effluent generated at the pulping stage, which is called as black liquor, contains a wide range of compounds like dissolved lignin and its degradation products, hemicelluloses, resin acid, fatty acids, tannins and phenols that are also responsible for giving the effluent its characteristic dark brown color and toxicity (Ali, 2001; Lara, 2003; Malaviya, 2007). Thus, the problems faced by the industry relate to the high organic content, toxicity and color. Discharging of these wastewaters without any treatment applications can cause serious pollution problems. Thus a reliable treatment method should be applied in order to meet discharge acceptance regulation. Mostly applied treatment methods are physical, chemical and biological treatment methods as well as combination of different methods in series. Application of chemical and physical methods has some disadvantages over the biological treatment methods such as their cost-effectiveness and residual effects. Biological treatment is known to be effective in reducing the organic load and toxic effects of pulp and paper mill effluent. There have been several attempts to use biological methods to decontaminate effluent from kraft mills because of their ability to degrade lignin by several microorganisms. The success of the biological treatment with respect to reduction organic load and toxic effects of pulp and paper making effluents have been proven in so many research articles. Biological treatment methods can be divided into two categories, aerobic and anaerobic; respectively. Aerobic treatment of the pulp and paper making effluents has long been known and widely used for these purposes. Aerobic treatments are effective for high COD and BOD removal efficiency (ranging from %70 to %90) but removal of AOX which are known to toxic and hardly biodegradable, cannot be removed effectively, the overall removal of

AOX from the effluents by aerobic treatment has been remained insufficient in so many situations (Savant, 2006). Alternatively, anaerobic treatment has become the most commonly used method not removes the wastewater pollution but also can able to produce methane gas that known as a renewable energy source (Rintala, 1994). Anaerobic treatment is simple to operate, relatively inexpensive technology, moreover; it consumes little energy. Pulp and paper making effluents are nutrient deficient. This feature of the effluent make anaerobic treatment more convenient since commonly used COD: C: N ratio in aerobic treatment is 100:5:1 while it is 350:5:1 in the anaerobic treatment (Maat, 1990). In a study anaerobic treatment was found to reduce AOX and COD by 73% and 66%, respectively. Also, when glucose was added to this effluent, there was generation of biogas containing 76% methane (Ali and Sreekrishnan, 2000).

Typical COD removal data for the treatment of papermill wastewaters shows that a relatively constant removal effciency of about 80% can be achieved and that the treated effluent has a COD concentration of about 800 mg/l. This COD concentration means that some form of additional treatment is required. Compairation of two system was studied, the three-step sequential bioreactor treatments by anaerobic and aerobic (fungus and aerobic bacteria) microorganisms and two step (fungus and aerobic bacteria), respectively and it was found that microorganisms exhibited significant reduction in colour (88.5%), lignin (79.5%), chemical oxygen demand (87.2%) and phenol (87.7%) in the two step aerobic sequential bioreactor, and colour (87.7%), lignin (76.5%), chemical oxygen demand (83.9%) and phenol (87.2%) in the three-step anaerobic-aerobic sequential bioreactor. They have concluded that in the anaerobic treatment, biogas is produced which can be utilized for energy generation; however; aerobic treatment (aerobic fungus + aerobic bacteria) was more significant than anaerobic–aerobic treatment (anaerobic + aerobic fungus + aerobicbacteria) (Chuphal et al. 2005). Numerous physico-chemical processes have also been developed to remove a variety of toxic materials from pulp effuents and to reduce parameters such as colour and COD. They include ozonation and adsorption, often in combination with coagulation, which is used as a pre-treatment stage (Thompson et al., 2001). Bishnoi et al. (2006) reported the biodegradation of pulp and paper mill effluent using anaerobic followed by aerobic treatment. Using a continuous stirred tank reactor (CSTR) for anaerobic digestion of black liquor, these authors reported a maximum methane production was found up to 430 ml /day.

a. Biogas Production

The interest in biogas production has grown considerably for the most of the industries. Anaerobic treatment producing methane that can be directly used as a source of energy has long been employed in industrial waste treatment. Anaerobic treatment is an effective means of decreasing the organic content of different wastewaters in the absence of oxygen (Noykova et al., 2002). Application of aerobic treatment is not commonly preferred due to the cost of oxygen supplementation and generation of higher sludge quantities and odors (Gavala et al., 1999). For the treatment of pulp and paper mill effluents, anaerobic digestion is essentially viable method due to waste reduction and energy potential. Actually anaerobic digestion consists of three main stages. The first step of anaerobic digestion called hydrolysis; complex organic molecules are broken down into simple sugars, amino acids, and fatty acids with the addition of hydroxyl groups which is accompanied by a rapid decrease in pH (Goblos et al., 2008). Step 2 is a fermentation process where acid-forming bacteria, also known as acidogens, convert the products of hydrolysis into simple organic acids, alcohols, carbon dioxide, and hydrogen gas. Finally, end-products of the fermentation process (acetate, butyrate, propionate etc.) are converted by methanogenic microorganisms into methane and carbon dioxide, together with trace quantities of other gases (Fig. 1).

In brief, two groups of methanogenic organisms are involved into the methane production; one group splits acetate into methane and carbon dioxide, and the second group uses hydrogen as electron donor and carbon dioxide as electron acceptor to produce methane. In general, biogas produced as end-product of anaerobic digestion consists of about 65–70% methane, 30–35% carbon dioxide and trace amounts of nitrogen, hydrogen, hydrogen sulphide and water vapor. It is the methane component of the biogas that will produce energy. The gas can be used to generate heat or electricity or both. Anaerobic treatment seems adequately not only removing the wastewater pollution but also producing methane gas which can be used for the energy requirement of the industry. Anaerobic wastewater treatment is typically used in different industries such as chemical, dairy, and pulp and paper mills. Application of anaerobic treatment of pulp and paper industry has been investigated by so many researchers. It has been noted that the adoption of this technology by pulp and paper industries has been limited, mainly due to the 30–60 day residence times required to process the sludge in conventional bioreactors (Elliott and Mahmood, 2007). The published reports that evaluate the recent developments of treatment technologies will be briefly discussed by means of biogas production from pulp and mill wastewaters and solid wastes.

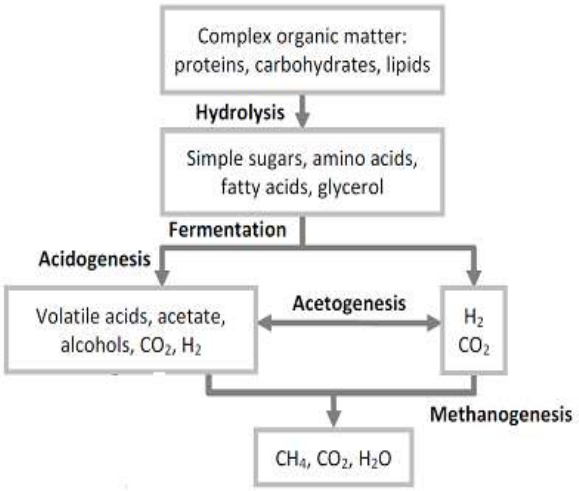

Figure 1. Anaerobic Methane Production

Anaerobic biogas production is actually a sensitive process. Presence of toxic materials in the effluent can be result in deterioration of the process which is undesirable. Unfortunately, pulp and paper industry effluents mainly contains high amount of lignin, adsorbable organic halide, color, low biodegradability (COD: BOD, 4–6) and potential toxicity problems. Inhibitory agents that can be found in pulp and paper industry effluents are summarized in Table 3. Providing that biomass is protected from toxic materials biogas production from pulp and paper industry can be successfully managed.

Wastewater	COD (mg/L)	Degradation (%)	Inhibitors
Pulping • Thermomechanical • Chemithermomechanical	 1000-5600 2500-13000	 60-87 40-60	 Resin Acids Resin Acids, fatty acids, sulfur
Sulfite condensate	7000	-	Sulfur, ammonia
Chlorine bleaching	900-2000	30-50	Chlorinated phenols, resin acids
Sulfite spent liquor	120000-220000	-	
Kraft condensate	1000-33600	83-92	Sulfur, resin acids, fatty acids, terpenes
Sulfite condensate	7500-50000	50-90	Sulfur, organic sulfur

Table 3. Inhibitors to methanogens in the effluent of pulp and paper industry (Rintala et al., 1994)

In the process of chlorine bleaching, so many toxic substances that affect the methanogens can be released. Also it is well known that chlorinated phenolics and chlorinated lignin derivatives are among the main chemical species responsible for the toxicity of pulp and paper mill effluents. Resin acids are tricyclic diterpenes that occur naturally in the resin of tree wood and bark and are transferred to process waters during pulping operations. Several workers have reported the accumulation of resin acids in anaerobic reactors treating mechanical pulping wastewaters. It was reported in a study that inhibition of methanogenic activity of the anaerobic consortium was noted at initial resin acid/biomass ratios exceeding 0.0031 mg resin acid/mg VSS. In addition to resin acids, unsaturated fatty acids, such as; oleic acids, linoleic acid and linolenic acid from pulp and paper mills employing softwood are also a source of toxicity. Since fatty acids can be degraded anaerobically, it is not entirely necessary to prevent them from entering the anaerobic reactors, however; the concentrations present in the wastewater should be kept below the maximum allowable level so that they do not cause significant inhibition to the anaerobic bacteria. For the removal of phenolic compounds white rot fungi have proved their potential in the lignin/phenolic wastewater treatment (Eaton et al. 1980). They have proved ideal organisms for decolorization as well as for the reduction of adsorbable organic halides (AOX) and the chemical oxygen demand (COD). Several researches have also shown that kraft mill effluents can be partly decolorized by white rot fungi (Gokcay and Dilek 1994).

For these reasons, the resent studies have been focused on the application of pretreatment technologies before anaerobic treatment in order to enhance biogas production. There are a number of physical, chemical or biological techniques (use of fungus and bacteria) to minimize the inhibitory effects of effluents prior to anaerobic treatment systems (Lettinga et al. 1991). Reactor design for anaerobic biogas production is also important. The use of thermophilic digesters has recently become more attractive due to their superior performance, better pathogen destruction, and higher digestion rates, which allow the anaerobic digestion facilities to operate at higher loading rates. Using two-stage systems, which segregate the formation of volatile fatty acids from methanogenesis, have also been developed, improving the overall digester performance. In a study performed by Yamini et al. (2009), Upflow anaerobic fixed packed bed reactor (UAFPBR) with brick ballasts as packing material was used in order to treat pulp and paper mill effluents. They have studied biogas production from paper and mill organic sludge in combination with fermented municipal sludge and cattle manure as inoculum. They have found that with a optimum hydraulic retention time (HRT) of 12 hr, reduction of 74.5% COD and 81% BOD was obtained. Additionally 30% inoculum concentration was best for the anaerobic treatment of the effluent with a maximum biogas production of 1.37 L / L effluent.

Beside pulp and paper effluents, pulp and paper industry solid wastes are also valuable for biogas production. In the late 1980s and early 1990s, several research articles have been published introducing anaerobic digestion for treating pulp and paper solid wates (Kowalczyk and Martynelis, 1989; Puhakka et al., 1988; Puhakka, 1991). The long residence time requirement of anaerobic sludge digestion has historically deterred its use in the pulp and paper industry. Techonological advancement that potentially can make anaerobic digestion more feasible has been the development and establishment of pretreatment of sludge prior to anaerobic digestion to accelerate the hydrolysis of sludge. Pretreatment enhances sludge digestion and the rate and quantity of biogas generated, thereby reducing the retention time requirement from 15 to 25 days to approximately 7 days. The studies were performed on both laboratory and pilot-scale systems. Generally, the results of these studies showed that anaerobic digestion of pulp and paper biosolids could reduce solid wastes by 30–70%, with the benefit of methane production. Studies were focused on cost and benefits of the anaerobic technology if pretreatment technologies, including high temperature, sonication, high-pressure homogenization, addition of acids and bases, or addition of enzymes, have been developed to solubilize the organic fraction of secondary sludge (Elliott and Mahmood, 2007; Barjenbruch and Kopplow, 2003; Bougrier et al., 2006; Chen et al., 2007; Khanal et al., 2007; Penaud et al., 1999; Tanaka et al., 1997; Valo et al., 2004). In addition to microbial biomass, pulp mill secondary sludge can contain residual cellulose, lignin and chemical components from the pulping process (Kyllönen et al., 1988). In a study performed by Wood (2009), thermal and caustic pretreatment can significantly increase both the extent and rate of anaerobic bioconversion of pulp mill secondary sludge to biogas.

4. Conclusion

The pulp and paper industry is considered to be a highly energy intensive and polluting industry. In recent years, the high cost of energy inputs and increased environmental concerns are forcing the pulp and paper industry to look for cost-effective and environmentally friendly alternatives. The general characteristics of the pulp and paper industry effluent can be listed as:

1. High lignin content,
2. High adsorbable organic halide (AOX) concentration (due to the bleaching process),
3. Color,
4. Low biodegradability which is indicated by their high chemical oxygen demand to biochemical oxygen demand ratios (COD/BOD), often in the range of 4–6,
5. Potential toxicity problems

Although physical and chemical methods are available for treatment of pulp and paper mill effluent, they are less desirable than biological treatment because of cost-ineffectiveness and residual effects. Biological treatment is known to be effective in reducing the organic load and toxic effects of pulp and paper mill effluent. Since the early 1980s anaerobic treatment of industrial effluents has found widespread application in the pulp and paper industry. Over 200 anaerobic plants are treating a large variety of different pulp and paper mill effluents. Anaerobic fermentation is especially valuable because its end product is methane, a renewable energy source. In the resent years, studies were performed on pretreatment techonologies to decrease toxicity of the effluent prior to anaerobic treatment. Advantages of anaerobic pretreatment are net production of renewable energy (biogas), minimised biosolids production and reduced emission of greenhouse gases. Anaerobic treatment of pulp and paper effluents combination with manure (co-digestion) has emerged among the new treatment

perspectives for these effluents. Additionally, other energy source is the anaerobic pulp and paper solid wates. The long residence time requirement of anaerobic sludge digestion has prevented its use in the pulp and paper industry. In an attempt to decrease the residence time requirement, pretreatment technologies have been developed in the recent years such as; high temperature, sonication, high-pressure homogenization, addition of acids and bases, or addition of enzymes. These pretreatment techonologies have been developed to solubilize the organic fraction of secondary sludge. Some of these technologies, using physical or chemical principles, and often a combination of them, have demonstrated their ability to substantially reduce the digestion time and thereby the reactor size. Increased gas production and reduced excess sludge generation have been reported to be the added benefits associated with them.

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Biosecurity and Major Diseases in Shrimp Culture

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Abstract: The global shrimp aquaculture has passed its 30th year as a significant and rapidly growing and now represents a multi-billion dollar a year industry. More than half of the global shrimp supply now comes from farms. Recent statistics show that in 2008, 3,399,105 metric tons (MT) of the total world supply of 6,519,671 MT of shrimp (or 52%) were produced from aquaculture. However, shrimp farmers have suffered significant economic losses over the last decade, largely from viral diseases that have plagued the industry. In Asia, mortalities of cultured shrimp due to White Spot Syndrome Virus (WSSV) and Yellow Head Virus (YHV) have resulted in significant economic losses, and Taura syndrome virus (TSV) is now spreading throughout this region. Similarly, in the Western Hemisphere, both WSSV and TSV have caused catastrophic losses on shrimp farms. In Ecuador alone, WSSV was responsible for an estimated 53% decline in shrimp production from 1998 to 2000, resulting in a loss of export revenue in excess of $516 million. It is believed that these diseases are transferred between regions through the importation of hatchery broodstock, postlarvae and shrimp products. Once new pathogens are imported to an area, infection of wild stock appears to be inevitable, eliminating future possibilities of using uncontaminated wild stock to culture. Good biosecurity measures are vital to maintaining healthy animals, to reducing the risk of acquiring diseases in aquaculture facilities and to harvest high quality good yield. Thus, biosecurity measurements for a shrimp farming facility includes; disease prevention, disease monitoring, effectively managing disease outbreaks, cleaning and disinfection between production cycles and general security precautions.

Key words: Shrimp, Culture, Biosecurity, Disease, Prevention,

1. Introduction

The global shrimp farming industry has passed its 30th year as a significant and rapidly growing industry. More than half of the global penaeid shrimp supply now comes from farms. Recent statistics (FAO, 2010) show that in 2008, 3,399,105 metric tons (MT) of the total world supply of 6,519,671 MT of shrimp (or -52%) were produced from aquaculture. The huge scale of the shrimp farming industry represents fourteen of billions of dollars of physical assets and hundreds of thousands of jobs. Two species are dominant in the global shrimp farming industry. These are the black tiger shrimp *Penaeus monodon* and the Pacific white shrimp *Litopenaeus vannamei.* In Asia, the dominant species of choice was the Giant Tiger shrimp P. monodon native to tropical, coastal regions of the Indo-Pacific basin. In the West, the principal farmed species was P. vannamei, the Pacific White shrimp which is native to the tropical Pacific coast of Latin America. In the early 1990s, Asian shrimp farmers contributed more than 90% of total world production while farmers in the West contributed less than 10% of the total. Development of specific pathogen-free SPF stocks of P. vannamei in the U.S. in the early 1990s and their industry-wide use caused a doubling of U.S. industry production. Subsequent introduction of the domesticated non-native SPF P. vannamei to Asia in the late 90^{s}, produced dramatic increases in shrimp production and rapid spread through Southeast Asia. Rapid and sustained increases in Asian shrimp production resulted from P. vannamei's widespread adoption and these drove global shrimp production to double since 2000. By 2004, P. vannamei emerged as the leading shrimp species in worldwide production contributing more than 50% of total world farmed-shrimp production. In 2008, P. vannamei production accounted for more than 70% of total world production and was the dominant species farmed in China, Thailand, and Indonesia the world's three leading production countries.

The vast majority of shrimp culture in the world is conducted in outdoor earthen ponds that are typically located in coastal zones and exposed to a variety of pathogens. The worldwide experience of the shrimp farming industry is that pathogens, especially viruses, are a serious threat to the productivity and even survival of the industry. Although farmed shrimp now represent more than 50% of the global penaeid shrimp supply, farmers have suffered significant economic losses over the last decade, largely from viral diseases that have plagued the industry (Table 1. Lightner, 2005). In Asia, mortalities of cultured shrimp due to White spot syndrome virus (WSSV) and Yellow head virus (YHV) have resulted in significant economic losses (Flegel and Alday-Sanz 1998), and Taura syndrome virus (TSV) is now spreading throughout this region. Similarly, in the Western Hemisphere, both WSSV and TSV have caused catastrophic losses on shrimp farms (Lightner, 2003). In Ecuador alone, WSSV was responsible for an estimated 53% decline in shrimp production from 1998 to 2000, resulting in a loss of export revenue in excess of $516 million (Rosenberry, 2000).

Virus	Year of emergence to 2001	Product loss (US dollars)
WSSV - Asia	1992	4-6 billion
WSSV - Americas	1999	> 1 billion
TSV	1991-1992	1-2 billion
YHV	1991	0.1-0.5 billion
IHHNV	1981	0.5-1.0 billion

Table 1. Estimated Economic Losses Since The Emergence of Certain Diseases in Penaeid Shrimp Aquaculture

The pandemics due to the penaeid viruses WSSV and TSV, and to a lesser extent to IHHNV and Yellow Head Virus (YHV), have cost the penaeid shrimp industry billions of dollars in lost crops, jobs, and export revenue. In response to these viral pathogens, the global shrimp farming industry is changing the way shrimp aquaculture is practiced. The social and economic impacts of the pandemics caused by these pathogens in countries in which shrimp farming constitutes a significant industry have been profound. In the wake of the viral pandemics the shrimp culture industry has sought ways to restore the industry's levels of production to the "pre-virus" years. The application of biosecurity to shrimp farming is central to those efforts (Lightner 2005). At the shrimp farm level, biosecurity refers to producing healthy shrimp in a well-controlled environment that excludes the introduction or propagation of unwanted organisms and includes the prevention or escape of organisms back into the natural environment. The primary goal of a biosecurity program in shrimp farming is to prevent the introduction of any infectious organism into a shrimp farming system. In this study a brief review was given of basic farm management strategies to improve the outlook for more biosecure production and control of disease in shrimp culture. A series of standard operating procedure recommendations was presented including farm location and design, pond preparation, stocking strategies, water exchange, feed management, health monitoring, and disease exclusion.

2. Biosecurity in Shrimp Farming

Biosecurity, as it is being applied to shrimp aquaculture, may be defined as the practice of exclusion of specific pathogens from cultured aquatic stocks in broodstock facilities, hatcheries, and farms, or from entire regions or countries for the purpose of disease prevention (Lightner 2003). Lightner (2003), discussed ways of excluding pathogens from stock (i.e., post larvae and broodstock), especially through the use of quarantine and specific pathogen-free (SPF) certified stocks, and restricting imports of live and frozen shrimp. Excluding vectors and external sources of contamination and preventing internal cross contamination were suggested methods for excluding pathogens from hatcheries and farms. In the poultry industry, biosecurity has been defined as an essential group of tools for the prevention, control, and eradication of economically important infectious diseases. While biosecurity in this context may have many facets, central to its application in shrimp farming are the concepts of stock control and pathogen exclusion. This has been accomplished through the practice of stocking farms only with shrimp that are free of the diseases of concern into farms with controlled water sources. The latter issue of controlled water sources is being accomplished through better farm siting, farm design and water management through the use of such strategies as inland shrimp farming, "zero" water exchange, and the use of water treatment devices that remove potential vectors from the source water (Browdy et al. 2001). Horowitz and Horowitz (2003) described physical, chemical, and biological precautionary measures to be taken as well as a second line of defense against potential disease outbreaks. Physical measures are those that aim at preventing the intrusion of disease-carrying vectors to the farm site, and include physical barriers, water treatment, and quarantine. Chemical measures are those used to treat materials before they enter the facility.

Chlorination and ozonization are often used to treat incoming water, and iodine and chlorine are used to treat other potential vectors such as tools, footwear, and clothing. Biological measures include the use of SPF shrimp, which are readily available commercially. A second line of defense for the shrimp industry is to use specific pathogen-resistant shrimp, which, in addition to being disease-free, are resistant to specific diseases. Since shrimp do not develop a specific immune response, common immunostimulants, such as β-1-3 glucan, lipopolysaccharides, and peptidoglycans are used to improve the ability of the shrimp to prevent infection.

The pathogens WSSV and IHHNV are considered to have been introduced into the Americas from Asia with live shrimp or with frozen infected commodity shrimp (FAO 2003; Tang et al. 2003). Both WSSV and IHHNV have been demonstrated in wild penaeid shrimp in the Americas (Motte et al. 2003) and Asia (Fegan and Clifford 2001). The establishment of these and other pathogens in wild shrimp stocks in the Americas has changed the way shrimp are farmed. Gone are the days when broodstock and postlarvae could be collected from the wild without concern that they might be carrying disease. Also gone are the days when shrimp farms, in all but the most geographically isolated locations, could be designed and operated without a biosecurity program. In the decade following the emergence and spread of WSSV throughout Asia and into the Americas and the emergence and spread of TSV throughout the Americas and into Asia, the industry has begun to adopt a variety of biosecurity measures and programs as its best defense against these and other diseases. In some shrimp farming regions, the application of the principles of biosecurity has helped farms in those regions to reduce losses due to disease and to improve production (Fegan and Clifford 2001).

If a disease presents itself at a particular pond, effective biosecurity measures should prevent the complete loss of the crop and the spread of disease to other ponds. Lightner (2003) recommended an approach to eliminating pathogens at the stock level and partial disinfection at the facility level. To eliminate pathogens in post-larvae and broodstock, affected tanks and ponds should be depopulated, disinfected, and restocked with SPF shrimp. It may, however, be necessary to depopulate the entire stock and to fallow the entire facility if partial disinfection (using lime, chlorine, or drying) is not successful. Horowitz and Horowitz (2003) suggested providing better environmental and biological conditions to the infected population to increase its ability to resist diseases. They discussed the following steps: a) effect physical measures (increase aeration, control temperature, improve the feeding regime, remove sludge and organic matter, and treat wastewater) to improve the environmental conditions, b) effect chemical measures, including control of pH and salinity, reduction of ammonia and nitrite, and application of antibiotics, and c) to use effective biological measures, consisting mainly of the use of probiotics containing a mix of bacterial species to establish beneficial microbial communities under culture conditions.

2.1. Control of Shrimp Stocks

The single most important principle of biosecurity is stock control, which may be simply defined as the use of captive or domesticated stocks, cultured under controlled conditions, and which have been the subject of an active disease surveillance and control program (Lightner 2003). While numerous methods have been incorporated into the operational design and management of shrimp farms previously affected by TSV and WSSV to eradicate them and to insure that they are not reintroduced, none can be expected to provide much protection against crop losses in farms that use seed stock derived from wild stock sources. The use of only domesticated shrimp stocks that have a known history of being free of pathogens of concern can help to mitigate this risk. However, an SPF history comes only from a long-term captive breeding and disease surveillance program at a facility that has a fully functional and effective biosecurity plan (Fegan and Clifford 2001). The successful application of the SPF concept is dependent upon the absence of the pathogen(s) of concern in the stocks being reared (or that are present), on the availability of sensitive and accurate detection and diagnostic methods for the pathogen(s), and the presence of an effective barrier (i.e., facility design and geographic location, government mandated import restrictions, etc.) to prevent the introduction of the specific pathogen(s) intended to be excluded. The International Council for the Exploration of the Sea (ICES) Guidelines (Code of Practice to Reduce the Risks of Adverse Effects Arising from the Introduction on Nonindigenous Marine Species, 1973, as reviewed in Sindermann (1988, 1990) was followed for the development of these stocks (Table 2).

Original ICES Guidelines	Adapted to SPF Shrimp Development
1. Conduct comprehensive disease study in native habitat	1. Identify stock of interest (i.e., cultured or wild)
2. Transfer {founder stock} system in recipient area	2. Evaluate stock's healtlddisease history.
3. Maintain and study closed system population	3. Acquire and test samples for specific listed pathogens (SLPs) and pests.
4. Develop broodstock in closed system	4. Import and quarantine founder (F0) population;

	monitor F0 stock.
5. Grow isolated F1 individuals; destroyoriginal introductions	*5.* Produce F1 generation from F0 stock.
6. Introduce small lots to natural waters - continue disease study.	6. Culture F1 stock through criticmonitor general health and test for SLPs. al stage(s); 7. If SLPs, pests, other significant pathologies are not detected, F-1 stock may be defined as SPF and released from quarantine.

Table 2. Recommended Steps in The ICES Guidelines for Risk Reduction in Aquatic Species Introductions

2.2. SPF and SPR Shrimp Stocks

Stock control requirements are being addressed in at least three ways. Where the industry has remained dependent upon wild (adult or postlarval = PL) stocks as its source of "seed," routine polymerase chain reaction (PCR) testing of broodstock and PLs for important pathogens like WSSV, TSV, YHV, and IHHNV has been adopted. Other components of the industry have chosen to attempt to develop and use specific pathogen resistant stocks (SPR) when pathogen exclusion from other sources such as the water supply is not a practical option (Lightner and Redman 1998). Nonetheless, the development and use of "specific pathogen free" (SPF) stocks is emerging as perhaps the best management strategy for stock control in farms, regions or countries with biosecurity programs. Although marketers commonly use the term "disease-free" to describe the live shrimp products in commerce, they are in reality marketing shrimp that are free of specific disease causing agents. Because nothing that is living is completely free of some sort of disease, such "disease free shrimp" are more correctly referred to as being free of certain specific pathogens or SPF.

The term SPF implies that the stock of interest is free of one or more specific pathogens (Fegan and Clifford 2001). To the USMSFP, SPF means the stock of interest has at least 2 yr of documented historical freedom of the disease agents listed on its working list of specific pathogens, that the stock has been cultured in biosecure facilities, and that the stock was either cultured under conditions where the listed disease agents would have produced recognizable disease if any were present and/or that the stock has been subjected to routine surveillance and testing for the listed pathogens. Those pathogens on the USMSFP SPF list have also met certain criteria including: 1) the pathogen(s) must be excludable; 2) adequate diagnostic and pathogen detection methods are available; and 3) the pathogen(s) poses significant threat of disease and production losses (Lotz et al. 1995; Lightner 2003), which are also among the criteria required for disease listing by the Office International des Epizooties, OIE **(**OIE 2003a, 2003b)

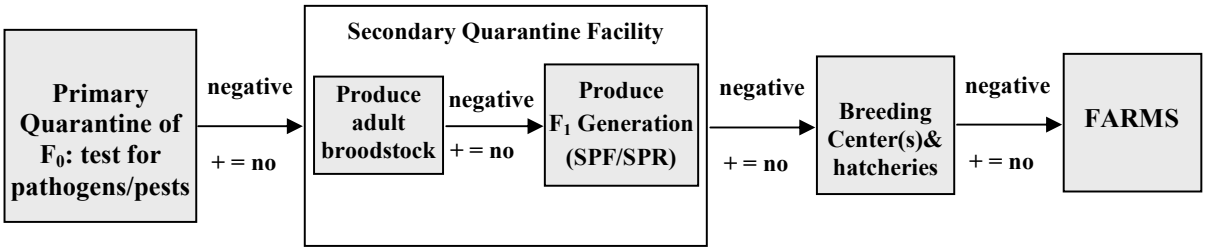

Figure 2. Schematic of The Steps in Developing Specific Pathogen Free Breeding Lines.

Specific pathogen free stocks developed by the USMSFP were developed in the spirit of the ICES Guidelines (Table 2; Fig. 1). To begin the process, each "SPF candidate population" of wild or cultured shrimpstocks of interest was identified. Samples of the stock were taken and tested using appropriate diagnostic and pathogen detection methods for the specific pathogens of concern. If none were found, a founder population (F,) of the "candidate SPF" stock was acquired and reared in primary quarantine. During primary quarantine, the F, stock was monitored for signs of disease, sampled, and tested periodically for specific pathogens. If any pathogens of concern were detected, the stock was destroyed. Those stocks that tested negative for pathogens of concern through primary quarantine (which ran from 30 d to as much as 1 yr for some stocks) were moved to a separate secondary quarantine facility for maturation, selection, mating, and production of a second (F,)

generation. The F, stocks were maintained in quarantine for further testing for specific pathogens of concern. Those that tested negative were designated as SPF, and used to produce domesticated lines of SPF and "high health" shrimp (Wyban et al. 1992; Brock and Main 1994; Pruder et al. 1995; Lotz et al. 1995)

3. Major Diseases in Shrimp Culture

Farmed shrimp are infected by a range of disease agents including bacteria, viruses, fungi and protozoa. This overview focuses mainly on viral and bacterial diseases that have had a significant impact on the shrimp farming industry. There are a number of viruses that infect shrimp, but not all of them cause fatal diseases. Infectious hypodermal and hematopoietic necrosis virus (IHHNV) has been observed in most commercially farmed shrimp species. It appears to be harmless in some species such as the Asian tiger shrimp, *Penaeus monodon*, but malicious in others causing mortality and growth retardation. There are a number of other viruses such as the monodon baculovirus (MBV), hepatopancreatic parvo-like virus (HPV), and baculovirus penaei (BP) that damage the cells of the hepatopancreas and make the shrimp susceptible to other disease agents. It is believed that infection by these viruses causes a reduction in growth rates. As noted earlier, the three viruses that cause acutely fatal diseases in shrimp farming are the white spot syndrome virus (WSSV), yellow head virus (YHV) and Taura syndrome virus (TSV). All three viruses can cause extensive mortality within a few days of the first clinical signs of the disease. As discussed below, the severity of a viral disease typically subsides in about two years after the first incidence of the given disease. This apparently indicates some type of an adaptive response to the disease agent. However, the viruses are never completely eliminated. They resurface periodically, particularly at times of stress, to cause large-scale mortalities. Furthermore, growth retardation often coincides with viral infections resulting in economic losses.

The most important diseases of cultured penaeid shrimp, in terms of economic impact, in Asia, the Indo-Pacific, and the Americas have infectious agents as their cause (Tables 3, 4). Among the infectious diseases of cultured shrimp, certain viruscaused diseases stand out as the most significant. The impact of White Spot Disease (WSD) due to white spot syndrome virus (WSSV) has been particularly noteworthy. Rosenberry (2001) estimated that disease due to WSSV "robbed the industry" of approximately 200,000 MT of production in 2000 worth more than $1 billion. The viral disease pandemics caused by WSSV and Taura Syndrome Virus (TSV) that began in 1992 and caused billions in lost revenue have forever changed the shrimp farming industry (Table 1; Lightner 2005). The social and economic impacts of the pandemics caused by these pathogens in countries in which shrimp farming constitutes a significant industry have been profound. In the wake of the viral pandemics the shrimp culture industry has sought ways to restore the industry's levels of production to the "pre-virus" years. The application of biosecurity to shrimp farming is central to those efforts. Some of the most important diseases (and their etiological agents) were once limited in distribution to either the Western or Eastern Hemisphere and many of the most significant shrimp pathogens were moved from the regions where they initially appeared to new regions even before the "new" pathogen had been recognized, named, proven to cause the disease, and before reliable diagnostic methods were developed. The diseases, due to the shrimp viruses IHHNV (infectious hypodermal and hematopoietic necrosis virus), TSV, and WSSV, were all transferred with live shrimp stocks from country to country and from one continent to another well before their etiology was understood (Lightner 2003).

Viral diseases	Bacterial and fungal diseases	Other diseases
White Spot Syndrome Virus	Vibriosis:	Epicommensals and parasites:
Yellow head Virus group	-septic HP necrosis	-*Leucothrix mucor*
Taura Syndrome Virus	-hatchery vibriosis	-peritrich protozoans
MBV group	-luminescent vibrio	-gregarines
IHHNV	Other bacteria:	-microsporidians
HPV group	-Rickettsia	Nutritional imbalances
RE0 group	Fungal:	Toxic syndromes
	-Larval mycosis	and environmental extremes
	-Fusariosis	

Table 3. Major Diseases of IndoPacific and East Asian Penaeid Shrimp **(**Lightner, 2005)

Viral diseases	Bacterial and fungal diseases	Other diseases
White Spot Syndrome Virus	Vibriosis:	Epicommensals and parasites:
Taura Syndrome Virus	-Sindrome Gaviota"	-*Leucothrix mucor*
IHHNV	-hatchery vibriosis	-peritrich protozoans
BP group	-luminescent vibrio	-gregarines
HPV group	-shell disease	-microsporidians
IMNV	-septic HP necrosis	Nutritional imbalances
RE0 III	Other bacteria:	Toxic syndromes
LOVV	-NHP bacterium	and environmental extremes
RPS	Fungal:	Zoea II syndrome
	-Larval Mycosis	
	-Fusariosis	

Table 4. Major Diseases of The American Penaeids **(**Lightner, 2005)

3.1. Yellow Head Virus

Yellow head virus was first reported in Thailand in 1991. A related virus called Gill Associated Virus (GAV) was reported from Australia in 1996. Yellow head virus caused severe disease outbreaks in Thailand until 1994. The disease typically occurs in juveniles or sub-adults. A spurt in feed consumption followed by loss in appetite, lethargy and erratic swimming are the gross signs first observed. Pale yellow coloration of the gills and cephalothorax is often noted. Mortalities start within a few days and can reach as high as 100% in 3-5 days after the gross signs are observed. Sporadic disease outbreaks still occur, mainly in Asia, but the mortalities are less severe than past **(**Lightner, 2005).

3.2. White Spot Syndrome Virus

White spot syndrome virus was first reported in Japan in 1993, although it might have originated in China. This virus has caused the most damage to the shrimp farming industry. It spread to almost all shrimp farming countries of Asia in a span of three years. It was reported in the United States in 1995, and spread to Central and South American countries in a span of four years. Almost all shrimp species have been affected. Further, most crustaceans can be infected with the virus and become carriers. The characteristic feature of WSSV infection is the presence of white spots or patches under the carapace, although this may not be present in all diseased shrimp. Soon after showing general signs of ill-health such as reduced feed intake and erratic swimming, mortalities occur. Mortality up to 100% may occur within seven days after the first sign of problems. The infection may occur at any stage in the life cycle of the shrimp. Stressful conditions such as sudden changes in environmental conditions, particularly lowered temperatures, trigger disease. Frequent WSSV disease outbreaks still occur worldwide, but there are more and more cases of shrimp populations escaping severe mortality in spite of WSSV infections **(**Lightner, 2005; Wyaban, 2009).

3.3. Taura Syndrome Virus

Taura syndrome was reported first in 1992 in Ecuador. Presence of TSV was reported in 1995. TSV spread throughout the Pacific coast of Central and South America and mainly affected the Pacifc White Shrimp, P. vannamei. Distinguishable gross signs of TSV are pale reddish coloration of the body, red tail fans, necrosis of the cuticular epithelium, and soft shells. Mortality during molting is common. Sometimes, the shrimp are affected only transitionally: gross signs of the disease may occur, but the shrimp may behave and feed normally. While TSV still occurs, the catastrophic losses suffered in the early years of TSV infection are less common now.

3.4. Vibriosis

Infection by *Vibrio* spp. is the most common bacterial disease problem in shrimp culture. *Vibrio* spp. are ubiquitous and naturally present in most aquatic ecosystems. Infections occur when shrimp are stressed or unhealthy. Infections may also occur as a result of high concentrations of Vibrio spp. in the culture system. Some species and strains, particularly *V. harveyi*, are more infectious than others. Shell lesions, black coloration of gills and discoloration of shells occur as a result of vibriosis. Severe mortalities may follow acute infections.

Chronic infections may result in erratic swimming behavior, abnormal coloration, external fouling and less severe, but sustained mortalities (Lightner 2003, 2005).

4. Biosecurity Protocol for Shrimp Farming

Biosecurity protocol for shrimp farming included three main management strategies focusing on: (a) pond bottom preparation and water management prior to stocking, (b) seed selection and stocking, and (c) post-stocking management (Clifford and Cook, 2002; Wyaban 2009).

4.1. Pond Bottom Preparation and Water Management Prior to Stocking

- Removal of bottom sludge, Particularly in ponds stocking higher densities (up to 8 PL/m^2).
- Plowing on wet soil if the sludge has not been removed completely.
- Use of lime in pond preparation.
- Disinfection of pond water
- Fertilization reduces the risk of disease outbreak in lower stocking density farms.
- Water filtration using twin bag filters of 250 μm mesh size.
- Water conditioning for 10–15 days before stocking.

4.2. Seed Selection and Stocking

- Uniform size and color post-larvae (PLs), actively swimming against the water current. Stocking of poor quality of seed (less active, more mortality during transportation and size of less than 16 mm in case of nursery reared juveniles increases the risk of shrimp disease outbreak.
- Stocking Pathogen Free (SPF) Larvae (SPF shrimp stocks are avaible in some countries)
- Longer transport time (>6 hours) of the seed from hatchery or nursery to the pond also increases the likelihood of a subsequent disease outbreak.
- Weak PL elimination before stocking using formalin (100 ppm) stress for 15–20 minutes in continuously aerated water.
- On-farm nursery rearing of PLs for 15–20 days.
- Stocking into green water and avoiding transparent water during stocking.

4.3. Post Stocking Management

- Perform a visual inspection of the pond on a daily basis.
- Sampling for growth and survival
- Monitor shrimp health and the appearance of disease using animals collected in the weekly growth and population samples
- Gut content and their color.

In general, 80% or more of the shrimp randomly sampled from a healthy, well nourished, recently fed pond should display the intestinal tract (mid-gut) running the length of the tail to be full of food. In addition to quantifying gut fullness and using it to detect under-feeding or predict the onset of disease, the color of the shrimp's gut contents can also be very informative (Table 5).

Gut Content Color	Probable Food Item	Probable Cause(S)
Black, dark brown	Benthic detritus, sediment	Under-feeding; inadequate feeding
Light or golden brown	Manufactured feed	Normal
Red, pinkish	Cannibalized body parts from dead shrimp	Disease event in pond
Green	Benthic algae	Under-feeding
Pale, whitish	None (disease condition)	Gregarines, or some other disease

Table 5. The Color of The Shrimp's Gut Contents and Predict The Onset of Disease

- Use of water reservoirs, and 10–15 days aging before use in grow out ponds.

- Water filtration-ponds using water filter nets of fine mesh have better production.
- Aeration-ponds using aeration tend to have higher shrimp production.
- High salinity and pH (>8.5) have an affect on risk of disease outbreaks
- Green water (pond color) ponds have better production and lower risk of disease outbreak.
- Clear water with bentic and filamentous algae lead to lower production.
- Regular use of agricultural lime, especially after water exchange and rain.
- No use of any harmful/banned chemicals.
- Use of feed check trays to ensure feeding based on shrimp demand.
- Feeding across the pond using boat/floating device to avoid local waste accumulation.
- Regular removal of benthic algae.
- Water exchanges only during critical periods.
- Weekly checking of pond bottom mud for blackish organic waste accumulation and unpleasant odor.
- Regular shrimp health checks, and weekly health and growth monitoring using a cast net.
- Removal and safe disposal of sick or dead shrimp.
- Emergency harvesting after proper decision-making.
- No draining or abandoning of disease-affected stock

4.4. A Biosecure Farm Model

A drawing showing a 100-ha farm comprised of fifty 2.0-ha ponds with a centralized pumping and ozone contact facility is presented in Fig. 2. The gross farm area of 182 ha includes 18 ha of pond surface area committed to a series of sedimentation, aeration, and retention ponds (Schuur, 2003).

The mechanical area includes a forebay or pumping basin that is accessed by gates for selecting water supply from either the treatment pond in a recirculation mode, or the raw water source in an exchange replenishment mode. From the forebay the water is pumped through an ozone injection device and then through a contact channel with sufficient volume to allow a minimum of 10 min retention time in a maximum flow situation. The effluent from the contact chamber is discharged into the primary supply channel that encircles the entire perimeter of the farm. The pump lift from the forebay is about 3 m in order to provide a sufficient hydraulic gradient for gravity distribution by the supply channel network to all of the ponds. The supply channel has cross-sectional area sufficient to carry peak flows to the furthermost ponds with only a minor loss of head.

The nearly square configuration is optimal for reducing the farm perimeter to a minimum for biosecurity purposes. There is an all-weather dike-top roadway outside the supply channel encircling the farm perimeter of roughly 5.4 km. For security purposes the farm perimeter can be circuited in about 10 min at a modest vehicle speed. The external roadway traffic naturally inhibits plant growth and cover for terrestrial crabs that might seek access. A further barrier to intrusion inside the roadway is a short fence constructed with metal or plastic sheet material embedded in the ground and suspended by stakes. This barrier is a common feature of many intensive farms in combination with lime and pesticide application. The roadway also provides a ‘killing zone’ before the barrier where any potential carriers can be detected and eliminated.

About 18% of the production pond surface is allocated to serial treatment ponds that provide sedimentation, aeration, and retention in order to improve water quality within the farm. The two sedimentation areas can be used in series or parallel flow, or in some cases one at time while the other is being dried and reconditioned. Additional retention time improves the water quality by providing additional area for autotrophic and/or heterotrophic processes to absorb and digest ammonia and organic matter. Mechanical aeration applied in the series provides more efficient oxygen transfer efficiency to the farm as a whole. This is due to the additional driving force provided by the difference between oxygen-depleted water from sedimentation ponds and the effluent concentration at the discharge of the aeration lagoon.

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Poisonous Marine Organisms In Turkey And First Medical Aids

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Abstract: There are many poisonous marine organisms in BlackSea, Mediterranean, Aegean Sea and Marmara Sea in Turkey. These organisms: Trachinus draco, Scorpaena scrofa, S. porcus, Rhizostoma pulmo, Chrysaora hysoscella, Aurelia aurita, Pelagica noctiluca, Anemonia sulcata sulcata. First aid : if tentacles of nematocysts are still stuck to the skin, they need to be removed gently. Be careful not to squeeze them as to not discharge more nematocysts. Local anesthetic spray or ointment may remove some of the pain on minor stings. Tannic acid is believed to work well. Give cardiovascular and respiratory assistance if needed. Medical treatment:The best anesthetic ointments in order of efficiency seem to be: Lignocaine 5%; Ultralan 0.5% . Lignocaine gel. Benadryl cream isn't as effective. Commercial creams don't work as long. Se For other jellyfish stings, soak or rinse the area in vinegar (acetic acid) for 15-30 minutes to stop the nematocysts from releasing their toxins. vere itching may occur after a few days. Steroid ointments (i.e. hydrocortisone) could help.

Keywords: Black Sea, Marmara Sea, Poisonous organisms, First aid.

Introduction

Human deaths attributed to poisonous marine animals, particularly fishes, have been recorded since biblical times and some religious laws still condemn eating fish that are finless or scaleless. Figures of scaleless, poisonous fishes have been found on Egyptian tombs. Some early naturalists went further than just recognizing dangerous animals, they actually used marine toxins to remedy ailments. For example, Pliny the Elder (29–79 A.D.) used ground sting ray stingers to relieve the pain of toothaches.

The best procedure to follow, if you are stranded, starved, and have to eat a fish you know nothing about, is to skin it, remove the head and internal organs carefully, and then soak the remaining meat in water for several hours, throwing away the water before cooking. Many poisons from plants and animals are soluble in water. Often, cooking alone will not destroy or remove the toxic substances. In Japan, finer restaurants have licensed puffer cooks that have been specially trained in preparing puffer for human consumption. Yet the Japanese, even though they are familiar with poisonous fishes, suffer about 100 deaths yearly from puffer poisoning. Puffer poison has the scientific name tetrodotoxin, after the family name for puffer fishes, *Tetraodontidae*. It can take 10 minutes or 3 hours before symptoms are evident: nausea, vomiting, muscular weakness, paralysis, and respiratory distress. No specific antidote is known.

It is estimated that 30,000 human illnesses from eating poisonous marine animals, primarily fishes and shellfish, occur each year, some of them resulting in death. With figures like that, the title of the article "Eat Puffer and Maybe Suffer" should be taken seriously.

Fortunately, we are not rich in point of dangerous marine organisms according to Australia and New Zealand. owever, some poisonous fish and jellyfish effect to human during summer time in Turkey.:

Scorpaena scrofa **Linnaeus, 1758 (Red scorpionfish)**

Distribution: Eastern Atlantic: British Isles (rare) to Senegal including Madeira, the Canary Islands, and

Cape Verde. Also throughout the Mediterranean except Black Sea. South African species thought to be the same as population in the northeast Atlantic.

Biology: Solitary and sedentary over rocky, sandy or muddy bottoms. Feeds on fishes, crustaceans and Mollusks

Human uses: Fisheries: commercial; aquarium: public aquariums

Scorpaena porcus **Linnaeus, 1758 (Black scorpionfish)**

Distribution: Eastern Atlantic: British Isles to the Azores, and the Canary Islands, including Morocco, the Mediterranean Sea and the Black Sea..
Biology: Solitary and sedentary over rocky, sandy or muddy bottoms. Feeds on fishes, crustaceans and Mollusks

Human uses: minor commercial; aquarium: commercial

Scorpaena notata **Rafinesque, 1810 (Small red scorpionfish)**

Distribution: Eastern Atlantic: Bay of Biscay to Senegal, Madeira, Azores and the Canary Islands, including the Mediterranean (rare in northern Adriatic) and the Black Sea (as *Scorpaena notata afimbria*).
Biology: Common in rocky littoral habitats. Feeds on crustaceans and small fishes. Flesh is tasty and used in making 'bouillabaisse'

Human uses: Fisheries: commercial; aquarium: commercial

Scorpaena elongata **Cadenat, 1943 (Slender rockfish)**

Distribution: Eastern Atlantic: Mediterranean Sea and Morocco to off northern Namibia
Biology: Sedentary species which occurs in rocky areas. Feeds on fishes, shrimps and other benthic invertebrates

Human uses: Fisheries: minor commercial

Scorpaena maderensis **Valenciennes, 1833 (Madeira rockfish)**

Distribution: Eastern Atlantic: Azores, Madeira, and Morocco to the Canary Islands, Cape Verde and Senegal. Also known from several localities in the Mediterranean Sea
Biology: Inhabits shallow coastal waters. Feeds on crustaceans and small fishes. Anterolateral glandular groove with venom gland

Human uses: Fisheries: commercial

Trachinus draco **Linnaeus, 1758 (Greater weever)**

Distribution: Eastern Atlantic: Norway to Morocco, Madeira and Canary Islands, including the Mediterranean and the Black Sea, Reported from Mauritania
Biology: On sandy, muddy or gravelly bottoms, from a few meters to about 150 m. Rest on the bottom, often buried with eyes and tip of first dorsal fin exposed. At night they swim around freely, even pelagically. Feed on small invertebrates and fishes; chiefly nocturnal. Oviparous, eggs and larval stages pelagic. There are dark markings along the scales; the anterior dorsal fin is black and contains venomous spines. Utilized fresh and frozen; can be pan-fried, broiled, boiled and baked. Spawning takes place in June and August, pelagic eggs are 1 mm.

Human uses: Fisheries: minor commercial; gamefish: yes; aquarium: public aquariums

Trachinus radiatus **Cuvier, 1829 (Starry weever)**

Distribution: Eastern Atlantic: Gibraltar to the Gulf of Guinea; probably further south. Known from the Mediterranean.

Biology: Found on sand and mud bottoms on the continental shelf from shoreline to a depth of about 150m. Oviparous. Eggs and larvae are pelagic.

Human uses: Fisheries: commercial

Trachinus araneus **Cuvier, 1829 (Spotted weever)**

Distribution: Eastern Atlantic: Portugal to Angola. Also known from the Mediterranean

Distribution in the Turkish coasts: Marmara Sea, Agean Sea and Mediterranean Sea

Biology: Inhabit shallow waters to about 100 m depth, burrowing in the bottom. Feed on small fishes and Crustaceans. Anterolateral glandular grooves and opercular spine with venom gland Oviparous, eggs and larvae are pelagic.

Human uses: Fisheries: minor commercial

Echiichthys vipera **Cuvier, 1829 (Lesser weever)**

Distribution: Eastern Atlantic: North Sea to the Mediterranean, Morocco and Madeira. Reported from the Canary Islands

Distribution in the Turkish coasts: Marmara Sea, Aegean Sea and Mediterranean Sea

Biology: Littoral and benthic, on sandy, muddy or gravelly bottoms, from a few meters to about 150 m (in winter). Rest on the bottom, often buried with eyes and tip of first dorsal fin exposed. Considered as the most dangerous of the European weevers, both for its poison and for its frequent occurrence very near to beaches There are venom glands on the first dorsal fin, which is totally black, and on the gill cover

Human uses: Fisheries: minor commercial; gamefish: yes

Dasyatis pastinaca **Linnaeus, 1758 (Common stingray)**

Distribution: Northeast Atlantic and Mediterranean Sea

Distribution in the Turkish coasts: Marmara Sea, Aegean Sea and Mediterranean Sea

Biology: Found over sandy and muddy bottoms, sometimes in estuaries and near rocky reefs. Feed on bottom fishes, crustaceans and mollusks. Ovoviviparous, gestation period about 4 months and 4-7 young are produced. Wings marketed smoked, dried-salted, and also used for fishmeal and oil. Harmful to shellfish banks; dangerous to bathers and fishers due to its poisonous spine. Barbed poison spine is a modified denticle that can be 35cm long, shed occasionally and replaced.

Siganus luridus **Rüppell, 1829 (Dusky spinefoot)**

Distribution: Western Indian Ocean: Red Sea and East Africa to islands in the western Indian Ocean. Immigrant to Mediterranean via the Suez Canal

Distribution in the Turkish coasts: South Aegean Sea and Mediterranean Sea

Biology: Found in small schools in very shallow water close to the bottom. Prefer hard bottoms of compacted sand with rock or coral debris. Solitary adults and groups of 3 or 4 adults have also been observed. Feed on a wide range of benthic algae. May suddenly stop and erect its fins (dorsal, anal and pelvic) presenting an encircling array of spined to potential predators; these spines are venomous. A food fish that is occasionally poisonous. Probably does not adapt well in captivity. Minimum depth from.

Human uses: minor commercial

Siganus rivulatus **Forsskål, 1775 (Marbled spinefoot)**

Distribution: Western Indian Ocean: Red Sea and East Africa to islands in the western Indian Ocean. Immigrant to Mediterranean via the Suez Canal

Distribution in the Turkish coasts: Aegean Sea and Mediterranean Sea

Biology: Inhabits shallow waters and generally in schools of 50 to several hundred individuals; prefers protected areas. Feeds by grazing on algae
Human uses: Fisheries: minor commercial; aquaculture: commercial

First Aids for Poisonous Fish

Venomous fish stings: - stonefish - catfish -other venomous stinging fish	Wash the wound site and immerse in hot water about 45ºC for a maximum duration of 90 minutes	3. Irrigate the wound and remove foreign debris 4. Radiograph to exclude retained spiny material 5. Give oral or parenteral analgesia and occasionally local or regional anaesthesia for severe pain Stonefish antivenom is available for stonefish stings with severe pain or systemic effects Surgical consultation for involvement of joints or bones
Stingray injuries	• Wash the wound site and immerse in hot water about 45ºC for a maximum duration of 90 minutes • Apply local pressure for bleeding and resuscitate if there are thoracic or abdominal injuries	6. Irrigate and debride the wound 7. Titrate intravenous analgesia and/or local or regional anaesthesia 8. Surgical consultation for deep injuries, injuries to the chest or abdomen, or with retained material 9. Resuscitation and surgical intervention for major trauma from thoracic or abdominal injuries

Table 1. First aids of poisonous fish

Results

An estimated 500 or so poisonous fishes are inshore species living in warm seas between 45 degrees N and 45 degrees S. Many forms are numerous around small islands in the Pacific. Unfortunately, it is impossible to just look at a fish and tell whether it is poisonous. In some fishes, toxicity is strongly associated with the ripening of their reproductive organs or where the fish lives. Fish toxins are sometimes concentrated in a single organ, such as the liver, muscles, skin, or reproductive organs, or the whole animal may be poisonous.

Puffers, of course, are not the only poisonous fishes. Certain species of snapper, sea bass, barracuda, jack, moray eel, parrotfish, shark, grouper, wrasse, and surgeonfish have also been implicated in human illnesses. Most of these fishes contain one or several toxins, one of which is known as ciguatera toxin. Ciguatera is more famous in Pacific waters; however, in Florida, the red tide organism, *Karenia brevis*, a one-celled dinoflagellate, and shellfish exposed to blooms of this organism, reportedly have a ciguatera-like toxin that can cause human suffering. Ciguatera poison is thought to originate at the base of the food chain. In Pacific waters, it has been traced to toxic blue-green algae that are eaten by small fishes and, in turn, are eaten by larger fishes. It is through the food chain that the toxin is taken in and accumulated.

Perhaps other animals of the sea are better known as poisonous and dangerous animals to be avoided. Their effect on man is more direct—by attack. This involves stinging cells or venom glands. The sea wasps or jellyfish of the Austro-Asian area have caused many swimmers pain, scars, and even death. There have been 55 documented deaths attributed to sea wasps since 1963. *Physalia*, the Portugese Man-of-War, is a jellyfish-like animal known as a siphonophore that periodically causes swimming activity to cease along the Florida east coast and other areas. First-aid stations are set up on beaches to help those suffering from *Physalia* attacks. Jellyfish and siphonophores have stinging cells called nematocysts in their tentacles, and some *Physalia* tentacles have been reported to extend 30 feet deep in seawater. *Physalia* toxin interferes with the conduction of nerve impulses and can cause the heart to stop beating. In addition to poisonous jellyfish and siphonophores, there are poisonous or venomous (having venom glands) cone shells, octopuses, sea cucumbers, sea urchins, marine worms, and other ocean denizens.

In almost all cases, the toxin interferes with the permeability of the nerve membrane and inhibits passage of nerve impulses. The physical effect may only involve nausea, drowsiness, weakness, or vomiting, or it may

proceed to paralysis and death. In most cases, a cure is not known; however, a drug called neostigmine has been successful in the treatment of barracuda poisonings. Some human illnesses attributed to eating fish are caused by decomposing bacteria and are common among jacks, skipjacks, and oceanic bonito; however, symptoms usually subside within 12 hours.
It is estimated that 30,000 human illnesses from eating poisonous marine animals, primarily fishes and shellfish, occur each year, some of them resulting in death. With figures like that, the title of the article "Eat Puffer and Maybe Suffer" should be taken seriously.

Poisonous marine animals can kill people, but unbelievable as it may sound, they can save lives too. Natural products from land plants have been used for years as antibiotics, narcotics, analgesics, anti-leukemia agents, and other drugs in the treatment of human distress. Why not use products from marine plants and animals as drugs? After all, poisons from marine animals show potential in the treatment of hearing diseases, intestinal troubles, infections, tumors and other ailments.

One of the biggest problems is money. It takes approximately 7 million dollars to develop a drug before it is submitted to the federal Food and Drug Administration and then only 1 out of 2,500 drugs submitted reach the commercial market. Another problem involves the collecting and harvesting of suitable marine organisms. If the chemical structure and properties of the poison are known, then scientists can artificially recreate the substance and need not worry about how many animals they have to collect. Prior to the 1960s, little was known about the chemical makeup of marine toxins, but now that scientists have unraveled the chemistry of these poisons, synthesis of these potential drugs is possible.

There is one outstanding use of a marine poison as a drug—puffer poison is being used as a narcotic for terminal cancer patients in Japan. Perhaps the Japanese, because they are surrounded by the sea and depend on it so desperately for food, are more attuned to its resources. The Japanese also found that a certain acid in the brown seaweed *Digenia* is a valuable drug in the control of tapeworm, whipworm, and roundworm. There are many natural compounds of seaweeds that show antibacterial, antifungal, and antiviral activity. However, these are not poisons, rather they are often components of the cell walls or byproducts of everyday functions. Ironically, some poisons are thought also to be the byproducts of everyday functions, particularly among the one-celled organisms.

One product of marine seaweeds, although not of a poisonous nature, deserves attention because of its potential anti-tumor and anti-leukemia activities in animals exposed to radiation. Sodium alginates of seaweeds tend to inhibit the absorption of radioactive strontium in the bloodstream and bone tissue of rats by 75 percent.

To cite examples of potential uses for poisons or toxins often involves using the effect of the poison as the cure. For example, ciguatera poison, which affects the neuromotor system, can relax spasms when administered in small doses. Another poison isolated from an electric eel shows potential as an antidote for pesticide poisoning. These are only a few examples, but they are enough evidence to support research on potential drug sources from the sea.

Poisonous Jellyfish
Rhizostoma pulmo Macri, 1778

Description

Umbrella hemispherical, translucent; exumbrella surface finely granular, jelly thick, central portion stiff, thinner and flexible in outer third. With 8-12 velar marginal lappets per octant; marginal tentacles absent. Eight rhopalia; rhopalial lappets smaller than inter- rhopalar, pointed. Subumbrellar musculature in eight distinct peripheral muscle fields. Stomach occupying central third of bell, roughly square with concave sides; from it 16 substantial canals connect to bell edge; younger specimens have narrow ring canal which follows closely outline of each marginal lappet; in many older specimens ring canal apparently absent in places and perhaps in some is completely lacking; an intermediate ring canal about 1/3 of radius in from margin, broad; centripetal to this is a coarse, irregular anastomosing network of canals, connecting only with intermediate ring canal and not with radial canals. Peripheral to intermediate ring-canal a similar but finer meshwork, branchings become increasingly more fine towards perimeter. Manubrium short, massive and translucent; concealed by 16 scapulets upon it. Each scapulet small, inverted Y-shaped in section, bearing numerous mouthlets. The eight oral arms are inverted Y-shaped in section, supporting two long, massive, outwardly-directed blades also bearing numerous mouthlets. Oral arms without lateral clubs and filaments, each arm with a large, translucent terminal club. Four gonads, each a much convoluted lobe fundamentally forming most of a circle but not obvious due to

convolutions. In older animals surface of gonad bearing grooves extending to its edge.

Ecology

Strobilation and the production of the ephyra stage seem restricted to the summer months; peak abundance of mature medusae in late summer and autumn with large numbers cast ashore in autumn and winter storms.

Specimens living in deeper offshore waters will probably survive the winter and can be encountered as late as June of the following year.

Depth range

Medusae are usually recorded at or near the water surface, but probably being more abundant in the (coastal) water column as the result of the strong currents of ebb and flow and resting on the bottom during slack-water periods.

World distribution

North and South Atlantic Oceans, Mediterranean, Black Sea, Red Sea.

Distribution in the Turkish coasts: Aegean Sea, Marmara Sea, Black Sea, Mediterranean Sea
Chrysaora hysoscella Linnaeus, 1767

Distribution: Belgian Coast, Dutch Exclusive Economic Zone European waters

Morphology: Umbrella flat smooth and thick, 15-49cm in diametar, the color is variable, but is characterized by 16 v-shaped gold-brown or yellow-brown marks on the upper umbrella, radiating from the central region, there are 24 marginal tentacles, which are easly broken off, and thirty-two pigmented semi-circular marginal lappets. Present from half May until half September. Umbrella between 1 and 12 cm. Young medusa with umbrella diameter less than 4 cm have only 8 tentacles and are hard to distinguish from Pelagia noctiluca (Leloup, 1952, Russell, 1970). Small medusa (2-4cm) identified as Pelagia noctiluca (De Blauwe, 2001) were in fact Chrysaora hyosescella. (C.hysoscella was very intensive around Marmara Sea, Çanakkale Strait and Aegean Sea in 2009.Tentacles reached to 2.45 cm.(Ozalp,Alparslan,and Dogu,2009).

Cassiopea andromeda Forskäl, 1775 (Upside down jellyfish)

Description

This jellyfish usually lies mouth upward on the bottom, in calm shallow water, gently pulsating its bell to create water flow over it's arms. The bell of Cassiopea is yellow-brown with white or pale spots and streaks. The outstretched arms are also brownish with extended frilly tentacles. Adults can grow to 30 cm in diameter. They are often mistaken as sea anemones. Habitat Cassiopea are typically found in shallow lagoons, intertidal sand or mud flats, and around mangroves. Cassiopea feed on drifting zooplankton. Individuals also harbors photosynthetic dinoflagellate algae that provides food to the jellyfish. The zooxanthellae live in the tissues on the ventral surface of the jellyfish, and the jellyfish sits on the bottom upside-down to provide sunlight to the symbiotic algae.

Distribution Hawaiian Islands Throughout main Hawaiian Islands. Native Range Indo-Pacific

Danger to humans and first aid

These jellyfish can deliver a painful sting. If stung, apply a cold pack to relieve the pain if necessary
Aurelia aurita Linnaeus, 1758

Life History

Sexual maturity in *Aurelia aurita* commonly occurs in the spring and summer. The eggs develop in gonads located in pockets formed by the frills of the oral arms. The gonads are commonly the most recognizable part of the animal, because of their deep and conspicuous coloration.

Anemonia sulcata Pennant, 1777

A.sulcata has long tentacles and cnidoblast cells. .Approximately, that can reach 12-15 cm.long.Colors chances yellow and viyola. Some effects of the sea anemone toxin, ATX-II, on vertebrate skeletal muscle have been described. At a concentration of 1 X 10(-7)-1 X 10(-6)M, ATX-II caused a sodium-dependent depolarization of the muscle fibres of the rat soleus and extensor digitorum longus, of the mouse soleus and extensor digitorum longus and of the chicken posterior latissimus dorsi. The muscle fibres of the frog sartorius were insensitive to the toxin. Action potentials generated by direct stimulation were prolonged by ATX-II, but the degree of prolongation was variable. Chicken posterior latissimus dorsi muscle fibres were most sensitive in this regard, and mouse extensor digitorum longus were least sensitive. Both denervated and immature muscle fibres were more sensitive to ATX-II than mature innervated muscle fibres. The sensitivity to ATX-II declined rapidly as muscle fibres matured. In some muscles, the prolongation of the action potential was enhanced by repetitive stimulation, but not by the passive depolarization or hyperpolarization of the muscle fibres. The actions of ATX-II could be reversed by washing in all but the innervated soleus of the mature rat.

Prevention

Wear protective clothing (gloves, wet suits, dive skins) when swimming in jellyfish-infested areas. Avoid picking up dead jellyfish. Dead jellyfish may still have live nematocysts that can still release toxins (even after they have dried up). Avoid going into known jellyfish-infested areas. If you do, know what type of jellyfish are common to the area. Be prepared to treat a jellyfish sting. Have a basic first aid kit (make sure it has an oral antihistamine in the kit) prepared and bring it with you. Take a course in basic first aid before heading to the beach, snorkeling, swimming, or scuba diving. In the evening or at night when swimming, snorkeling, or scuba diving, take care to look for jellyfish on the surface of the water. Expel air from the alternate air source while ascending during scuba diving to disperse any jellyfish directly above you. Educate yourself as to the type of jellyfish that may be in the waters in which you are swimming, snorkeling, or scuba diving. Bring Safe Sea Jellyfish After Sting® pain relief gel in case you do get stung. Do not swim in waters where large numbers of jellyfish have been reported. Wearing a wet suit or Lycra dive skin can prevent stings. If you have a known insect sting allergy carry an allergy kit, which contains injectable epi-pens (epinephrine, adrenaline). Make sure those with you know how to administer the epi-pen in case you are unable to do so. Do not touch any marine life while swimming, snorkeling, or scuba diving. Most marine animals have a protective coating that when touched, is rubbed off when and exposes the animal to bacteria and parasites; moreover, touching, "playing," or moving marine animals is stressful for them. Corals are easily damaged when touched and the area if the coral touched by hands, fins, or the body will die. To protect the ocean environment, when swimming, snorkeling, or scubadiving look, don't touch, and leave only bubbles. Never use fresh water for the skin.

Jellyfish Stings Treatment

If you are stung by a box jellyfish, seek medical help immediately. While you are waiting for medical help, flood the area with vinegar until medical help is available and keep as still as possible. If you are not close to medical care, soak the area and tentacles for 10 minutes or more, before attempting to remove them. If the sting is on the arms or legs, you can place a pressure dressing (like an ACE wrap used for a sprained ankle) around the sting. Be careful that you do not stop blood flow - the fingers and toes should always stay pink. This will help to slow down the spread of the toxin. For other jellyfish stings, soak or rinse the area in vinegar (acetic acid) for 15-30 minutes to stop the nematocysts from releasing their toxins. If you do not have vinegar available, rinse in sea water,70% isopropyl alcohol, or Safe Sea Jellyfish After Sting® pain relief gel. Do not use fresh water. Fresh water will cause the nematocysts to continue to release their toxin. For the same reason, do not rub the area, apply ice or hot water. Remove tentacles with a stick or a pair of tweezers. Wear gloves if you have them available. Apply shaving cream or a paste of baking soda to the area. Shave the area with a razor or credit card to remove any adherent nematocysts. Then reapply vinegar or alcohol. The shaving cream or paste prevents nematocysts that have not been activated from releasing their toxin during removal with the razor. Eye stings should be rinsed with a commercial saline solution like Artifical Tears; dab the skin around the eyes with a towel that has been soaked in vinegar. Do not place vinegar directly in the eyes. Mouth stings should be treated with 1/4 strength vinegar. Mix ¼ cup of vinegar with ¾ cup of water. Gargle and spit out the solution. Do not drink or swallow the solution. For pain, take acetaminophen (Tylenol) 325 mg 1-2 tablets every 4-6 hours for pain; or Ibuprofen (Motrin) or Aleve every 8 hours for pain. CPR may be necessary for all stings if the person stops breathing and/or no longer has a pulse.

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Importance of Sustainable Aquaculture in Rural Development

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Abstract: Aquaculture is one of the fastest growing segments of the Turkey agriculture. Its popularity and success as an investment opportunity and a means of diversifying farming operations have resulted in a growing interest among traditional agriculture producers and others. As Turkish people have become more health conscious, the demand for fisheries production has increased. Per capita consumption of seafood has grown from about 1kg in mid 1980's to around 7 kg in 2008. To be successful, producers must have the ability to make a reasonable assessment of sustainable aquaculture enterprise opportunities and limitations including current breeding, feeding, water quality, production technologies and management practices. Therefore, in the present paper some aspects of sustainable aquaculture on the rural development will be discussed.

Key words: sustainable, aquaculture, rural development

Sustainable Development

The Brundtland Commission (WCED, 1987) defined sustainable development as:'...the ability to meet the needs of the present without compromising the ability of the future generations to meet their own needs'. The Principle of Sustainable Development as it was endorsed in the Rio-Declaration of 1992, interpreted as comprising the inter-relation of natural and technological aspects on the one hand, with socio-economic and value-based considerations on the other. Folke and Kautsky (1992) reported that a successful aquaculture system should not have wastes, only by-products, to be used as positive contributions to the surrounding ecosystems and the economy. The Food and Agriculture Organization of the United Nations (FAO,1995) define sustainable development in their Code of Conduct for Responsible Fisheries, as:. . . the management and conservation of the natural resource base and theorientation of technological and institutional change in such a manner as toensure the attainment and continued satisfaction of human needs for presentand future generations. Such sustainable development (in the agriculture,forestry, and fisheries sectors) conserves land, water, plant, and animal resources,is environmentally non-degrading, technically appropriate, economically viable,and socially acceptable. Sustainability can be defined simply as the maintenance of capital (Goodland and Daly, 1996). According to Edwards and Demaine (1997) a new revolution or philosophy is required to promote sustainable development that will more equitably allocate resources among the world population. The Western philosophy in which humanity is considered as above and not part of nature, with a mandate to exploit it, should be replaced by the Oriental philosophy of man being a part of nature.

Most of the countries in the world, the poor people live in rural areas. The most reported problems of rural areas are: poverty, unemployement, lack of land etc.. (Yanik, 2009a, Yanik 2010a). Various types of aquaculture form an important component within agricultural and farming systems development. These can contribute to the alleviation of food insecurity, malnutrition and poverty through the provision of food of high nutritional value, income and employment generation, decreased risk of monoculture production failure, improved access to water,enhanced aquatic resource management and increased farm sustainability (FAO 2000, Prein and Ahmed 2000). In order to solve these problems global aquaculture is now the fastest growing food production sub-sector in many countries. For example, FAO supports this process by promoting sustainable aquaculture development in its member countries and aims to assist them in achieving an increased contribution of this sector to rural development. As a developing country Turkey shows many similarities with the other countries with respect to reduce poverty and hunger and to ensure food security. Rural development has various dimensions such as the process of sustained growth of the rural economy and improvement of well-being of rural men, women and children (Yanik 2009b) .

Fisheries being one of the four sub-sectors (plant production, animal husbandry and forestry) of the agricultural sector of Turkey. Although it has very large potential for aquaculture with its marine and fresh waters, it is not easy to say that the fisheries sector, with a share of 0.3% in GNP (Gross National Product) and 2.7% in the agricultural sector, has played its expected role in agriculture and national economy. However, it is estimated that more than 5 000 employees work in the sector and related activities (Okumus, 2003); the secondary support services, namely feed, equipment and consultancy are also developing rapidly and provide job opportunities. Aquaculture is one of the fastest growing segments of the Turkey agriculture (Yanik 2005). Its popularity and success as an investment opportunity and a means of diversifying farming operations have resulted in a growing interest among traditional agriculture producers and others. As Turkish people have become more health conscious, the demand for fisheries production has increased. Per capita consumption of seafood has grown from about 1kg in mid 1980's to around 7 kg in 2008 (Yanik, 2009b) . The aquaculture share of total fishery production (140.000 metric tonnes in 2007) is around 10–14 percent by volume and around 25 percent by value. The majority of production (about 98 percent) comes from intensive farming systems; rainbow trout is mainly consumed locally, while around 75 percent of seabass and the seabream are exported to EU countries. Almost all the aquaculture products are marketed as whole fresh fish. Aquaculture sector is developing in Turkey (Yanik 2009a and Yanik 2010ab). Major strengths of the sector are public support, fish demand and relatively cheap labour, and the limiting factors of it are poor species and product diversity, resource use conflicts, water availability and increasing environmental and animal welfare issues.

To be successful, producers must have the ability to make a reasonable assessment of sustainable aquaculture enterprise opportunities and limitations including current breeding, feeding, water quality, production technologies and management practices. Some problems have been faced in the rural regions for sustainable aquaculture production:
-Feed staffs and proving feeds for the farmers,
-business viability and competitiveness,
-marketing and processing problems
-water sources should be cleaned by filtering or transferring sewages with a pipe and collecting in a septic tank. -
-Then this could be used as manure for agricultural purposes.
-Soil erosion to the riverine systems
-Adaptations to mitigate climate change. Due to climate changes some of the species may not give best performance, so studies should be conducted considering this matter (Yanik, 2009).

Sustainable System

According to FAO, (1995) the sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (in agriculture, forestry, fisheries sectors) conserves land, water, plant, and animal resources, is environmentally non-degrading, technically appropriate, economically viable, and socially acceptable.
It is believed that the rapid development of aquaculture and its social-economic environment necessitates a periodical re-assessment of the guidelines as well as their implementation. The sustainable development of aquaculture requires adequate consideration of interactions among environmental, social, and economic factors that accompany any development (Chua 1992; WB 1998; NACA/FAO 2000). In assessing the sustainability of any enterprise or technology, consideration should be given to at least the following (Frankic and Hershner, 2003):

. the sustainability (or continuity) of supply, and quality of inputs;
. the social, environmental and economic costs of providing the inputs (e.g., depletion of resources elsewhere);
. the long-term continuity (or sustainability) of production;
. financial viability;
. social impact and equity;
. environmental impact; and
. efficiency of conversion of resources into useful product.

Full development of aquaculture has been constrained by a variety of technical, institutional, and financial problems. More specifically, aquaculture is faced with the following key constraints: (i) limited access of fish farmers to high-yielding environment-friendly aquaculture technologies; (ii) inadequate research and protocol development for breeding high value species; (iii) inadequate processing facilities for producing value-added

products for the export market; (iv) lack of private sector participation in various stages of aquaculture production, trade, and marketing; (v) inadequate regulatory framework including land and water use; (vi) slow market development including infrastructure and market information support, trade and commercialization; and (vii) non-implementation of international accreditation systems (e.g., European Union and Hazard Analysis Critical Control Point). (Anonymous, 2005). Ommani and Chizari (2010) showed the interactions between social, ecological and economical factors in sustainable system (Fig 1).

According to Greenpeace (2010), in order to be regarded as sustainable, an aquaculture system should have following properties that must be fully realised to achieve the sustainability.
-using of plant-based feeds originating from sustainable agriculture
-not using fishmeal or fish-oil-based feeds from unsustainable fisheries
-using cultured juveniles instead of wild-caught ones.
-cultivating non native species in land-based tanks
-not releasing discharges and effluents to the surrounding environment
-not disturbing the ecological balance by representing a risk to local wild plant and animal populations
-not using genetically modified fish or feed
-using suitable stock size to prevent the risk of disease outbreaks and transmission
-not depleting local resources, i.e, drinking water supplies
-not creating risks for the health of inhabitants
-giving support to the long-term economic and social well-being of local communities (Greenpeace, 2010).

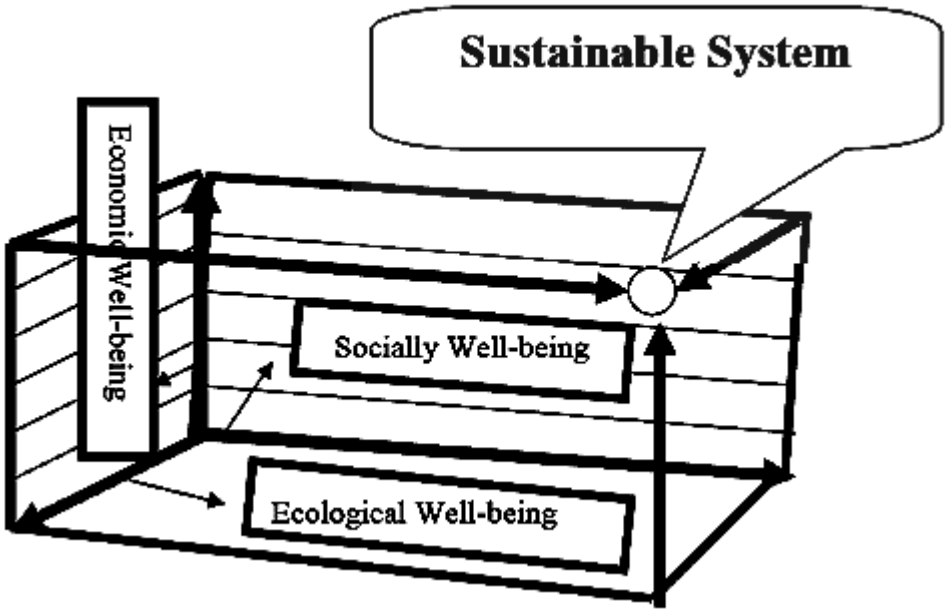

Fig. 1. Indicators of ecological, economic and social aspects of sustainability of the fishery system (Ommani and Chizari 2010).

Regarding sustainable development many efforts has been given to increase aquaculture in rural areas (Caffey et al. 1998;Yanık, 2005) For this purpose many guideleness have been published and symposiums were held in many countries. For example The First International Symposium on Sustainable Fish Farming in Oslo in 1994 and the Second International Symposium on Sustainable Aquaculture in Oslo in 1997. It was the time the Holmenkollen Guidelines for Sustainable Industrial Fish Farming were declared. According to Holmenkollen guidelines for sustainable aquaculture (Anonymous 1998.)

Each State should:
-establish an aquaculture development plan based upon the need for food security, rural development, disease control, biodiversity and sustainable use of resources. The context of integrated use of water resources and of potential production areas should be applied
-establish and implement a national strategic development plan, which identifies and designates areas and resources important for future aquaculture or other food productions, and protects them from being irreversibly allocated to other purposes.

-ensure co-ordination between relevant governmental departments, and implementation of participatory planning processes involving local communities and all stakeholders, in the development of aquaculture.
-establish, implement and enforce appropriate laws and regulations to ensure responsible aquaculture, including food safety, environmental safety and ethical criteria and the protection of the rights of indigenous people and local communities.
-establish and implement a licensing or regulatory system governing the use of exotic species, including genetically modified organisms and organisms from breeding programs, with due considerations to human health and to impacts of escapees.
-be appreciative of the difficulty that allowing aquaculture to develop
in response to market demand can generate problems of equity, for example if aquatic resources currently consumed by the poorer section of the community are to be used as feed for aquaculture.

Producers and industry should:
-take full advantage of new technologies and management procedures that can improve quality and quantity of aquaculture products and reduce risk of adverse effects on the environment and on the livelihood of other people including future generations.
-strictly abide by the internationally agreed food safety, environmental safety and ethical criteria if genetically modified organisms, chemo-therapeutants or hormones are utilized in the production.
-develop standards and practices, which embody ethical principles for ensuring health and welfare of fish and shellfish and for slaughter practices.
-become increasingly customer oriented in defining quality attributes and strengthen dialogue with the consumer. In particular the industry has an independent responsibility to provide adequate product and production information on all issues recognized to be of consumer concern.

The scientific and technological community should:
-give a priority to domestication of relevant aquaculture species, involving control of the whole life cycle and thus allowing genetic improvement. As the economic costs of domestication efforts are high, concentration will be on few species. However, this should not preclude the evaluation of alternative species.
-give a priority to the development of integrated, polyculture-based fish farming for omnivorous or herbivorous species, specially those useful in utilizing organic wastes.
-give a priority to the development of sources for animal feed other than fish protein and fish lipid.
-recognize the responsibility to develop and make available the best technology, in particular for the efficient use of the resources and for avoiding harm to the environment.

Intergovernmental organizations and development agencies should:
-recognize the potential of aquaculture to contribute significantly to the world´s aquatic food supply and support its realization.
-require, as a precondition for involvement in aquaculture development projects, that all parties abide by these guidelines.
-give a priority to transfer, adaptation and implementation of technological innovations, capacity building, training and education in order to harvest the full potential of aquaculture in developing countries.

Conclusions

Farmers should be able to;
-Explain the primary water chemistry parameters and water quality management strategies required to maintain health.
-Recognize how to select an aquaculture site and explain the differences in construction techniques, and yields from levee ponds, cages, raceways, and recirculating aquaculture systems.
-Describe the life histories (reproductive, nutritional and temperature) and production strategies for 20 species of food, bait, sport, and ornamental species with highest aquaculture potential.
-Describe the processing and marketing strategies with special emphasis on niche marketing.
-Select a species, production system, and market and write an aquaculture business plan (Yanik 2009b).

Recommendations

The Technical Assistance

The Technical assistance should be given freely and help to construct fish farms at different capacities as long-term aquaculture subsector strategy that will reduce poverty and enhance the sustainability of the subsector. It will cover teaching govermental laws and policies about rural areas, projecting fish farms to be submitted Ministry of Agriculture and Rural Affairs (MARA), aquaculture support infrastructure facilities and services, including research, training and extension, credit, trade and marketing as well as fish health management. The outcomes will include rationalization of subsector policies, institutional arrangements, and planned interventions expansion of aquaculture production and productivity that will particularly benefit the poor and prevent the migration from villages to city centers or even big cities.

Methodology and Key Activities

In long term, area specific strategies and interventions based on an in-depth study and evaluation of present conditions and projected changes in the regional, national, and international settings should be created to overcome the constraints of the areas. In order to solve the problems, the technical assistance will be included surveys to gather pertinent information in support of strategy formulation, and workshops for consultation with stakeholders.
In short term, considering the aquacultural potential of the areas, the technical assistance will cover the analyzing existing policies and institutional arrangements and identify required changes for subsector development; reviewing technical issues relevant to aquaculture development and management, and formulating a strategy and innovative measures to effectively address the issues i.e finding suitable places for aquaculture and solutions for the water pollution. As an example Aras et al. 2002 reported that the nort eastern anatolia has 30000 metric tonnes per year aquacultural potential, although there has been only about 1000 metric tonnes of annual production.

Implementation Arrangements

There should be a reponsible govermental organization such as Managery of Agriculture in city centers for administration, implementation and designing strategies for sustainable aquaculture. It will implement the technological assistance through its Fisheries division.

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Environmentally Sustainable Salmonid Culture

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Abstract: Until very recently most research relating environmental quality and aquaculture was limited to assessment of environmental conditions necessary for culture. Emphasis was placed on dissolved oxygen requirement of the culture fish or the maximum dissolved nitrogen level that could be tolerated without impairment of growth rates or survival. Most attention was directed towards the effect of the environment upon the aquaculture operation, while the converse perspective, the effect of aquaculture upon environmental quality, was largely ignored. The sustainability of aquaculture development and the environmental impacts of aquaculture operations have become a matter of considerable concern for all stakeholders. The development of the aquaculture industry, especially if it is to sustain its current growth, depends on finding ways to increase its environmental, economic and social acceptability. The technique used to culture salmonids throughout the world varies greatly with respect to the water source and means of confining the fish. With the rapid growth of salmonid cage culture over the past decade has come increased examination of this industry segment as a potential pollution source. Aquaculture pollution mainly originates from the physical and chemical characteristics of feed and the applied feeding management. This article reviews the available information on those environmental impacts of salmonid culture and three reportedly environmentally-friendly alternatives; a marine floating bag system; a land-based saltwater flow-through system; and a land-based freshwater recirculating system.

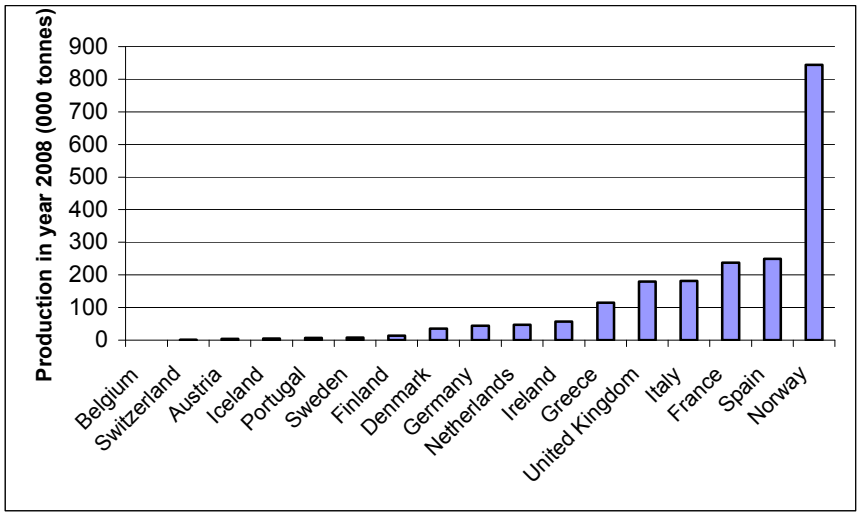
Key words: Salmonid, Aquaculture, Environment

1. Introduction

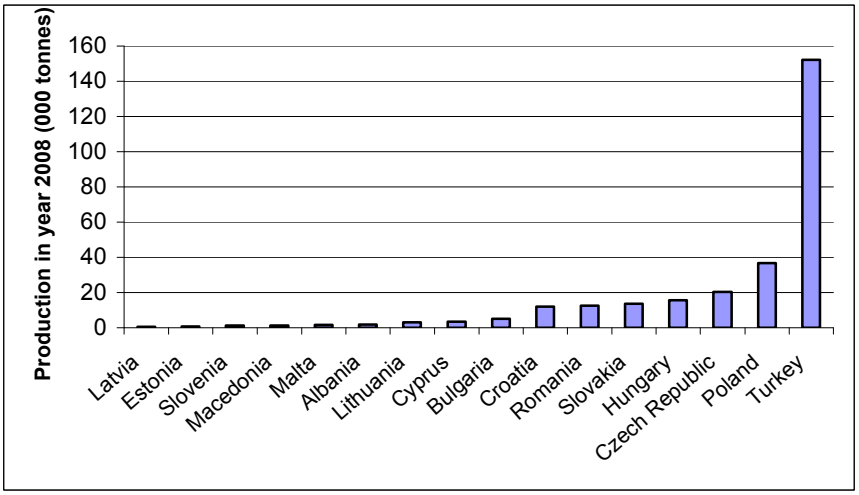
Aquaculture has been the most important food source in the world, as an alternative to land based agriculture. The FAO records indicate this industry as the fastest growing sector in agriculture. The production amount had increased from 16.8 million metric tonnes to 68.35 m metric tonnes between 1990 and 2008. (FAO 2010) Based on these statistics, aquaculture is growing more rapidly than all other animal food-producing sectors. Aquaculture production in Europe has grown to become a significant industry over the past decade and has partly compensated for the decrease in capture pro duction due to dwindling natural stocks (European Commission 2002). The largest aquaculture producer in Europe in 2008 was Norway (Fig. 1). In terms of volume of production there are four other countries in Western Europe, aside from Norway, which are major producers, namely Spain, France, Italy and the United Kingdom. In Eastern Europe, in terms of volume of production, Turkey is the major producer (Fig. 1; Fishstat 2010). The most important species in terms of volume and value of production for aquaculture is the Atlantic salmon (Salmo salar) (high market value but also high cost of production), while the species with the second highest levels of production are mussels (in terms of volume) and seabream and seabass (in terms of value) . It seems that high production (volume and value) is associated with intensive farming of marine fish species (salmon, while the highest production purely in terms of volume (i.e. mussel farming) is associated with lower market value.

Of the total world aquaculture production in 2008, 43% was in the form of finfish and crustacean species, the production of which is dependent upon the supply and use of external off-farm nutrient inputs in the form of compound aquaculture feeds. Feed development may need to place increased emphasis on the efficient use of resources and the reduction of feed waste and nutrient discharge. The technique used to culture salmonids throughout the world vary greatly particulary with respect to the water source(i.e., groundwaters or fresh, salt or brackish surface waters) and the means of confining the fish (i.e., raceways,tanks,ponds,cages). Land-based culture vs. cage culture in open water is a major dichotomy central to the prediction of likely environmental impacts. A wide variety of waste recovery or treatment

techniques are available to the land-based culturist where effluent is confined within some form of conduit.In cage culture the effluent is immediately diluted within the receiving water body with little or no opportunity for waste recovery and treatment. A land-based salmonid farm is generally viewed by regulators as a typical point-source discharge.It will often be required to have some means of waste retention or treatment (e.g.,settling pond or filtration), and the effluent will be regulated for parameters such as total suspend solids (TSS) and biochemical oxygen demand (BOD). However, a cage farm is subject to none of these treatment or effluent limitations, even if it contains as great or greater fish biomass as its land-based counterpart. This article reviews the available information on those environmental impacts of salmonid culture and three reportedly environmentally-friendly alternatives; a marine floating bag system; a land-based saltwater flow-through system; and a land-based freshwater recirculating system.



A (Western and Central Region of European Aquaculture)



B (Eastern Region of Europaen Aquaculture)

Figure 1. European aquaculture production (FAO, 2010).

2. Types of Wastes Associated with Salmonid Culture

2.1. Particulate Wastes

The primary types of particulate waste from salmonid culture are feces and uningested feed

pellets.When fed a dry pelleted diet, salmonid feces typically comprise about one-third of ingested material on a dry weight basis (Butz and Vens-Cappell 1982). The amount of uningested feed will depend upon many factors, including the feed type and metod of dispersal, so consequently estimates of feed wastage vary greatly. Between 1 and 40 % of the feed provided to the fish will not be ingested. Such methods have shown that food losses are typically 1–15%, although if feeding with trash fish they can be as high as 40% (Wu 1995). Feed pellets may be rejected by the fish rather than swallowed if they are contaminated in any way or the fish does not feel like eating (Smith et al. 1993). There is some evidence that feed waste is lower in land-based systems than in cages, possibly due to more efficient feeding in tank sor pond (Beveridge 1987).

2.2. Nitrogen and Phosphorus

Pelleted salmonid feed typically 1-1.5 % phosphorus. The phosphorus in most feeds is both in exceess of the dietary needs of the cultured fish and partially in an unassimilable form. Consequently, a substantial fraction of the phosphorus provided is lost to the environment via the feces, in addition to lesser amounts excreted in the urine. Ammonia and, to a lesser extent, urea are the principale nitrogenous wastes associated with fish culture, anda re produced as by products of protein metabolism. Ammonia may be present either as the non-toxic ammonium ion (NH^+_4) or as the toxic un-ionized form (NH_3). The relative pproportions of the two form are dependent upon temperature and pH, with formation of the toxic NH_3 favoured by high temperature and high pH. No cases of ammonia toxicity to aquatic life downstream from fish farm have been reported. Nitrogen and phosphorus are recognized as limitin nutrients in many aquatic systems. The addition of these nutrients generally results in an increase in plant growth.

2.3. Dissolved Oxygen Depletion

Salmonid culture will reduce dissolved oxygen concentration through both fish respiration and mineralization of the organic-rich wastes(i.e., feed, fece, soluble metabolites). Salmonid rspiration rate depends upon fish, age, sex, activity and temperature, but an average respiration rate for routine metabolism is about 300 mg O_2/kg wet weight/h (Kils 1979). The BOD of the feces and metabolic wastes may consume about 1.5-3 times as much oxygen as respiration alone (Willoughby et al. 1972). Effluent released from salmonid farm can deplete dissolved oxygen in receiving water, either because the effluent itself is oxygen depleted, because of its high BOD, or a combination of both factors. There is also the possibilty of indirect effects, such as nutrient-induced growth of micro- or macroalgae, and the eventual oxygen depletion accompanying decomposition of this algal biomass.

2.4. Chemotherapeutants

Chemotherapeutants are employed to treat viral,fungal,bacterial or parasitic infections of culture salmonids.The most commonly used parasiticide/fungicide in salmonid culture is formalin. A wide variety of antibiotics are administered as feed supplements to treat bacterial diseases in salmonids. On a worldwide basis, oxolinic acid and oxytetracycline have historically comprised the vast majority of total antibiotic use by the salmonid culture industry, although their use has diminished in recent years. Other antibiotic used in one or more salmonid-producing countries include potentiated sulfonamides, flumequin,chloramine T, and erythromycine. Little is known about the environmental fate and effects of salmonid chemotherapeutants despite the fact that a substantial portion of the drugs often leave the culture site via the effluent,or in the case of cage culture, are directly released to the environment. Regulatory agencies have generaly assumed that rapide dilution of the therapeutant would result in little or no environmental impact.

3. Environmental Impacts of Land-Based Facilities

Land-based salmonid culture systems in freshwater include hatcheries, systems for the production of fry and smolts, and systems for growth to consumption or restocking size. Following this early stage, salmonids may be grown using a variety of land-based or cage.Land-based sysrems include tanks, earth ponds and raceways. Such systems typcally are of the ‘flow-through’ type, but some ‘recycle’ systems are also in use. Recycling systems are used in fish farming when water availibity is limited, or there is a need for strict control over the culture environment. The high cost of recycling systems has restricted their use in salmonid culture to a few hatcheries that heat water to accelerate egg development and then recycle the water to conserve heat.

3.1. Waste Products and Loading

Uneaten feed and excreta give rise to elevated concentrations of suspended solids, BOD, nutrients and minor elements in land-based salmonid farm effluent. Many studies show considerable variation in waste loading, attributable to differences in species, fish size, physiological status,method and intensity of culture, and temperature. Waste loading from hatcheries are likely to be small during egg incubation because there is no feeding. After hatching, use of artificial feed results in increasing waste loading from discharge of uneaten pellets,feces and soluble excreta. Following early growth stage, salmonids will be transferred to different grow-out systems,the type of which affects total waste loading. During winter, when shorter day length and lower water temperature limits activity and feeding, wastage rates fall dramatically. On a daily basis, waste loading vary depending principally upon feeding schedules and tank, pond or raceway cleaning. Suspended solid, BOD and total phosphorus commonly peak during and immediately after feeding, later followed by peak ammonium concentration. A number of studies reviewed in Alabaster (1982) reveal a net reduction in solids concentration as water passed through the farm. However, accumulation of solids in pond and tanks can lead to very high "shock" loads of solids during harvesting or tank cleaning.

3.2. Environmental İmpacts

3.2.1. ***Water*** **Use:** Water requirement forland-based salmonid culture depend on stock biomass and feeding patterns.Withdrawal of water for land-based salmonis farm has the potential to reduce water flow from streams and rivers, with potetial impacts including: (1) changes in channel shape, patters of sedimentation, water movement and silation; (2) loss of spawning areas for fish stocks, or loss of nursery areas; (3)barriers to the movement of migratory fish; (4) changes in biological communities, through loss of dilution capacity between inflow and outflow, reduced turbulence and oxygenation,plus possible loss of habitat due to stranding and desiccation in channel areas above the waterline.

3.2.2. ***Dissolved Oxyge*****n:** A survey of effluent from land-based tank and pond farm by Alabaster (1982) found a mean decrease of 1.6 mg/l. from inflow to outflow, with an average flow of 12.6 $ls^{-1}.t^{-1}$ of annual fish production. Depending on the quality of the effluent, further changes in dissolved oxygen in receiving water may occur. The need to maintain oxygen levels to protect the farm stock shoukd ensure that significant depletion downstream from farm is unlikely in most cases, although the possibility exists of some localized depletion associated with deposition of organic solids.

3.2.3. ***Chemotherapeutants*****:** Toxicity to downstream biota attributable to discharge of waste chemotherapeutants is possible, although there is little information on such effects. Formalin and Iodophors are the most widely used disinfectants in European aquaculture (Henderson and Davies 2000). Antifoulants are, by their nature, toxic to marine organisms. The amounts involved may be substantial-for example, around 156 tonnes of copper were released into the environment from the use of antifouling treatments in salmon farming in Norway in 1994. Formalin is widely used asan immersion treatment on tank, pond and cage farm for control of ectoparasites,usually as a bath treatment at 150-250 mg/l. for 1 h. lethal concentration of formalin vary from 60-600 mg/l. for fish (for exposures of 24-96 h.), 0.3-0.5 mg/l. for alg, to up to 835 mg/l. for certain aquatic insects, suggestion the possiblity of some localized toxic effects on aquatic biota directly below land-based outfalls, particulary for the more sensitive planktonic and microbial organisms.

3.2.4. ***Microorganisms*****:** Some qualitative changes in the bacterial microflora of trout farm effluents have been observed, altough the bacteria present are generally similar in terms of number and composition to those found in the inflows (Austin 1985). Although some studies have shown increases in the number of fecal coliform during the passage of water through trout farm (Hinshaw 1973), the data are fragmentary and the consensus seems to be that this phenomenon is not a significant problem. Viruses have also been detected in farm effluent. Leon and Turner (1979) measured effluent concentrations of infection hematopoietic necrosis virus (IHNV) as high as 400 plaque-forming units (pfu) ml^{-1} during a disease outbreak at a salmonid hatchery.

3.2.5. ***Benthic Impacts*****:** Impacts of fish farm wastes include a loss of sensitive invertebrate species at or just below the point of discharge, with an increase in the density and biomass of organisms tolerant of organic pollution such as olgochaetes, chironomids and certian leeches. Markmann (1982) also reporteda loss of 'clean-water species' such as Plecoptera, Ephemeroptera and Trichoptera and an increase in oligochaetes, leeches,

Diptera larvae and gastropods below Danish rainbow trout farm. Organic-rich particulate wastes appear to be the most significant source of impact and there is evidence that benthic communities can return to background condition if suspended solids are removed from effluent (NCC 1990).

3.2.6. *Macrophytes*: Publised data on the effects on land-based farm on macrophytes are limited, although enhanced macrophyte growth, particularly growth of pollution-tolerant species, is frequently cited as a response to fish farm discharge in English rivers. Studies on the River Hull show greater adventitious root growth and shoot extension in *Ranunculus penicillatus* var. *Calcareus* collected below a trout farm discharge,although effects related to weed cutting may also have been important (Carr 1988).

3.2.7. *Wild Fish Populations*: Water withdrawal for land-based tank or pond farm may result in physical and chemical changes to fish habitats, and some loss of habitat has been reported in England (Allan 1983). However, studies in Denmark (Rasmussen 1988) and the U.S. (Hinshaw 1973) showed that addition of fish farm effuent may increase the productivity of downstream fish populations.

4. Waste Reduction and Treatment

4.1. Feeding Techniques and Feed Type

Uneaten food, faecal losses, food conversion ratios (FCR; the ratio of the weight of feed added to the weight of fish produced) and digestibility can be estimated to derive expressions of various wastes, such as for N or P. The result is a budget showing the flow of nutrients from the food offered, the assimilation of food in the fish as a result of growth (metabolism) and the loss of nutrients into the sediments and water column. Wastage of whole pellets may depend on various factors. If pellets are supplied at a rate that exceeds the ability of the fish to eat them or under conditions such that the pellets are not detected as they settle, there will be wastage of whole pellets. Davies (2000) reported predicted dissolved N release rates in the range of 35–45 kg per tonne of salmon produced, depending on the details of the stocking, feeding and harvesting strategies adopted. GESAMP (1996) reported values for the rate of excretion of dissolved N by farmed fish of around 75–120 kg N/tonnes of production. If the FCR, wastage from uneaten pellets and indigestibility can be reduced further, it is anticipated that release rate of dissolved N would be reduced to 33 kg/tonne of production (Davies 2000). Further reductions need new technology and additional innovative approaches. Careful feeding and the use of correct diet offer good potential to reduce effluent loads at the source. Overfeeding of fish also decreases feed digestibility and increases fecal production. Thus, a reduction in feed losses by monitoring of feed losses and careful hand-feeding, either exclusively or as a supplement to automatic feeders, can significantly reduce effluent loads and reduce impacts on running waters (Bromage et al. 1990).

The physical characteristics of the fish food are very important in term of pollution potential of the feed. The use of dry pellets rather than moist pellets or"trash" or "rough" fish considerably reduce the amount of wastage (Alabaster 1982). Unstable pellts may also increase waste loading if rapidly broken down into unacceptably small-size particles. Foof with low settling velocity also help to prevent excess wastage. The amount of phosphorus discharge from fish farm is determined by the amount and digestibility of phosphorus in the feed (Crampton 1987). The total concentration of phosphorus must be kept low and its digestibility high to minimize waste phosphorus release. Most waste phosphorus is bound in the particulate fraction, although a significant part of this particulate fraction is easily dissoveld. In the marine environment, losses of P from fish farms have been estimated as 19.6–22.4 kg/tonne fish (trout) produced, 34–41% of which is released in dissolved form with the remainder lost by sedimentation. Holby and Hall (1991) estimated that 4–8% of the sedimentary P was returned to the water column per year. There would thus seem to be excellent potential for reducing phosphorus levels in salmonid farm effluent by reducing phosphorus in feed.The level of protein and amino acid balance has been determined (decreased N content in the feed, 45% protein in the feeds), and the P content in the feeds has been decreased (from 1.5 to 0.7 in salmon feeds). Nitrogen excretion depends on many factors including its bioavailability and feeding rate, but on average, 60 % of dietary nitrogen is excreted (Beamis and Thomas 1984)The quality of fish meal and other protein sources used in the diet dictates the proportion of feed protein that can be assimilated into muscle tissue.Ammonia excretion rates are higher if protein is used as energy source, because ammonia is a by-product of protein metabolism. Poor quality carbohydrate sources result in increased suspended solids and BOD and can cause growth of sewage fungus in receivingwaters. Alternatively, if the carbohydrate(or lipid)source is insufficient, then

ammonia and other nitrogenous wastes increase. In the production of extrude pellets, the higher temperatures and pressures may result ingelatinization of dietary starch, thus increasing the bioavailability of carbohydrate. Alternative protein sources to replace fishmeal (e.g. soya) and methods of reducing the discharge of feed from farms have been examined (Hardy 1996). Although carbohydrates can be used as an alternative to fishmeal, research has shown that certain fish, such as rainbow trout (*Oncorhynchus mykiss*), use dietary carbohydrates rather poorly: they show prolonged postprandial hyperglycaemia. The efficiency of glucose utilization as an energy source by rainbow trout is low (Panserat et al. 2000). Further research is needed to understand dietary carbohydrate utilization in fish in order to enable the development of diets that can replace fishmeal as the major source of dietary protein for farmed fish. Recently, a reduction in N released to the environment was achieved through a general reduction in FCR, which is currently 1:1 for salmon farming in Western Europe (Pearson and Black 2001). Oil and fats may contribute to visible surface scums and the BOD of fish farm effluent. Problems associated with these constituents can be partly avoided by the use of high quality ingredients and a correct balance between requirement and concentration in the diet. Many freshwater diets are formulated as "high energy" diets that contain high level of fat.Thes diets are designed to minimize protein metabolism and can be used to reduce ammonia excretion.

4.2. Settlement Treatment

Settlement treatment work on the principal that solid particles with a densiity greater than water will fall out of suspension when water fow is reduced.the rate at which particles will setle in stil water condition depens largely on particle size and density; larger or more dense particles will settle more rapidly than smaller or less dense ones. The design and effectiveness of a settlement system is therefore dependent on the retention time of effluent in a settling tank or pond as well as the surface area available for settling. It is also desirable to prevent the solid in the effluent becoming fragmented as particle break up will inhibit settling and promote leaching of nutrient from the solid waste. Fish farm and settling tanks sholud be designed to minimize break up due to unnecessary turbulance.The stuidies show that up to 90 % of suspended solids, 60 % of BOD and 50 % of total phosphorus loads can be removed by settlement treatment, although system performance is extremely variable. When level of suspended solids are <10 mg/l., is common in salmonid farm effluent, efficiency is greatly reduced, although it is possible for suspended solids to be increased by pre-concentration treatment.It is also difficult to obtain suspended solids levels of < 6 mg/l in settled effluent (Henderson and Bromage 1988). Other problems are that the area required for settling ponds or lagoons can be large in comparison with the size of the farm. Others class of settling tank desing are based on a circular water flow (centrifuge) and the swirl concentrator . A major constraint upon the use of settlement devices remains the characterization of particle size of loads; as previously mentiond, both the nature and quantity of wastes produced by a farm varies substantially both during a day, and throughout the growing season. A consequnce of this varying waste output is that in order for settlement devices to be effective waste treatment systems,they must be designed to operate efficiently over a wide range of partile sizes.

4.3. Screening and Filtration Treatment

The most popular method of mechanical particle separation is the treatment by static or rotating microscreens. The treatment efficiency of microscreens has been tested in several studies (Lekang et al., 2000; Makinen et al., 1988; Wedekind, 1996) and a wide range of nutrient removal could be found. By using microscreens, reduction of solids achieved 50 – 74%, 49.3 – 63% of total phosphorus (TP) and 10– 42.7% of total nitrogen (TN). Salmonid farm effluent may be treated by passage through a screen to remove particulate matter. It is a self-cleaning or rotating filter. The most common configurations are variation of rotary screens, where the screen operates only partially submerged in the water that is to be filtered. The submerged section of the screen filtes the water passing through it while the remainder of the screen is cleaned, usually by a high pressure water jet, with the residue running to a settling pond. The clean section of screen then rotates to replace the submerged section. One of these systems are the "Triangelfilter". Its removal efficiencies data clearly demostrate the potential of these and similar screen filters for removing materials from fish farm effluent. The advantage of the "Triangelfilter" or similar systems is that solids are separated from the effluent water relatively quickly, thereby reducing the amount of time for leaching of soluble material from solid particules. After screening, filtration may be used as a secondary systems for fine solids removal. Diatomaceous earth filters are good at removing extremely fine particulate matter (0.1-5 μm), but are not cost effective in treating effluent from salmonid farm. The most common filter medium is sand and gravel ranging in size from 0.25-5mm, usually graded coarse to fine in the direction of water flow. The growing concern over potential impacts of therapeutants on the environment has stimulated interest in techniques for removing such chemicals from fish farm effluent. But

there is little information on methods for treatment of chemical.

4.4. Biofiltration

Biofiltration can, in theory, be used to improve effluent water quality from salmonid farm. In aquaculture, biofiltres are commonly used in recycle sytems to prevent accumulation of ammonia and nitrite.The technique is not considered practical or economic for treatment of salmonid farm wffluent in most circumstances due to low temperatures (NCC 1990) and large volum of effluent involved. There has been some interest in using algae and aquatic macrophytes, such as reeds, to reduce levels of nutrients in effluent. Reed beds are being investigated for nutrient removel from small scale sewage works and water hyacinths and duckweed have been grow for this purpose in warmer countries (Zirschky and Reed 1988). As with settlement pond, one of the major constraints to biofilters is that of space required.

4.5. Constructed Wetlands

Constructed wetlands represent a natural treatment system based on biological symbiosis between macrophytes (*Phragmites sp., Typha sp*., etc.) and microorganisms (bacteria, fungi, algae), and their interactions with the soil chemistry. In recent years, created wetlands have been developed to successfully treat agricultural, municipal, or industrial wastewaters. Depending on the choice of construction and function, macrophyte treatment systems can be divided into:

1. ponds with free-floating or submersed plants and no effluent; percolation through the soil
2. root zone systems with emergent plants and completely effluent percolation through the soil;
3. hydrobotanic systems as link between (1) ponds and (2) root zone systems.

Moreover, these treatment systems can be subclassified by the flow direction of effluents (vertical or horizontal), the plant species or type of soil (Kehrer, 1997). Biotic and abiotic purification mechanisms of constructed wetlands are based on the following processes (Gumbricht 1993): (a) mechanical screening and sedimentation, (b) microbial degradation, (c) biochemical nutrient removal of plant rhizomes, (d) adsorption through ligand exchange, (e) precipitation and chemical fixation of reactive soil ingredients.Removal efficiency is strongly influenced by the microorganisms inhabiting soil particles and the rhizome of plants. Plants with aerenchym root systems aerate the soil and consequently aerobic microorganism (e. g. Nitrosomonas sp., Nitrobacter sp.) growth is promoted. Bahlo and Wach (1993) found more intensive biological degradation of ammonium to nitrate close to the rhizomes. Microbial elimination of nitrate – nitrogen (denitrification) occurs in the anaerobic parts of the soil, which can be found even in effluents of constructed wetlands with oxygen levels of more than 4 mg/l. Particle bound phosphorus is mineralized by heterotrophic microorganism and at low redox-potential sorpted to iron-, aluminium-, manganese hydroxides/-oxides, calcium or clay minerals (Gumbricht, 1993). Removal processes of constructed wetlands show increased efficiency by using smaller soil particle sizes.

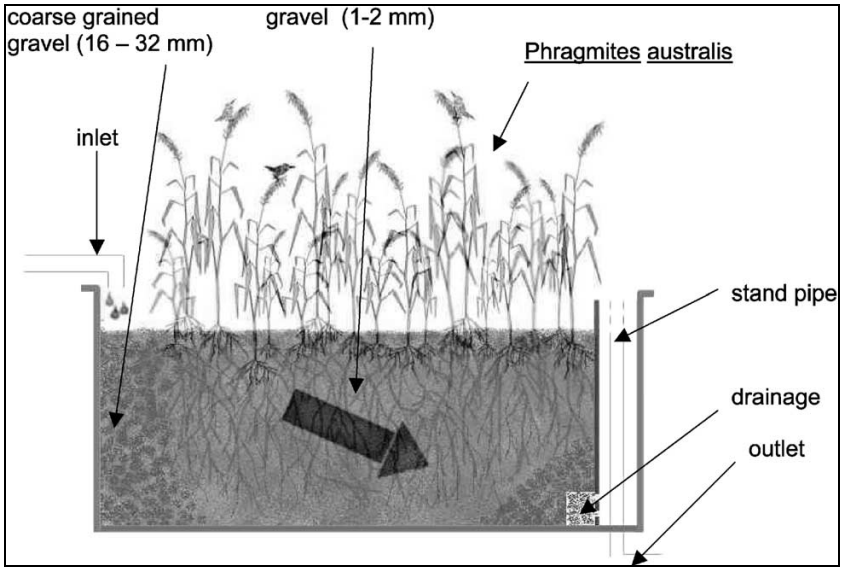


Figure 2. Design of used root zone constructed wetlands with horizontal flow and emergent plants; larger substrate at inlet and outlet to facilitate influent distribution and effluent drainage (Schulz et al. 2003).

Schulz et al. (2003) investigated treatment of aquaculture effluents of flow- through systems in created wetlands. The constructed wetlands types used in this study were subsurface root zone systems with emergent plants and horizontal effluent soil percolation (Fig.2). Three 1.40 x 1.00 x 0.70 m (L x W x H) root zone systems were filled with sands of 1 – 2 mm particle size and planted with 20 rooted shoots of reed per square meter (*Phragmites australis*). Nutrient removal of rainbow trout (*Oncorhynchus mykiss*) effluents flowing through the wetland was determined for hydraulic loading rates of 1, 3 and 5 l/min corresponding to very short hydraulic residence times (HRTs) of 7.5, 2.5 and 1.5 h, respectively. Inflowing nutrients were removed within every continuously flooded wetland. Total suspended solids (TSS) and chemical oxygen demand (COD) were reduced by 95.8 – 97.3% and 64.1 – 73.8%, respectively, and demonstrated no influence of HRT. Total phosphorus (TP) and total nitrogen (TN) removal rates varied from 49.0% to 68.5% and 20.6% to 41.8%, respectively, and were negatively correlated with HRTs. Effluent purification was best at HRT of 7.5 h, but sufficient removal rates were achieved for shorter HRTs. Obtained removal rates demonstrated that created wetlands with high hydraulic loads reduced inflowing nutrients by amounts comparable to, or exceeding that achieved by mechanical treatments such as microscreens or sedimentation tanks. Thus, created wetlands are a viable alternative treatment for aquaculture effluents.

4.6. Integrated Aquaculture

The salmon aquaculture industry has adopted a number of strategies to reduce nutrient wastes and its impacts on the local environment, including improved feed formulations and digestibility, improvements in feed/waste monitoring and feeding techniques, site rotation and fallowing, and reduced stocking densities. Integrating the culture of filter-feeding bivalve molluscs (e.g. mussels, oysters, scallops) with salmon farms has long been advocated as another potential strategy to alleviate waste loadings and environmental impacts associated with open-water salmon culture (Folke et al., 1994; Kautsky et al., 1997). In a conceptual open-water integrated culture system as proposed by Kautsky et al. (1997), filter-feeding bivalves are cultured adjacent to meshed fish cages, reducing nutrient loadings by filtering and assimilating particulate wastes (fish feed and faeces) as well as any phytoplankton production stimulated by introduced dissolved nutrient wastes. Waste nutrients, rather than being lost to the local environment, as in traditional monoculture, are removed upon harvest of the cultured bivalves. With an enhanced food supply within a fish farm, there is also potential for enhancing bivalve growth and production beyond that normally expected in local waters. Therefore, integrated culture has the potential to increase the efficiency and productivity of a fish farm while reducing waste loadings and environmental impacts. This model of integrated bivalve – fish culture is certainly simple and, intuitively, appears promising. However, few practical studies have been undertaken, with conflicting conclusions regarding the potential for open-water integrated culture to enhance bivalve production and, by implication, to significantly reduce fish farm wastes. Studies have shown that bivalves are capable of utilising fish farm wastes as an additional food supply (Mazzola and Sarà 2001), likely explaining the increased growth displayed by mussels (Wallace, 1980) and oysters (Jones and Iwama, 1991) grown adjacent to fish cages. However, other studies have reported no, or minimal, growth enhancement of bivalves cultured in an integrated bivalve – fish system (Gryska et al.,1996).

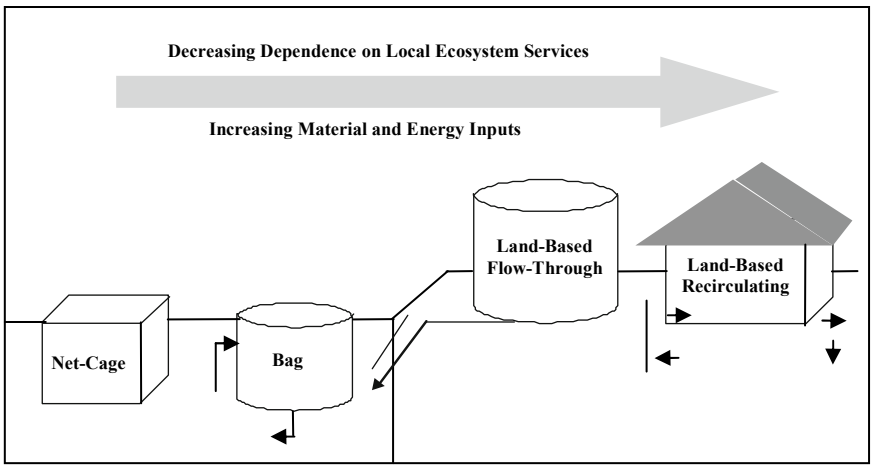


Figure 3. The flow of material and energy inputs in relation to the dependence on ecosystem services

4.7. Land-Based Recirculating Systems

In recent years, particular emphasis has been placed on the development of closed-containment systems, a term widely used to describe a range of production systems that employ an impermeable barrier to isolate the culture environment from surrounding ecosystems. Theoretically, by culturing fish in a closed environment, fish farmers can exert greater control over the rearing conditions, allowing them to improve the quality of the fish while at the same time reducing proximate environmental impacts. Some of the potential advantages of closed-containment systems are: (1) minimized fish escapes; (2) minimized predator interactions; (3) reduced disease transmission; (4) lower feed inputs; (5) higher stocking densities; and (6) improved waste management capabilities. The system is entirely contained inside a warehouse and consists of a series of circular concrete tanks of various sizes. New water is continuously pumped into the tanks from an on-site freshwater well. Approximately 99% of the water is recirculated back into the system after passing through an extensive mechanical and biofiltration process.Wastewater that is lost from the system at various stages passes through a holding tank where solids are settled out and the remaining wastewater enters the municipal sewer system. The solid fish wastes are collected in the holding tank for future use as a substitute for conventional synthetic fertilizers for plants fertilizer in an adjacent greenhouse. Ayer and Tyedmers (2008), studied on Assessing alternative aquaculture technologies: life cycle assessment of salmaonid culture systems in Canada. In the study, four different system such as; Marine net-pen, Marine floating bag, Land-based flow-through and Land-based recirculating were studied. At the end of study, the recirculating system was the only system at which wastes were managed. The differences of the systems was presented in Fig. 3 (Ayer and Tyedmers 2008).

5. Conclusions

Intensive salmonid cultivation can introduce significant quantities of nutrient wastes from uneaten feed, faeces and excretory products into the local environment. Along with the growth of the salmon aquaculture industry, so too have concerns regarding the environmental impacts from aquaculture wastes. One of the major challenges for the sustainable development of salmonid culture, and the aquaculture industry generally, is to minimise environmental degradation concurrent with its projected expansion. The impacts of particulate wastes such as uneaten fish feed and faeces are largely on the benthic environment immediately surrounding fish farms; alterations to sediment biogeochemistry and benthos from sedimented solid wastes are well-documented (Brooks et al., 2003). Remineralised nutrients from these deposits, along with fish metabolic wastes, particularly ammonia, are dispersed within the receiving water body and may contribute to localised hypernutrification. During seasonal cycles of nutrient availability, additional dissolved nutrient wastes have the potential to stimulate benthic algal production, increase phytoplankton production leading to localised eutrophic conditions, and alter dissolved N/P ratios that promote the growth of toxic algal species (Folke et al., 1994). Bubridge and Burbridge (1994) identify three ways in which it would be possible to achieve control of feed impacts from aquaculture: (1) control of the sites where the culture farms are located; (2) control of the released effluents; (3) monitoring of impacts generated by effluents once the farm begins its work. Polyculture, or inte- grated aquaculture associating shellfish

and algae culture with fish culture may be part of the solution (Cheshuk et al. 2003). The development and application of Environmental Quality Standards (EQS) and the design of models for evaluating environmental impacts are other initiatives for controlling and monitoring the environmental impact of fish farms.

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The Sustainability of Agricultural Activities and its Effects on Internal Waters And Living Areas

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Abstract: Residues of some medicals and fertilizers used in agricultural areas can reach to some receptors through some processes such as irrigation and surface waters. These natural receptors are rivers, lakes and seas. The materials coming from agricultural areas have more destructive effects on the lakes and rivers since these are smaller. The most pronounced pollutants coming from agricultural areas to rivers and lakes are pesticides and fertilizers which are known as a source of nitrogen and phosphor. Chemicals in some areas where pesticide were used are mixed into rivers and lakes through that way they reach to water habitats and organisms. On the other hand, this causes to increase organic ratio, eutrophication and for ecological balance to be destroyed.

Pathogens are transmitted to surface waters with human and animal wastes and then these contaminated surface waters threat human health. An important amount of pathogens is distributed to receptors through use of wastewaters for irrigation. In order to this negative effects to be removed, in order to save rivers and lakes, wild irrigation must be stopped, the direct approach of wastewaters into the rivers and lakes must be prevented, the usage of fertilizers and pesticides must be controlled, mechanical and biological war must be strengthen. The sustainable ecological living areas can be constructed by taking the water sources and biological kinds under control with these precautions.

Introduction

Some reasons, such that the environment knowledge of population has not been well developed, the world population has increased very fast, and the industry and technology have developed too fast, cause that the drinking water is decreased in time. Beside these, pollution of water sources irresponsibly will cause problems can not be solved (Haviland, 2002; Dağlı, 2005; Akın, 2007).

Increasing demand on the food with increasing population makes that the quality and quantity must be increased. As a result of these demand, the usage of fertilizer and pesticide are increased in time (Huber et al., 2000; Causape et al., 2004). The chemicals used agricultural areas are classified in two groups to be fertilizers and pesticides (Alloway, 1995). They are very important issue since they are toxic, decomposition of them is very difficult, and they can be deposited in living organisms and environment (Egemen, 2006). Pesticides and chemical fertilizers are mixed into rivers which are one of the ecosystems mostly affected from environmental pollution (Huber et al., 2000, Causape et al., 2004; Taş, 2006).

The pollutions caused by agricultural activities are firstly transferred into the rivers and then goes to lakes and seas throughout rivers. It can prevent the development of zoo and phytoplankton which have an important place on the feeding chain of aquatic livings even in the case of the existence of pesticides in trace level in the water (Aguilar et al., 1997).

This pollution is badly affecting not only livings living in pollution but also it can reach human through feeding chain (Yılmaz, 2004). It is important to note that the determination of existence of DDT (pesticide) on the penguins, seal and people living in poles where no pesticides have never been used shows the power of circulation of chemicals used in agriculture over the world (Egemen, 2006).

The harms given by the improper usage with the increase of this improper usage of pesticides and chemical fertilizers will reach to so high level (Öztürk and Tosun, 2004). At present, as the production and usage of pesticides and chemical fertilizers continue to increase, in order to the health and environmental problems the

production to be decreased, this case must seriously be taken under control (Atasoy and Rastgeldi, 2006).

Agricultural Activities And Pesticide

Since pesticides remain in nature for so long time without decomposition, they have no selectivity on the selected organisms and collected in some parts of food chain, they can cause destructions of some beneficial kinds and ecological balance and appearing of new kinds presenting resistance to these kind of products (Kambur et al., 2005).

It has been well known that pesticides can reach ecosystem of water in several ways. For example, some several medicines can contaminate into water with direct application of pesticides to the buggies during fighting against wild grass in or around the canals of drainage and irrigation or vector insects such as mosquitoes. The medicines in some places where pesticides were used several pesticides reaches to aquatic plants and insects in a way of mixturing these pesticides to river or ground water by rain water. The pesticides mixture into ground or surface waters have limit values for livings according to some structural properties presented in some receptors. The concentrations exceeding these limit values badly effect the life of livings. The first step of bioconsantration mechanisms in aquatic systems is consisted of plankton. An important part of plankton in aquatic habitats consists of algae. Since algae are primary producer, they play a functional role in habitats on which algae exist. Algae which are primary produces in aquatic environment form the base of organic production and they are quite sensitive organisms for physical and chemical changes in an environment where they exist. Algae are key targets for pesticide contaminations since they haw echophysiological similarities (Kambur et al., 2005). The primary production presented by algae forms foundations of whole organic production in aquatic environment. Algae forming the first circle of chain of feeding in waters are organisms which are quite sensitive to the physical and chemical changes in environment where they exist (Round, 1984; Hutchinson, 1967).

Sensitivity of algae, which is an important group in either plankton or benthic organisms in fresh water, to different toxic materials is different. Algae have an important role in determination and improvement of water quality and in rehabilitation of waste water. On the other hand, algae remove some elements such as nitrogen and phosphors, existing in quite large amount in aquatic environment, from environment using them as materials of feeding. Because of this, a change in quality and quantity of algae which is primary produces in aquatic environment cause a whole ecosystem to be destroyed (Turan, 2008).

It has been understood that fishes are harmfully affected from the low level residues of several pesticides mixed into water in several ways and attitudes of fishes are changed. It has also been reported that babies of some kind of fishes are too sensitive to pesticides. The residues of pesticides even in minimal level, in stagnant waters uses up oxygen in water and destroy the feeding environment for fishes (Anonymous, 2004).

The organisms dead by the effects of pesticides are deposited in the bottom of the water by sinking. CO_2 or poison gases raised during the decay prevent aquatic organisms coming near to these areas (Anonymous, 2004). Pesticides transferred to aquatic ecosystems presents some different effects on organisms in receptor environments. These effects cause death of fishes, other vertebrates and in invertebrates and algae to be harmed, and also cause disappear from environment. In addition to this, pesticide residues cause chronic toxicity to be developed by food chain and drinking contaminated water (Turan, 2008). As a result of this, biological variety in ecosystems has been affected. Some increases in the pollutants cause some organisms to be increased too much while cause some organisms to be removed from environment or to be annihilated. Some types can only be left which can tolerate pollution. Some damages, which cannot be reversed, appear as a result of destruction of the ecological balance (Kalyoncu et al., 2009).

The gills of fishes first met pesticides and, therefore, the most series damages are taken place on that organ (Heath, 1987). On the other hand, it has some harmful effects on haematology depending on kind of fishes (Shakoori et al., 1991; 1996; Atamanalp and Güneş, 2002a; Atamanalp and Güneş, 2002b; Atamanalp and Cengiz, 2002; Atamanalp and Yanık, 2003). The specimens taken from liver have shown that some histopatological effects beside some changes on the colour and size (Atamanalp et al., 2002). The osmoregulation event which is very important event in either sea or fresh water fishes are badly affected by changes of permeability of the gills and skin (Heath, 1987). Attitudes of fishes exposed to chemicals present some differentiations from others. Especially some changes on the some staminal attitudes, such as feeding and adaptation, may cause the fish to loss health. The problems on the neural system appear to be problems on the central neural system as well as problems on the working systems of receptors (Heath, 1987). Pollutants have different effects in the each of different stages of pregnancy biology depending on the groups belonging to, active material contained, concentration and kind of fishes (Çelikkale, 1991; Heath, 1987; Dhawan and Kaur, 1996; Holcombe et al., 1976). It is well known that the s-triazine compounds, which comprise Atrazine and Terbuthylazine, are usually termed recalcitrant, and especially the first one, due to its asymmetric substituent groups, is particularly resistant to biodegradation (Varghaa et al. 2005). These two chemicals are furthermore

herbicides which affects the photosynthetic electronic transport, inhibiting the algal growth in aquatic environment (Eullaffroy and Vernet, 2003), the primary level of the food web. In addition Atrazine even at low exposure concentrations (5µg l^{-1}) affected significantly aquatic organisms (Steinbergi et al., 1995).

Agricultural Activities And Chemical Fertilizers

When we have looked the harmful effects of fertilizers on environment, it has been thought that mostly nitrogen and phosphors containing fertilizers have given harm on the environment; especially it is well known that it causes the water quality in the watery areas are destroyed as a result of that nitrogen and phosphors containing pollutant are transferred into rivers in anyway and then it also causes eutrophication with increases on the amount of nitrogen and phosphors (Ceran, 2001).

The amount of nitrate mixed into drinking water and rivers through washing out process are increased as a result of usage fertilizers containing nitrogen in high level (Sencar et al., 1993). The compounds containing nitrogen has several effects in the view of water pollution, and the most harmful effect is known to be that of changing oxygen compositions, eutrophication, hygiene on the obtaining of drinking water and toxicity problems (Uslu and Türkmen, 1987).

Approach of phosphor to surface water causes some undesirable effects in aquatic systems as a result of increase in the primary production. Too much increase in green plants and algae in some rich parts in oxygen of water (eutrophication), increase in the blurrily of water, increase in the light input of aquatic macrophytes, not enough oxygen and an increase of amount of some death of plants in the bottom of the water starts anaerobic conditions and reduces the quality of the water are the most important factors on the reduction of the water quality (Muslu, 1985).

Phosphor components broken up into orthophosphate by aquatic plants are important compositions of food materials. If too much phosphor is loaded, pH value of water and tampon systems are changed (Muslu, 1985). A layer on the water is produced by decreasing surface tension of the water. This layer reduces the transmission of light and oxygen transfer and effect biological activities destructively (Akman et al., 2000). The load of nitrogen and phosphor existing in the environment put pressure on the aquatic ecosystems. Although phosphor has some feeding properties for algae, the extremely high existence in the environment cause some algae to be removed from environment and some of them to be destroyed. This also results with extremely development of taxa tolerating the increase of feeding salts. This change taken place in aquatic ecosystem is not only effective on algae but also destructively affects other living groups (Kalyoncu et al., 2009).

Results And Suggestions

The use of chemical fertilizers and pesticides unplanned and in extremely high amount in agricultural areas effect destruct on all ecosystems. Some cases must be considered before the usage of chemical fertilizers and pesticides in order to completely prevention or minimization of the destructive effects.

- It must be note that the pesticides used in agriculture must be easily separable in nature. Beside this, biological fighting methods must be taken over instead of pesticides produced synthetically.

- If applications of pesticide are un-exceptionally necessary, farmers must be educated and trained to apply enough and to avoid over use. The technical and sustainable production with plants, which is more economical and suitable for ecosystems, must be carried out for especially in areas near basins and sources of water.

-It is well known due to the human health and environment that the chemical fertilizers and pesticides used in agricultural areas are important source of pollutants and reaches to aquatic system with surface water. In order to types of kinds in the aquatic systems to be protected, attention must be applied for application of them in suitable time and dose. The effects of chemical components applied on the aquatic ecosystems must be studied and sustainable control must be carried out.

- The ecological agriculture together with advanced agricultural techniques must be applied. Technical and environmentalist agriculture must be carried out for ecological balance to be saved. Some types suitable against diseases and for dried climate must be produced and mechanical and biological techniques for pest management must be developed and then made suggested for common use.

- Instead of too much water, enough water applications must be desired, wild and surface irrigations must be left. System must be turned to pressurized irrigation, irrigation time for plants must be determined. Irrigation policies must be put into the agricultural irrigation programs of governments.

- On the other hand, system must be changed from opened system to closed systems. The usage of water and fertilizer applied by farmers must be planned, controlled and sustainable.

- Refinery system for wastewater must be constructed legally in cities. Water and wastewater must be transmitted through different waterworks and leakages from the system must be minimized. Purified water must be used in green areas and urban agricultural areas.

- Especially the problem of drainage must be solved by completing the foundation of irrigation. The regulation for price of irrigation must be made in the most suitable manner. Economical and efficient irrigation must be supplied and direct indirect encouragement must be applied.

- More advantageous against erosion, desert condition, dried climate, more environmentalists, sustainable advanced agricultural techniques must be applied.

- As a result, harmful materials reached to aquatic areas as a result of agricultural activities effects on all of livings from algae to fishes living aquatic areas. The importance of agriculture for humanity is unquestionable. But, the aquatic systems are as important as agricultural areas. The chemicals reaching to aquatic areas coming from agricultural areas returns back to people with usage and drinking waters and causes series destructive effects in health. The fresh and clean water sources have gained more importance because of the changes on the global climate. The environmental pollution must be stopped by protecting aquatic ecosystems. The ecology must be kept to be sustainable and carefully followed.

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Recent Developments On The Aplication Of Artemia In The Ornamental Fish Culture

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Abstract: Production of animals for the aquarium hobbyist trade is a rapidly growing sector of the aquacultural industry, and it will continue to become more important as restrictions are placed on collecting animals for the wild. Improved techniques for marine food-fish larviculture since the early 1980's have greatly enhanced the growth and survival of freshwater ornamental fish larvae largely through improved technology regarding live food culture and larval rearing practices. Research developments in larviculture and early rearing technology have allowed 90% of currently marketed freshwater ornamental fish to be cultured. However, for marine ornamentals, the reverse is true as only a handful of species is produced via aquaculture technology. A major task in devising a protocol for the artificial propagation of a fish species is the development of a feeding regimen for the larvae. Live feeds are a convenient and often essential food source for the larvae of some cultured species, especially those without a fully developed digestive system. In such cases, live food organisms provide digestive enzymes that breakdown the food ingested by larvae and can be described as naturally encapsulated bags of nutrients. Two major concerns among aquaculturists are providing organisms appropriate to the size of the larvae at the first feeding stage and then supplying the large numbers of feed organisms necessary to maintain the larvae. Since no artificial feed formulation is yet available to completely substitute for *Artemia*, feeding live prey to young fish larvae still remains essential in commercial hatchery operations. This paper reports the recent developments in the applications of *Artemia* nauplii, decapsulated *Artemia* cysts and on-grown *Artemia* in the ornamental fish culture.

Key words: *Artemia*, Ornamental Fish, Larvae, Feeding

1. Introduction

The ornamental fish sector is a widespread and global component of international trade, fisheries, aquaculture and socio-economic development. Since 1985, the international trade in exports of ornamentals, which usually takes place in the majority of developing countries, followed an increasing trend with an average growth rate of approximately 14% per year. The entire industry has been estimated to be worth around US$15 billion. This vast industry has the potential to contribute to the economic growth of developing countries which may face future challenges regarding environmental safety (Olivotto et al., 2006). Production of animals for the aquarium hobbyist trade is a rapidly growing sector of the aquacultural industry, and it will continue to become more important as restrictions are placed on collecting animals for the wild. Currently, approximately 90% of freshwater fish traded in the hobbyist industry are captively cultured. While a majority of aquacultural production worldwide is devoted to food production, ornamental fish production is an important component of the aquaculture industry in several nations. In Singapore, ornamental fish accounts for 40% of their total exports. In the United States, ornamental fish production is the fourth largest sector behind catfish, trout, and salmon. Farms in Florida produce 800 varieties of freshwater fish (Tlusty, 2002).

Successful rearing of larval stages of aquatic organisms is a challenge for aquarium hobbyists, an aim and a necessity for the success of the aquaculturist. All these specialists will agree that the primary problem in any type of larval rearing is that of food. Ideally, one would prefer to feed larvae their natural diet, which is characterized by a wide diversity of nutritious live organisms. Live feed is an essential food source for the fry of cultured species, especially those without a fully developed digestive system. In the freshwater ornamental fish culture, *Artemia* nauplii are used as the live feed. Two major concerns of aquaculturists are: (i) providing organisms appropriate to the size of the feed to the first feeding stage and (ii) supplying adequate number of feed organisms to ensure higher survival and faster growth (Arulvasu and Munuswamy, 2009). In nature, zooplankton

is one of the primary foods of larval fish. The brine shrimp *Artemia* is in the phylum Arthropoda, (Crustacea, Anostraca). *Artemia spp.,* are zooplankton, like copepods and *Daphnia*, which are used as live food in the aquarium trade, and for freswater and marine fish larval culture and crustacean larval culture (Lim et.al., 2001). While the adult form of *Artemia* is primarily used as a live, frozen, or freeze-dried food in the aquarium trade, the nauplius stage is used exclusively in fish hatchery operations. It was recognized long ago that freshly hatched *Artemia* nauplii are a high value feed for fish larvae and fry. Because of the size of the nauplius stage, *Artemia* also represent the only practical food source for the early stages of many fish and crustacean larvae. (Tamaru et al., 2001). In Singapore, the top-exporting country of freshwater ornamental fish in the world, *Moina* used to be the most common live food organism used in the industry. As *Moina* is cultured in ponds using pig waste, they are often contaminated with fish pathogens, as well as bacteria of public health concern, such as *Salmonella* and *Vibrio cholera.* To minimize the risk of fish being contaminated with the pathogens, more and more freshwater ornamental fish farmers in Singapore have shifted from *Moina* to the cleaner *Artemia* nauplii for feeding their fish. (Lim et al,. 2002, 2003). Since no artificial feed formulation is yet available to completely substitute for *Artemia*, feeding live prey to young fish larvae still remains essential in commercial hatchery operations. There are more than 50 geographical strains of *Artemia*. Many commercial harvesters and distributors sell brands of various qualities. This paper reports the recent developments in the applications of *Artemia* nauplii, decapsulated *Artemia* cysts and on-grown *Artemia* in the ornamental fish culture.

1.1. Why is Live Feed Necessary?

Fish biologists categories larvae of two types: precocial and altricial. Precocial larvae are those that, when the yolk sac is exhausted, appear as mini-adults, exhibiting fully developed fins and a mature digestive system including a functional stomach. Such fish can ingest and digest formulated diets as a first food and are best exemplified by the salmon and trout raised extensively in hatcheries around the world without the benefit of live food. Altricial larvae are those that, when the yolk sac is exhausted, remain in a relatively undeveloped state. The digestive system is still rudimentary, lacking a stomach, and much of the protein digestion takes place in hindgut epithelial cells (Govoni et al., 1986). Such a digestive system seems (at this point) to be incapable of processing formulated diets in a manner that allows survival and growth of the larvae comparable to those fed on live feed. Altricial larvae therefore appear to require live feed, but there may be other reasons besides the digestibility question. Live feeds are able to swim in the water column and are thus constantly available to the larvae. Formulated diets tend to aggregate on the water surface or, more commonly, sink quickly to the bottom, and are thus normally less available to the larvae than are the live feeds. In addition, the movement of live feed in the water is likely to stimulate larval feeding responses, since evolutionary history has probably adapted them to attack moving prey in nature. Formulated diets are generally capable of moving only in a downward direction, towards the bottom. Finally, live prey, with a thin exoskeleton and high water content, may be more palatable to the larvae once taken into the mouth, compared with the hard, dry formulated diets. This last point is rather critical, especially when considered in light of the fish larva's absence of feeding appendages; any foods must enter the mouth whole (i.e. the larva's mouth gape must be of sufficient size for particle ingestion to occur) and they are quickly either accepted or rejected on the basis of palatability (Stottrup and McEvoy, 2003).

2. *Artemia*

Artemia has several characteristics which make it ideal for aquaculture use. It is easy to handle, adaptable to a wide-range of environmental conditions, non-selective as a filter-feeder which can ingest algae, protozoa and bacteria of the correct size (10–50 μm) and is capable of growing at very high densities (Landau et al. 1985; Lèger et al. 1989). *Artemia* also has a high nutritive value (40–60 percent protein, rich amino acid composition), an unchanging food requirement, high conversion efficiency, short generation time, high fecundity rate and long lifespan. The whole animal (even adult stage) may be consumed without previous processing by many aquaculture organisms. In the food chain the nutritional value of *Artemia* depends on both the macronutrients (proteins, fats and carbohydrates) and micronutrients (vitamins and minerals) it can accumulate from the filtered food. The brine shrimp is considered a continuous, non-selective, obligate phagotrophic filter feeder zooplankton (Fig.1).

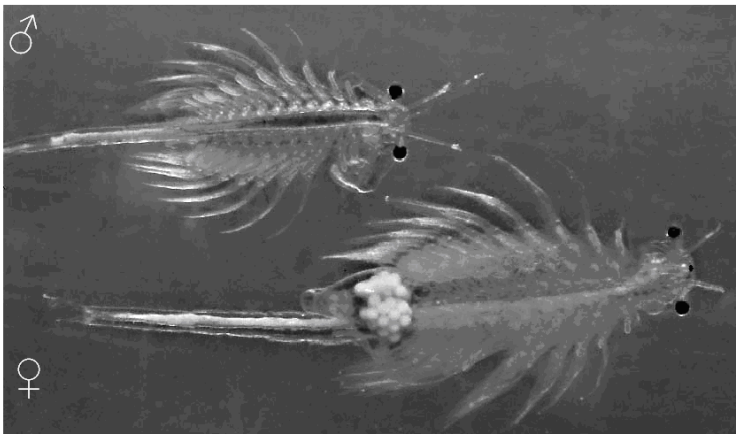

Figure 1. Adults *Artemia* sp.

Artemia are extremely euryhaline, withstanding salinities from 3 ppt to 300 ppt. They can even survive short periods of time in freshwater, but cannot reproduce in it. *Artemia* survive temperatures ranging from 15 to 55 ^{o}C. They have two modes of reproduction. Sometimes nauplii (first *Artemia* swimming stage) hatch in the ovisac of the mother and are born live. However, when the body of water where adult *Artemia* are living begins to dry up and salinities rise, embryos are encased in a hard capsule, or cyst, so that they are protected and can hatch later when conditions are better. The cyst is 200 to 300 micrometers in diameter, depending upon the strain. Its external layer is a hard, dark brown shell (Fig 2). Dry conditions cause the encysted embryo to enter a dormant state, which allows it to withstand complete drying, temperatures over 100 ^{o}C or near absolute zero, high energy radiation, and a variety of organic solvents. The dehydrated cyst can be stored for months or years without loss of hatchability.

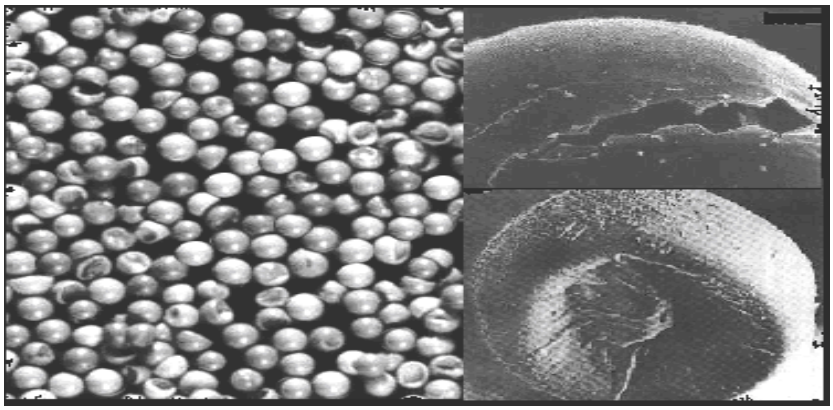

Figure 2. *Artemia* Cysts.

Only water and oxygen are required to initiate the normal development of the *Artemia* embryo, but it does help the hatch rate to maintain the temperature above 25 ^{o}C and place a light near the eggs. The durable, easily hatched cyst makes *Artemia* a convenient, constantly accessible source of live feed for the finfish hatchery operator. *Artemia* cysts are best stored in a tightly sealed container in a cool, dry environment and, if possible, vacuum packed. Within 15 to 20 hours after being placed in seawater at 28 ^{o} the shell breaks and the prenauplius in E-1 stage appears (Fig. 3). For the first few hours, the embryo hangs beneath the cyst shell in what is called the umbrella stage. The newly hatched *Artemia* relies on its yolk sac for nutrients because its mouth and anus are not fully developed. The pre-nauplius E-2 stage is then released as a free-swimming nauplius called an Instar 1 nauplius. In this stage it is brownish orange because of its yolk reserves. It uses specially modified antennae for locomotion and later for food filtering. Approximately 12 hours after hatch it molts into the second larval stage (Instar II) and starts filter feeding on microalgae, bacteria and detritus. The *Artemia* nauplius can live on yolk and stored re-serves for up to 5 days or through the Instar V stage (Fig. 3), but its caloric and protein content diminish during this time (Briksi et.al., 2008).

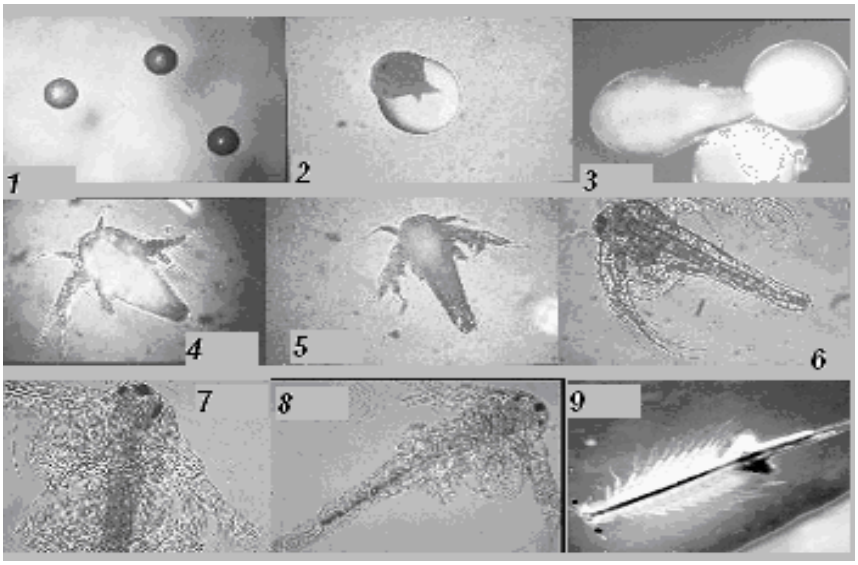

Figure 3. Steps in Life Cycle of *Artemia*
1: Cysts, 2: Breaking stage, 3: Umbrella stage: emerging embryo, 4: Instar I(E-1) newly hatched nauplii (with yolk), 5: Instar II(E-2), 6: Differeatiation (molting) stage, Instar III-IV, 7: Instar VI-VIII, 8: Instar IX-X, Sub-adult stage, 9: Adult stage.

As a food source for the larvae, it is imperative that *Artemia* is of high quality, as nutritionally complete as possible, and maintained in this state until consumed by the larvae. There are four distinct stages involved in *Artemia* culture. These stages are: (1) decapsulation, (2) hatching, (3) storage, (4) enrichment, (5) harvestin and usage. *Artemia* also represent a potential vector for disease introduction into the larviculture production system. As such, all *Artemia* production and storage procedures must be conducted utilizing hygienic production protocols and proper hatchery sanitation procedures. This document provides the background, rationale, and detailed production protocols for all stages of high-quality *Artemia* culture to developments on the aplication of *Artemia* in the ornamental fish culture.

2.1. Decapsulation of *Artemia* Cysts

Artemia represent one of the few live feeds that can be cultured in sufficient numbers and are of appropriate size for larva to transition to between daphnia, blood worms and weaning diets. During a portion of their life cycle, *Artemia* hibernate as a desiccated cyst that is capable of withstanding extreme environmental conditions for long periods of time. Cysts are easily shipped and are thus the form purchased by aquarists. However, *Artemia* cysts can cause problems during larviculture because: 1. The shell of the cyst is indigestible and may cause intestinal blockage when ingested by larva, 2. Cysts are a potential vector for pathogen introduction to the culture system, 3. *Artemia* consume high levels of endogenous energy reserves when hatching through the cyst shell, 4. Cysts must be physically separated from the live *Artemia* after hatching. Decapsulation of *Artemia* cyst is a process whereby the external shell or chorion is chemically removed from the cyst. This process addresses the concerns noted above and has become standard practice by fish hatcheries looking to produce high quality *Artemia*.

The fry of all the five common ornamental fish species tested (guppy *Poecilia reticulata*, molly *Poecilia sphenops*, platy *Xiphophorus maculatus*, swordtail *Xiphophorus helleri* and neon tetra *Hyphessobrycon herbertaxelrodi*) could readily feed on the decapsulated cysts, and their performances in terms of stress resistance, growth and survival are comparable to or better than those fed on *Artemia* nauplii or *Moina*. A culture system for production of on-grown *Artemia* has also been developed specifically for the use in freshwater ornamental fish farms (Lim et al. 2003).

2.1.1. *Artemia* Decapsulation Procedure and Decapsulation Requirements

Artemia cysts: 1 kilogram (kg)
Decapsulation vessel: 20 liters (L)
Chlorine bleach (NaOCl; 5.5%): 8 L at 2-10 degrees Celsius (°C)
Sodium hydroxide (NaOH; 40%): 4 L at 2-10°C
Sodium thiosulfate ($Na_2S_2O_3$): 100 g

Harvest bag: 100 micrometer (μm)

2.1.2. Hydration

The first step in the decapsulation procedure is *Artemia* cyst hydration. Hydration of cysts allows for separation of the nauplii from the chorion, facilitating the decapsulation process. For this step, *Artemia* cysts are placed in either fresh or saltwater at room temperature for approximately one hour, using a concentration of 1 g of cysts per 15 milliliters (ml) of water. It is important during this step to maintain sufficient mixing via aeration to keep cysts well suspended. After one hour of hydration, the water and hydrated cysts should be drained through a 100 μm harvest bag; the concentrated cysts are then placed back into the empty decapsulation vessel.

2.1.3. Decapsulation

For decapsulation, pour the chilled sodium hydroxide solution into the decapsulation vessel with hydrated cysts, again making sure there is adequate aeration within the vessel to keep cysts suspended. The chilled bleach should then be added to the cysts to initiate the decapsulation process. Because the chemical reaction during decapsulation is exothermic, it is helpful to begin with chemical solutions chilled to a temperature of 2°C to 10°C. These starting temperatures will prevent the temperature of the chemical solution from exceeding 35°C, which may damage the cysts. As decapsulation progresses, the chorion is chemically removed, resulting in the cysts gradually changing color from brown to grey, then to orange, and finally to bright orange. This bright orange color indicates that the process is complete. (Cyst buoyancy can also be used as an endpoint indicator: when approximately 90 % of cysts sink, the process is complete). The process should take from one to three minutes, but time may differ due to temperature variations. Cysts can easily be damaged by overexposure to the decapsulation solution, adversely affecting the resulting hatch rate. It is imperative to closely monitor the process and standardize it for your particular conditions (Fig. 4).

2.1.4. Decapsulated Cysts Harvest

When it is determined that the cysts are adequately decapsulated, add 75 g of sodium thiosulfate to the decapsulation vessel to neutralize the chlorine, then immediately begin to drain cysts into the 100 μm harvest bag. During the harvest process (Fig. 4), rinse with ample amounts of water (fresh or salt) while providing ample aeration via an air stone to keep decapsulated cysts in suspension. When all decapsulated cysts have been collected, the remaining sodium thiosulfate should be added to the harvest bag. Continue rinsing the bag until water runs clear and no presence of chlorine can be detected.

2.1.5 Decapsulated Cysts Storage

Decapsulated cysts can be drained of excess water and stored in an airtight container in a refrigerator (+ 4 ºC) for up to 5-6 days. For longer-term storage (two weeks or more), cysts must be dehydrated by placing them in aerated brine (330 g of sodium chloride (NaCl) per liter of water) at the concentration of 1 g of cysts per 20 ml of brine for 24 hours. They can then be drained and placed into a suitable container, topped with fresh brine, and placed in a refrigerator (Fig. 5).

Figure 4. Harvesting Decapsulated *Artemia*

Figure 5. Decapsulated *Artemia* Cysts Hatching Storage

2.2. Hatching of *Artemia* Cysts and Hatching Requirements

Temperature: 26-30°C
pH: 8.0-9.0
Dissolved oxygen: > 4 mg/L
Light level: ~2000 lux
Salinity: 25-35 parts per thousand (ppt)
Hatching density: ≤ 2 g dry cysts/L
(up to 5 g/L with supplemental O_2)
Sodium bicarbonate ($NaHCO_3$): 0.5 g/L
Antifoam (silicone based): 1 ml/100 L

Fill a clean, cone-bottomed hatching tank with warm, filtered seawater or fresh water addet 30-35 g salt. If warm seawater is not available, allow enough lead time for water to be warmed to 26°C to 30°C in the hatching tank via submersible heaters. Add 0.5 g of sodium bicarbonate per liter of water in order to maintain the pH between 8.0 and 9.0 throughout the entire hatching process. The use of antimicrobial products such as INVE's Hatch Controller can be used to help minimize growth of pathogenic bacteria in the hatching tank. The proper stocking density for nondecapsulated cysts is approximately 2-3 g (max. 5 g) per liter. When using decapsulated cysts, approximately 5 g per liter can be stocked. These numbers can be doubled through the use of pure oxygen supplementation, which is needed to maintain dissolved oxygen levels greater than 4-5 milligrams per liter. Attempting to hatch at higher stocking densities can result in physical damage to the nauplii and reduced quality It is important to maintain sufficient aeration at the bottom of the cone to keep cysts suspended. When hatching large volumes of cysts, it is advantageous to use a food-grade antifoam product to minimize excessive foaming in the culture. Hatching times will vary based on strain and age of cysts, temperature and salinity of water, etc. Thus, it is important to minimize variation between hatches for consistency. Generally, *Artemia* require 18 to 24 hours of incubation to hatch. Decapsulated cysts, however, may be ready to harvest after only 16 hours of incubation. When feeding nauplii directly to fish, timing of the hatch is very important. If nauplii remain in the hatching tank for too long, they will grow too large and their nutritional quality will decrease. Determining the endpoint of the hatch should be made through microscopic observation of the relative numbers of hatched nauplii, prehatched nauplii, and unhatched cysts (Fig 6).

Figure 6. *Artemia* Hatching Cone
(pure oxygen injection regulators on wall and wire from submersible heater on front edge of tank)

The harvesting procedure varies depending upon whether decapsulated or nondecapsulated cysts were hatched. Harvesting of *Artemia* nauplii is done after 5 to 10 minutes interruption of the aeration and remove the airstone. Wait approximately 5 minutes for the empty casings to float to the surface of the water. Empty cyst shells float to the surface, while the nauplii concentrate in the lower part of the tank and the unhatched cysts accumulate underneath the nauplii. Since most nauplii are positively phototactic, their concentration can be hastened and increased by shading the upper part of the hatching container with a black plastic sheet so that light reaches the lower part of the container only. Remove the unhatched cysts for the second hatching, after which the nauplii can be collected. A second collection of nauplii may be done 5 to 10 minutes after the first. Newly hatched nauplii should then be collected in the harvest bag and rinsed for at least five minutes. If nauplii have

settled properly, only 75 percent of the water column will need to be drained. While harvesting, check on the relative ratio of nauplii to cysts by transferring a sample to a glass beaker. This will help determine when the harvesting process is finished or if more time is needed to allow *Artemia* to settle. Remove the unhatched cysts for the second hatching, after which the nauplii can be collected. A second collection of nauplii may be done 5 to 10 minutes after the first. The nauplii are now ready to be fed to your fish, transferred to subsequent enrichment, or placed into cold storage.

2.3. Enrichment of *Artemia* and Enrichment Requirements

Temperature: 25°C
pH: 8.0-8.5
Dissolved oxygen: > 4 mg/L
Salinity: 20-30 ppt
Density: ≤ 300 nauplii/ml
DC DHA dosage: 0.6 g/L
Enrichment duration: 20-24 hours

Before being fed to larvae, *Artemia* nauplii are usually fed a specialized diet in order to increase their size and nutritional profile. While freshly hatched *Artemia* nauplii are rich in protein and can serve as a bridge between daphnia, rotifer and enriched *Artemia* for many species, they are largely void of the beneficial fatty acids required for proper growth and development of most larvae. For the purpose of the following *Artemia* enrichment procedure, the protocol developed for the use of the INVE product, DC DHA SELCO, will be utilized.

Olivotto et al. (2006) studied on growth and metamorhosis larvae of Sunrise Dottyback, *Pseudochromis flavivertex*. Larvae were divided into different experimental groups and fed on different feeding combinations in order to test the importance of food enrichment on larval survival, growth and metamorphosis timing. A first group (Group A) was fed on enriched *Brachionus plicatilis* and enriched *Artemia nauplii*; a second one (Group B) on enriched *B. plicatilis* and not enriched *Artemia nauplii* and a third one fed on not enriched live preys (Group C) used as control group. Live prey enrichment was essential for rearing this species. In fact, larvae fed on not enriched live preys did not past day 7. Highest survival rates (39% juveniles) were observed in Group A with respect to Group B (11% juveniles). Moreover, evidences of the importance of enrichment on growth and metamorphosis timing were observed since larvae reared using enriched live preys grew faster and completed metamorphosis earlier than those fed on not enriched *Artemia nauplii*. The results presented here provide additional evidence of the importance of live prey enrichment in ornamental larval fish rearing.

2.3.1. *Artemia* Enrichment Procedure

There are a number of commercially available *Artemia* enrichment products. Because these products have different ingredients, nutritional profiles, and enrichment protocols, it is up to hatchery managers to decide which product is most suitable for their conditions and species. Once an enrichment product is chosen, it is important that standardized protocols be developed and strictly followed. Slight changes in temperature or enrichment time, for example, can have significant effects upon the size and nutritional quality of the final product. Preparation of enriched *Artemia* requires a two-day lead time: one day is required for hatching of *Artemia* (see *Artemia* hatching protocol) and a second day for the enrichment process. Having a second, dedicated enrichment tank is necessary to facilitate this process. As with hatching, a cone-bottomed tank is ideal for enrichment and helps to ensure adequate mixing and complete draining during harvest. Prior to stocking, the enrichment tank should be filled with a suitable amount of water, and water-quality parameters (salinity, temperature, and pH) must be adjusted to match the requirements listed above. It is important to begin the enrichment process with healthy, high-quality nauplii. Nauplii that are damaged or sluggish prior to enrichment will result in suboptimal nutrient uptake. Care should be taken to remove hatched cysts (nondecapsulated cysts) or hatching membranes (from decapsulated cysts) as described in the *Artemia* hatching section. *Artemia* nauplii should also be rinsed well prior to stocking into the enrichment tank. This is especially important when using an additive such as INVE's Hatch Controller or antifoam during the hatching process, as ingredients in these products can interfere with enrichment uptake.

During enrichment, vigorous aeration should be applied through the bottom of the enrichment vessel, and dissolved oxygen levels should be closely monitored throughout the process (Fig. 7). The use of supplemental oxygen during this stage will likely be necessary to maintain oxygen levels above 4 milligrams per liter. Temperature must also be maintained at 25°C through the use of submersible heaters or ice packs, as dictated by ambient conditions (Delbos, 2009).

Figure 7. Multiple *Artemia* Enrichment Cones (heavy aeration)

2.4. Harvest and Cold Storage

At the end of the enrichment process, the entire volume of water should be drained into a 100-125 µm harvest bag with sufficient aeration to keep enriched *Artemia* in suspension. Oxygen levels should be closely monitored in the harvest bag. The bag containing the *Artemia* should be rinsed well for five minutes or until the water runs clear. Thereafter, *Artemia* should be transferred into a container containing clean water of a known volume, aerated vigorously, and enumerated as discussed above. If *Artemia* will not be fed to larvae immediately, it should be placed directly into cold storage, as described below. *Artemia* not fed to larvae or enriched immediately needs to be stored under cold conditions. Cold storage of *Artemia* dramatically decreases its metabolism, which directly reduces further growth and metabolism of their protein and lipid stores. *Artemia* should be transferred to a cooler or suitable container and stored at 2°C to 10°C, with adequate aeration to prevent settling (Fig. 8). Under these conditions, *Artemia* can be concentrated as high as 5,000 per milliliter and stored for up to 24 hours (Delbos, 2009).

Figure 8. Cold-Banked *Artemia*
(ice jugs for temperature control and air line for aeration to keep *Artemia* suspended)

3. Conclusions

The ornamental fish producer would have no problem to assign such a small area for setting up the culture system in their aquarium or farms. While the use of a batch culture system instead of a flow-through system would cut down the volume of seawater required for *Artemia* culture, the use of artificial seawater would enable farms that have no access to seawater to operate the system. To cut down the cost of salts required for

preparation of artificial seawater, the present system, for the first time in commercial *Artemia* production, used diluted artificial seawater (salinity 30-40 ppt) instead of full strength seawater for the culture. Change of water was not necessary during the 14-16 day culture period. These characteristics made the system suitable for operation in freshwater ornamental fish farms, and would allow existing ornamental fish farmers to integrate the *Artemia* production system in their farm operation. The present system did not use expensive mechanical and biological water treatment equipment such as bio-filter, mechanical filter, plate separator, sensors etc. and hence the cost of setting up the system was € 90,000-100,000 only. Bioencapsulation to enhance the nutritional quality of on-grown *Artemia* was conducted only when the *Artemia* failed to meet the fish requirement. The same applied to all other live food organisms such as rotifers and *Artemia* nauplii which might also require bioencapsulation due to their nutritional deficiency (Leger and Sorgeloos 1992; Sorgeloos and Leger 1992; Sorgeloos et al. 1995, Sorgeloos et. al., 2001). It was performed by fish farmers just before feeding the *Artemia* to fish, and not by producer of the organism. Hence the cost of bioencapsulation was not included in the production cost of the *Artemia.* Nevertheless, the cost of the enrichment media (€ 80-90/kg) used in bioencapsulation was estimated to be € 3-5/kg of on-grown *Artemia* (in 50 liter of water at 0.6 g/L.). The present *Artemia* culture system is a cheap alternative to the more sophisticated intensive system used in sectoral aplications. Compared to the complex automated system, the present system is cost effective, simple and easy to set up and operate. As the system occupies only a small land area and uses diluted artificial seawater for culture, the freshwater ornamental farmers will have no problem to integrate *Artemia* production using the culture system into their farm operation to increase farm profitability. By varying the time of harvesting, farmers may harvest any specific size of on-grown *Artemia* of up to 5 mm from the culture system to suit the age and size of their fish. The use of the right size of on-grown *Artemia* for feeding would ensure a better energy balance in food uptake and assimilation, thereby improving the performance of the fish. These characteristics, coupled with the use of bioencapsulation technique to enhance the quality of the on-grown *Artemia,* would make the organism an ideal nursery diet for freshwater ornamental fish. The availability of on-grown *Artemia* and the application of bioencapsulation techniques using the organism are likely to have a positive impact to the ornamental fish industry.

The food value of a live food organism for a particular fish species was primarily determined by its size and form. While a small food organism was desirable for fish larvae in term of ingestibility, the use of larger organisms was more beneficial as long as the size of the food organism did not interfere with the ingestion mechanism of the predator (Merchie 1996). Fish would take a long time to attain satiation if fed with smaller live food organism, and this would result in poor growth due to inefficient feeding and waste of energy. The on-grown *Artemia* in the culture system grew from 0.45 mm at inoculation to an average length of about 5 mm in 12 days. This size range was considered suitable for all sizes of freshwater ornamental fish species of up to 10 cm total length. By varying the harvesting time during the 12-day cycle, it was possible to obtain *Artemia* of any specific size within the size range for feeding, which would ensure a better energy balance in food uptake and assimilation. The nutritional quality of on-grown *Artemia* was comparable or superior to the common food organisms being used by the freshwater ornamental fish industry, such as *Artemia* nauplii, *Moina* and bloodworms. The on-grown *Artemia* was rich in protein (67 %) and low in crude fat (4 %). It was reported to have superior nutritional digestibility and a thin exoskeleton rich in essential amino acids (Leger et al. 1989). The latter was consistent with our amino acids analyses, which showed that the essential amino acids in the on-grown *Artemia* were comparable to *Moina* and richer than *Artemia* nauplii and bloodworms. An important dietary characteristic of live food organism was its composition of essential fatty acids. Watanabe (1987) reviewed the essential fatty acid requirement of freshwater and marine fish and concluded that freshwater species required mainly LLA (linolenic) or LNA (linolenic acid) or both. Although the on-grown *Artemia* obtained from the present study was deficient in LNA, its LLA was the highest among all the four diets tested. The DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid), which were widely considered as essential for marine organisms (Dhont and Lavens, 1996), were also highest in on-grown *Artemia.* Due to lack of published data, it was not known whether the levels of LLA, LNA, EPA and DHA in food organisms would be important to freshwater ornamental fish. Recent study on the fatty acid profiles of common feed items used by the industry for maturation such as beef heart and tubifex worms found unusually high ADA (arachidonic acid) levels (Ako et al. 1999). Availability of the on-grown *Artemia* would offer our farmers and exporters the possibility to apply the bioencapsulation technique to improve their fish performance and quality. In addition, the effective bioencapsulation characteristics of on-grown *Artemia* also make the organism a useful tool for larval nutrition study on freshwater ornamental fish. The present *Artemia* culture system is a cheap alternative to the more sophisticated superintensive system. By varying the time of harvesting, aquarists may harvest any specific size of on-grown *Artemia* of up to 5 mm from the culture system to suit the age and size of their fish. The use of the right size of on-grown *Artemia* for feeding would ensure a better energy balance in food uptake and assimilation, thereby improving the performance of the fish. These characteristics, coupled with the use of bioencapsulation technique to enhance the quality of the on-grown *Artemia,* would make the organism an ideal nursery diet for freshwater ornamental fish. The availability of on-grown *Artemia* and the application of bioencapsulation

techniques using the organism are likely to have a positive impact to the ornamental fish industry. Finally, demonstrated that the commercial production of on-grown *Artemia* using the present culture system was highly viable for freshwater ornamental fish applications.

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Aquaponic (Integrating Fish and Plant Culture) Systems

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Abstract: Aquaponic is the combined culture of fish and plants in recirculation systems, has become increasingly popular. Nutrients, which are excreted directly by the fish or generated by the microbial breakdown of organic wastes, are absorbed by plants cultured hydroponically (without soil). Fish feed provides most of the nutrients required for plant growth. As the aquaculture effluent flows through the hydroponic component of the recirculation system, fish waste metabolites are removed by nitrification and direct uptake by the plants, thereby treating the water, which flows back to the fish-rearing component for reuse. Aquaponic has several advantages over other recirculation aquaculture systems and hydroponic systems that use inorganic nutrient solutions. The hydroponic component serves as a biofilter, and therefore a separate biofilter is not needed as in other recirculating systems. Aquaponic systems have the only biofilter that generates income, which is obtained from the sale of hydroponic produce such as vegetables, herbs and flowers. In the UVI system, which employs raft hydroponics, only calcium, potassium and iron are supplemented. The nutrients provided by the fish would normally be discharged and could contribute to pollution. Removal of nutrients by plants prolongs water use and minimizes discharge. Aquaponic systems require less water quality monitoring than individual recirculation systems for fish or hydroponic plant production. Aquaponic increases profit potential due to free nutrients for plants, lower water requirements, elimination of a separate biofilter, less water quality monitoring and shared costs for operation and infrastructure.

Keywords: Aquaponic, Aquaculture, Agriculture

1. Introduction

Aquaponic, also known as the integration of hydroponics with aquaculture, is gaining increased attention as a bio-integrated food production system. In aquaponics, nutrient-rich effluent from fish tanks is used to fertigate hydroponic production beds. This is good for the fish because plant roots and rhizobacteria remove nutrients from the water. These nutrients generated from fish manure, algae, and decomposing fish feed are contaminants that would otherwise build up to toxic levels in the fish tanks, but instead serve as liquid fertilizer to hydroponically grown plants. In turn, the hydroponic beds function as a biofilter stripping off ammonia, nitrates, nitrites, and phosphorus so the freshly cleansed water can then be recirculated back into the fish tanks. The nitrifying bacteria living in the gravel and plant roots play a critical role in nutrient cycling.

In hydroponics applications, the nutrient solution needs to be prepared measured, mixed, and then added to the reservoir. In aquaponic, there's no mixing fertilizer involved, making it a great way for beginners to cultivate plants. Only the fish needs to be fed. In closed recirculation systems with very little daily water exchange (less than 2%); dissolved nutrients accumulate in concentrations similar to those in hydroponic nutrient solutions. Dissolved nitrogen, in particular, can occur at very high levels in recirculation systems. Fish excrete waste nitrogen, in the form of ammonia, directly into the water through their gills. Bacteria convert ammonia to nitrite and then to nitrate Ammonia and nitrite are toxic to fish, but nitrate is relatively harmless and is the preferred form of nitrogen for growing higher plants such as fruiting vegetables.

Aquaponic systems offer several benefits. Dissolved waste nutrients are recovered by the plants, reducing discharge to the environment and extending water. Minimizing water exchange reduces the costs of operating aquaponic systems in arid climates and heated greenhouses where water or heated water is a significant expense. Having a secondary plant crop that receives most of its required nutrients at no cost improves a system's profit potential. The plants remove nutrients from the culture water and eliminate the need for separate and expensive biofilters. Aquaponic systems require substantially less water quality monitoring than separate hydroponic or recirculation aquaculture systems. Savings are also realized by sharing operational and

infrastructural costs such as pumps, reservoirs, heaters and alarm systems. In addition, the intensive, integrated production of fish and plants requires less land than ponds and gardens. Aquaponic systems do require a large capital investment, moderate energy inputs and skilled management. Niche markets may be required for profitability. A number of universities globally are currently exploring the science of aquaponics to advance this extreme cultivation technique (Dunning et al. 1998, Edwards, 2003, Diver 2006, Rakocy et al. 2004, 2006).

2. Aquaponic Systems

2.1. System Design

The design of aquaponic systems closely mirrors that of recirculation systems in general, with the addition of a hydroponic component and the possible elimination of a separate biofilter and devices (foam fractionators) for removing fine and dissolved solids. Fine solids and dissolved organic matter generally do not reach levels that require foam fractionation if aquaponic systems have the recommended design ratio. The essential elements of an aquaponic system are the fish-rearing tank, a settleable and suspended solids removal component, a biofilter, a hydroponic component, and a sump (Fig. 1).

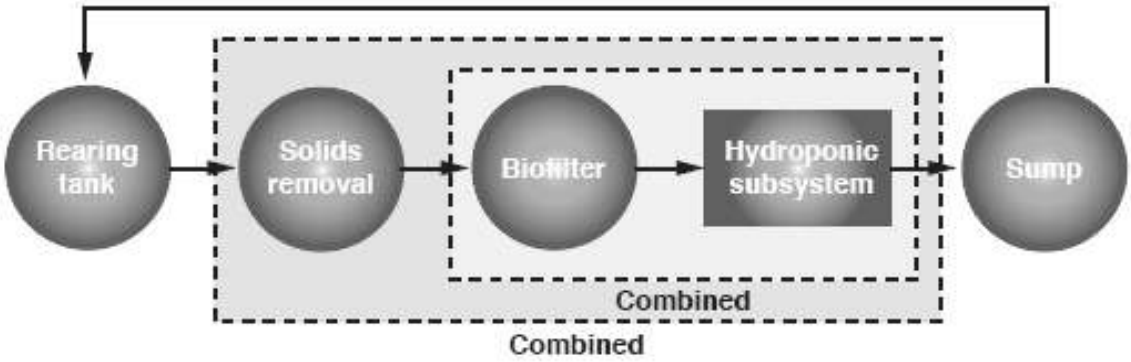

Figure 1: Optimum Arrangement of Aquaponic System Components (Rakocy et al. 2006).

Effluent from the fish-rearing tank is treated first to reduce organic matter in the form of settleable and suspended solids. Next, the culture water is treated to remove ammonia and nitrate in a biofilter. Then, water flows through the hydroponic unit where some dissolved nutrients are taken up by plants and additional ammonia and nitrite are removed by bacteria growing on the sides of the tank and the underside of the polystyrene sheets (i.e., fixed-film nitrification). Finally, water collects in a reservoir (sump) and is returned to the rearing tank. The location of the sump may vary. If elevated hydroponic troughs are used, the sump can be located after the biofilter and water would be pumped up to the troughs and returned by gravity to the fish-rearing tank. The system can be configured that a small side-stream flow may go to a hydroponic component after solids are removed, while most of the water passes through a biofilter and returns to the rearing tank.

The biofilter and hydroponic components can be combined by using plant support media such as gravel or sand that also functions as biofilter media. Raft hydroponics, which consists of floating sheets of polystyrene and net pots for plant support, can also provide sufficient biofiltration if the plant production area is large enough. Combining biofiltration with hydroponics is a desirable goal because eliminating the expense of a separate biofilter is one of the main advantages of aquaponic. An alternative design combines solids removal, biofiltration and hydroponics in one unit. The hydroponic support media (pea gravel or coarse sand) captures solids and provides surface area for fixedfilm nitrification, although with this design it is important not to overload the unit with suspended solids. As an example, Fig. 2 shows the commercial-scale aquaponic system that has been developed at the University of the Virgin Islands (UVI). It employs raft hydroponics (Rakocy et al. 2004, 2006).

2.2. Fish Production

Tilapia is the fish species most commonly cultured in aquaponic systems. Although some aquaponic systems have used channel catfish, *Clarias* spp., largemouth bass, crappies, rainbow trout, sturgeon pacu, common carp, koi carp, silver carp, grass carp, goldfish, Asian sea bass (barramundi) and Murray cod, most commercial systems are used to raise tilapia. Most freshwater species, which can tolerate crowding, will do well

in aquaponic systems (including ornamental fish). One species reported to perform poorly is hybrid striped bass. They cannot tolerate high levels of potassium, which is often supplemented to promote plant growth. To recover the high capital cost and operating expenses of aquaponic systems and earn a profit, both the fish rearing and the hydroponic vegetable components must be operated continuously near maximum production capacity. The maximum biomass of fish a system can support without restricting fish growth is called the critical standing crop. Operating a system near its critical standing crop uses space efficiently, maximizes production and reduces variation in the daily feed input to the system, an important factor in sizing the hydroponic component. There are three stocking methods that can maintain fish biomass near the critical standing crop: sequential rearing, stock splitting and multiple rearing units (Szyper 1989, Rakocy et al. 2006, Lorena et al. 2008).

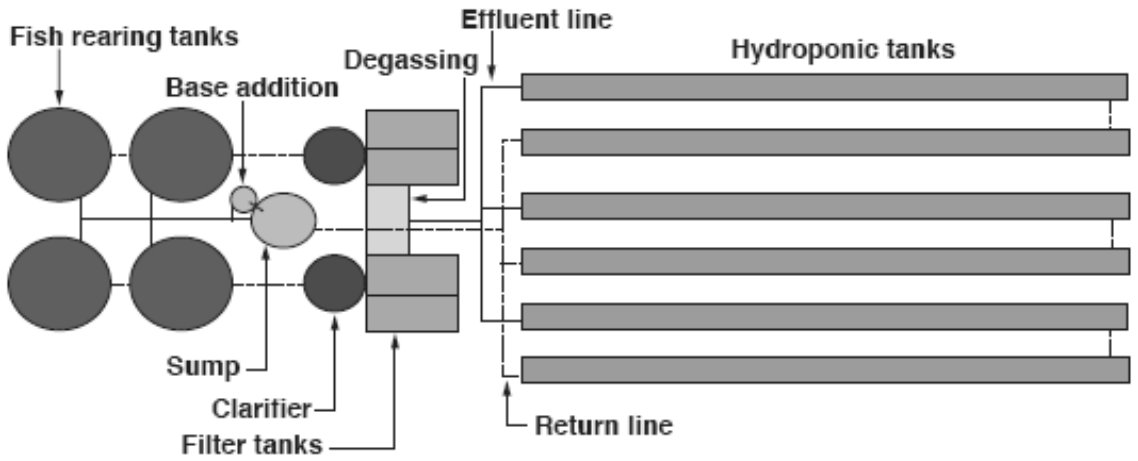

Figure 2. Layout of UVI Aquaponic System (Rakocy et al. 2006).

2.2.1. *Sequential Rearing*

Sequential rearing involves the culture of several age groups (multiple cohorts) of fish in the same rearing tank. When one age group reaches marketable size, it is selectively harvested with nets and a grading system, and an equal number of fingerlings are immediately restocked in the same tank. There are three problems with this system: 1) the periodic harvests stress the remaining fish and could trigger disease outbreaks; 2) stunted fish avoid capture and accumulate in the system, wasting space and feed; and 3) it is difficult to maintain accurate stock records over time, which leads to a high degree of management uncertainty and unpredictable harvests.

2.2.2. *Stock Splitting*

Stock splitting involves stocking very high densities of fingerlings and periodically splitting the population in half as the critical standing crop of the rearing tank is reached. This method avoids the carryover problem of stunted fish and improves stock inventory. However, the moves can be very stressful on the fish unless some sort of "swimway" is installed to connect all the rearing tanks. The fish can be herded into the swimway through a hatch in the wall of a rearing tank and manoeuvred into another rearing tank by movable screens. With swimways, dividing the populations in half involves some guesswork because the fish cannot be weighed or counted. An alternative method is to crowd the fish with screens and pump them to another tank with a fish pump.

2.2.3. *Multiple Rearing Units*

With multiple rearing units, the entire population is moved to larger rearing tanks when the critical stand-ing crop of the initial rearing tank is reached. The fish are either herded through a hatch between adjoining tanks or into "swimways" connecting distant tanks. Multiple rearing units usually come in modules of two to four tanks and are connected to a common filtration system. After the largest tank is harvested, all of the remaining groups of fish are moved to the next largest tank and the smallest tank is restocked with fingerlings. A variation of the multiple rearing unit concepts is the division of a long raceway into compartments with movable

screens. As the fish grow, their compartment is increased in size and moved closer to one end of the raceway where they will eventually be harvested. These should be cross-flow raceways, with influent water entering the raceway through a series of ports down one side of the raceway and effluent water leaving the raceway through a series of drains down the other side. This system ensures that water is uniformly high quality throughout the length of the raceway. Another variation is the use of several tanks of the same size. Each rearing tank contains a different age group of fish, but they are not moved during the production cycle. This system does not use space efficiently in the early stages of growth, but the fish are never disturbed and the labour involved in moving the fish is eliminated. A system of four multiple rearing tanks has been used successfully with tilapia in the UVI commercial scale aquaponic system (Fig 2). Production is staggered so one of the rearing tanks is harvested every 6 weeks. At harvest, the rearing tank is drained and all of the fish are removed. The rearing tank is then refilled with the same water and immediately restocked with fingerlings for a 24-week production cycle. Each circular rearing tank has a water volume of 7,800 litters and is heavily aerated with 22 air diffusers. The flow rate to all four tanks is 375 litters/minute, but the flow rate to individual tanks is apportioned so that tanks receive a higher flow rate as the fish grow. The average rearing tank retention time is 82 minutes. Nile tilapia are stocked at 77 fish/m3 and red tilapia are stocked at 154 fish/m3. Annual production has been 4.16 mt. for Nile tilapia and 4.78 mt for red tilapia (Tab. 1). However, production can be increased to 5 mt. with close observation of the *ad libitum* feeding response (Rakocy et al. 2006).

Tilapia	Harvest weight per tank (kg)	Harvest weight per unit volume (kg/m^3)	Initial Weight (g/fish)	Final Weight (g/fish)	Growth Rate (g/day)	Survival (%)	FCR
Nile	480	61.5	79.2	813.8	4.4	98.3	1.7
Red	551	70.7	58.8	512.5	2.7	89.9	1.8

Table 1: Average Production Values for Male Mono-Sex Nile and Red Tilapia in the UVI Aquaponic System.

The logistics of working with both fish and plants can be challenging. In the UVI system, one rearing tank is stocked every 6 weeks. Therefore, it takes 18 weeks to fully stock the system. If multiple units are used, fish may be stocked and harvested as frequently as once a week. Similarly, staggered crop production requires frequent seeding, transplanting, harvesting and marketing. Therefore, the goal of the design process is to reduce labour wherever possible and make operations as simple as possible. For example, purchasing four fish-rearing tanks adds extra expense. One larger tank could be purchased instead and partially harvested and partially restocked every 6 weeks. However, this operation requires additional labour, which is a recurring cost and makes management more complex. In the long run, having several smaller tanks in which the fish are not disturbed until harvest (hence, less mortality and better growth) will be more cost effective (Racoky et al. 2004, 2006).

2.3. Solids

Most of the fecal waste fish generate should be removed from the waste stream before it enters the hydroponic tanks. Other sources of particulate waste are uneaten feed and organisms (e.g., bacteria, fungi and algae) that grow in the system. If this organic matter accumulates in the system, it will depress dissolved oxygen (DO) levels as it decays and produce carbon dioxide and ammonia. If deep deposits of sludge form, they will decompose anaerobically (without oxygen) and produce methane and hydrogen sulphide, which are very toxic to fish. Suspended solids have special significance in aquaponic systems. Suspended solids entering the hydroponic component may accumulate on plant roots and create anaerobic zones that prevent nutrient uptake by active transport, a process that requires oxygen. However, some accumulation of solids may be beneficial. As solids are decomposed by microorganisms, inorganic nutrients essential to plant growth are released to the water, a process known as mineralization. Mineralization supplies several essential nutrients. Without sufficient solids for mineralization, more nutrient supplementation is required, which increases the operating expense and management complexity of the system. However, it may be possible to minimize or eliminate the need for nutrient supplementation if fish stocking and feeding rates are increased relative to plants. Another benefit of solids is that the microorganisms that decompose them are antagonistic to plant root pathogens and help maintain healthy root growth. Sand and gravel hydroponic substrates can remove solid waste from system water. Solids remain in the system to provide nutrients to plants through mineralization. With the high potential of sand and gravel media to clog, bed tillage or periodic media replacement may be required. The use of sand is becoming less common, but one popular aquaponic system uses small beds (250 cm by 125 cm) containing pea gravel

ranging from 0.31 to 0.63 cm in diameter. The hydroponic beds are flooded several times daily with system water and then allowed to drain completely, and the water returned to the rearing tank. During the draining phase, air is brought into the gravel. The high oxygen content of air (com- pared to water) speeds the decomposition of organic matter in the gravel. The beds are inoculated with red worms (*Eisenia foetida*), which improve bed aeration and assimilate organic matter (Hutchinson et al. 2004, Racoky et al. 2004, 2006).

2.3.1. *Solids Removal*

The most appropriate device for solids removal in a particular system depends primarily on the organic loading rate (daily feed input and feces production) and secondarily on the plant growing area. For example, if large numbers of fish (high organic loading) are raised relative to the plant growing area, a highly efficient solids removal device, such as a microscreen drum filter, is desirable. Microscreen drum filters capture fine organic particles, which are retained by the screen for only a few minutes before backwashing removes them from the system. In this system, the dissolved nutrients excreted directly by the fish or produced by mineralization of very fine particles and dissolved organic matter may be sufficient for the size of the plant growing area. If small amounts of fish (low organic loading) are raised relative to the plant growing area, then solids removal may be unnecessary, as more mineralization is needed to produce sufficient nutrients for the plants. However, un- stabilized solids (solids that have not undergone microbial decomposition) should not be allowed to accumulate on the tank bottom and form anaerobic zones.

A reciprocating pea gravel filter (subject to flood and drain cycles), in which incoming water is spread evenly over the entire bed surface, may be the most appropriate device in this situation because solids are evenly distributed in the gravel and exposed to high oxygen levels (21 percent in air as compared to 0.0005 to 0.0007 percent in fish culture water) on the drain cycle. This enhances microbial activity and increases the mineralization rate. With clarification as the sole method of solids removal, large quantities of solids would be discharged to the hydroponic component. Therefore, another treatment stage is needed to remove re-suspended and fine solids. In the UVI system, two rectangular tanks, each with a volume of 700 litres, are filled with orchard/bird netting and installed after each of the two clarifiers (Fig. 2). Effluent from each clarifier flows through a set of two filter tanks in series. Orchard netting is effective in removing fine solids. The filter tanks remove the remaining 50 percent of total particulate solids. The orchard netting is cleaned once or twice each week. Before cleaning, a small sump pump is used to carefully return the filter tank water to the rearing tanks without dislodging the solids. This process conserves water and nutrients. The netting is cleaned with a high-pressure water spray and the sludge is discharged to line holding ponds. The organic matter that accumulates on the orchard netting between cleanings forms a thick sludge.

Anaerobic conditions develop in the sludge, which leads to the formation of gases such as hydrogen sulphide, methane and nitrogen. Therefore, a degassing tank is used in the UVI system to receive the effluent from the filter tanks (Fig. 2). A number of air diffusers vent the gasses into the atmosphere before the culture water reaches the hydroponic plants. The degassing tank has an internal standpipe well that splits the water flow into three sets of hydroponic tanks. Solids discharged from aquaponic systems must be disposed of appropriately. There are several methods for effluent treatment and disposal. Effluent can be stored in aerated ponds and applied as relatively dilute sludge to land after the organic matter in it has stabilized. This method is advantageous in dry areas where sludge can be used to irrigate and fertilize field crops. The solid fraction of sludge can be separated from water and used with other waste products from the system (vegetable matter) to form compost. Urban facilities might have to discharge solid waste into sewer lines for treatment and disposal at the municipal wastewater treatment plant (Hutchinson et al. 2004, Racoky et al. 2004, 2006).

2.4. Biofiltration

A major concern in aquaponic systems is the removal of ammonia, a metabolic waste product excreted through the gills of fish. Ammonia will accumulate and reach toxic levels unless it is removed by the process of nitrification (referred to more generally as biofiltration), in which ammonia is oxidized first to nitrite, which is toxic, and then to nitrate, which is relatively non-toxic. Two groups of naturally occurring bacteria (*Nitrosomonas* and *Nitrobacter*) mediate this two-step process (Fig 3) (Cacchione 2007). Nitrifying bacteria grow as a film (referred to as biofilm) on the surface of inert material or they adhere to organic particles. Biofilters contain media with large surface areas for the growth of nitrifying bacteria. Aquaponic systems have used biofilters with sand, gravel, shells or various plastic media as substrate. Biofilters perform optimally at a temperature range of 25 to 30 °C, a pH range of 7.0 to 9.0, saturated DO, low BOD (<20 mg/liter) and total alkalinity of 100 mg/liter or more. Nitrification is an acid-producing process. Therefore, an alkaline base must be added frequently, depending on feeding rate, to maintain relatively stable pH values. Some method of removing dead biofilm is necessary to prevent media clogging, short circuiting of water flow, decreasing DO values and declining biofilter performance (Hutchinson et al. 2004).

If a separate biofilter is required or if a combined biofilter (biofiltration and hydroponic substrate) is used, the standard equations used to size biofilters may not apply to aquaponic systems, as additional surface area is provided by plant roots and a considerable amount of ammonia is taken up by plants. However, the contribution of various hydroponic subsystem designs and plant species to water treatment in aquaponic systems has not been studied. Therefore, aquaponic system biofilters should be sized fairly close to the recommendations for recirculation systems. Nitrification efficiency is affected by pH. The optimum pH range for nitrification is 7.0 to 9.0, although most studies indicate that nitrification efficiency is greater at the higher end of this range (high 8s). Recommended pH ranges for hydroponic systems are between 5.5 and 6.5 and for aquaculture systems are between 6.5 and 8.5 (Tyson et al. 2004). The pH of a solution affects the solubility of nutrients, especially trace metals. Essential nutrients such as iron, manganese, copper, zinc and boron are less available to plants at a pH higher than 7.0, while the solubility of phosphorus, calcium, magnesium and molybdenum sharply decreases at a pH lower than 6.0. Compromise between nitrification and nutrient availability is reached in aquaponic systems by maintaining pH close to 7.0. Nitrification is most efficient when water is saturated with DO. The UVI commercial-scale system maintains DO levels near 80 percent saturation (6 to 7 mg/L) by aerating the hydroponic tanks with numerous small air diffusers (one every 4 feet) distributed along the long axis of the tanks. Reciprocating (ebb and flow) gravel systems expose nitrifying bacteria to high atmospheric oxygen levels during the dewatering phase. The thin film of water that flows through NFT (nutrient film technique) channels absorbs oxygen by diffusion, but dense plant roots and associated organic matter can block water flow and create anaerobic zones, which precludes the growth of nitrifying bacteria and further necessitates the installation of a separate biofilter. Ideally, aquaponic systems should be designed so that the hydroponic subsystem also serves as the biofilter, which eliminates the capital cost and operational expense of a separate biofilter. Granular hydroponic media such as gravel, sand and perlite provide sufficient substrate for nitrifying bacteria and generally serve as the sole biofilter in some aquaponic systems, although the media has a tendency to clog. If serious clogging occurs from organic matter overloading, gravel and sand filters can actually produce ammonia as organic matter decays, rather than remove it. If this occurs, the gravel or sand must be washed and the system design must be modified by installing a solids removal device before the media, or else the organic loading rate must be decreased by stocking fewer fish and reducing feeding rates.

Raft hydroponics, which consists of channels (with 30 cm of water depth) covered by floating sheets of polystyrene for plant support, also provides sufficient nitrification if solids are removed from the flow before it reaches the hydroponic component. The waste treatment capacity of raft hydroponics is equivalent to a feeding ratio of 180 g of fish feed/m2 of plant growing area/day. This is equivalent to about 4.5 kg of feed for each 250 cm x 125 cm sheet of polystyrene foam. After an initial acclimation period of 1 month, it is not necessary to monitor ammonia and nitrite values in the UVI raft system A significant amount of nitrification occurs on the undersides of the polystyrene sheets, especially in the areas exposed to strong currents above air diffusers where the biofilm is noticeably thicker (Hutchinson et al. 2004, Racoky et al. 2004, 2006).

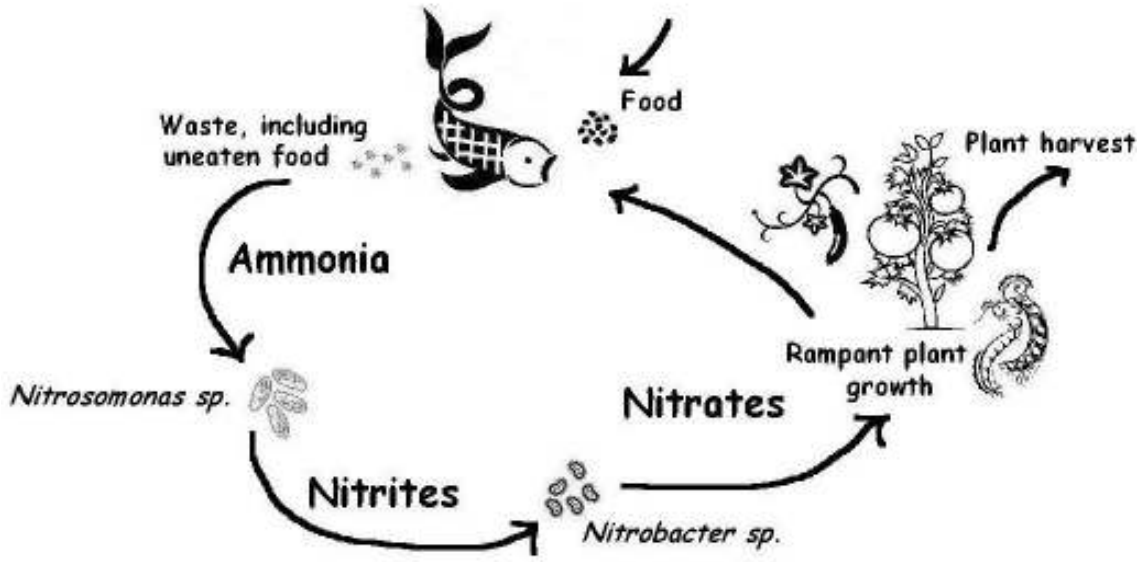

Figure 3: The Nitrogen Cycle in Aquaponic Systems (Cacchione 2007).

2.5. Hydroponic Subsystems

A number of hydroponic subsystems have been used in aquaponic. Gravel hydroponic subsystems are common in small operations. To ensure adequate aeration of plant roots, gravel beds have been operated in a reciprocating (ebb and flow) mode, where the beds are alternately flooded and drained, or in a non flooded state, where culture water is applied continuously to the base of the individual plants through small diameter plastic tubing. Depending on its composition, gravel can provide some nutrients for plant growth (e.g., calcium is slowly released as the gravel reacts with acid produced during nitrification). One popular gravel-based aquaponic system uses pea gravel in small beds that are irrigated through a distribution system of PVC pipes over the gravel surface. Numerous small holes in the pipes distribute culture water on the flood cycle. The beds are allowed to drain completely between flood cycles. Solids are not removed from the culture water and organic matter accumulates, but the beds are tilled between planting cycles so that some organic matter can be dislodged and discharged. Sand has been used as hydroponic media in aquaponic systems and is an excellent substrate for plant growth. In an experimental system, sand beds (7.5 m long by 1.5 m wide by 15 cm deep) were constructed on slightly sloped ground covered by polyethylene sheets adjacent to in-ground rearing tanks, with the tank floors sloping to one side. A pump in the deep end of the rearing tank was activated for 30 minutes five times daily to furrow irrigate the adjacent sand bed. The culture water percolated through the sand and returned to the rearing tank. A coarse grade of sand is needed to reduce the potential for clogging over time and some solids should be removed before irrigation. Perlite is another media that has been used in aquaponic systems. Perlite is placed in shallow aluminium trays (7.5 cm deep) with a baked enamel finish. The trays vary from 20 cm to 10 cm wide and can be fabricated to any length; with 50 cm the maximum recommended length. At intervals of 50 cm, adjoining trays should be separated by 7.5 cm or more in elevation so that water drops to the lower tray and becomes re-aerated. A slope of 2.5 cm in 30 cm is needed for water flow. A small trickle of water enters at the top of the tray, flows through the perlite and keeps it moist, and discharges into a trough at the lower end. Solids must be removed from the water before it enters the perlite tray. Full solids loading will clog the perlite, form short-circuiting channels, create anaerobic zones and lead to non-uniform plant growth. Shallow perlite trays provide minimal area for root growth and are better for smaller plants such as lettuce and herbs.

A floating or raft hydroponic subsystem is ideal for the cultivation of leafy green and other types of vegetables. The UVI system uses three sets of two raft hydroponic tanks that are 30 m long by 125 cm wide by 4 m deep and contain 3 m of water. The channels are lined with low-density polyethylene liners (20 mil thick) and covered by expanded polystyrene sheets (rafts) that are 250 cm long by 125 cm wide by 3.8 cm thick. Net pots are placed in holes in the raft and just touch the water surface. Two-inch net pots are generally used for leafy green plants, while 7.5 cm net pots are used for larger plants such as tomatoes or okra. Holes of the same size are cut into the polystyrene sheet. A lip at the top of the net pot secures it and keeps it from falling through the hole into the water. Seedlings are nursed in a greenhouse and then placed into net pots. Their roots grow into the culture water while their canopy grows above the raft surface. The system provides maximum exposure of roots to the culture water and avoids clogging. The sheets shield the water from direct sunlight and maintain lower than ambient water temperature, which is a beneficial feature in tropical systems. A disruption in pumping does not affect the plant's water supply as in gravel, sand and NFT subsystems. The sheets are easily moved along the channel to a harvesting point where they can be lifted out of the water and placed on supports at an elevation that is comfortable for workers (Alka et al. 2000, Racoky et al. 2006).

2.6. Sump

Water flows by gravity from gravel, sand and raft hydroponic subsystems to a sump, which is the lowest point in the system. The sump contains a pump or pump inlet that returns the treated culture water to the rearing tanks. There should be only one pump to circulate water in an aquaponic system. The sump should be the only tank in the system where the water level decreases as a result of overall water loss from evaporation, transpiration, sludge removal and splashing. The sump is a good location for the addition of base to the system. Soluble base such as potassium hydroxide causes high and toxic pH levels in the sump. However, as water is pumped into the rearing tank, it is diluted and pH decreases to acceptable levels (Hutchinson et al. 2004, Racoky et al. 2006).

2.7. Construction Materials

Many materials can be used to construct aquaponic systems. Budget limitations often lead to the selection of inexpensive and questionable materials such as vinyl-lined, steel walled swimming pools. Fibreglass is the best construction material for rearing tanks, sumps and filter tanks. Fibreglass tanks are sturdy, durable, non-toxic, movable and easy to plumb. Polyethylene tanks are also very popular for fish rearing and gravel hydroponics because of their low cost. NFT troughs made from extruded polyethylene are specifically designed

to prevent the pudding and water stagnation that lead to root death and are preferable to makeshift structures such as PVC pipes. Plastic troughs are commercially available for floating hydroponic subsystems, but they are expensive. A good alternative is the 20-mil polyethylene liners that are placed inside concrete block or poured-concrete side walls. They are easy to install, relatively inexpensive and durable, with an expected life of 12 to 15 years. A soil floor covered with fine sand will prevent sharp objects from puncturing the liners. Lined hydroponic tanks can be constructed to very large sizes hundreds of feet long and up to 9 m wide (Racoky et al. 2004, 2006).

2.8. Component Ratios

Aquaponic systems are generally designed to meet the size requirements for solids removal (for those systems requiring solids removal) and biofiltration (if a separate biofilter is used) for the quantity of fish being raised. After the size requirements are calculated, it is prudent to add excess capacity as a safety margin. However, if a separate biofilter is used, the hydroponic component is the safety factor because a significant amount of ammonia uptake and nitrification will occur regardless of hydroponic technique.

The optimum ratio of daily fish feed input to plant growing area will maximize plant production while maintaining relatively stable levels of dissolved nutrients. A volume ratio of 30 litter of fish-rearing tank to 220 litter of pea gravel hydroponic media (0.31 cm to 0.63 cm in diameter) is recommended for reciprocating (flood and drain) gravel aquaponic systems. This ratio requires that tilapia be raised to a final density of 250 g/4 l and fed appropriately. With the recommended ratio, no solids are removed from the system. The hydroponic beds should be cultivated (stirred up) between crops and inoculated with red worms to help break down and assimilate the organic matter. With this system, nutrient supplementation may not be necessary.

As a general guide for raft aquaponics, a ratio in the range of 60 to 100 g of fish feed/m^2 of plant growing area per day should be used. Ratios within this range have been used successfully in the UVI system for the production of tilapia, lettuce, basil and several other plants. In the UVI system all solids are removed, with a residence time of <1 day for settleable solids (>100 micrometers) removed by a clarifier, and 3 to 7 days for suspended solids removed by an orchard netting filter. The system uses rainwater and requires supplementation for potassium, calcium and iron (Racoky et al. 2004, 2006).

2.9. Plant Growth Requirements

For maximum growth, plants in aquaponic systems require 16 essential nutrients. These are listed below in the order of their concentrations in plant tissue, with carbon and oxygen being the highest. The essential elements are arbitrarily divided into macronutrients, those required in relatively large quantities, and micronutrients, those required in considerably smaller amounts. Three of the macronutrients carbon (C), oxygen (O) and hydrogen (H) are supplied by water (H_2O) and carbon dioxide gas (CO_2). The remaining nutrients are absorbed from the culture water. Other macronutrients include nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P) and sulphur (S). The seven micronutrients include chlorine (Cl), iron (Fe), manganese (Mn), and boron (B), zinc (Zn), copper (Cu) and molybdenum (Mo). These nutrients must be balanced for optimum plant growth. High levels of one nutrient can influence the bioavailability of others. For example, excessive amounts of potassium may interfere with the uptake of magnesium or calcium, while excessive amounts of either of the latter nutrients may interfere with the uptake of the other two nutrients. Water temperature is far more important than air temperature for hydroponic plant production. The best water temperature for most hydroponic crops is about 24 °C. However, water temperature can go as low as the mid-60s for most common garden crops and slightly lower for winter crops such as cabbage, brussel sprouts and broccoli (Alka et al. 2000, Racoky et al. 2004, 2006).

2.10. Vegetable Selection

Many types of vegetables have been grown in aquaponic systems. However, the goal is to culture a vegetable that will generate the highest level of income per unit area per unit time. With this criterion, culinary herbs are the best choice. They grow very rapidly and command high market prices. The income from herbs such as basil, cilantro, chives, parsley, portulaca and mint is much higher than that from fruiting crops such as tomatoes, cucumbers, eggplant and okra. For example, in experiments in UVI's commercial scale system, basil production was 5,000 kg annually at a value of $110,000, compared to okra production of 2,900 kg annually at a value of $ 6,400. Fruiting crops also require longer culture periods (90 days or more) and have more pest problems and diseases. Lettuce is another good crop for aquaponic systems because it can be produced in a short period (3 to 4 weeks in the system) and, as a consequence, has relatively few pest problems. Unlike fruiting crops, a large portion of the harvested biomass is edible. Other suitable crops are Swiss chard, pak choi, Chinese cabbage, collard and watercress. The cultivation of flowers has potential in aquaponic systems. Good results

have been obtained with marigold and zinnia in UVI's aquaponic system. Traditional medicinal plants and plants used for the extraction of modern pharmaceuticals have not been cultivated in aquaponic systems, but there may be potential for growing some of these plants. All plant production has to be coupled to the producer's ability to market the final product (Rakocy et al. 2006). In Canada, greenhouse tomato and cucumber production in aquaponic system in 2004/2005 reached 20.7 kg/plant/year and 33.4 kg/plant/year respectively exceeding average yields of these crops in greenhouse sector in Alberta for the first time. The average yield of basil increased in from 8.7 kg/m^2 of greenhouse area to 11.9 kg/m^2 in 2005 compared to 2005 (Savidow 2005).

2.11. Pest and Disease Control

Pesticides should not be used to control insects on aquaponic plant crops. Even pesticides that are registered would pose a threat to fish and would not be permitted in a fish culture system. Similarly, therapeutants for treating fish parasites and diseases should not be used because vegetables may absorb and concentrate them. The common practice of adding salt to treat fish diseases or reduce nitrite toxicity is detrimental to plant crops. Nonchemical methods of integrated pest management must be used. These include biological control (resistant cultivars, predators, pathogens, antagonistic organisms), physical barriers, traps, and manipulation of the physical environment. There are more opportunities to use biological control methods in enclosed greenhouse environments than in exterior installations. Parasitic wasps and ladybugs can be used to control white flies and aphids. In UVI's systems, caterpillars are effectively controlled by twice weekly spraying with *Bacillus thuringiensis*, a bacterial pathogen that is specific to caterpillars. Fungal root pathogens (*Pythium*), which are encountered in summer at UVI and reduce production, dissipate in winter in response to lower water temperature. The prohibition on the use of pesticides makes crop production in aquaponic systems more difficult. However, this restriction ensures that crops from aquaponic systems will be raised in an environmentally sound manner and be free of pesticide residues. A major advantage of aquaponic systems is that crops are less susceptible to attack from soil borne diseases. Plants grown in aquaponic systems may be more resistant to diseases that affect plants grown in standard hydroponics. This resistance may be due to the presence of some organic matter in the culture water that creates a stable growing environment with a wide diversity of microorganisms, some of which may be antagonistic to plant root pathogens (Racoky et 2006).

2.12. Economics

The economics of aquaponic systems depends on specific site conditions and markets. It would be inaccurate to make sweeping generalizations because material costs, construction costs, operating costs and market prices vary by location. The UVI system is capable of producing approximately 5,000 kg of tilapia and 630 cases of lettuce or 5,000 kg of basil annually based on studies in the Virgin Islands. Enterprise budgets for tilapia production combined with either lettuce or basil have been developed. The U.S. Virgin Islands represent a small niche market with very high prices for fresh tilapia, lettuce and basil, as more than 95 percent of vegetable supplies and nearly 80 percent of fish supplies are imported. The budgets were prepared to show revenues, costs and profits from six production units. A commercial enterprise consisting of six production units is recommended because one fish-rearing tank (out of 24) could be harvested weekly, thereby providing a continuous supply of fish for market development (Rakocy et al. 2006). In Canada, water use efficiency in mixed basil/tilapia operation was 394.3 liters per $100 of output, which is for 65.7% more efficient than in the best hydroponics system (600 liters per $100 of output) (Savidow, 2005).

3. Conclusion

Aquaponic systems retain water for long periods of time, require less monitoring, and provide free nutrients. Aquaponic system encounters fewer pest and disease problems than traditional hydroponic systems due to the amount of organic material in the water. In contrast to the sought after sterile environment of hydroponics, the aquaponic system thrives on a diversity of bacteria – bacteria that can be antagonistic to pathogens and bacteria that boost plants' immune systems. In fact, the aquaponic system has operated for several years without changing the water. Unlike traditional hydroponic solutions that require a complete nutrient mix, the UVI system's tilapia provides adequate amounts of 10 of the 13 nutrients essential to plants. Only potassium, calcium and iron must be supplemented. And to maintain the proper pH level the operators add either calcium hydroxide or potassium hydroxide, which provide the missing potassium and calcium nutrients. Iron is added separately Normal recirculation aquaculture systems discharge an estimated five to ten percent of system water daily due to excess nitrate accumulation. UVI's system uses nitrates and other nutrients for plant growth, so it discharges less than one percent of system water daily, alleviating the potential for pollution related to water

discharge. Aquaponic is the only system in the world that has a biofilter that makes money (Sherrill 2008). New technologies take time to be accepted and implemented. However, global water shortages have created a more urgent interest in aquaponic, one of the most water-efficient systems in the world.

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Treatment Trials Of Parasites Of Sea Bass (Dicentrarchus labrax) and Sea Bream (Sparus Aurata) in Turkey

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Abstract: With over 8300 km of coastline and 25 million square hectares of useably sea, Turkey has particularly bright future in aquaculture. Interest has centred on two major species sea bream, sea bass, Those are most favourable have been the Aegean and Western Mediterranean coasts. Sea bass and sea bream pruducts have reached to 75,000 tons in Turkey. The gradually increase of this production of fish resulted in serious pathological problems in all countries where intensive aquaculture is practiced. Thus, focus has been placed on fish diseases in these enterprises and their economic and ecological impact. Especially, parasitical diseases have become increasingly visible during the latest decades in connection with the development of aquacultural industries troughout the world. In this study, various studies were carried out in different time about parasites of cultured gilthead sea bream (*Sparus aurata* L.) and sea bass (*Dicentrarchus labrax* L.) in Turkey and their treatment were investigated. Different species such as *Trichodina* spp., *Costia* spp., *Amyloodinium ocellatum*, *Furnestinia echeneis, Microcotyle chrysophrii, Diplectanum aequans, Caligus minimus, Lernanthropus kroyeri* and *Ceratothoa oestroides* were reported on the gills of sea bream and sea bass in these studies. In this review, the parasites observed on sea bass and sea bream, and their epizootiology, clinical signs, pathogenicity of the parasites and their treatment were given, separately.

Keywords: Sea bass, sea bream, parasite, diagnosis, control, treatment

Introduction

Turkey is a country of which three sides have been surrounded by the seas. Its coastline is 8333 km and 25 million square hectares of useable sea. There is a great aquaculture potential in Turkey. Therefore, Turkey is a most important aquaculture producer in the Mediterranean. The Gilthead sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) are the main cultured fish specieses in the Mediterranean area. Recently, it is shown in Table.1 that sea bass and sea bream pruducts have reached to 80,940 tons in Turkey (TUIK, 2009).

The intensification of aquaculture and globalization of the seafood trade have led to remarkable development in the aqauculture industry. The industry has been plagued with disease problems caused by viral, bacterial, fungal and parasitic pathogens. In recent years, disease outbreaks are becoming more frequent in he aquaculture and associated morbidity and mortality have caused substantial economic losses. Health problems have two fiscal consequences on the industry: loss of productivity due to animal mortality and morbidity, and loss of trade due to food safety issues. Thus, disease is undoubtedly one of the major constraints to production, profitability and sustainability of the aquaculture industry.

Vibriosis, pasteurellosis and tenacibaculosis are serious threatening bacterial infections of sea bass and sea bream. The most important parasites for cultured sea bass and/or sea bream are *Trichodina* spp., *Ichthyobodo* spp., *Amyloodinium ocellatum*, *Furnestinia echeneis, Microcotyle chrysophrii, Diplectanum aequans, Caligus*

minimus, Lernanthropus kroyeri and *Meinertia oestroides*. This research presents the individual parasies types producing probles in sea bream and sea bass. Each section is presented with 1. aetiyology, the parasitic organism responsible for the disease, 2. epizootiology, the transmission of the diseases and life cycle of the parasite, 3. pathogenicity, how the parasite produces diseases in the fish, 4. symptoms, clinical signs of the diseases, 5. diagnose, how the infection can be identificated, 6. treatment, how the infection can be controlled.

Type of fish	**2004**	**2005**	**2006**	**2007**	**2008**
Inland water					
Trout	43 432	48 033	56 026	58 433	65 928
Carp	683	571	668	600	629
Marine water					
Trout	1 650	1 249	1 633	2 740	2 721
Sea bream	20 435	27 634	28 463	33 500	31 670
Sea bass	26 297	37 290	38 408	41 900	49 270
Mussel	1 513	1 500	1 545	1 100	1 772
Prawn	-	-	-	-	-
Other	-	2 000	2 200	1 600	196
Total	**94 010**	**118 277**	**128 943**	**139 873**	**152 186**

Table.1. Aquaculture production of Turkey (TUIK, 2009)

1. *Trichodina* Spp.

Trichodinid protozoans are cosmopolitan aquatic parasites, common on gills and skin of fish in both the freshwater and marine environments. Trichodinids are peritrich ciliates (order Mobilina, family Trichodinidae) that glide on the surface of the fish. They normally feed on bacteria and mucus and are often considered as ectocommensal nuisances rather than true parasites.

1.1. Aethiology: *Trichodina* spp. are a group of dorsal-ventrally flattened oval ciliated protozoan parasites of marine and freshwater species of finfish. The diameter of the ciliate is mostly about 50 to 100 µm. A readily distinguishable characteristic of these organisms is the presence of a prominent denticular or "tooth-like" internal cytoskeleton ring. There are four additional genera of trichodinids (*Trichodina, Trichodinella, Paratrichodina, Tripartiellea, Hemitrichodina*) which are similar in description and life cycle.

1.2. Epizootiology: Trichodinids reproduce by simple binary fission under conditions that are usually optimal for the host fish. Most species are host specific and presumably spread from fish to fish by incidental contact between susceptible host fish, as well as through contact with the organism in the water column. Transmission is direct, from fish to fish. Within 8 to 10 h's of the host's death, trichodinids leave the host but, depending on the temperature, may survive for several days in the water (Lom, 1995).

1.3. Patogenicity: While small numbers of these organisms on a fish generally do not cause much of a health problem, large numbers can cause moderate to serious pathology and ultimately, death of fish. Small fish and fry are especially susceptible, and mortality can occur quickly if undiagnosed (Toksen, 2004). *Trichodina* spp. cause irritation by feeding on the epithelial layer of cells covering the surface of the gills and skin of the fish. This can result in hyperplasia (proliferation) of the epithelial cells, clubbing of the gill filaments and even fussion of the gill filaments. This affects the ability of the gills to maintain optimal respiratory and excretory activities, and the ability of the skin to maintain proper homeostatic osmoregulatory properties. Massive infestations of these parasites on fish can also directly result in superficial to deep ulcerative skin lesions which then allow for secondary bacterial and fungal infections to develop at the affected site (Lom 1995). *Trichodina spp* can cause extensive fish mortality in an aquaculture system. The ability of this parasite to quickly multiply under certain environmental conditions or when the fish are stressed by other factors makes early detection of this parasite a high priority in an aquaculture facility. Once diagnosed, an appropriate treatment or management response is essential to prevent rapid loss of fish stocks (Samartin-Duran et al., 1991).

1.4. Symptoms: Heavily infected fish may have a greyish-blue coat, which is formed by excessively secreted mucus and peeled epithelia. The fins may be frayed (Lom, 1995).

1.5. Diagnose : The following measurements and counts are of primary diagnostic value; diameter of the adhesiv disc, diameter of the denticulate ring, number and size of denticles. The diameter of the horseshape macronucleus and position of the micronucleus in relation to the macronucleus is also of diagnostic value.

1.6. Treatment: There are several methods by which *Trichodina* spp. may be controlled in the aquaculture of foodfish. These include chemical treatments, freshwater baths, and flushing. UV is generally considered ineffective due to the high dosage rates required to kill the organism.

A formalin bath of 170-250 ppm for 60 minutes is applied effectively (Toksen, 2004). However, experience has shown that a single formalin bath may not completely remove all of the parasites from fish, especially marine fish, and long term or periodic treatments may be needed to keep this parasite under control. Therefore a continuous bath of 25 ppm formalin is also approved for use on foodfish.

Another common method for controlling *Trichodina* spp. on marine finfish is to utilize periodic fresh water dips. Though stressful on fish due to increased handling and the osmotic stress, this method can be very effective in reducing the overall number of parasites on fish. This is an effective method for treating individual fish such as broodstock, but may not be a viable option in a production facility due to the logistics associated with handling and treating large numbers of fish (Brown and Markus, 1998).

Flushing of production systems (i.e., the removal of system water prior to treatment) is another means of reducing infestation levels of *Trichodina* spp. This method may be effective by physically removing any dislodged parasites in the water column from the system.

2. *Ichthyobodo* Spp.

Ichthyobodo necator (former *Costia necator*) is a common parasite that infects a wide range of freshwater fish species. The parasite is found on the skin and gills of fish, most commonly attaching to the edges of the gills. Infected fish have a disease called ichthyobodosis. The first observation of *Ichthyobodo* spp. infection in cultured seabream in Turkey carried out by Toksen. Fifty to sixty percent of mortality was observed in a farm of gilthead seabream (*Sparus aurata L.*) (1g) which were trasferred from Yumurtalık, South-East Mediterranean Sea to Kokar Bay, Western Coast of Aegean Sea (Toksen, 2000).

2.1. Aetiyoloy: Free swimming form is ovoid to spherical and measures 5-18 µm. It has two flagella, one of them longer than the other. It uses flagella for motility and to attach to the host fish (Lom, 1995; Toksen, 2000).

2.2. Epizootiology: Both free swimming and parasitic stages multiply by longitudinal binary fission. The parasit is not host spesific. Malnourished and young fish are more secerely affected then healthy adults (Robertson, 1985; Toksen, 2000).

2.3. Pathogenicitiy: These parasites do not cause distinctive lesions on the fish but do block the flow of oxygen when heavily loaded on the gills. As with most protozoa, environmental degradation and crowded conditions cause them to become more damaging. However, prevention measures such as reducing stocking densities and lowering feeding rates may make fish production unprofitable. But stocking and feeding rates should be kept reasonable. Contact a qualified aquaculture or fisheries scientist for advice on proper stocking densities for the fish species you are raising skin and fins. The base of the stalk attaches to a hard, calcified surface such as scales and fin rays or spines. *Ichthyobodo* occurs on the skin and gills (Lom, 1995).

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2.4. Symptoms: Ichthyobodosis causes damage to the gills and skin of fish. Infected fish can lose condition, become emaciated and be very lethargic. These symptoms can be seen in fish with only a light infection. The attachment and feeding of *Ichthyobodo necator* causes severe damage to skin and gill cells. Hyperplasia can occur within the gills, reducing respiratory efficiency. The gills may also swell with fluid, and fish often die as they are unable to control the movement of water in and out of their bodies. The parasite also causes irritation and infected fish produce excess mucus (Lom, 1995).

2.5. Treatments: Formalin is used against to *Ichthyobodo* spp. effectiveliy (Toksen, 2000). Bithionol (25 ppm for 3 h or 2 consecutive days) is very effective in eliminating the paraiste from rainbow trout (Tojo et al., 1994).

3. Amyloodinium Ocellatum

3.1. *Amyloodinium ocellatum* is an important and the most common dinoflagellate that infects the gills and skin of both marine and brackish water fishes (Lauckner, 1984). A similar organism, *Oodinium* spp., is found in freshwater fish. The disease caused by these organisms has been referred to as "velvet," "rust" and "gold dust disease" because of the shiny sheen the parasite imparts to heavily infected fish.

3.2. *Amyloodinium* spp. can cause great losses of aquarium fish or fish held in high-density culture systems and has caused serious problems in public aquaria, aquaculture facilities and home aquaria (Montgomery-Brock et al, 2001). If allowed to become established in high-density recirculating systems, it can be difficult to control. For example, cultured red drum have been shown to be extremely susceptible to this infection. *Amyloodinium* infects a wide variety of fish and has been reported to occur in more than 100 species in North America. In Turkey, first *Amyloodinium* enfestation was observed on cultured 15-20 g of sea bass in pond with 100% mortality (Cagirgan and Toksen, 1996).

3.3. Aetiyology: The trophont is pear-shaped to ovoid and up to 350 um long. An osmophilic ring encircle the basal region, and an attachment plate bearing numerous filiform rhizoids exista through the break in the theca. Divisions withina common cyst wall produce up to 256 dinosporea. Dinospores are 8-13.5 µm long by 10-12.5 µm wide (Lom, 1995).

3.4. Symptoms: Often, the first indication of an amyloodinium infection is dead or dying fish. Amyloodinium should always be considered as a possible cause of mortality when a disease outbreak involving marine or brackish water fish occurs. Behavioral signs may include a decrease in or complete lack of feeding activity, flashing (rubbing against objects in the tank or on the bottom substrate) and coughing (backflushing water across the gills). The skin of heavily infected fish may have a dull gold or brown sheen. Closer examination of the skin may reveal scale loss and patchy accumulation of mucus (Reed and Francis-Floyd, 1994). Diseased fish shows sluggishness and asphyxia symptoms with darkened pigmentation of the skin and V shaped loss by the reason of necrosis of tail. The gill is pale and haemorrhagic in infected fish. Extensive necrotic areas are observed in macroscopycally on the gill (Cagirgan and Toksen, 1996).

3.5. Epizootiology**:** Amyloodiniosis is limited to warm waters. The optimal temperature for tomont division and sporulation ranges from 23-27 ºC. Completion of tomont division is limited to 16-30 ºC (Paperna, 1984). Infections do not occur at less than 17 ºC. The minimum effective salinity varied from 1 to 20 ppt, depending upon the isolate (Paperna, 1984). Tomonts or infective dinospores can be introduced directly with incoming seawater, becoming a source of infection for fish in the system. Obviously, introducing fish infected with trophonts into a culture system will serve as a source of infection as soon as the throphonts detach and begin the reproductive process.

3.6. Diagnosis: The only sure way to diagnose an amyloodinium infestation is by identification of the parasite in infected tissue. Preparations of gill, fin and skin (scrapings of mucus and scales) can be examined with a light microscope. The trophont attaches to the tissue of the fish by means of an attachment plate, which may be visible with a light microscope. Trophonts are removed brushing the fish gently, followed by microscopic examination of the sediment, which contains detached parasites (Noga, 2000).

3.7. Treatment: The most commonly applied treatment for control of amyloodinium is copper. In marine recirculating systems, which do not contain invertebrates, copper is added to the system gradually over a period of several days until the free copper ion (Cu^{2+}) is at a concentration of 0.12-0.15 mg/l; this level is then maintained for up to 3 weeks (Cardeilhac and Whitaker, 1988). This standard procedure, observed for many years, is moderately effective but requires repeated testing of the copper concentration to ensure that amyloodinium is being controlled without killing fish. This treatment will kill all invertebrates present in the system and certain groups of fish.

Freshwater dips are effective in killing free-swimming stages of amyloodinium; however, since encysted stages are protected, a single freshwater dip is not an effective treatment. Decreasing the salinity in a system has been suggested as a method for controlling amyloodinium epizootics, but because the organism flourishes in brackish water, the effectiveness of this strategy is doubtful.

Given the lack of a safe, effective therapeutant for the control of amyloodinium, avoidance is an extremely important means of preventing outbreaks of this parasite. All incoming fish should be quarantined for a minimum of 3 weeks before being introduced into an existing system. Do not feed live or frozen food items

that may be infected with amyloodinium. Do not introduce water into a system that may be contaminated with amyloodinium dinospores without using effective filtration or sanitation procedures (Reed and Francis-Floyd, 1994).

4. Furnestinia Echeneis

The monogenean was found on the gill of sea bream *Chrysophrys aurata* by Wagener in 1857 and formerly named as *Dactylogyrus echeneis* Euzet ve Audouin (1959) renamed as *F. echeneis* (Oliver, 1969).

4.1. Aetiyology: *F. echeneis* is 560-890 μm in length, 140-230 μm in width in ovary level. Parasite has a haptor 190-270 μm in diameter and lamellar shaped squamodisc 180-220 μm in diameter in haptor.

4.2. Epizootiology: Infestation is successfully transmitted to naïve gilthead seabream by egg exposure. Parasite occure in all seasons of year but the number of parasite increase in spring (Revarsat et al., 1992). *Furnestia echeneis* caused high mortality in *Siganus auratus* (Paperna, 1978).

4.3. Symptoms: Infested fish showing severe signs of asphyxia due to necrosis on the gill and mass mucuos secretion. *Myxobacterium* spp. is found in necrotic lessions on the gill (Paperna et al., 1977).

4.4. Pathogenicity: No pathological signs are referred to *F. echeneis* infections, also with 50 specimens/gill arch infection intensity (Quaglio et al., 2007). But in heavily infestation shows hyperplasia of gill epithelium with thickening of lamellae up to fusion.The gills show diffused degeneration and necrosis in the filament epithelial tissue (Reversat et al., 1992). It has been reported to cause mortalities in natural sea bream in Red Sea and Acabe Bay (Paperna and Baudin Laurencin, 1979).

4.5. Treatment: Formalin bath 200 ppm 1 h is effective (Paperna et al., 1977; Toksen, 1999).

5. Microcotyle Chrysophrii

S. chrysophrii Euzet and Noisy 1981, originally called *Microcotyle chrysophrii* (van Beneden and Hesse 1863) (Microcotylidae: Polyopisthocotylea), is a common parasite of cultured Gilthead sea bream which has caused lethal epizootics in sea cages (Alvarez-Pellitero 2004).

5.1. Aetiyology**:** The parasite belong to genus *Microcotyle* (Microcotylidae, Polyopisthocotylea) comprising 17 recognized species in European waters. Monogenean is 3-5 mm in length, 0.5-0.7 mm in width in ovary level (Euzet et Noisy, 1979).

5.2. Epizootiology: *Sparicotyle chrysophrii* is successfully transmitted to naïve gilthead seabream by egg exposure and cohabitation with parasitized fish (Sitjà-Bobadilla and Alvarez-Pellitero**,** 2009). Parasite occure in all seasons of year (Reversat et al., 1992).

5.3. Pathogenicity: *S. chrysophrii* shows a high pathogenicity at low infection intensity (8 parasites/gill arch) with gross lesions such as gill and systemic anaemia already noticeable at necropsy. In this case histology shows severe hyperplasia of gill epithelium with thickening of lamellae up to fusion, and heavy sloughing off of the epithelial cells. Moreover the gills show diffused degeneration and necrosis in the residual epithelial tissue. The hematophagous attitude of *S. chrysophrii* is evident for the presence of several erythrocytes in the parasite gut (Quaglio et al., 2007; Reversat et al., 1992). It has been reported to produce mortalities in farmed fish (Alvarez-Pellitero, 2004), and it is frequently found in mixed infections with other parasites and bacterial infections (Padros and Crespo, 1995).

5.4. Symptoms: Infested fish swim near the water surface, showing severe signs of anemia as lethargy, emaciation, anoreksi and excessive mucus production (Padros and Crespo, 1995).

5.5. Treatment: Formalin bath of 250 ppm for 60 minutes is applied effectively (Toksen, 1999).

6. Diplectanum Aequans

Diplectanum aequans (Wagener, 1857) Diesing, 1858 is a common parasite of both wild and cultured European sea bass *D. aequans* is considered to be potentially harmful in intensive sea bass farming (Gonzalez-Lanza et al., 1991; Toksen, 1999).

6.1. Aetiyology: Monogenean parasite is 650-1.700 µm. in length and 260-500 µm. in width in ovary level. There is a haptor in the posterior end of body. The diameter of haptor is 0.11-0.30 µm. and has a squamodisc (180 µm. in diameter), two pairs of hamuli and 14 marginal hooks (Oliver, 1980; Toksen, 1999). The adult of *D. aeqauans* is observed on the gills of sea bass (Cecchini et al., 1991; Toksen, 1999) but larval stages of parasites can be also observed on the skin. parazitin genç evrelerine deride de rastlanılmaktadır (Cognetti, et al., 1992; Gonzales et al., 1991).

6.2. Epizootiology: The life span of *D. aequans* at 20°C is estimated to be 30 days. The parasites are oviparous and produce the eggs on the gill of sea bass. The diameter of egg is 59.14±6.96 µm. The parasite has 5 stages in ith life cycle; larval stage (oncomiracidium), post larval stage, 2. post larval stage, intermedier stage and adult stage (Silan and Maillard, 1989). The adult parasite is exhibiting hermaphroditism. The contamination is occured bye means of eggs between hosts.

6.3. Symptoms and Pathogenicity: *D. aequans* attaches to the gill lamellae and cause hyperplasia of the epithelium and mucuos cells, with resulting deformation and fusion of the secondary lamellae. Heavily infected fish exibit lethargy, anorexia and asphyxia symptoms (Oliver, 1977; Toksen, 1999).

6.4. Diagnosis: *D. aequans* is easiliy distinguished on the basis of the shape and size of the haptor, hamuli and hooks on the haptor, and male copulatory organ of adult parasite (Silan and Maillard, 1989; Lambert et Maillard, 1974).

6.5. Treatment: Rafoxanid bath of 6 ppm for 48 hours is applied effectively (Cognetti et al., 1992), trichlorfon bath in dose 0.15 ppm for 2 days is effective (Cognetti et al, 1991). Formalin has not good effect against *D. aequans* affect the parasite (Toksen, 1999).

7. Caligus Minimus

Caligus sp. or 'sea lice' are common copepod parasites in the family Caligidae, infesting a wide range of fish species in the coastal zones and cultured fish.

7.1. Aetiyology: *Caligus minimus* is seen in the mouth cavity and on the gill of sea bass in Mediterranean Sea, Adriyatic Sea and Atlantic ocean. Adult parasites show sexual dimorphism, the female is larger then the male. The female 3-5.5 mm in length, the male parasite is 8 mm in length with 4. legs (Radujkovic and Raibaut, 1989).

7.2. Epizootiology: Caligid copepods have direct life cycle, consisting of a free-living planktonic I. nauplii stage, II. nauplii stage, copepodid stage, I-VI chalimus stages, pre-adult stage and adult stage, and last 17 days at 22-24°C after hatchig (Hallett and Rroubal, 1995). The intensity of copepod infestation generally increases after rainfall and late spring and decline in winter and summer due to the lack of recruitment and parasite death. This is a major problem in cage cultured fishes (Jithendran et al., 2008).

7.3. Clinical Sings and Pathogenicity: The main lesions are observed on the skin of the head region, the buccal cavity, the palate, the tongue and the base of the gill arch (Ragiasa et al., 2004). The integument where parasites are located showed ulceration of the epidermis with marked inflammatory of the dermis as a result of the attachment and feeding activity of the parasites. The attachment is achieved by means of second pair of the antennae which were inserted into the host epidermal tissue. A marked reactive epidermal hyperplasia is observed at those areas as well as at the periphery of ulcerated lesions. Many epidermal cells around the damaged area show signs of necrosis, the vacuolar degeneration of basal cells was prominent and epidermis is also characterized by diffuse areas of spongiosis. In many cases, increased fibroplasia and spongiosis is noticed within dermal collagenous connective tissue (Ragiasa et al., 2004).

7.4. Treatment: Trichlorfon bath of 300 ppm at 20 minutes (Pike, 1989), dichlorvos 1 ppm 1 h (Branson, 1996), hydrogen peroxide 1500 ppm 20 minutes (Branson, 1996; Hodneland et al, 1993) and freshwater bath (Landsberg et al., 1991) are effective.

8. Ceratothoa Oestroides

Ceratothoa oestroides (Cymothoidae) is a ubiquitous fish parasite. It has been reported in 6 different fish families, Sparidae, Carangidae, Clupeidae, Maenidae, Scorpaenidea and Mugilidae, and has been most frequently isolated from the bogue bream *Boops boops* and sea bream *Sparus aurata* (Sparidae) (Charfi-Cheikhrouha et al., 2000; Toksen, 1999).

8.1. Aetiyology: The body of parasite is dorso ventrally flattened and is lacking a carapace. The isopod thorax consists of 7 free segments with 7 pairs of thoracic legs. As a result of the well-sheltered environment of the buccal cavity, species that establish there have evolved a thinner cuticular mineralisation and the pleopods of the three last pairs have transformed into respiratory organs. Paired eyes consist of numerous eyelets. On its ventral side, between the swimming legs, the female bears a brood pouch or "marsupium", shielded by special plates, called "oostegites", to carry the eggs and the larvae for some time after hatching.

8.2. Epizootiology: Female *C. oestroides* bear embryonated eggs in the brood pouch that develop first into stage I pullus, and then into pulli II and III (with rudimentary periopods of VII pairs), and finally into pullus IV, at which stage postlarval evolution begins (Mladineo, 2002). As a protandric hermaphrodite, the parasite passes through different developmental stages: male puberty, prolonged male puberty, transitory stage, female puberty and finally prolonged female puberty (Trilles 1969). During the male puberty stage, the parasite loses its swimming capacity and, once settled in the buccal cavity of a fish, it is incapable of active migration to another host. This fact is important in the epizootic evaluation of the route of infection. After settlement in the host, the parasite begins hematophagic nourishment, which comprises alternating cyclic periods of blood-sucking and blood absorption by the intestine (Trilles, 1969). As a consequence of its sedentary life in the wellsheltered buccal cavity, the parasite has evolved some structural changes, e.g. a thinner cuticle, the last 3 pairs of pleopods transformed into respiratory organs and a thinner-walled incubation chamber (Trilles, 1969).

8.3 Symptoms and Pathogenicity: Heavy infestations of parasitic larvae may kill smaller fish when they first infect them seeking permanent attachment. Pulli II larvae and juveniles attack relatively younger fish, about 5g-20g of weight and cause considerable damage to the skin around the head, the eyes and the gill epithelium by injuring the gill lamellae. Their voracious haematophagy and the mechanical damage of their hooks lead to severe inflammation and necrosis of head, eye and gill tissues. The infested fish are usually apathetic and anorexic and may show respiratory distress. The haemorrhagic and necrotic head tissues are evident when observing the fish in their cage. When the sick fish are removed from the water, several isopod larvae may be seen in their buccal and gill cavities and/or on the skin near the opercula (Varvarigos, 2003; Mladineo, 2002; Toksen, 1999).

Injured tissues are frequently invaded by secondary bacterial pathogens, such as *Aeromonas spp., Tenacibaculum spp., Vibrio spp.* and this may lead to severe escalation of mortality. In young stocks, the cumulative mortality due to parasitism by the pulli II larvae may run as high as 15% even without any bacterial implications (Varvarigos, 2003).

The adult isopods are haematophagus and cause anaemia. The parasitised fish have significantly lower erythrocyte counts as well as haematocrit and haemoglobin values. The leukocyte counts are increased, obviating the host's immune response to the presence of the isopods. In addition, the established adult isopods can cause considerable damage to the mouth tissues with their biting and sucking mouth parts, or their copulation activity. Their large size (up to 6 cm in length) may cause atrophy of the tongue, dysplasia of teeth and slackening of the cartilagenous tissues leading to a "bag-shaped" lower jaw. Invariably, the presence of large adult parasites in the buccal cavity interferes with feeding, causes chronic stress and results in growth retardation and a predisposition to bacterial and/or endo-parasitic invasions (Varvarigos, 2003).

Isopod infestation is confirmed by gross observation of the parasites on the skin, mouth, or in the gill chamber of the fish. In addition, they often produce the lesions described above that characterise

8.4. Treatment: Cypermethrin and deltamethrin are effective in dose of 10 ppb for 60 minutes (Martinsen et al., 2001)

9. Lernanthropus Kroyeri

Lernanthropus is the most common genus of parasitic copepods. So far, more than 100 species isolated from gills of different marine teleosts have been described. Some species of
Lernanthropus are strictly host specific, but many are parasitic on several species of fish within one or several genera (Sharp et al., 2003).

9.1. Aetiyology: Female parasite body is elongate, 2,9 mm including fourth legs 3.7 mm in length (Toksen et al., 2008).

9.2. Symptoms and Pathogenicity: Fish infected with *L. kroyeri* spp. show signs of respiratory distress, enhanced mucus secretion, congestion, haemorrhages associated with the feeding activity of the parasite, primary gill lamella erosions and lethargy, dark coloured skin and surface swimming (Toksen, 2007). Histologically, erosion, desquamation and vacuolar degeneration occurred near the site of attachment. Lamellar fusion in the distal ends of the filaments was observed. Compression of gill tissue by the head and second antennae of female parasite resulted in erosion of the branchial lamellar epithelium and lacerate tissue. Second antennae and maxilliped of parasite has caused partial occlusion and ruptures in capillary (Toksen, 2007) .

9.3. Treatment: Emamectin benzoate of 100 µg kg-1 in feed is effective (Toksen, et al., 2006).

Conclusion

The intensification of aquaculture and globalization of the seafood trade have led to remarkable development in the aqauculture industry. The industry has been plagued with disease problems caused by viral, bacterial, fungal and parasitic pathogens. In recent years, disease outbreaks are becoming more frequent in he aquaculture and associated morbidity and mortality have caused substantial economic losses. Toksen (2000; 2004) reported that Ichthbodosis and trichodiniasis caused fifty to sixty percent of mortality in different two farm of gilthead sea bream (*Sparus aurata L.*). Recently, almost 400,000 gilt head bream died in a single night on fish farms located in the southwestern province of Muğla's Güllük Gulf this week. But the reason of death could not determine. Sustainable development of aquaculture relies on disease prevention.

In summary, parasitic diseases are economically important parasites in marine aquaculture. Disease outbreaks and subsequent mortalities caused by parasite are now rare due to the development of a variety of effective treatments. However, large economic losses still occur as the result of reduced feed conversion and growth, indirect mortality, loss of product value, and treatment costs. Although it is well understood that parasites have a major impact on sea bream and sea bass aquaculture, there are relatively few published reports of disease and/or disease treatments. There are no reports of economic costs associated with these infections. Husbandry practices as well as a variety of engineering, environmental, and biological factors can have an impact on the level of infection by parasitic copepods. However, the relative importance of these factors in controlling parasite abundance varies between sites. There is no evidence from field studies to support the suggestion that parasites can act as vectors for fish diseases. The aim of this paper is to present general overview of parasitic diseases occured on sea bass and sea bream.

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Sustainable Aquaculture and Environmental Interactions

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Abstract : Aquaculture is the fastest growing sector in all of the world in recent years. It is necessary to support the development of sustainable aquaculture in the world. For this purpose The Commission of the European Communities prepared a communication on the strategy for the sustainable development of european aquaculture. Salmon, trout, sea bass and sea bream farming have been developed in european countires. Differents farming methodes and technics are used in aquaculture. But especially marine fish farming has been criticised for its environmental and ecological impacts. The extensive and semi intensive farming methods have less environmental impacts than intensive aquaculture. In this paper we try to review differents fish culture methods and their impacts on the aquatic environment. It is also discussed the necessary measures to be taken to minimize the effects of fish farms on the environments

Key words: Sustainable aquaculture, environmental impacts, aquaculture methods,

Introduction

Fish is an important dietary source of animal protein. Humans consume most of the world's fish production, and by 2030 the average person is expected to eat as much as 20 kilograms of fish each year.

Aquaculture may be a recent addition to our vocabulary, but the farming of fish and the cultivation of shellfish dates back millennia, from old Chinese civilisations to the Roman Empire. What is new is the level of production now demanded by a growing world population and the challenge this presents to farmers who want to conduct their activity in a sustainable way.

Modern aquaculture represents a major innovation in the production of fish and aquatic food and has been the fastest growing food production sector with an average worldwide growth rate of 6-8% a year. With a global production of nearly 52 million tonnes in 2006, world aquaculture has increased. Aquaculture is an important economic activity in certain coastal and continental areas

Elvevoll (2010) asks how much seafood should we eat, in themselves, omega-3 fatty acids are not enough, we need to eat fish. Seafood is rich in antioxidants, fat-soluble and water-soluble vitamins, easily digestible proteins with special amino acid composition, minerals, trace elements and fat of the healthy, polyunsaturated type. He has carried out a clinical study that shows the uptake of omega-3 is three to four times greater from salmon fillet than from fish oil.

Different values exist in the scientific literature for what is the ideal daily or weekly intake of EPA and DHA for human health. Government advice varies considerably between countries. However, as a general rule, a healthy diet is generally assumed to include 1-2 fish per week, especially fatty fish.

Environmental Interactions

Most of the information given below about environmental interactions is taken from Consensus portal available at Euraquaculture organisation. The CONSENSUS initiative was funded by the European Union as part of its key action "Food Quality and Safety". 21 European Organisations are Consensus partners. With its stakeholder representation of consumers, aquaculture producers, environmental and other nongovernmental organisations, Consensus is building *sustainable aquaculture protocols* based on low environmental impact, high competitiveness and ethical responsibility with regard to biodiversity and animal welfare.

The development of aquaculture has raised some associated environmental concerns. Like any farming operation on land, fish farm cages produce waste materials. These fall into three categories - uneaten feed, fish faeces and dead fish. Most of the environmental impacts of coastal aquaculture can be managed and minimised

through understanding of the processes involved, responsible management and the effective siting of farms (FAO 1966).

- *Uneaten Feed*

    - *If uneaten feed reach the bottom of a cage, processes that break it down can reduce the amount of oxygen in the sediment. In severe cases, oxygen levels in the water above may also decrease, creating "anoxic" conditions in which only a few animal species can survive. Should the feed contain antibiotics used to treat the farmed fish above, bacteria in the sediment and the natural breakdown of waste material might be affected.*
    - *In practice, fish farmers do everything they can to prevent such a situation, since the cost of fish feed amounts up to 40 percent of the total production cost. Feed reaching the sediment is lost, and it is in the farmer's interest to minimise such waste. On well-managed farms, feeding is carefully regulated to ensure that the maximum amount of food is taken up directly by the fish and farmers aim to ensure that less than 5 percent of the feed is wasted. To improve uptake by fish, feed pellets are manufactured to either float or to sink slowly through the water.*

- *Fish Faeces*

Unlike land animals, fish do not generally produce compact solid faecal material and more often excrete a loose cloud of faecal material that is easily dispersed by water currents. In still conditions, however, faecal material can build up beneath fish cages. It is, however, not in the farmer's interest to let this happen, since the buildup of faecal material can lead to anoxic conditions which affect the fish above. Fish farmers wanting to ensure the health of their fish will frequently check the bottom below their fish cages to ensure that faecal material is not building up. In addition, in many EU Member States, the government employs diving teams to carry out inspections. If faecal build-up is observed, farmers will be advised to move their cages, allowing the bottom to recuperate for a short period, however full recovery typically takes between three to ten years. In recent years, improved feed formulations have also been introduced that fish digest more efficiently, producing less waste. Fish farmers generally avoid overly sheltered and stagnant sites, preferring areas that contain a healthy flow of water through the cages. Such flows disperse fish faeces so it can enter the natural food chain.

Dead Fish

Dead fish are a loss to the farmer and a potential health hazard to the stock as well as a source of pollution. Fish farmers will, at all times, endeavour to minimise the number of dead fish on their farms and to remove such mortalities where they occur. Fish farms are required to report significant fish deaths when they occur and are inspected by state agencies at least twice a year.

Pond Fish Farming

Fish pond systems represent the oldest fish farming activity in Europe, at least dating back to medieval times. Ponds were built in areas where water supply was available and the soil was not suitable for agriculture. The wetlands of Central and Eastern Europe are good examples of this. The total European production from pond farming is approximately 475,000 tonnes. About half of this production is cyprinid fish, such as common carp, silver carp and bighead carp. The main producer countries are the Russian Federation, Poland, Czech Republic, Germany, Ukraine and Hungary.

In order to reach higher yields, farmers today introduce nutrients into the pond such as organic manure. This is accompanied by stocking of fingerlings and by water being flushed through the pond. Fish pond production, however, remains ‘extensive' or ‘semi-intensive' (with supplementary feeding) in most countries, where semi-static freshwater systems play an important role in aquaculture. Chemicals and therapeutics are not usually used in such ponds. Hence the main environmental issue is the use of organic fertilisers, which may cause eutrophication in the surrounding natural waters. The use of organic fertilisers is regulated at national levels.

Extensive fish ponds are usually surrounded by reed belts and natural vegetation, thus providing important habitats for flora and fauna. They play a growing role in rural tourism. Many pond fish farms have been turned into multifunctional fish farms, where various other services are provided for recreation, maintenance of biodiversity and improvement of water management. In areas where water is scarce, some farm systems recirculate, treat and re-use their water.

Such systems are generally self-contained and therefore pose little threat to the environment. Solid waste material produced in such systems is rich in organic compounds and often used as a fertilizer elsewhere. Alternatively, new hydroponic systems have been developed to grow vegetables and other food crops in the nutrient-enriched water. There is much interest in these systems, but their economic viability remains challenging.

Recirculation Aquaculture Systems

Recirculation Aquaculture Systems (RAS) are land-based systems in which water is re-used after mechanical and biological treatment so as to reduce the needs for water and energy and the emission of nutrients to the environment. These systems present several advantages such as: water and energy saving, a rigorous control of water quality, low environmental impacts, high biosecurity levels and an easier control of waste production as compared to other production systems.

The main disadvantages are high capital costs, high operational costs, requirements for very careful management, high land prices and difficulties in treating disease. RAS is still a small fraction of Europe's aquaculture production and has its main relevance in some European countries. The main species produced in RAS are catfish and eel but other species are already being produced using this type of technology such as turbot, sea bass, pikeperch, tilapia and sole.

The Case Of Escaped Fish

It is inevitable that fish farmed in net pens in either fresh or salt water will sometimes escape into the wild. In some cases, there will be a small but steady release of fish. Sometimes, large numbers will escape due to severe damage to the net pen by way of storms, predator attacks or vandalism. Therefore, a limited escape of farmed fish would be unlikely to have a serious effect on wild fish populations. Only if very large numbers of fish escape into a small area, would interbreeding occur and the fitness of the local population potentially be reduced.

In its Aquaculture Europe 2005 conference, the European Aquaculture Society invited the North Atlantic Salmon Conservation Organisation (NASCO) to hold a special workshop on the interactions between wild and farmed salmon. The summary report of this event "Wild and Farmed Salmon - Working Together" drew the following main conclusions: Through the use of single bay management, single generation sites and synchronised fallowing, real progress is being made in relation to minimising impacts of diseases and parasites, which are key issues for wild fish interests.

The development of third-party audited containment management systems may represent a significant step forward. The liaison group should look more at the possibilities of rearing all-female triploid salmon, which could eliminate genetic interaction with the wild stocks, but which need to be balanced by the production cost of these fish, as well as consumer resistance to what could be seen as genetic manipulation.

Sustainable Feed Resources

Fish farming is very efficient in terms of the conversion of protein, which means an important ecological advantage in light of the sustainability of fish feed resources.

One of the most-frequently cited issues with the sustainable development of aquaculture is the capture of other fish as raw material to be used as fish feed in the form of fish meal and fish oil. It is seen as an issue because a food production sector is in part relying on a capture fishery for the supply of raw materials for the production of aquaculture feed.

Typically, these other fish species are small, oil-rich, bony pelagic fish that are not normally used for direct human consumption. Two decades ago, the majority of fish meal and oil was used to make feeds for land animal production. At present, over 50 percent of fishmeal and over 80 percent of fish oil is used for aquaculture.

If aquaculture is to fill the gap in demand for seafood, this raises important sustainability issues as to the availability of sufficient feed supply. This is particularly relevant given the fact that fishmeal and fish oil production has been, and is likely to remain, relatively constant at around 6 million and 0.9 million tonnes per year, respectively.

However, as the demand for fishmeal and fish oil in aquaculture has increased, so the price has risen. This has driven both terrestrial agriculture and aquaculture to seek nutritional alternatives to fishmeal and fish oil.

This is an on-going process and estimates made by the International Fishmeal & Fish oil Organisation show that the growth of aquaculture and the substitution of fishmeal and fish oil can continue together.

Replacement of Marine Protein Sources by Terrestrial Plant Protein

For various reasons, fish meal and fish oil are gradually being replaced by plant proteins in feed that is used in fish farms. Plant proteins can be less costly and they are free of potential contaminants like dioxin, PCB or mercury.

However, fishmeal is an important ingredient in fish feed and can only to a limited extent be replaced by vegetable proteins without reducing feed efficiency and growth. After all, carnivorous or 'piscivorous' fish naturally feed on other fish. The fatty acid composition in the flesh from farmed fish will also reflect the feed composition and inclusion of vegetable oil will reduce the level of omega-3 fatty acids.

Although the introduction of plant protein into the feed can be seen as a way of reducing the sector's dependence on fish meal and fish oil, some have questioned the trend because:

- carnivorous fish do not naturally feed on plants;
- plant proteins may have anti-nutritional effects on fish;
- there is a maximum level of replacement, after which the texture and eating quality of the fish is compromised;
- some plant proteins could be derived from GMOs .

Constraints of Aquaculture in Turkey

Especially marine aquaculture systems are criticised for their environmental and ecological impacts. The extensive and semi intensive farming methods have less environmental impacts than intensive aquaculture. It is necessary to support the development of sustainable aquaculture.

For this reason European Commission designed in 2002 a strategy document for the sustainable development of aquaculture in Europe (CCE 2002). As a candidate country to the European Community, Turkey takes all the measures to respect and to adopt the rules designed by the European Commission. Fisheries and Aquaculture file is one of the 31 files to be discussed with European Commission. The importance of aquaculture has been recognized by the Ministry of Agriculture and Rural Affairs (MARA) and by the private sector in collaboration with the Universities. The development of aquaculture is very important in Turkey because it provides jobs.

The General Directorate for Agriculture Production and Development of MARA is the responsible authority for development and management of aquaculture. The aquaculture sector in Turkey is facing some constraints (Canyurt 2005) such as:

- The complexity of licensing procedures,
- Site selection problems,
- The complexity of project preparation and application,
- Problems with some other sectors, such as tourism, protected areas and navigations,
- High prices of inputs and difficulties in supplying,
- Disease risk with imported eggs and fry,
- Marketing and quality control problems,
- Non organization of the sector,

can be cited as major constraints of aquaculture in Turkey to be solved.

Conclusions and Recommendations

Turkey has rich inland water sources, about 200 natural lakes, about 750 artificial lakes or ponds, about 193 reservoirs, 33 rivers and streams of 177.714 km length and 8.333 km of coastal strips. Some lagoons covering of 70.000 hectares in Aegean and Mediterranean coastal strips are very suitable for aquaculture.

Aquaculture development, especially trout farming in inland waters and sea bass and sea bream in marine waters in Turkey is growing rapidly (Canyurt 1996 &1997, Canyurt&Akhan 2009). Turkey has the third fastest growing aquaculture sector in the world (Deniz 2007, MARA 2006, TSI 2007). Marine and inland water resources provide an important source of protein for human nutrition. In addition to this appreciation, aquaculture has some advantages over capture fisheries in term of marketing the products. One of these advantages is that aquaculture creates jobs. More than 25 000 persons are working in the sector of aquaculture in Turkey (Deniz 2007). Some ecological and socio-economical interactions should be discussed for a sustainable

aquaculture (Canyurt 2005, Deniz 2007), that is why it is necessary to support the development of sustainable aquaculture.

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Ectoparasitic Diseases in Freshwater Ornamental Fish and Their Treatments

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Abstract: Fish parasites and their effects have become increasingly visible during the latest decades inconnection with the development of fresh water ornamental Fish industries troughout the world. Diseases problem including hazards caused by parasitic organisms are the main threat to further increase of the industry. Ectoparasites are the most common and widely distributed of freshwater ornamental Fish. Such as, protozoan ectoparasites of aquarium fish (*Ichthyophthirius multifiliis, Ichthyobodo necatrix, Chilodonella cyprini, Oodinium limneticum,* Trichodinids); external worms of fish (*Dactylogyrus extensus*, *Gyrodactylus bullutarudis*); external crustaceans (parasitic copepods, *Argulus japonicus, Argulus foliaceus, Lernaea cyprinacea*).The fish louse Argulus spp. is now the main problem in cage-cultured freshwater ornamental Fish in the fresh water environment in Europa countries. *Gyrodactylus bullatarudis* had caused the mortality in guppy ornamental fish. White Spot Disease (Ichthyophthiriosis) occurs in ornamental fish fry interprise caused the considerable economic loss. Ornamental fish were affected heavily by ectoparasites due to the very fine structure of the skin. Ectoparasites causing in ornamental fish only kills the fish but also reduces the market value of fish. The present work aim to the parasitic diseases of freshwater **o**rnamental fish, how they are transmitted, which effects they have on **o**rnamental fish, how they could be diagnosed, and how they could be controlled and treated.

Introduction

Fish parasites and their effects have become increasingly visible during the latest decades inconnection with the development of freshwater ornamental Fish industries troughout the world. Diseases caused by parasites are widespread and cause loses of fish in intensively stocked pond and aguarium. Ectoparasites of freshwater ornamental fish come in all sizes and shapes and inculude single-celled protozoan, and mullticellular trematodes (flatworms), crustaceans and artropods (Roberts 2010). Parasites can infest the outer surface or penetrate the paranchyma of almost any tissue of the host. Fish can serve as an intermediate, paratenic (transport) or definetive host for various stages of parasites. Ectoparasitic infections in freshwater ornamentals fishes are diagnosed by wet mount cytology preparations of skin scrapes, gills biopsies, and by direct observation (macroscopic parasites) (Woo 2006, Roberts 2010)**.** Ectoparasites are the most common and widely distributed of freshwater ornamental Fish (Tab.1). These parasites, in crowded pools and aquariums, together with increasing water temperature when appropriate conditions are found to cause large losses. Ornamental fish were affected heavily by ectoparasites due to the very fine structure of the skin. Ectoparasites causing in ornamental fish only kills the fish but also reduces the market value of fish (Mousavi 2003,Tokşen 2006, Koyuncu 2009). In this review, treatment and control of ectoparasites of freshwater ornamental fish in the recent developments were reviewed.

The Study

Research Significance

In this study, ectoparasite of freshwater ornamental diseases and drug therapy are discussed. Ectoparasite freshwater ornamental that can be used in treatment of diseases and drugs are defined and explained the general features.

Important Fish Ectoparasite Groups Caused Loses in Ornamental Fish

In this section, the systematic groups that represent the most important examples are chosen.

Protozoa:

Protozoans are the most common ectoparasites encountered in ornamental fish. Although some authors consider them harmless, many serious fish losses are caused by protozoan ectoparasites (Krier and Baker 1987 Durborow et al.1998, Scholz 1999, Wildgoose 2001). Protozoans vary in shape and size and live mainly on the gills, fins, and skin of fish.

There are a number of protozoan ectoparasites long recognized as causative agents of severe diseases such as flagellates of the genus *Oodinium* sp, or *Ichthyobodo sp*. and the cilli protozoan ectoparasites, *Ichthyophthirius multifiliis*, *Chilodonella* sp. *Trichodina* sp. are some of the most significant pathogens in ornamental fish (Tab. 1). (Durborow 2003).

Oodinium sp. is a problem in freshwater ornamental fishes. Most reports of the parasite have been on aquarium fishes.(Lom et.al. 1983).

Ichthyobodo sp. - formerly (and still commonly) called Costia. A flagellated protozoal ectoparasite. A normal inhabitant of fish skin. Poor water quality and other stresses (especially crowding) may allow this normally mutualistic parasite to reproduce rapidly and overwhelm the host. Microscopically the protozoa are very small (5-10 microns), move rapidly, and are shaped like small sickles. They may be attached to host tissue or swimming free. Most common in freshwater species of fishes (Joyon et al., 1969).

Ichthyophthirius multifiliis - known commonly simply as "Ich." The largest protozoal parasite of fish and one of the most commonly encountered. Trophozoites may reach 1.0 mm in diameter. This interference will be placed into the skin. Protection against other pathogens in patients with low-grade infection destroys the system. Whereas in cases of severe infections can cause death quickly. Excessive growth of cysts on the pool floor and as such is a suitable environment for this group is very high virulence of the parasite infection

In particular, in the ornamental fish Ichthyophthiriosis loss caused millions of measured by dollars (Durborow et.al., 1998).

Chilodonella sp. - A ciliated protozoan which can cause high morbidity and mortality among freshwater tropical fishes at the wholesale and fish farming levels of the industry. Attacks skin and gills. Easily identified microscopically by its heart-shaped structure and slow circular motion when not crawling on the surface of the fish (Koyuncu, 2003).

Trichodina sp.- A disc-shaped ciliate protozoan found on the skin and gills of many freshwater fish. Circular rows of denticles and a ciliary girdle give this parasite a unique radial symmetry. Probably not harmful when present in small numbers (Ozer et al., 1998).

Monogenean Platyhelminthes:

Monogeneans are parasitic flatworms or flukes with direct live cycle that infest the external surfaces of almost any species of ornamental fish. The mongeneans have an anterior oral sucker used for feding on mucus and sloughed epithelial cells, while the posterior end has a organ for attaching to host. These parasites cause focal irritation, increased mucus production, and hyperplasia of the epithelial tissues, and open a portal for secondary bacterial and fungal infections. Severe infections can cause erratic swimming behavior, 'flashing' respiratory activity, scattered hemorrhages with epithelial ulceration and frayed fin. Monogenea species the economic importance of fish in the severe loss causes: Common genera found in ornemantal fish inculude: *Dactylogyrus* sp. and *Gyrodactylus* sp. Fancy gold fish are commonly infected with 'gill' flukes, *Dactylogyrus extensus*, while *Gyrodactylus katherineri* skin flukes infestastion are more often observed in koi. *Gyrodactylus bullatarusdis* and *Gyrodactylus Turnbull* are guppy fish flukes (Tab. 1). (Woo 2006, Roberts2010).

Arthropoda (Crustacea):

Crustasea s play an important role in fish parasites is a group. There are a number of crustacean parasites that infect the skin and gills of tropical and ornamental fish (Tab. 1), *Lernaea* sp. or ' anchor form' is a copepod crustacean of pond-reared fish, especially gold fish, carp, koi and guupy. The infections larval stage of this particular parasite penetrates the skin of the fish and continues to develop. There is usually an intense focal inflammatory reaction at the site of penetration, which often results in hiperplasia of tissue around the site of parasites development(Roberts , 2010)

Ergasilus sp. is a species of another type of copepod parasite. The parasites are most commonly found attached to the gill filaments of many species of pond and ornamental fish. (Robert, 2010)

The 'fish louse', *Argulus* sp. is a common branchiurid crustacean parasite of many species of pond and ornamental fish. This parasite carwls over the surface of the fish and uses its stylet to pierce the outer epithelial cells of the fish and ingest the cell's contents. There is a severe inflammatory reaction at the site of stylet penetration, sugesstion that a substance is released by the parasite to facilitate feeding. Because of the this feding activity this parasite has also been imlicated in the mechanical transmission of several bacterial, viral and hemoprotozoal diseases (Toksen, 2006, Robert, 2010) The fish louse Argulus sp. is now the main problem in cage-cultured freshwater ornamental Fish in the fresh water environment in Europa countries (Woo, 2006).

Parasites	**Size**	**Host**	**Position Location**	**Way of transsimition**
Protozoa:				
Flagella				
Oodinium sp.	12-90 µm	Freshwater ornamentals fish	Skin	Of floating phase skin invasion
Icthyobodo sp.	5-18 µm	Freshwater ornamentals fish	Skin	Of floating phase skin invasion
Ciliate				
Ichthyophthirius multifiliis	50-1000µm (trophozoites)	Freshwater ornamentals fish	Skin, Epithelial tissues	Of floating theront invasion
Trichodina sp.	35-60 µm	Freshwater ornamentals fish	Skin and gills	Of floating phase skin and gills invasion
Chilodonella sp.	30-80 µm	Freshwater ornamentals fish	Skin and gills	Of floating phase skin and gills invasion
Monogenea:				
Gyrodactylus sp	350-460 µm	Freshwater ornamentals fish	Skin and fin	Body contact
Dactylogyrus sp.	990-1584 µm	Freshwater ornamentals fish	Gills and skin	Body contact
Arthropoda				
Lernaea sp.	5-20 mm	Freshwater ornamentals fish	Skin and fin	Body contact
Ergasilus sp.	1-2 mm	Freshwater ornamentals fish	Gills	Body contact
Argulus sp.	8-13 mm	Freshwater ornamentals fish	Skin and fin	Body contact

Table 1. Common Ornamental Fish Ectoparasites

Medicaments Used in Treatment of Freshwater Ornamental Parasites:

The applied treatments for diseases are prevention and good health management. However, Chloramines-T Formaldehyde, Potassium permanganate, Acetic acid, Copper sulfate, Malachite green and salt are commonly used to control protozoan fish ectoparasites (Tab. 2). Salt, formaldehyde, and vinegar appeared to be the most effective chemicals to treat protozoan infestation (Stoskopf, 1993, Noga, 2001, Timur et. al ,2003 Kayis et. al,. 2005, Balta et al., 2008, Dörücü et.al., 2008, Kayis et al., 2009). Levamisol, Mebendazole Triclorphon and formalin are commonly used to control treat metazoan parasites (Lasee, 1995, Toksen, 2006). Among the chemicals that are used to treat or prevent parasitic fish diseases in Turkey, Acetic acid, Betadine, Chloramin-T, Copper sulfate, Formalin, Hydrogen peroxide, Malachite green, Levamisol, Mebendazole, Potassium permanganate and salt are authorized by the European Union by the council regulation (EEC) no. 2377/90 of the European Council.

In most countries, very few drugs and chemicals have been registered for treatment of food fish. Indeed, many biocides (e.g., malachite green) are banned from use in most countries and severe measures are taken against exporters of fish and shellfish that contain residues. Due to the carcinogenic and genotoxic potentials of malachite green, it has been prohibited for use in the production of consumer fish in the European Union by regulation no. 2377/90 of the European Council. Drugs and chemicals used to treat fish must be safe to the fish and the environment, as well as to human.

Used for the control of freshwater ornamental ectoparasites in the market are several chemical substances. These chemicals in general are also used in other hosts. Metabolism of fish is different, the effects of these substances in freshwater ornamenta ectoparasites is weak. Therefore, the fish farms to prevent excessive loss of fish to specific research and development antiparazit compounds are needed. Toltrazuril similar drugs are promising for broad spectra (Tab. 2). (Dörücü et.al , 2008).

Antiparasitic agent	*Chemical Dosage;time*	*Ectoparasite*	*Treatment*
Chloramin-T*	7-15 mg/l; 1 h	Protozoan, monogenetic trematodes	Bath treatment
Formaldehyde*	0.167-0.25 mg/l; 1 h 0.25 mg/l; indefinite	External parasites	Bath treatment
Hydrogen peroxide*	250-500 mg/l; 30-60 min	External parasites	Bath treatment
Copper sulfate*	0.5 mg/l	External parasites	Bath treatment
Acetic acid*	1-2 mg/l; 1-10 min	External parasites	Bath treatment
Betadine*	50 mg/l; 30 min	External parasites	Bath treatment
Malachite green*	0.1-0.15 ppm/12-24 h	External parasites	Bath treatment
Levamisol*	50 ml/l; 2 h	Monogenetic trematodes	Bath treatment
Mebendazole	1 mg/l; 24 h	Monogenetic trematodes	Bath treatment
Toltrazuril	4ml(1000 ml water)	Monogenetic trematodes	Bath treatment
Qunine hydrochloride	13.5 ppm for several days	Artropoda ectoparasites	Bath treatment
Atebrine	10 ppm for sevaral days	Artropoda ectoparasites	Bath treatment
Potassium permanganate*	2-5 mg/lt 1h	Artropoda ectoparasites	Dip treatment
Dimilin	0.01 mg/lt	Artropoda ectoparasites	Bath treatment
Triclorphon	0.25-5 ppm for several hours	Artropoda ectoparasites	Bath treatment
DTHP	2.5 ppm 1hour	Artropoda ectoparasites	Bath treatment
Salt*	3% solution; 15-30 min 0.5% solution; indefinite	External parasites	Bath treatment

* Chemicals authorized by council regulation (EEC) no. 2377/90 of the European Council

Table 2. Control and Treatment of Ectoparasitic Diseases in Freshwater Ornamental Fish

Conclusions

Hundreds of fish parasites in their natural environment type has been found infected, although rarely leads to death of fish. In tropical fish culture reduces the number of common parasites, but they do influence is great. Parasites of fish death, loss of appetite, the slowdown in growth, deterioration of reproductive ability, reduce resistance to other pathogens, and cause marketing with unpleasant views. Despite these negative effects on the market for the treatment of fish parasites in a small number of drugs are used. Of this review, the treatment of diseases in tropical fish culture, fish ectoparasites shed light manufacturers believe.

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Life Table Analysis and Sustainable Fisheries

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Abstract : In this study, the Life Table Method also known as the Cutler-Ederer life table technique, was introduced and practicability of this technique for determining life period of fish species of which natural mortalities were found by estimation using parameter of length weight relationships has also been searched. The aim of this study is to show that life table method used for human beings, can be also used to predict fish species. The data employed in the present study is that of scaldfish *Arnoglossus laterna* (Walbaum, 1792) (Pisces: Bothidae) obtained from the Aegean Sea. Life span of five years and its ages were directly taken into account in the table prepared by the data concerned. Consequently, according to the data estimated, the life expectancy of the species in the Aegean Sea is approximately 11 years. Furthermore, the number of individuals estimated to live more than 5 years from the scaldfish population including 1000 individuals was calculated to be some 970.

a. Introduction

Preservation of the living or the non-living natural resources and transferring them to future generations consists in sustainability. Fisheries in almost all seas have rarely been sustainable. Rather, overfishing has led to gradual depletions, long masked by improved technology, geographic expansion and exploitation of previously spurned species lower in the food web (Pauly et al. 2002).

Estimations should be performed on the number of the animals especially for endangered species even for strains in the same species to determine their population in the future, according to which new programmes should be developed and precautions taken. Methods of calculation depend on in the related techniques and number of the equations used, and whether or not they consist of seasonal influences, are classified as quantitive (time serious analysis, causal models and survival analysis) and qualitive (market analysis, desicion hypothesis, growth cures, simulation) ones. According to the data and the hypothesis to be tested, survival analyses performed by the three methods: Life Table Method (Cutler-Ederer Method), Kaplan-Meier Method, and Cox Regression Method (Özdamar, 1999).

The life table method is one of the oldest to measure mortality and describe the survival experience of a population. It has been used by actuaries demographers, governmental agencies and medical researchers in the studies of survival, population growth, fertility, migration, and so on. There are two kinds of population life tables namely: the cohort life and current life tables. The cohort life table describes the survival or mortality experience from birth to death of a specific cohort of individuals which were born at about the same time. The current life table is made by applying the age-specific mortality rates of a population in a given period of time to a hypothetical cohort of 100.000 or 1000.000 individuals. One of the most often reported statistics from current life tables is the life expectancy. The life expectancy of a population is a general indication of the capability of prolonging life. It is used to identify trends and compare longevity. The term 'population life table' is often used to refer to the current life table (Lee & Wang 2003).

The aim of the study is to show that the life table technique used extensively for human beings (Lee 1992; Lee & Wang 2003; Keiley & Martin 2005) can also be employed in prospective estimations of the numeral magnitude of the fish species whose natural mortality is found by the above mentioned calculations.

b. Material and Methods

The data used in the present study belongs to scald fish samples obtained from the Aegean Sea coast of Turkey from January 2002 to March 2003. The total length (TL) of each fish obtained was measured to the nearest cm. The total body weight (W) was determined to the closest 0.01 g.

The sagittal otoliths were removed from the specimens, and cleaned with distilled water. The otoliths were placed in a black dish with glycerin (30%) and alcohol (70%) to improve readings. The translucent bands observed under a stereoscope with reflected light (30 magnifications) were counted. Based on the otolith readings, the age distribution of the samples ranged from I to V years. The length-weight relationships for weight was calculated using the equation, $W=aL^b$ (Ricker 1979) where *a* is a coefficient related to body form and *b* is an exponent indicating isometric growth when equal to 3. It has been suggested that there is a correlation such as $M=W^{-1/b}$ between spontaneous mortality and mean weight of the specimen using mean weight value in which von Bertalanffy's growth constants were found in rate of spontaneous mortality (M) (Sparre et al.1989; Avşar, 1998). $M=W^{-1/b}$,where W is the mean weight and value (b) is the slope of regression constants calculated by length-weight relationships for the same material.

Current life tables usually have the following columns (Lee & Wang 2003):

6. Age interval [x to $x + t$]. This is the time interval between two exact ages x and $x + t$; t is the length of the interval.

7. Proportion of individuals alive at beginning of age interval but dying during the interval ($_tq_x$). The information is obtained from census data. This column is usually calculated from the data of the decennial census of population and deaths occurring in the given time interval.

8. Number living at beginning of age interval (l_x). The initial value of l_x, the size of the hypothetical population, is usually 100,000 or 1,000,000. The successive values are computed using the Formula

$$l_x = l_{x-1}\,(1 - {}_tq_{x-t})$$

where $1 - {}_tq_{x-t}$ is the proportion of individuals who survived the previous age interval.

10. Number dying during the age interval ($_td_x$)

$${}_td_x = l_x({}_tq_x) = l_x - l_{x+1}$$

- Stationary population ($_tL_x$ *and* T_x). Here $_tL_x$ is the total number of years lived in the *i*th age interval or the number of individual-years that L_x individuals, aged x exactly, live through the interval. For those who survive the interval, their contribution to $_tL_x$ is the length of the interval. For those who die during the interval, we may not know exactly the time of death and the survival time must be estimated. The conventional assumption is that they live one-half of the interval and contribute *t/2* to the calculation of $_tL_x$. Thus,

$${}_tL_x = t(l_{x+1} + {}_{t/2}d_x)$$

The symbol T_x is the total number of individual-years lived beyond age t by individuals alive at that age, that is,

$$T_x = \sum_{j \geq x} {}_tL_j$$

and

$$T_x = {}_tL_x + T_{x+t}$$

- Average remaining life time or average number of years of life remaining at the beginning of age interval ($\overset{0}{e}_i$). This is also known as the *life expectancy* at a given age, which is defined as the number of years remaining to be lived by individuals at age x.

$$\overset{0}{e}_x = \frac{T_x}{I_x}$$

The expected age at death of a person aged x is $x+\overset{0}{e}_x$. The $\overset{0}{e}_x$ at $x = 0$ is the life expectancy at birth. The life expectancy of a population is a general indication of the capability of prolonging life. It is used to identify trends and compare longevity (Lee, 1992; Lee & Wang, 2003).

c. Results and Discussion

Sample of 1081 speciemens was used to determine age. The age distribution of individuals of *A. laterna* population was found to be between I and V. The natural mortality rates calculated for each age (I-V) group of *A. laterna* inhabiting the Aegean Sea and the life table obtained are presented in the Tab. 1 Consequently, the data estimated indicates that life expectancy of the species in the Aegean Sea is approximately 11 years. Furthermore, the number of individuals likely to survive for over V years from the scald fish population of 1000 individuals was calculated to be some 970.

Age (x)	N_x	D_x	m_x	q_x	p_x	I_x	d_x	L_x	T_x	e_x
I	43	0.823	0.019	0.019	0.981	1000.000	18.958	990.521	10609.070	10.609
II	337	0.737	0.002	0.004	0.995	981.042	4.282	1957.802	9618.547	9.804
III	321	0.701	0.002	0.007	0.993	976.760	6.378	2920.713	7660.745	7.843
IV	312	0.658	0.002	0.008	0.992	976.760	8.205	3890.631	3890.631	3.983
V	68	0.642	0.009	0.046	0.954	970.382	44.751	4740.031	4740.031	4.885

Table 1: The life table for calculated natural mortalities of scaldfish.

Reliability of the estimations obtained by life table analysis requires validity of the assumptions admitted by it. The number of the individuals in the last age group considered in the table in particular of whose future we are not convinced tends to effect estimations of the other age groups. Morever, rates of mortality by ages considered regarded in structuring the table is another factor to affect accuracy of the estimations concerned. Both factors above can be said to be drawbacks of the analysis itself.

Meanwhile number of many species decreases with their genetic diversity gradually becoming extinct. Estimations of howlong the species could further survive in the studies related to biologies of the species of economic value and to their protection of fauna to be likely to extinction and in those involving aquaculture and fisheries have been of great importance.

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Investigation of Growth Features of Perch (Perca fluviatilis L. 1758) Population in Urkmez Dam Lake(Izmir-Turkey)

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Abstract: In this study, the growth properties of perch (*Perca fluviatilis* L. 1758) population living in Urkmez Lake were investigated. The ages of 876 fish specimen which was caught from june 1997 to May 1999 ranged from I-IV. The population was composed of 52.78 % females and 47.22 % males. The fork lengths and weights of caught samples on female and male varied from 15.97 to 32.01 cm, and 15.87 to 31.43 cm and 79.69 to 697.83 g and 80.87 to 674 g, respectively. Length-weight relationships were found as $W= 0.0082*L^{3.2716}$ for males, $W= 0.01*L^{3.2097}$ for females and $W=0.0082*L^{3.2716}$ for combined sex. Growth parameters were estimated as; $L\infty= 49,621$ k=0.205, to= -0835 for males, $L\infty= 49.983$, k=0,212, to= -0.838 for females and $L\infty= 51.16$, k=0,199, to= -0,865 for combined sex.

Key Words :Growth, *Perca fluviatilis*, Length-weight, Urkmez Dam Lake

Introduction

Perch **(*Perca fulivatilis)*** is existent in different regions in Turkey. Geldiay and Balık (1988) announced that this species is existent in Marmara, Black Sea basin, Sapanca and Küçük Çekmece Lakes, Lake Ladik, Samsun, Terma, Northern Anatolia Region, and in rivers between Bafra-Terma.

This species, which is mainly found in fresh water lakes in the Black Sea and Marmara Regions, has not been for in Aegean Region. However, Perca fluvatilis has been introduced to Ürkmez Dam Lake in western Turkey.

When various studies are examined, it is seen that it was examined in various aspects in different countries. For example; Karas (1996) gave information about entrance into the inventory of perches in Baltic Shores, Gutti (1993) about its growing and feeding, Zeh et al. (1989) about spawning and the growing of the eggs, of the perches in the Lake Zürich, and Wheller (1969) about its feeding; Gutti (1993) studied on about its death rate, growing and feeding , Jamet J.L (1994) on its feeding activities, Jamet, J.L., Desmolles, F. (1994) on its growing, breeding and condition. Many studies have been made on this species like the examples provided. However, it is seen that there are not many studies on this species carried out in Turkey. For example, Kır, İ., and Polat (1996-1997) studied on the feeding, Polat, N., and Kır, İ(1996-1997) on the nutiritions of it. There are also few other studies.

Need for studies on this species was felt because of reasons like there have not been many studies on it and especially it was brought into Urkmez Dam Lake subsequently. These studies were needed to monitor its evolution after the dam reservoir was fertilized with perch.

Some growing features of the perch existent in Urkmez Dam Lake were tried to be determined in this study.

Materials and Method

Ürkmez Dam Lake is located 25 kilometers away from the town Menderes in its south eastern part, in the city of İzmir in the Aegean Region in Turkey, where the study was carried out (Figure 1). This dam built for irrigation was put into operation in 1991. The study was carried out between 1997-1998.

Samples were collected with trammel nets and the net existent in the reservoir. The widths of the spaces on the inner wall were 22, 28, 32 and 36 mm and those of the outer wall were 180 and 250 mm. 180 mm outer wall were used for 22 and 28 mm inner wall and 250 mm trammel nets were used for 32 and 36 mm tor nets.

Perches were brought to the laboratory following every fishing, after explanatory information like the catching date, the type of fishing gear and the place of catching was noted. A fish ruler with a sensitivity ± 1 mm was used to measure the length of the perches and a digital scale with a sensitivity of 0.01 g was used to measure the weight of the perches.

Otoliths were evaluated for the determination of age. The otoliths of the samples measured were taken and put to envelopes and kept dry. Afterwards, the otoliths were put into a NaOH solution of 3% in order to clean the particles on them and they were kept in this solution for 15-20 minutes until they are clean. After they are cleaned they were taken out of the solution and put into an alcohol series of 30%, 40%, 50%, 60%, 70% respectively. In the end, they were dried with blotting paper and their ages were determined with binoculars on a black ground in a petri plate including with water in order to make it easy to see the age circles.

Allometric growth equation of $W=aL^b$ was used to observe the relation between length-weight (Gulland, 1969).

$W=aL^b$

Where :

W= The total body weight (g)

L= The fork length (cm)

a and b = Constants

Growth equations developed by von Bertalanffy were used in the calculation of the growth parameters of perches in the reservoir (Sparre and Venema, 1989; Beverton and Hold. 1957).

Growth equation of von Bertalanffy is as follows:

$$Lt = L\infty\left[1 - e^{-k(t-to)}\right]$$

$$Wt = W\infty\left[1 - e^{-k(t-to)}\right]^b$$

L∞ = The length of the fish, it is assumed to have in the eternity (asymptotic length), cm

L∞ = The weight of the fish, it is assumed to have in the eternity, g.

Lt = The length of the fish at the age t, cm

Wt = The weight of the fish at the age t, g.

K = Brody growth coefficient, depending on the speed of the fish to reach the asymptotic length

e = Natural logarithm base

b = Regression constant in the relation of length-weight

to = The age when the length of the fish theoretically zero.

Proportional increase in weight and proportional increase in length, and absolute length and absolute weight were calculated as they are defined by Erkoyuncu (1995).

For proportional increase in length; $OL= [L_t-(L_{t-1})]/(L_{t-1})*100$,

Proportional increase in weight; $OW= [W_t-(W_{t-1})]/(W_{t-1})*100$

For absolute growth in length

$MB= L_2 - L_1$

For absolute growth in weight;

$MB= W_2 - W_1$

Results

876 perches were caught in this study carried out in Ürkmez Dam Lak. 47.72% of the samples examined were male, 52.28% was female. Sex ratio was determined as 1:1.09. Sex ratios according to age groups are shown on Table 1.

Age Groups	Male		Female		Male + Female	
	N	%N	N	%N	N	%N
I	142	16,21	142	16,21	284	32,42
II	209	23,86	233	26,60	442	50,46
III	64	7,31	77	8,80	141	16,09
IV	3	0,34	6	0,67	9	1,03
Total	418	47,72	458	52,28	876	100

Table 1. Distribution of Age, Sex, and Percentage in the Population of *Perca fluviatilis* in Ürkmez Dam Reservoir

The individuals at the ages of I-IV among the samples takes were determined. The reason for not encountering older individuals is that 4 years had passed after this species was put into the reservoir. Considering the distribution ratio as seen in Table 1, the densest group together with females and males is the group of two-year-old individuals with a ratio of 50.46%. The sparsest group is four-year-old individuals with a ratio of 1.03%.

Average lengths according to age groups and sex were determined considering the length distributions of the samples in every age group and average lengths were calculated (Table 2).

	Age Groups			
	I	II	III	IV
	Male			
Observed	15,87	22,41	26,78	31,43
Sx	0,25	0,15	0,45	1,99
Calculated	16,12	22,46	27,61	31,78
Relative increase	15,87	6,54	4,37	4,17
	Female			
Observed	15,97	22,97	27,79	32,01
Sx	0,21	0,13	0,33	0,74
Calculated	15,95	22,39	27,62	31,85
Relative increase	15,97	7	4,82	4,22

Table 2. Average Length Distribution Values Observed and Calculated According to Age Groups and Sex in the Perch Population (cm) (Sx: standard error)

Von Bertalanffy growth equation parameters in the perch population hunted were calculated separately according to male, female and female+male individual groups (Table 3). L∞ was calculated as 49.621 at males, as 49.983 at females and as 51.160 at males and females together.

Sex	L∞ (cm)	K	to(Yıl)	Von Bertalanffy Growth equation
Male	49,621	0,205	-0,835	$Lt = 49.62[1-e^{-0,2054(t-0,8353)}]$
Female	49,983	0,212	-0,838	$Lt = 49.983[1-e^{-0,2126(t-0,8332)}]$
Male + Female	51,160	0,199	-0,865	$Lt = 51.16[1-e^{-0,1997(t-0,8653)}]$

Table 3. Von Bertalanffy Growth Parameters Calculated in the Perch Population (L∞ Eternal length, k-Growth constant, to- The age of the fish when its length was zero)

Average weights according to age groups and sex were determined considering the distributions of the fish in every age group and average weights were calculated (Table 4).

	Age Groups			
	I	II	III	IV
	Male			
Observed	80,87	225,23	411,71	674
Sx	3,82	5,35	22,8	96,94
Calculated	72,01	224,83	424,51	656,04
Relative increase	80,87	144,36	199,60	231,53
	Female			

Observed	79,69	224,94	459,94	697,83
Sx	3,29	4,43	16,89	61,18
Calculated	73,41	218,29	427,98	676,59
Relative increase	79,69	145,25	235	237,89
	Male + Female			
Observed	80,28	225,10	435,825	685,91
Sx	2,53	3,31	14,57	52,50
Calculated	73,25	214,21	418,81	663,60
Relative increase	80,28	144,82	210,73	250

Table 4. Average Weight Values Observed and Calculated According to Age Groups and Sex in the Perch Population (g).

As a result of measurements of the samples taken, Von Bertalanffy growth increase equations for female+male, male and female individuals are shown on Table 5.

Sex	W∞(g)	K	to(Yıl)	Von Bertalanffy Growth equations
Male	49,621	0,205	-0,835	$Wt = 2624{,}05[1-e^{-0{,}2054(t-0{,}8353)}]^{3{,}3379}$
Female	49,983	0,212	-0,838	$Wt = 2872{,}611[1-e^{-0{,}2126(t-0{,}8332)}]^{3{,}2097}$
Male + Female	51,160	0,199	-0,865	$Wt = 3013{,}12[1-e^{-01997(t-0{,}8653)}]^{3{,}2716}$

Table 5. Von Bertalanffy Growth Parameters Calculated in the Perch Population (L∞ Eternal weight, k-Growth constant, to- The age of the fish when its length was zero)

Regression parameters and the length-weight relation equation calculated according to male, female and male+female individuals caught in the Ürkmez Dam Reservoir in the study are shown on Table 6. Length-weight relation among all individuals caught without sex discrimination is shown on Table 2.

Sex	Growth Parameters			Length-Weight Relation Equations
	a	b	r	
Male	0,0066	3,3379	r= 0,9387	$W=0.0082\ L^{3.3379}$
Female	0,01	3,2097	r =0.9341	$W=0{,}01\ L^{3{,}2097}$
Male +Female	0,0082	3,2716	r =0,9385	$W=0{,}0082\ L^{3{,}2716}$

Table 6. Length-Weight Relation Equation and Correlation Coefficient of Perces According to Sexes.

It was determined that the difference among groups is insignificant as a result of the comparison of the values measured and calculated in the every age group for male, female and male+female individuals (Table 7).

	Age	N	Sx	Observed LF	Calculated LF	LF2-LF1	T-Test
Male	I	142	0,25	15,87	16,12	+0,15	P>0.05
	II	209	0,15	22,41	22,46	+0,05	P>0.05
	III	64	0,45	26,78	27,61	+0,83	P>0.05
	IV	3	1,99	31,43	31,78	+0,35	P>0.05
Female	I	142	0,21	15,97	15,95	-0,02	P>0.05
	II	233	0,13	22,46	22,39	-0,07	P>0.05
	III	77	0,33	27,79	27,62	-0,17	P>0.05
	IV	6	0,74	32,01	31,85	-0,16	P>0.05
Male + Female	I	284	0,16	15,93	15,96	+0,03	P>0.05
	II	442	0,1	22,44	22,34	-0,10	P>0.05
	III	141	0,27	27,33	27,57	+0,24	P>0.05
	IV	9	0,59	31,82	31,84	+0,02	P>0.05

Table 7. Importance Check of the Length Distribution Measured among *Perca fluviatilis* Samples and Calculated According to von Bertalanffy and the Difference among Them.

It is observed that considering the average length and the proportional increases in length of the *P. fluviatilis* population measured and calculated according to von Bertalanffy, measured and calculated length values are close to each other, however, proportional increases in length decreases as age increases (Table 8). Similarly, it is observed that considering the measured and calculated weights, the values are close to each other, however, proportional increases in weight decreases as age increases (Table 9).

			Observed			Calculated		
	Age	N	FL	Lt-Lt1	OL	FL	Lt-Lt1	OL
Male	I	142	15,87	_	_	16,12	_	_
	II	209	22,41	6,54	41,21	22,46	6,34	39,33
	III	64	26,78	4,32	19,28	27,61	5,15	22,93
	IV	3	31,43	4,65	17,36	31,78	4,17	15,10
Female	I	142	15,97	_	_	15,95	_	_
	II	233	22,46	6,49	40,64	22,39	6,44	40,38
	III	77	27,79	5,33	23,73	27,62	5,23	23,36
	IV	6	32,01	4,22	15,19	31,85	4,23	15,31
Male + Female	I	284	15,93	_	_	15,96	_	_
	II	442	22,44	6,51	40,87	22,34	6,38	39,97
	III	141	27,33	4,89	21,18	27,57	5,23	23,34
	IV	9	31,82	4,49	16,43	31,84	4,27	15,49

Table 8. Proportional Lengths and Proportional Increases in the Lengths of *Perca fluviatilis* Measured and Calculated According to van Bertalanffy (Lt-Lt1 = Annual Increase in Length, OL= Proportional Increase in Length)

			Observed			Calculated		
	Age	N	W	Wt-t1	OW	W	Wt-Wt1	OL
Male	I	142	80,87	_	_	72,01	_	_
	II	209	225,23	144,36	178,51	224,83	152,82	212,2
	III	64	441,71	186,48	82,79	424,51	199,68	88,81
	IV	3	674	262,29	63,70	656,04	231,68	54,54
Female	I	142	79,69	_	_	73,41	_	_
	II	233	224,94	145,25	182,27	218,29	144,88	197,36
	III	77	459,94	235	104,47	427,98	209,69	96,36
	IV	6	697,83	237,89	51,72	676,59	248,61	58,21
Male + Female	I	284	80,24	_	_	73,25	_	_
	II	442	225,10	120	114,29	214,21	140,96	192,44
	III	141	435,83	210,73	93,62	418,21	204,6	95,51
	IV	9	685,91	250,08	57,38	663,60	244,79	58,44

Table 9. Proportional Weights and Proportional Increases in the Weights of *Perca fluviatilis* Measured and Calculated According to van Bertalanffy (Lt-Lt1 = Annual Increase in Weight, OL= Proportional Increase in Weight)

The importance check of difference of the values was carried out as a result of the calculations of weights calculated and measured on all of the male, female, male+female individuals of the perch population in Ürkmez Dam Reservoir. As a result, it was determined that the difference insignificant (Table 10).

	Age Groups	N	Sx	Observed W1	Calculated W2	W2-W1	T-Test
Male	I	142	3,82	80,87	72,01	-8,86	P>0.05
	II	209	5,35	225,23	224,83	-0,4	P>0.05
	III	64	22,8	411,71	424,51	+12,8	P>0.05

	IV	3	96,94	674	656,04	-17,96	P>0.05
Female	I	142	3,29	79,69	73,41	-6,28	P>0.05
	II	233	4,43	224,94	218,29	-6,65	P>0.05
	III	77	16,89	459,94	427,98	-31,96	P>0.05
	IV	6	61,18	697,83	676,59	-21,24	P>0.05
Male + Female	I	284	2,53	80,28	73,25	-7,03	P>0.05
	II	442	3,31	225,10	214,21	-10,9	P>0.05
	III	141	14,57	435,83	418,81	-17,02	P>0.05
	IV	9	52,17	685,91	663,60	-22,31	P>0.05

Table 10. The Weight Measured on the *Perca fluviatilis* Samples and Calculated According to von Bertalanffy and the Importance Check of the Difference.

Discussion

Sex ratio changes according to species. It changes between two different populations of the same species from year to year, among age groups and according to the reaction of the species to environmental conditions. In general, male:female ratio of many species is 1:1 (Nikolski, 1980; Çetinkaya, 1989; Erkoyuncu, 1995). Çetinkaya (1989) states that the male:female ratio of perch populations may differ between 1:1 and 1:9. It was observed in this study that male:female ratio of the 876 individuals is 1:1,09. Çetinkaya (1989) stated that females are more dominant in the perch populations. Although there is not an apparent difference, females are also more dominant in this study. Treasurer (1993) revealed male:female ratios of perches in three different lakes separately. According to the study stated, male:female ratio is determined as 1:0,95 in Lake Loirston, as 1:0,81 in Lake Sand and as 1:0,89 in Lake Lowers. It is observed that they are close to the values in Lake Ürkmez.

Çetinkaya (1989) stated that perches can live until the age of 13. The oldest perches found in the Ürkmez Dam Resevoir are IV years old. The reason for this is the fact that those fish were brought to this dam reservoir subsequently and there were no individuals older than IV years of age in the hunting period.

Treasurer (1993) determined the average length value distributions of perches according to ages in his study in the lakes of Northeastern Scotland. According to this study, the average age distribution of I year of age in Lake Loriston was 5.81cm and that of II years of age was 11.81 cm. The average age distributions of the older individuals in this lake were not stated. It was stated as 6.20 cm in I-year-old age group, 12.82 cm in II-years-old age group, 18.25 cm in III-years-old age group in Lake Sand. It was stated as 8.03 cm in I-year-old group group, 15.69 cm in II-years-old age group, 20.61 cm in III-years-old age group and 24.2 cm in IV-years-old age group in Lake Lower, his another area of study. Average length in Lake Ürkmez was calculated as 15.93 cm in I-year-old age group, 22.44 cm in II-years-old age group, 27.33 cm in III-years-old age group and 27.33 cm in IV-years-old age group. Comparison of those values shows that the average length of the perches in the Lake Ürkmez is longer than the others. One of the reasons for that is the fact that as is known, water temperature affects the growth of fish. Ürkmez Dam Reservoir in Turkey is in far south of the lakes in Scotland and is in a warmer region. This may have caused the perches in Turkey to grow more. Salatenko (1955-56) stated this species as 10,75 cm at the age of I, 18.63 cm at the age of II, 24.33 cm at the age of III and 27.80 cm at the age of IV, however, as there was no explanation about the place, no comments could be made.

The average weights according ages were determined as 80.24 g. at the age of I, 225.10 g. at the age of II, 435.83 g. at the age of III and 689.91 g. at the age IV. Çelikkale, 1994 and Slastenenko, 1955-56 stated that this species weighed 45 g. at the age I, 145.5 g. at the age of II, 277.3 g. at the age of III and 522 g. at the age of IV. As it is the case in their lengths, the weights of the perches in Ürkmez Dam Reservoir are more than those values. The fact that they are in this warm region and so they grow faster and probably the fact that they do not have nutrition problems result in their fast growth.

Treasurer (1993) calculated the $L\infty$ values of the perches in Loirston, Send and Lower Lakes. At the end of his study, he calculated the $L\infty$ values of only the female individuals in Loirston as 31.6 and calculated the $L\infty$ values of only the male individuals in Lower as 29,0. He made calculations for both of the sexes in Lake Sand; found the $L\infty$ value of the male individuals as 37.9 and the $L\infty$ of the female individuals as 35.1. The $L\infty$ value of the male individuals was found to be 49.62 and the $L\infty$ value of the female individuals was found to be 49.98 in Ürkmez Dam Reservoir. The reason for the fact that $L\infty$ value of the perches in this lake is higher than the other lakes is predicted to stem from biotic and abiotic factors of the lake. Berg (1965) stated that the maximum length this species can reach can be between 30-51 cm. Wheller (1969), Geldiay and Balık (1988) stated that the maximum length of this species can reach up to 50 cm. As a result of the calculations performed, the $L\infty$ value for Ürkmez Dam lake is found to be close to the maximum value of 51 cm determined by (Berg 1965).

Considering the values obtained as a result of the study, this species can grow fast according to the conditions of the water it is in. That is why; this species can be utilized by the pisciculture of it. However, as it is a carnivorous species, pisciculture areas of it should be selected well. It should be carried out in risk free places as the fish may escape The fact that it is carnivorous may be a disadvantage for pisciculture areas but it will create an advantage for sport fishing.

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The Research of Diesel Engine Performance Using Neutralized Safflower Oil as Fuel

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Abstract: Vegetable oils for use as fuel are one of the methods of use of biofuels. However, high viscosity of vegetable oils causes to some problems use long period. The problem was either solved modified vegetable oil or by modified engine. The effect of some of the physical properties of diesel fuel and safflower oil on the engine performance with kit were measured and compared in the study. In this study funded by a project of TÜBİTAK 108 O 419, fuel properties of safflower oil was investigated and transforming safflower oil to standard fuel (DIN V 51605) and its direct usage in the diesel engine with aid of a designed kit was studied. Diesel engine which is a four-stroke, single-cylinder, 15 kW was used for laboratory tests. The engine operated under 40-50% load for 1000 hours. According to the results of this research, there was 10,18% change in torque and 22,43% power engine data in comparison with diesel fuel when the safflower oil and diesel fuel were used.

Keywords: Diesel Engine, Vegetable oil, Neutralize**,** Safflower oil, Kit

Introduction

Diesel fuels play an important role in the industrial economy of a country. These fuels run major part of the transport sector and their demand is increasing steadily, requiring an alternative fuel which is technically feasible, economically competitive, environmentally acceptable, and readily available (Bouaid, et al, 2005). Vegetable oils are widely available from various sources, and the glycerides present in the oils can be considered as a viable alternative for diesel fuel. The heating value of vegetable oils is similar to that of diesel fuel.
Therefore vegetable oil which was the first fuel of diesel engines has become the focus point of all researches again. Our country, as an agricultural country, has got great biomass resources. Renewable energy sources have an importance by the point of using them as alternative engine fuels (Oğuz, 2004).

Related to vegetable oils (DIN V 51605) the direct use as a fuel without appropriate standards occurs to cause the problem to the fuel injection pumps, injectors and combustion chamber in engines. Therefore, to reduce viscosity or to make the standards oil is to done investigations (Oğuz et. al, 2009)

Vegetable oils can be used directly as fuel engine without converted for biodiesel. In this case, running the engine with diesel fuel and vegetable oil must be heated. Used as fuel directly of vegetable oil in is not notice of the new oil or waste oil fries (Öğüt & Oğuz 2006). The standardized of vegetable oils were prepared by researcher. This standard was given in Table 1.

characteristics/	**units**	**limiting values**		**test procedure**
substances		**min.**	**max.**	
characteristic properties				
Density (15ºc)	kg/m3	900	930	DIN EN ISO 3675 DIN EN ISO 12185
Flash point	° C	220		DIN EN ISO 22719
Calorific value	kJ/kg	35,000		DIN 51900-3
Kinematic viscosity (40 °C)	Mm2/s		38	DIN EN ISO 3104
Behaviour at low temperatures				rotation viscosimetry
Cetane number				process is being evaluated
Coke residues	% by mass		0.40	DIN EN ISO 10370
Iodine number	G/100g	100	120	DIN 53241-1
Sulphur content	mg/kg		20	ASTM D 5453-93
Variable characteristics				
Total contamination	mg/kg		25	DIN EN 12662
Neutralisation value	Mg KOH/g		2.0	DIN EN ISO 660
Oxidation stability	h	5.0		ISO 6886
Phosphor content	mg/kg		15	ASTM D3231-99
Ash content	% by mass		0.01	DIN EN ISO 6245
Water content	% by mass		0.075	pr EN ISO 12937

Table 1. Quality standard for rapeseed oil as a fuel (DIN V 51605)

Vegetable oils do not contain any sulphur, aromatic hydrocarbons, metals or crude oil residues. The absence of sulphur means a reduction in the formation of acid rain by sulphate emissions which generate sulphuric acid in our atmosphere. The reduced sulphur in the blend will also decrease the levels of corrosive sulphuric acid accumulating in the engine crankcase oil over time (Almeida, et al.2002).

Procedure

Safflower Oil Was Neutralized

Natural oils physical properties vary widely, even though they are composed of the some or similar faty acids. These differences result from differences in the proportion of the fatty acids and the structure of the individual triglycerides. Among the factors that effective the vegetable oil fatty acid compositions are climate conditions, soil type, growing season, plant maturity, plant health, microbiological seed location within the flower, and the genetic, variation of the plant (Brien, 1998).

The safflower oil was neutralized in this study. Therefore a pilot production plant was used. The Photo of a pilot production plant was given in figure 1. For neutralized process raw safflower oil into reactor and was heated up to 85 ^{o}C. Water was heated up to 85 ^{o}C other tank. Phosphoric acid is added to safflower oil at a rate of 0,002 were mixed for 10 minutes. Than liquids of 5% diluted caustic were mixed with safflower oil for 5 minutes. Finally, with water up to 10% safflower oil was washed with a shower method. Phase expected to occur by 60 minutes and the right bottom of the wash water and other substances that accumulated were taken. Then the safflower oil and their blending dried under vacuum at 100 ^{o}C. Neutralizing the safflower oil is heated up to 85 ^{o}C again. 0.01 percent of soil was given slowly bleaching and bleaching operations were. Soil taken from the bottom of the oil in the bleaching process has been completed.

Fig 1: Pilot Production Plant

2.2 The determination of safflower oil properties and diesel fuel.

The properties of safflower oil and diesel fuel tested in Selcuk University Faculty of Agriculture are shown in Table 2. As shown in the table, diesel fuel has the higher calorific value and the lower viscosity.

	Diesel Fuel	Raw Safflower Oil	***DIN V 51605***	
			Min -	Max
Density at 15 ºC (kg/m^3)	826,4	925,3	900	930
Kinematic viscosity (mm^2/s) at 40 ºC	2,745	31,51	-	36
pH	-	5,5	-	-
Copper Strip Corrosion (3 hours at 50 °C)	1a	1a	-	-
Flash Point (ºC)	60	158	220	-
Colour	1,7	2,0	-	-
Water Content (mg/kg)	29,168	419,17	-	750
Iodine value (g iyot/100g)	-	117,9	95	120

Acid Value (mg KOH/g)	-		-	2,0
Calorific value (kJ/kg)	46581	38997	36000	-
Cetane Number	58,38	49,31		
Cloud point, ºC	-12	-13,3		
Flow point, ºC	-28	-14		
Phosphor content, mg/kg		5,56		

Table 2: The properties of neutralized safflower oil and diesel fuel and their comparison with standard values

Kit Is Installed in Diesel Engine and Working Together

The engine must be started in the diesel fuel position. After the engine has started you can over to straight vegetable oil (SVO) immediately. The green led is on over the control panel now. After reaching the engine operation temperature (70 °C), blue led is off, the system will switch really over to SVO-run, and the yellow led is off. Until this time the engine will run on diesel fuel. Finally it needs two conditions to run on SVO: first, the switch must be in position SVO and second, the engine must be warm. The engine should run with diesel fuel before you stop it as log as it needs replace the SVO in the injection system with diesel fuel.

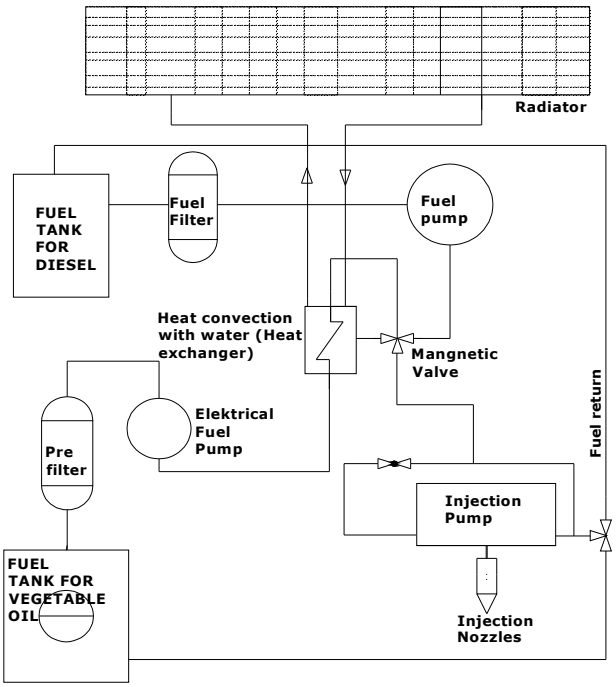

Fig. 2: Shape of kit with use of vegetable oil

Fig.3: The photos on shows the kit installed in a diesel engine.

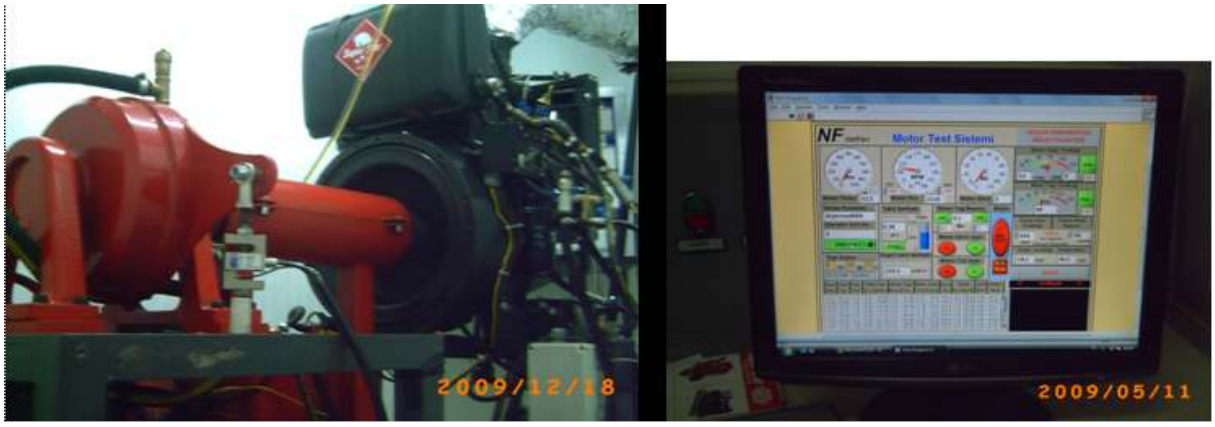

Fig. 4: The engine test rig and control unit.

Experimental Study

Facilities to monitor and control engine variables, such as engine speed, torque, power, fuel consumption, specific fuel consumption, water and lubrication oil temperatures etc., are installed on a fully automated test bed (shown in Fig. 4), single cylinder, water cooled, Super Star, experimental standard engine located at the first author's laboratory which is supported The Scientific and Technological Research Council of Turkey (TÜBİTAK). On the test bed, the engine is coupled to a hydraulic dynamometer. General properties of diesel engine are shown in Table 3.

	Unit	
Model		Super Star
Cylinder Number		1
Type		four stroke, direct injection
Fuel		Diesel
Cylinder Bore	mm	108
Piston stroke	mm	100
Volum	liter	0,92
Compression ratio		17:1
Max. Power	BG	15
Max. Torque	Nm	60
Fuel pomp		Bosch Type
Cooling		Water cooled

Table 3: General properties of diesel engine

A plan was designed for the experimental investigation. The engine was ran once diesel fuel than its ran safflower oil with kit on full loads and on different engine speed. The engine speed was controlled by the control panel. During the tests, the parameters were recorded such as engine power, torque, fuel consumption, specific fuel consumption, and emissions.

Result and Discussion

The experimental results show that the engine performance – power, torque, fuel consumption and specific fuel consumption are comparable to diesel when fueled with safflower oil. The test results are shown in the following figures 5-8. Figure 5. shows the test results of the engine power outputs for diesel fuel and safflower oil with kit as fuels.

Researchers in various countries carried out many experimental works using vegetable oils as diesel engine fuel substitutes. These results showed that thermal efficiency was comparable to that of diesel with 22,43% amounts of power loss while using safflower oils and there was 10,18% change in torque (fig. 6). Safflower oil can be used as fuel in diesel engines with kit.

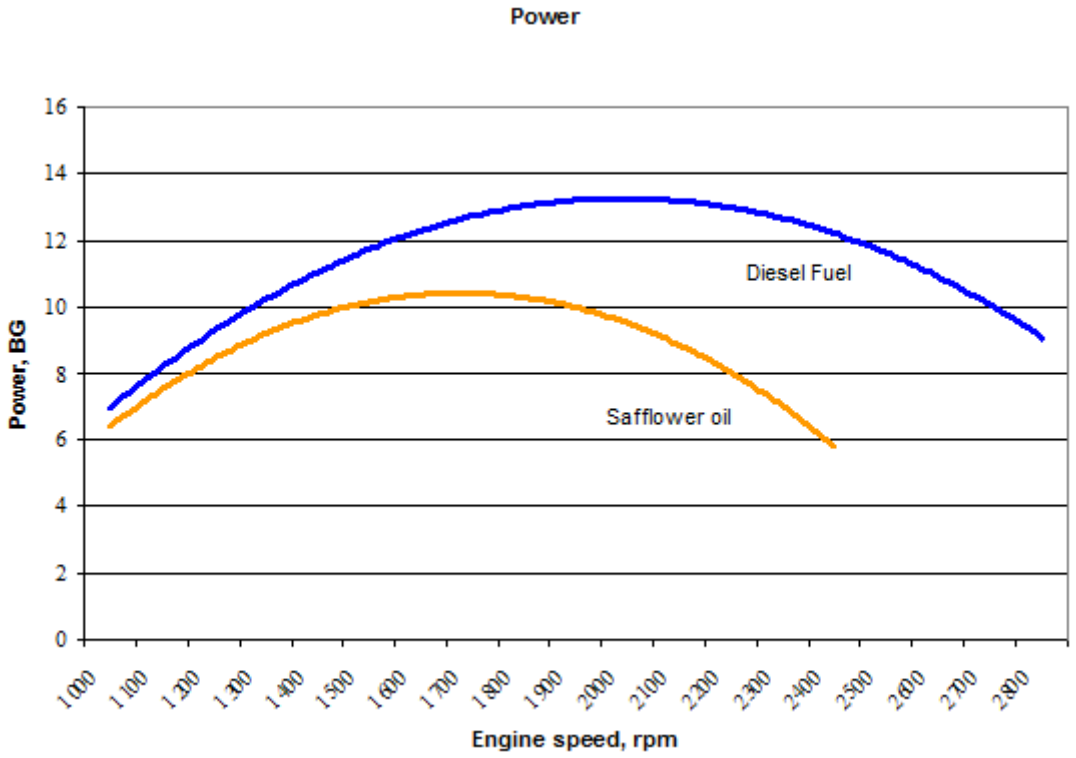

Figure 5: The comparison of engine power of diesel fuel and safflower oil as fuels with kit.

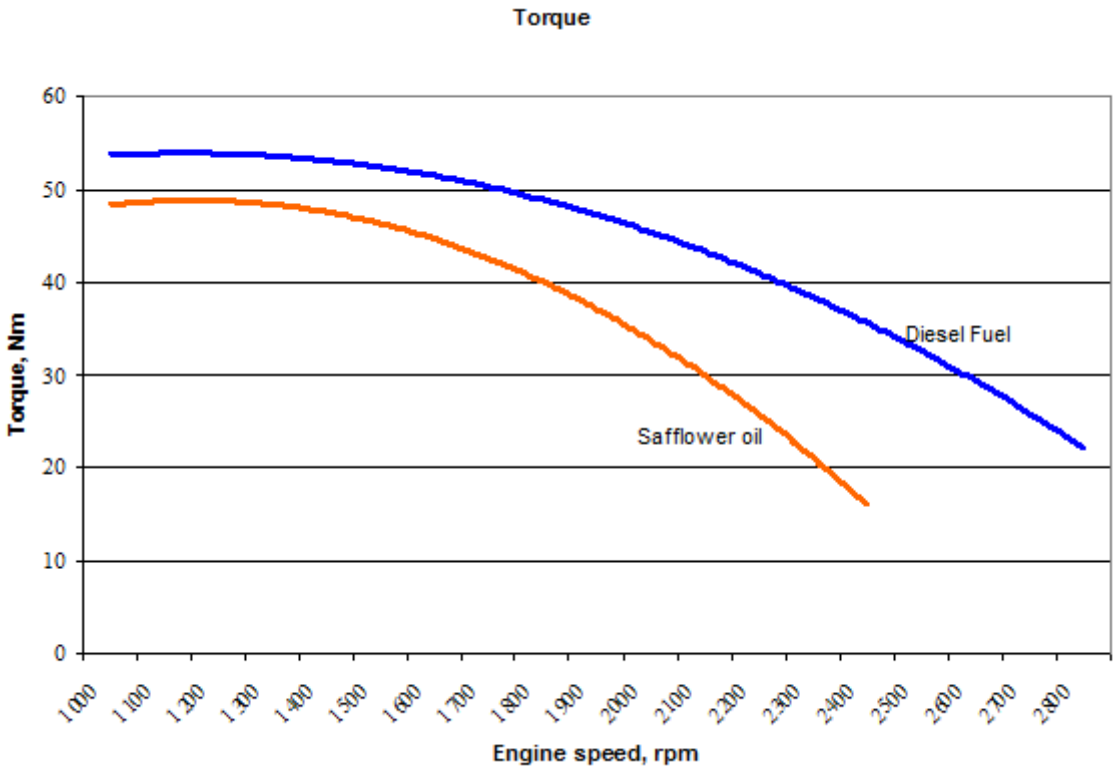

Figure 6: The comparison of engine torque of diesel fuel and safflower oil as fuels with kit.

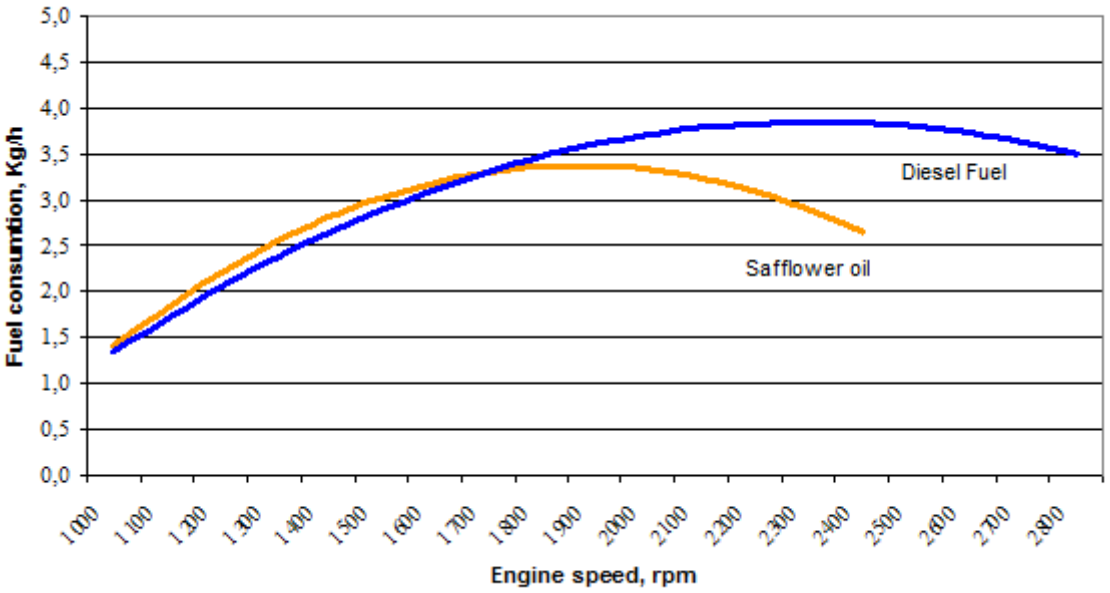

Figure 7: The comparison of engine fuel consumption of diesel fuel and safflower oil as fuels with kit.

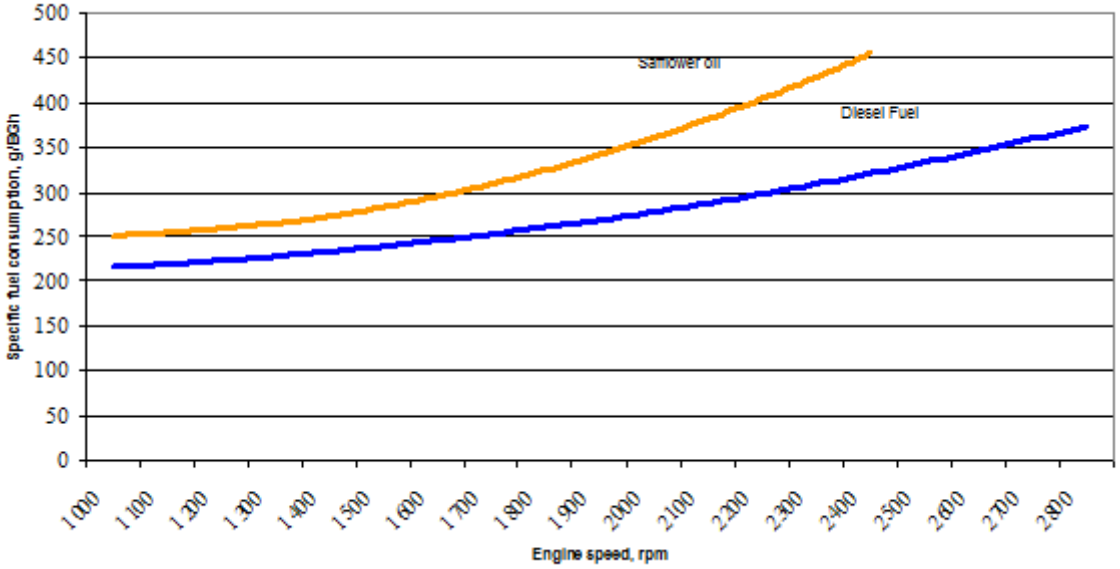

Figure 8: The comparison of engine specific fuel consumption of diesel fuel and safflower oil as fuels with kit.

Specific fuel consumption increased with increase of engine speed. Because of the low calorific value of safflower oil, specific fuel consumption is high up. The engine performance of the safflower oil was not similar to that of diesel fuel and with higher fuel consumption reflecting their lower energy content.

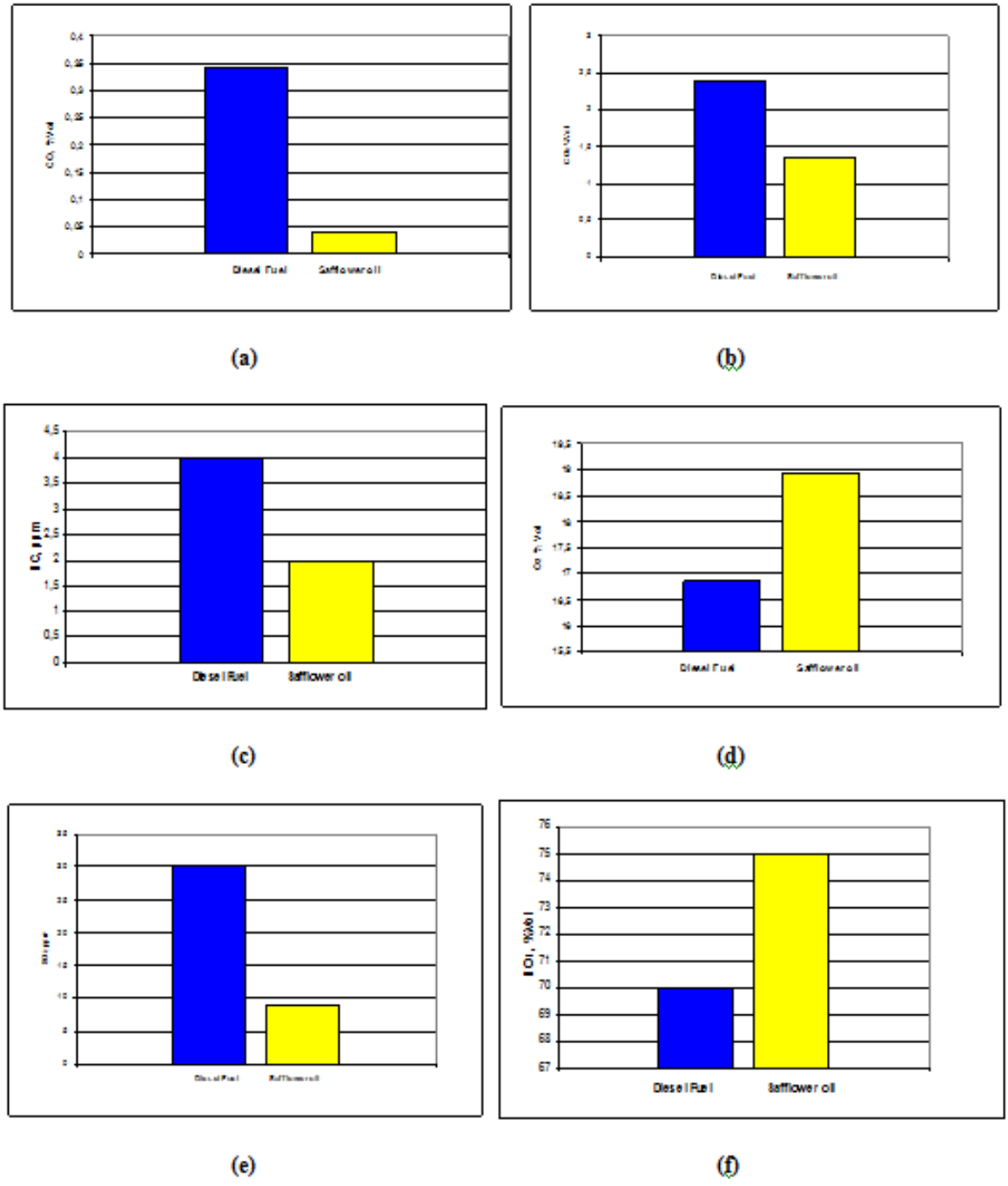

Figure 9: The comparison of CO, CO_2, HC, O_2, NO_x, and SO_2 emissions of diesel fuel and safflower oil

The fuel type on the gaseous emissions of CO, CO_2, HC, O_2, SO2 and NO_x, are shown from Figure 9 at 1500 1/min of engine speed. The CO emission from the diesel fuels is higher than that from safflower oil. This is possibly due to at the engine full load, the temperature in the cylinder of engine is higher, which makes the safflower oil easier to atomize, a better air/fuel mixture and then a better combustion can be achieved; with kit and the oxygen contents in the safflower oil makes it easier to be burnt at higher temperature in the cylinder.

HC and SO_2 emissions of safflower oil are lower than that of diesel fuel. The safflower oil produced NOx emissions that were 7 % higher than the diesel fuel.

The use of safflower oil as diesel engine fuels can play a vital role in helping the developed world to reduce the environmental impact of fossil fuels.

As a conclusion, safflower oil, in diesel engines can be used as an alternative fuel with kit. The advantages are biodegradability, their emission values are low; in addition they can be supplied by means of the energy in agriculture sector with their own facilities.

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Friction Welding And Its Applications In Today's World

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Abstract : By developing technology of today, the necessity of using different materials by joining came out. The most suitable method in joining two different alloyed steel is to weld. The fact that the properties of welding zone are naturally different from the properties of steels in different alloyed at post welding process has came up and these differences occur some important problems. Among many kinds of welding methods, using the melting welding methods has also increased the number of these problems. However, in the connecting zone, many different zones come out by depending on composition and properties of the connecting materials. Deposite remain of the melting welding methods, welding faults of porosity and inside tightens of cooling are the important disadvantages of these methods and they decreases the strength of welding. For this reason, solid state welding methods are more suitable due to these melting welding faults. The most important and applicability of these methods are friction welding. For these reasons, in this study importance and application areas of friction welding were explained.

1. Introduction

The ideas of using heat obtained by friction in welding and forming of materials are not new. Friction welding obtained by frictional heat is a commercial process, which has found several applications in different parts of the world with the advancement in technology. First, simple devices having lathe machine type and metal rods have been used in butt welding trials. However, these studies can onl be regarded as preliminary technical trials with little practical importance. The firts trial of friction welding goes back to the 15th century and the first patent was granted to J.H. Bevington, who then was a machinist. Bevington first applied friction welding in elding of metal pipes. Friction welding which was first applied to cutting tools in metal processing industry has found several applications. W. Richter patented the friction welding process in 1924 (in England) and 1929 (in Germany) and H.Klopstock patented the same proces in the USSR (1924). H. Klopstock and A.R. Neelands obtained a patent for friction welding of cylindrical parts. Studies on welding of plastic materials were carried out in the 1940s in the USA and Germany [1, 2]. A Russian machinist named A. J. Chdikov has realized scientific studies and suggested the use of this welding method as a commercial process. He has successfully done a welding process between two metal rods and patented this process in 1956. Vill and his colleagues have further investigated the process with a number of studies. Researchers of American Machine and Foundry Corporation named Holland and Cheng have worked on thermal and parametrical analysis of friction welding [3]. By the way, the first studies of fricton welding in England were carried out by the Welding Institute in 1961. By modifying the friction welding, the Caterpillar Tractor Co. in the USA developed the method of inertia welding in 1962. After this study, conventional friction welding has been regarded as the Russian type process and inertia welding as the Caterpillar type process. With these advances, applications of friction welding have found several applications throughout the world. Friction welding is one of the most widely used welding methods in the industry after electron beam welding [4].

This study addresses friction welding, its significance and types, welding capability, welding parameters and their applications.

2. Friction Welding

All welding methods can be investigated in one of the two main categories; melt and pressure welding. Friction welding is a type of pressurized welding method. Friction welding is a solid state process, where no electric or other power sources are used, mechanical energy produced by friction in the interface of parts to be welded are utilized. Using heat efficiently in the welding region is only possible by efficiently distributing heat on surfaces, to which welding will be applied. During the welding process, surfaces are under pressure and this period called the heating phase continues until plastic forming temperature is achieved. The temperature in the welding region for steels is between 900 and 1300 ^{o}C. Heated metal at the interface accumulates by incerasing pressure after heating phase. Thus, a type of thermomechanical treatment occurs in the welding region and this region has stable particle structure. Metals and alloys, which cannot be welded by other welding methods, can be welded using friction welding. In order to obtain welding connection between parts, untreated surfaces need to be contacted to one another. This contact is efficient because friction corrects contacting problems. The melting process does not normaly occur on contacted surfaces. Even though, a small amount of melting may occur, accumulation caused by post-welding process makes it invisible. Figure 1 gives the stages of friction welding. One of the parts is stationary while the other one rotates (Figure 1_1). When the roational speed rises to a certain value, axial pressure is applied and locational heating occurs in parts at the interface. Then, rotation is stopped, heated material at the interface accumulates (Figure 1_3) [5, 6]. The stages of friction welding during the welding process are given in Figure 2 [7].

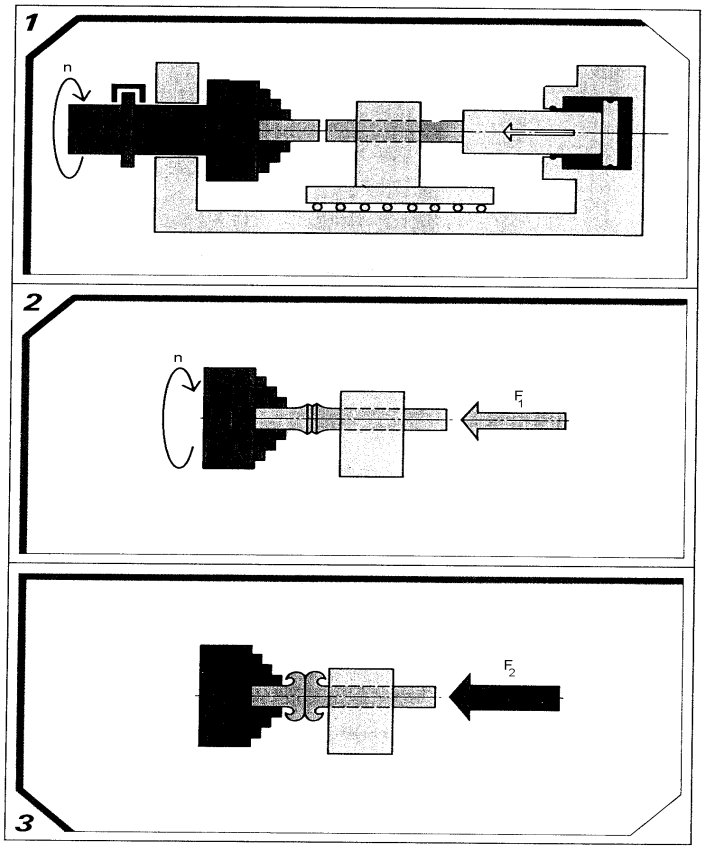


Figure 1. The schematic stages of friction welding [7].

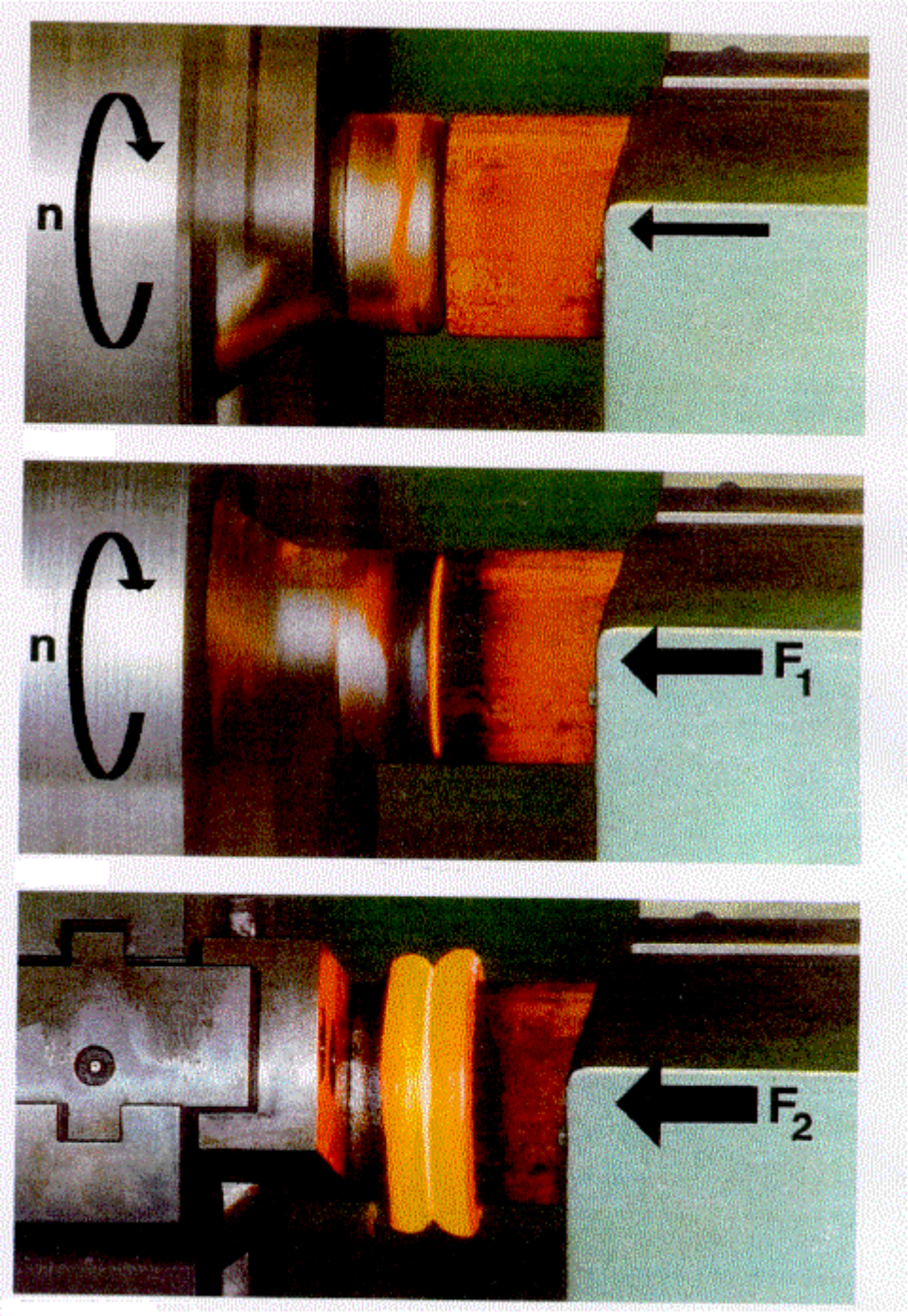


Figure 2. Actual look of friction welding process [11].

Applications of friction welding are generally used in the welding of pipes and circular rods. The basic movement in this kind of application is the rotational movement causing friction [8]. Figure 3 shows conventional friction welding methods in joining of certain size rods and pipes.

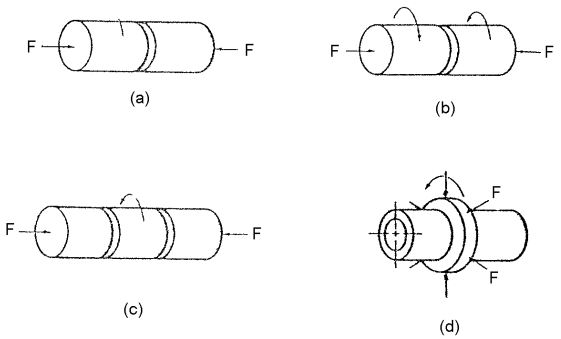


Figure 3. Applications of friction welding [9, 10].

Figure 3-a shows the most simple and used application. In this application, the axes of parts to be welded are the same and rotate around other axes. Under the rotational pressure, friction forces occur on cotact surfaces. Figure 3.b suits best to the small size samples requiring higher rotational speed. It is used in applications where higher relative rotational speeds are required. Figure 3.c is for the applications where parts being very long are efficiently joined. Even though it could not find widespread applications, Figure 3.d is mainly used in welding of pipes rotating under radial forces [9, 10].

It needs to be known that a high quality welding connection can only occur in parts having claen and smooth surfaces. Several inclusions, oxides formed on the surface, films absorbed by the surface are always present and negatively affects bond formation and welding quality. These problems are removed from welding connections by wearing off surfaces during friction [8].

In friction welding, orbital movement as well as rotational movement, linear vibration movement and angular vibration movement can be applied. Orbital movement is fr the welding of non-cylindrical parts. Application shown in Figure 4 is between a stable part and a part rotating circularly [5].

Figure 4. Friction welding including orbital movement [5].

One of the parts in figure 5 moves forward and backward in linear vibration movement. This method has firs been suggested by Vill. In angular vibration movement, one of the parts makes an orbital movement under applied pressure [3].

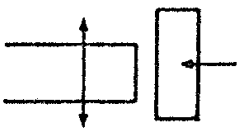


Figure 5. Friction welding including linear rotation movement [3].

2. 1. Types of Friction Welding

Friction welding can be applied by using one of the two methods depending on the source of mechanical energy. With current advances, a combined welding method including both of the methods aforementioned has been developed. These are continuous driven friction welding, flywheel driven friction welding and a combination of the two [1, 5].

2.1.1. Continuously Induced Friction Welding

A inducement driven group provides the necessary energy for rotation. Mechanical energy is converted to heat by applying pressure from rotating part to non-rotating part. This method is generally mentioned in the literature for friction welding. One of the parts is connected to the engine inducement unit and rotates at a constant velocity; a constant axial force is applied to parts. Working parts interact with each other during welding or until axial shortening occurs. Then, braking system stops the process. Pressure applied during welding is increased and stays at a certain value until weld cools down. The essential welding parameters are rpm, friction force on the surface, the length of friction period, forging force and forging time [1, 5].

A schematic of continuous inducement friction welding machine is given in Figure 6 and process parameters in Figure 7.

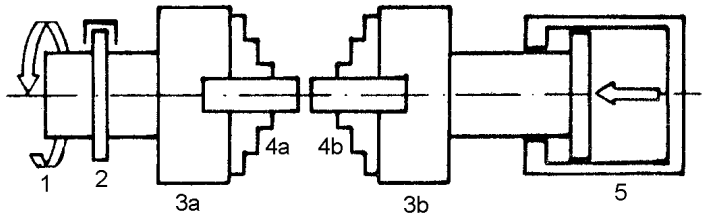


Figure 6. A schematic of continuous inducement friction welding machine [1, 5].
(1.Inducement engine, 2. Brake 3 a. Spindle of rotating working part, 3 b. Spindle of stationary working part, 4 a. Rotating working part, 4 b. Stationary working part, 5. Accumulation cylinder)

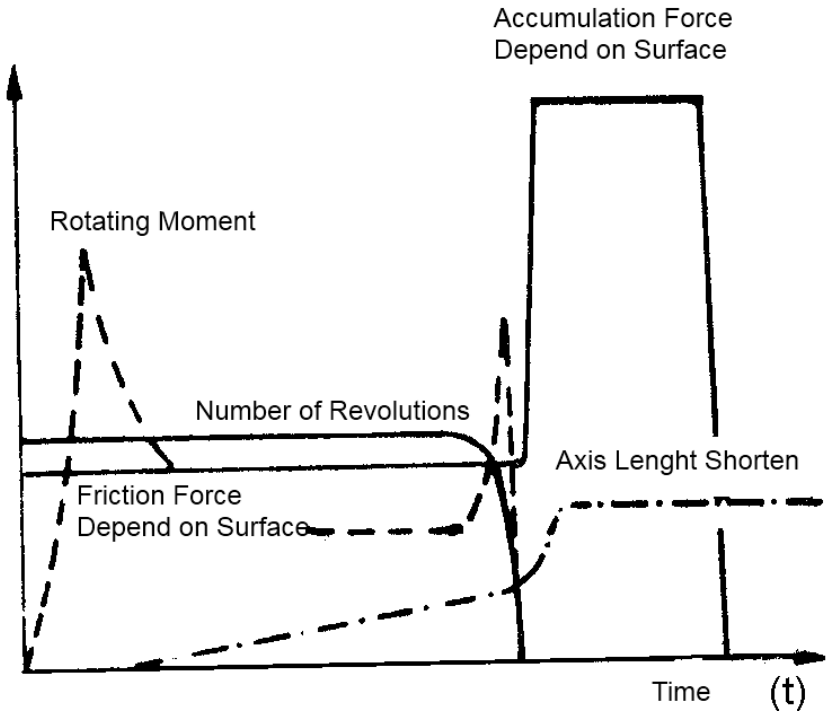


Figure 7. Process Parameters versus time in friction welding [1, 5].

2.1.1. Flywheel Induced Friction Welding

In this welding method, flywheel induced system constantly rotates and is joined to flywheel shaft system to achieve a certain speed. After reaching a certain speed, engine flywheel is separated from shaft flywheel. Shaft flywheel having a low moment of inertia stops without braking. Therefore, this welding method is known as welding of inertia in the literature. One of the parts is connected to the flywheel and accelerates at a certain speed and thus mechanical energy is stored in the flywheel. Then, the two parts are contacted and a certain welding pressure is applied. Parts under this pressure interact with each other and energy stored in the flywheel is spent for friction. The speed of flywheel decreases as welding region heats up. In some circumstances, pressure is increased before flywheel completely stop and the effect continues for some time. Flywheel induced friction welding has better seam, narrower ITAB region, better serial production, lower power need and more simple apparatus than continuous induced friction welding. The essential welding parameters are rpm, forging force on the surface, the mass of flywheel, and forging time [1, 5].

A schematic of flywheel induced friction welding machine is given in Figure 8 and process parameters in Figure 9.

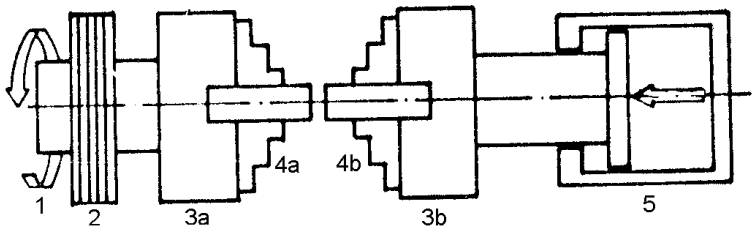


Figure 8. A schematic of flywheel induced friction welding machine [1, 5].
(1.Inducement engine, 2. Changeable Flywhell, 3 a. Spindle of rotating working part, 3 b. Spindle of stationary working part, 4 a. Rotating working part, 4 b. Stationary working part, 5. Accumulation cylinder)

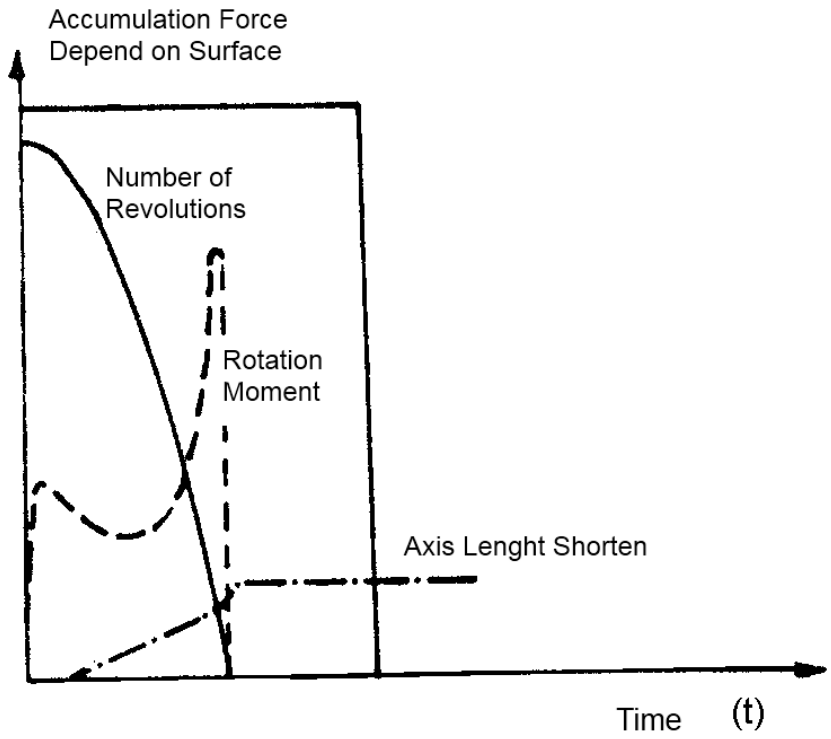


Figure 9. Process Parameters versus time in flywheel induced friction welding [1, 5].

2.1.3. Combined (Hybrid) Friction Welding

This method is a combination of aforementioned the two methods of friction welding. It has advantages in joining parts with high capacity. This method is also sometimes termed as flywheel induced friction welding. The essential welding parameters are rpm, friction force on the surface, the length of friction time, and forging time on the surface, forging time and time of brake [1, 5]. Process parameters for the combined friction welding is given in Figure 10.

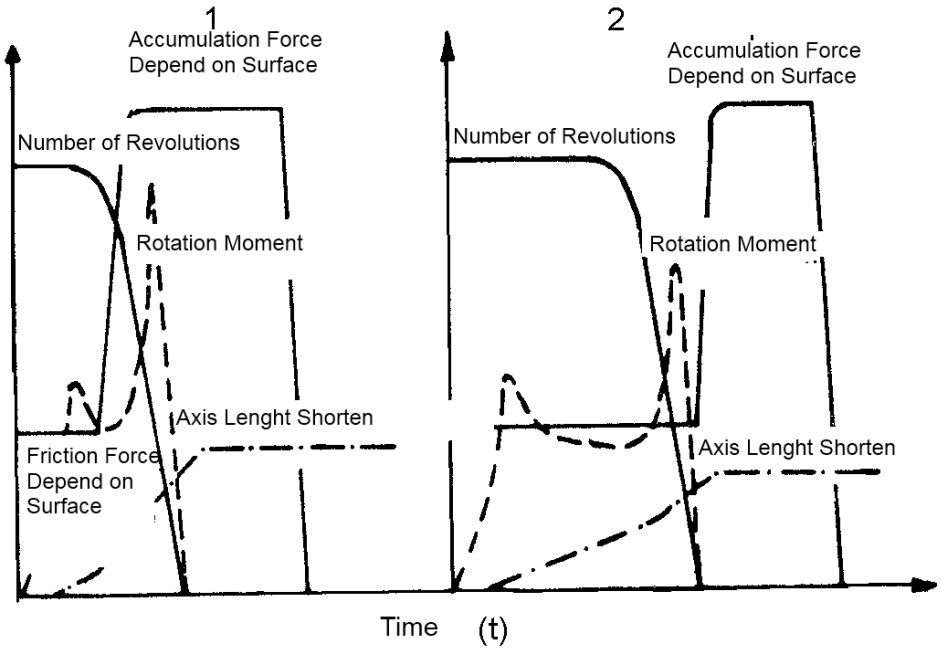


Figure 10. Process Parameters versus time in combined friction welding [1, 5].

The process of welding includes friction and accumulation stages as given in Figures 7, 9, and 10. Moment curves are essential to understanding of process parameters in all the welding methods studied. Dry friction between parts exists in the beginning of process and moment curve stabilizes after reaching the maxima.

Naked surface interactions increase due to disintegration of oxide layers among contacted surfaces and strong atomic bonding occurs as a result of these interactions. These bonds are forced to be broken due to friction. However, strong adhesion forces occur, moment increases and temperature reaches to the desired level. Velocity decreases quickly due to braking and moment becomes zero [1, 5].

2.2. Expected Properties of Friction Welding Machine

Friction welding machines are generally similar to lathe and drill. The first friction welding machines are modified forms of these machine tools. The schematic of friction welding machine is given in Figure 6 or Figure 8. As can be seen from the figures, a friction melding machine has the main body, joining parts, rotate and accumulate mechanisms, brake system, power supply, control unit and control panel. Fricton welding machines are all-mechanized machines. Joining and releasing of parts, turning of capaklar produced due to accumulation after welding are automatically accomplished. The main functions in friction welding are joining, compressing and releasing of parts, rotation and friction under pressure, braking, accumulation and meticulous adjustments of required processing times.

Sample joining apparatus needs to have a certain rigidity, must resist increased moments, must eliminate vibrations and leaks. Especially, possible vibrations during welding process need to be taken into account while designing the friction welding machine. In addition to vibrations, other radial and axial forces have to be accounted for. Therefore, joining apparatus has to have a design which will counter compressing forces. For this process, V type two chaps or special chaps are used [6].

All stopping apparatus used to hold friction equipment must be highly dependable. A slight deformation in parts to be joined may result in a low quality welding and may also damage brake system. Brake systems automatically centerd are used in most of the applications. Friction welding machines have certain particle size and material limitations. For example, a machine having 120KN compressed force and 15KW electric engine can be used in the welding of stells with cross-sectional areas of 130-800mm^2. All machines can be adjusted to meet certain specifications and can automatically be controlled. This process is sometimes done by just manually turning off the switch or protectors [11].

2.3. The Suitability of Friction Welding and Friction Welding Capability of Materials

Knowledge on material properties and applicability of metallic materials and material combinations for friction welding is not completely clear. Experimental studies and practical applications have been giben to address this problem. Preliminary trilas have been carried out in order to determine optimum parameters of welding, the applicability of welding process for every new material or material combinations. The results of these studies are not concrete since they are experimental. They can be modified or redefines as new facts come out [12, 13].

The citeria needed for other welding methods are not valid for friction welding because friction welding is applied to materials which can not be processed with other welding methods [10].

The strength of a material and its deformation capacity under heat are the two parameters needed for the test of suitability of a material to welding. The strength of material has to be high enough to resist axial pressure and torque, which may occur due to excessive deformation. Morover, the material to be joined needs to exhibit enough heat treatment deformation behavior for the quality of joining process [12].

Materials and their combinations can be categorized into two groups depending upon the characteristics of materials to be joined. The first group of materials are the ones showing the same type of heating behavior and the second group includes materials having different hor material strength and melting temperatures. The direct welding process is applied to the first group of materials. But, preliminary trials are carried out for the second group of materials before applying welding process [10].

Several iron based and non-iron materials can be joined using the friction welding. In addition, friction welding can be used in joining of metals exhibiting different thermal and mechanical properties. Most of the time, these materials can not be processed using conventional welding methods. Friction welding method is more preferred than any other conventional welding method because metals can be joined at temperatures lower than their melting point and welding time is a lot shorter. Friction welding of metals having different thermal amd mechanical properties causes asymmetrical deformations. A higher welding strength is generally achieved for the materials giving symmetrical deformations. To achive this, Vill suggested a 15 to 25% increase in ductile parts during the welding process [11].

Any material not having good friction properties but forgable with friction welding can easily be welded. Alloy elements supplying dry oiling prevent the joining section from reaching welding temperature.

Ferrous based material from soft steel to high alloyed steels can be processed using friction welding. Steels with lower strength can be more easily joined with a large parameter range. High alloyed steels, on the other hand, requires critical processing parameter range and higer axial forces. Heat-treated stainless steels can be welded in a more sensitive parameter range just as in high alloyed steels. For high alloyed steels, higher forces on the surface and long friction time are needed due to their lower deformation capability. Especially for “air watered steels”, a suitable ITAB region is required to minimize cooling rate of welding region. Since crack formation is very fast in high strength materials, joined surfaces have to be rid of crack effects [11].

Sintered materials, Al, Cu, Ti, tr, Mg alloys, heat resistant Ni and Co alloys and refractory materials such as Ta and Mo alloys can successfully be joined by friction welding [13].

- Austentistics steels due to their higher ductility and heat deformation capability need lower friction time and pressure,

- Higher stregh alloys due to their lower heat conductivity and higher heat strength capability need higher friction time and lower friction pressure,

- Cu, Al, Ti and their alloys are subjected to friction welding at higher rpm and lower friction pressures.

A successful friction welding can not be achived in some metals and alloys due to their inherent metallurgical properties.

These are as follows:
- All pig iron due to its friction temperature limitation caused by free graphite,
- bronze and grass having Pb concentration of more than 0.3% and automat steels having S or Pb concentrations more than 0.13%,
-highly anisotropic materials due to their high fractureability in the transtition region
-materials having graphite, Mn, S and free Pb in their structure [10, 13].

2.4. Preparation of Materials for Friction Welding and the Design

Parts to be processed using griction welding method have different design considerations from those processed with conventional welding methods. Paint, oil and other impurities do not pose a problem in friction welding. Though not preferred, surfaces cut by oxygen can be welded. Moreover, additional layer on the surface such as corrosion layer does not affect welding process. However, thick oxide layers, pin sand needles on the surfaces, deep cuts and holes habe to be avoided. A poor heat distribution may occur if too many indent and bulge are present. Bulges behave as bracket beam when surface roughness is very high. Inner layers occur and addition layers occur even with deformation because root (base) structure is cold. Deformation in welding region must remove these structures. In addition, surface pre-teratment of different metals and alloys is significant. A special form of a material on surfaces to be weld is not needed as in the case of traditional welding processes. However, spherical or conical mouth may be necessary in high diameter parts to assit in friction. Mininum axial loss is required in parts to be welded. The tolerance of welding depens on not only defects in working parts but also the welding machine itself [12, 14]. The tolerance value for lenth is given as 0.203 mm. Begg and Humpreys have reported 0.2mm axial KACIKLIK tolerance and 0.001 rad angular tolerance [15].

Basic design of friction welding includes rod-rod, pipe-pipe, pipe-sheet, rod-sheet and pipe-disc combinations. Based on friction welding theory, at least one of the parts has to be able to rotate. Mixed type parts and difficult to be forged parts can be joined using more than one friction welding machine. The angular range in friction welding is given to be between 30 and 45 or 45 anf $60^{0.}$ D. L. Kuruzar suggested an angle more than 30°. In some of the designs, welding joints are specifically designed to account for problems in removing metal parts after welding [14].

2.5. Parameters of Friction Welding

Apart from traditional welding methods, several welding parameters can be controlled in friction welding. These parameters include diameter of experimental rod, rpm of the part, rpm of parts in to lathe, friction contact time, forging delay time, forging time, time of increased friction pressure, friction pressure. Moreover, other parameters such as geometry of parts and material properties are also significant. The rpm of rotating parts, friction time, friction pressure, forging pressure and time are the parameters needed to be take into account while optimizing the welding process. A successful welding process can occur if parameters are optimized [8].

The lower rpm of roating parts causes enormous moments and nonuniform heating results in. On the other hand, lower rpm values minimize formation of intermetallic compounds. With higher rpm of rotating parts, ITAB widens, and power supply is not affected. To prevent overheating in the welding region, friction pressure and friction time have to be carefully controlled.

Pressure values applied in welding is very significant bcause it controls temperature gradient and affects rotoational torque as well as power.

Friction and forging pressure are directly related to geometry and material properties of parts to be welded and have a wide range.

Over applied pressure values increase power needs accordingly. Due to increased energy input, higher pressures decrease the width of ITAB, accelerate metal displacement ratio and reduces welding time resulting in heat band on the boundary. The variable of pressure can be controlled by the temperature in welding region and decrease in

axial length. Optimum pressure must be applied to materials in order to get uniform deformations throughout [13].

Friction pressure has to be high enough to allow the removal of oxides, to get uniform heating throughout and to interrupt the affinity between surfaces and the air. The application of forging pressure especially during friction process improves welding properties.

Forging pressure depends on the heat yield stress of the material. It should neither be high enough to cause welding accumulation nor is it low enough to cause under welding. Forging pressure in some materials are determined depending on the lower strength material. The diffusion of macro particles from surfaces to surfaces occur during forging. Bonds continuously form and break down during friction at interface locations. In the beginning of forging maximum bonding have to occur on the surface because permanent bonds are these lastly formed bonds. Parts need to interact with each other under pressure and this pressure should not be reduced until welding heat cools down. [11].

Friction and forging times are directly related to material properties. The friction time should allow plastic deformation to occur or remove possible residuals and particles. For a high quality welding joint, minimum friction time needs to be exceeded. Lower friction times as well as nonuniform heating result in nonjoined areas at the interface and inadequate plastic deformation. This brings the problem of low quality weld. Higher friction times, on the other hand, causes rough structure and wide ITAB region formation. This is especially important to the welding of different materials because poor mechanical properties may be obtained due to formation of undesirable substances. Moreover, overheating and material loss are also possible [13].

2.6. Applications of Friction Welding

This method is especially useful for the serial production. Relatively high overhead cost is balanced with higher production rate and lower labor requirement. Process has several dimensions and hardware could easily be adjusted. Thus, the method also becomes useful for the production of relatively smaller parts. With these advantages, friction welding has found widespread application in the industry. Friction welding can generally be applied in the following industries with listed applications:

-Machine production and spare part industry: cogwheels, piston rods, hydraulic cylinders, radial pomp pistons, shaft with worm screw , crankshafts, drill bits, valves.

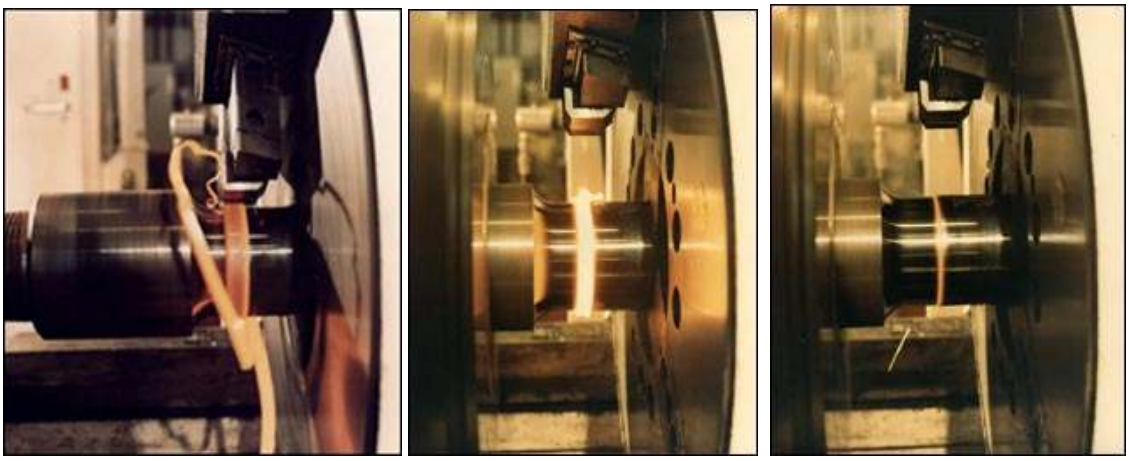
-Automative industry : valves, clack valve, drive shafts, gear levers, axle fasteners, break spindles, transmission mechanisms, preheat rooms, pipe spindles, banjo axles.

- Aviation and space industry: repulsion jets, combustion chambers, spindles, turbines, rotors, pipes, fittings, flanges.

- Work set industry: Spiral drills, milling cutters , borers, reamers, cutting tools.

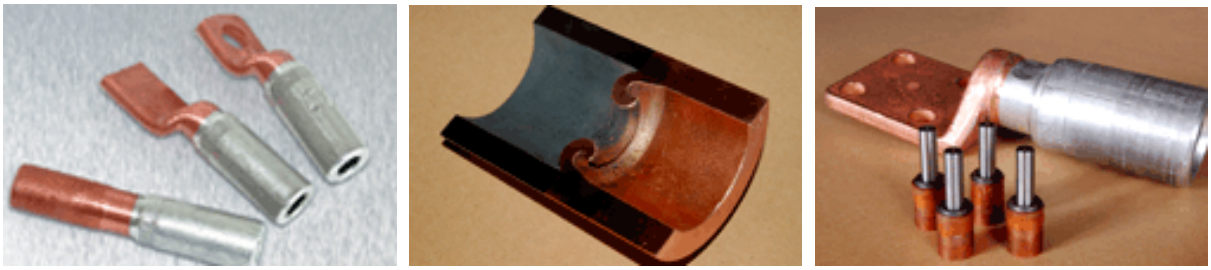
- Electrical, electronics, and chemical industry: receiver camera for gas analysis, segregation columns forchromatograph, Electrical connectors, continuous solder top, swing contacts, pipe fittings [16].

2.7. Some Examples of Applications of Friction Welding



Phase 1 **Phase 2** **Phase 3**

Phase 1: Low temp interface heat cycle by spinning one component against another stationary component.
Phase 2: Solid forging cycle showing displaced plastic state material when final axial forging force is applied.
Phase 3: Plastic state flashing is removed easily, even for hardenable materials that would otherwise require grinding [17].



Electrical connectors

Air bag canisters Gear levers Stanley tools

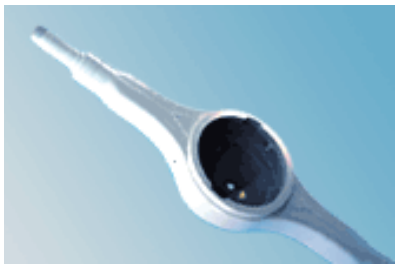
Airbag component Drill bits Engine valves

Pump shafts

Piston rods

Drive shafts

API drill pipe



Truck banjo axle

Gear cluster

Track roller

Bent axle

Blisk

Large piston rod

Hydraulic cylinders

[18].

2.8. Advantages and Disadvantages of Friction Welding

Friction welding has better technical and economical properties than conventional welding methods. Friction weldinfg is generally compared to electrical resistance welding. However it can also be compared to other welding methods such as electron beam welding and electrical arc welding. [11].

- One of the main advantages of friction welding is lower energy requirement.

- The process has unusual high yield and lower energy requirement and power supply. Moreover, power requirement of friction welding is about one tenth of electrical resistance welding (Figure 11). Friction welding causes triphase in the engine and the power factor is Cos φ = 0.80-0.85. However, electrical resistance welding is one phase process and the power factor is Cos φ = 0.40- 0.60.

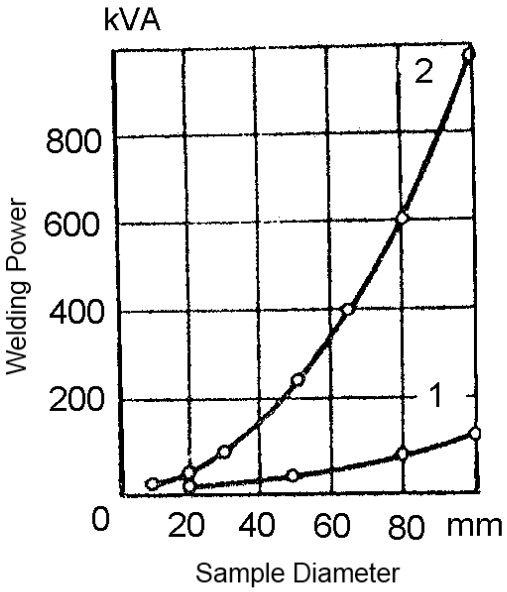


Figure 11. The power requirement during welding for different welding methods (1. Friction welding 2. Electrical resistance welding).

3. Results

- Cooling time is very short because the amount of heated metal during friction welding is very small. The timeframe ranges from several seconds to several minutes. This allows us to achieve friction welding at very high speeds (only comparable to electrical resistance welding).

- Heat in friction welding occurs in welding region and is distributed to the surfaces of parts to be welded. However, heat loss is very high in other conventional welding methods because heating is applied to the all material in a nondiscrimating manner.

- Material loss during friction and forging is minimum making the friction welding a viable economic alternative.

- Surface preparation is minimum and the process does not produce vast amount of waste and a high quality seam is obtained.

- Friction welding can be considered a serial method since the process is very fast.

- The control of parameters affecting welding quality is very easy and is easily accomplished.

- Friction welding system can also bea automated easily.

- Since friction welding is a solid state welding method, no slack and waste are present.

- The efficiency of the process is very high because several parameters including axial load, speed of rotation and YIGMA amount can easily be controlled.

-The disadvantages include geometrical limitations of parts, excessive material accumulation and the need for its removal, and higher capital cost.

Table 1 lists the comparison of several welding methods in terms of material and process variables.

Property	Friction Welding	Electron Beam Welding	Electrical Resistance Welding	Electrical Arc Magnetic Active Welding
Material to be welded	✔	-	-	-
Crossectional area	✔	-	-	-
Welding geometry	-	✔	✔	-
Preparation of parts	✔	-	-	-
Accretion of Weld Materials	-	✔	-	-
Additive ofMaterials	-	✔	-	✔
Compatibility Cross Section to Welded Joint	✔	-	-	-
Process Control	✔	-	-	-
Accounting Rate of Return	-	-	✔	-

Table 1. Comparison of Different Welding Methods (13)

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Energy Harvesting from the Biomechanical Movements of Human Body

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Abstract: In this presentation, the subject of biomechanical energy harvesting, and the studies performed in this field are introduced. Currently used lower limb prostheses manufactured with modular components cannot properly provide the expected functions and the needs of daily living activities due to their passive structure. Although substantial effort has been made in the field of developing active prostheses, these devices have not adequately become widespread because of the necessity of carrying large and heavy batteries which must have been charged frequently. Therefore, some studies have been performed in order to generate energy by utilizing the biomechanical movements of the human body, such as a mechanism converting the mechanical energy from the vertical movement of carried suspended-load in backpack to electricity, and an energy harvester mounted at the knee joint which generates electricity, during human walking. To meet a portion of the energy requirement for amputees wearing the active lower limb prosthesis, and for individuals having high electricity demands in rural areas are aimed with the harvested energy.

Introduction

Many people with lower extremity amputations are using prostheses for restoration of their lost functions. The effective restoration of amputees' lost functions can be acquired by the use of these prosthetic devices. This is one of the most important factors improving their life quality. Passive prostheses being currently in use do not respond to the needs of daily living activities of many amputees. For example, it is difficult to climb stairs with natural posture and to adjust the stiffness of the knee joint motion during the swing phase. High metabolic energy consumption and insufficient symmetry of the gait are the consequences of non-powered artificial joints. The duplication of the kinematics and dynamics of gait patterns is limited with conventional prostheses. They do not allow knee extension after heel strike at the beginning of the stance phase. The absence of the prosthetic leg's push-off phase, which is due to the sudden contraction of the shank's back face muscles at the end of the stance phase, causes the insufficient gait symmetry, shortens the stride length and decreases the gait velocity. In order to remove these disadvantages, it is necessary to add energy producing or storing modules to the system (Kapti, 2007).

On the other hand, humans have become increasingly dependent on technology, particularly electronic devices. During the past decade, electronic devices have become more mobile, enabling people to use medical, communication, and global positioning system devices as they move around cities or in the wilderness. At present, all of these devices are powered by batteries, which have a limited energy storage capacity and add considerable weight. Although substantial progress has been made in reducing the power requirements of devices and increasing the power densities of batteries, there has not been a breakthrough in the parallel development of a portable and renewable human-driven energy source. The combination of limited energy and the large weight of batteries poses the most critical problem for individuals, such as field scientists or explorers, having high electricity demands in remote areas and who are already carrying heavy loads. At present, replacement batteries may make up a substantial proportion of the very heavy packs that such users must carry (Rome, 2005).

During terrestrial locomotion, the environment does no work on the body and humans do no work on the environment. Almost all of the mechanical work is generated and dissipated inside the body. This makes it exceedingly difficult to capture mechanical energy to drive an electrical energy conversion apparatus, because

the device would need to be either surgically placed within the body or attached to the outside of the body, which would affect the person's maneuverability and comfort. Therefore, researchers in the field have focused on putting devices in the only accessible location. Although the shoe is the first thing comes to mind, such heel-strike devices have permitted only small levels of electrical energy generation. The primary reason for this limitation is that on a hard surface, essentially no mechanical work is done at the foot-ground contact point, because under normal circumstances the point of vertical force application does not move in the vertical plane. Although one can make the shoe compliant so that the foot moves a small distance because of compression of the sole and heel, this is problematic because increasing compliance leads to declining maneuverability and stability. Although considerable effort has gone into developing exotic energy-generating technologies for shoe devices, the small magnitude of the mechanical energy source remains a limitation (Rome, 2005).

In order to help solving mobile human-driven energy problem, some studies for developing energy harvesting device which extracts mechanical energy from the human body movements during daily living activities, and converts it to electricity for powering portable devices were performed in the literature. The studies performed in the field of energy harvesting from the human body movements are mostly been on the regions of back, knee joints, and foot. In this review, after giving one example from the literature for each of these classifications, the applicability of biomechanical energy harvesting approaches in the field of active lower extremity prostheses will be examined.

In the Backpack

The vertical movement of a heavy load in the backpack carried in gravitational field during walking represents a source of mechanical energy and a potential opportunity to generate substantial levels of electricity. A walking person acts like an inverted pendulum. Due to this movement causing the center of mass of the body move up and down by 4 to 7 cm, a load in a backpack has to go up and down the same vertical distance. In the case of a 36-kg load and a 5-cm vertical load displacement, 18 J of mechanical energy transfer accompanies each step, and this is equivalent to 36 W, at the walking velocity of 2 steps per second. Although this represents a large potential source of mechanical energy, it is also inaccessible if the load is rigidly attached to the body. In order to extract this mechanical energy, Lawrence C. Rome et al. (Rome, 2005) developed the suspended-load backpack device decoupling the load from the body, to allow the differential movement between the load and the body for mechanical energy extraction and ultimately electricity production. In this device interposed between the body and the load (Fig. 1), the pack frame is fixed to the body, but the load is suspended by springs from the frame. During walking, the load is free to ride up and down on bushings constrained to vertical rods. Electricity generation was accomplished by attaching a toothed rack to the load plate, which when moving up and down during walking, meshed with a pinion gear mounted on a geared dc motor, functioning as a generator, rigidly attached to the backpack frame.

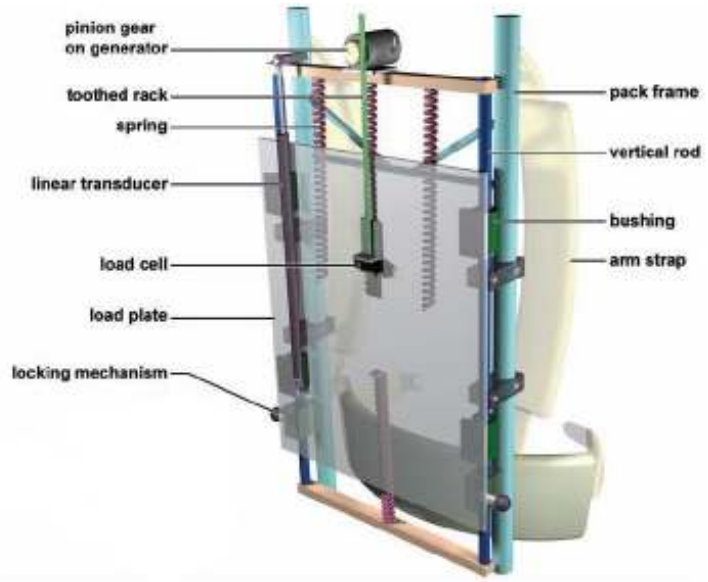

Figure 1. The suspended-load backpack device (Rome, 2005).

The average electrical power obtained by them was 5.6 W in the trial of 38-kg load and 4.5-cm relative movement of the load, and the number of revolution of 25:1 geared dc motor was reached up to 5000 rpm. Average electrical power increased with walking speed and the weight of the load. The maximum electrical power output obtained on the flat was 7.37 W. The mechanical power harvested by the generator is the product of the average force exerted on the rack, the displacement of the load, and the step frequency. The efficiency of conversion of mechanical energy to electrical energy (that is, electrical power output divided by mechanical power input) was nearly constant (30 to 40%). To power portable devices or charge batteries, the alternating polarity of the voltage and current must be rectified. Using circuitry for voltage smoothing, the suspended-load backpack can power multiple devices such as cell phones (Rome, 2005).

If generating electricity while wearing the backpack markedly increased metabolic rate, the device would be of limited use. One would expect that because mechanical energy is continuously removed from the system by the generator, the muscles would need to perform additional mechanical work during electricity generation in order to replace it. For instance, the mechanical power input to the generator is 12.15 W while walking at 5.6 km/h and carrying a 29-kg load. Because the maximum efficiency of mechanical power production by human muscle is about 25% (Margarira, 1968), if the body movement was the same, one might anticipate a minimum increase of 48.6 W in metabolic power input. They measured the rate of O_2 consumption and CO_2 production of participants walking with the backpack. They found that the metabolic rate increase compared to that with the locked backpack was only about 19.1 W, which is much less than would be predicted. These results indicate that electricity can be generated metabolically more cheaply than anticipated (Rome, 2005).

The energy-harvesting backpack is novel because it generates useful amounts of electrical power while costing less metabolic energy than would be expected. The saving only applies in comparison to a person already walking with a heavy load. The explanation may lie in the transition between pendulum-like walking steps, when the body's center of mass is redirected from one pendular arc to the next (Fig. 2). The center of mass is located near the hip joints and undergoes a small U-shaped displacement during this step-to-step transition, which occurs mainly when both legs contact the ground. Force is exerted by, and directed along, each leg, with the leading leg performing negative work on the center of mass and the trailing leg positive work. The leading leg's force is at such an angle with the direction of center of mass displacement that negative work is unavoidable, if the center of mass is to be redirected to another pendular arc. This negative work is thought to be largely dissipated as an energy loss. An equal magnitude of positive work performed by the trailing leg cancels this loss, as is needed to walk at steady speed (Kuo, 2005).

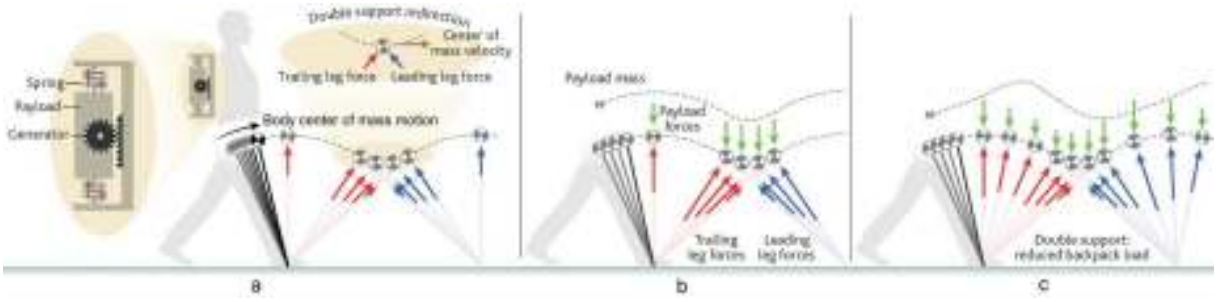

Figure 2. Simple models of an energy-harvesting backpack and its relation to human walking (Kuo, 2005).

On the Knee Joint

J. M. Donelan et al. (Donelan, 2008) have developed a device that generates electricity during human walking with little extra effort. The general view, the internal structure and the schematic diagram of this device called biomechanical energy harvester are shown in Fig. 3. The device has an aluminum chassis and generator mounted on an orthopedic knee brace, totaling 1.6-kg mass, with one worn on each leg (Fig. 3-A). The chassis contains a gear train that converts low velocity and high torque at the knee into high velocity and low torque for the generator, with a one-way roller clutch that allows for selective engagement of the gear train during knee extension only and no engagement during knee flexion (Fig. 3-B). The schematic diagram shows how a computer-controlled feedback system determines when to generate power using knee-angle feedback, measured with a potentiometer mounted on the input shaft (Fig. 3-C). For electrical power generation over longer durations, it would be desirable to harvest energy from everyday activities such as walking. Unlike conventional human-powered generators that use positive muscle work, their technology assists muscles in performing negative work. Energy-harvesting performance was tested (see Donelan, 2008) on six male subjects who wore a device on each

leg while walking on a treadmill at 1.5 m/s. For convenient testing, generated electrical power is dissipated with a load resistor rather than being used to charge a battery. The energy harvester mounts at the knee and selectively engages power generation at the end of the swing phase. Test subjects walking with one device on each leg produced an average of 5 W of electricity. They estimated metabolic cost using a standard respirometry system and measured the electrical power output of the generator. In the continuous-generation mode, subjects generated 7.0 ± 0.7 W of electricity with an insignificant 18 ± 24 W increase in metabolic cost over that of the control condition. This electricity is sufficient to power 10 typical cell phones simultaneously. The results demonstrate that substantial electricity could be generated with minimal increase in user effort. Producing substantial electricity with little extra effort makes this method well-suited for charging powered prosthetic limbs and other portable medical devices (Donelan, 2008).

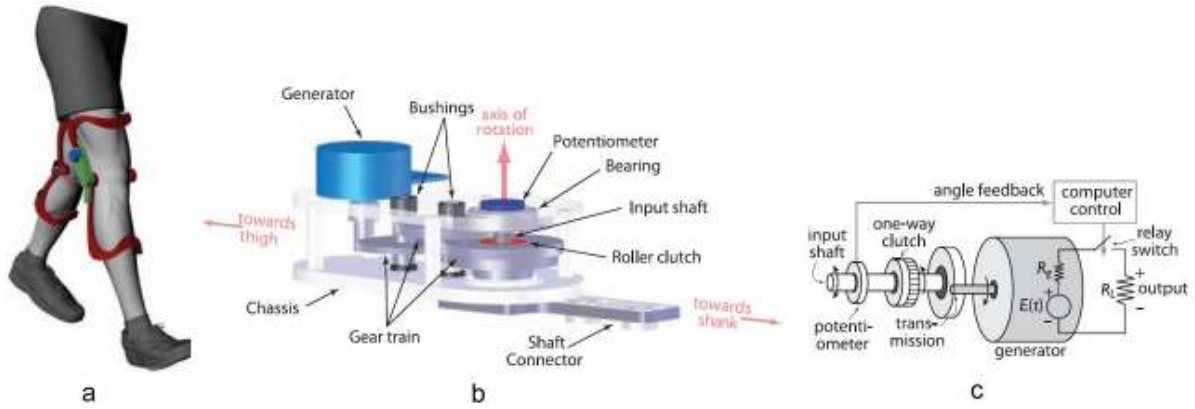

Figure 3. Biomechanical energy harvester (Donelan, 2008).
(a: the general view of the device, b: the inertial structure of the device, c: the schematic diagram of the device)

Under the Sole

The ankle normally produces a larger work than any other joint during walking (Winter, 1991). Ankle impairments following amputation, joint fusion or stroke typically reduce ankle work and increase metabolic energy expenditure by at least 20%, comparable to carrying an extra 15 kg load or walking 20% faster. Ankle function might be restored by powering the joint directly, a technique that shows promise (Sawicki, 2008, Au, 2009) but requires large motors and energy sources that are heavy and bulky. Much of the dissipation in normal walking occurs when the body center of mass velocity is redirected at the transition between steps. During each step, the stance leg behaves similarly to an inverted pendulum as it transports the center of mass along an arced path. When the other leg contacts the ground, it flexes slightly and performs dissipative negative work as it redirects the center of mass to the arced path of the next step as part of the step-to-step transition. To walk at steady speed, all dissipation must be recovered by an equal amount of positive work. Total work may theoretically be minimized if the positive work is performed by trailing leg push-off and timed immediately before heel-strike, reducing the change in center of mass velocity performed by the collision. This reduces both the dissipation and the amount of positive work needed to recover loss. Normal ankle push-off appears appropriate for this purpose, performing positive work beginning just before and in nearly equal magnitude to the collision loss. If the collision energy can be successfully recycled, it may therefore be sufficient to supplement an impaired push-off (Collins, 2009).

Steven H. Collins and Arthur D. Kuo (Collins, 2009) developed an energy-recycling artificial foot (Fig. 4) that captures collision energy and returns it for push-off. 1.37-kg weighed this device approximates the size and form of a conventional prosthetic foot, but has separate rear-foot and fore-foot components that rotate about an axis at mid-foot. When the heel contacts the ground at the beginning of a stride, the rear-foot component rotates and compresses a coil spring. At maximum compression, the rear-foot is latched by a continuous one-way clutch. Rather than releasing the spring energy spontaneously as in conventional elastic prostheses, our device stores it until sufficient load is detected on the fore-foot. It then releases the fore-foot, and the spring provides push-off as the person begins to unload the trailing leg, with timing similar to normal ankle push-off. A small return spring resets the device during the ensuing swing phase, so that the rear-foot is in position for the next step. All of the energy capture is performed passively, so that the only active elements are a microcontroller and two micro-motors that release the energy-storing spring and reset the mechanism. The device is powered by a small battery at about 0.8 W of electricity. Active control of energy storage and return distinguishes this device

from conventional prosthetic feet with passive elastic elements, which have not been found to significantly reduce the metabolic energy consumption of walking with ankle impairment, while low electrical power requirements distinguish it from other robotic prostheses.

Steven H. Collins and Arthur D. Kuo (Collins, 2009) tested the artificial foot on able-bodied human subjects walking with an artificially-immobilized ankle, at a speed of 1.25 m/s. Subjects wore the device on one leg using a prosthesis simulator, a rigid boot that immobilizes the ankle and provides a prosthesis attachment beneath the foot. This allowed direct comparison between normal walking and prosthesis test conditions. Subjects also wore a lift shoe on the other foot to equalize height. The device was compared against a conventional prosthetic foot. Mechanical performance was recorded through motion capture and a force plate-instrumented treadmill. They used motion and force data to estimate the work captured and returned by the device, the work performed by the human leg and device on the center of mass, and the work performed at each biological joint. They also recorded rates of oxygen consumption to estimate metabolic energy expenditure. The conventional prosthesis reduced ankle push-off and increased metabolic expenditure for all subjects. The energy recycling artificial foot captured collision energy and returned it as positive ankle work later in stance phase, resulting in greater push-off and lower metabolic expenditure than with the conventional prosthesis. The rate of increasing of metabolic expenditure was determined as 23.1% for conventional prosthesis, and as 13.8% for the energy recycling artificial foot, and 9.3% improvement was provided (Collins, 2009).

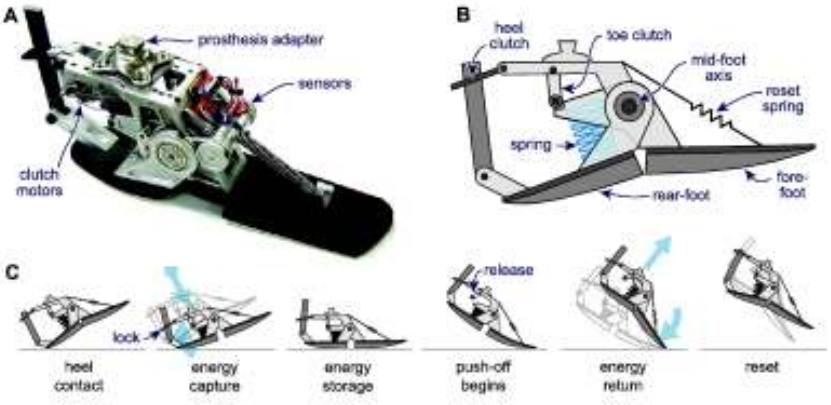

Figure 4. Prototype energy recycling device (Collins, 2009).
(A: The general view of the device, B: Schematic design, C: The energy recycling sequence)

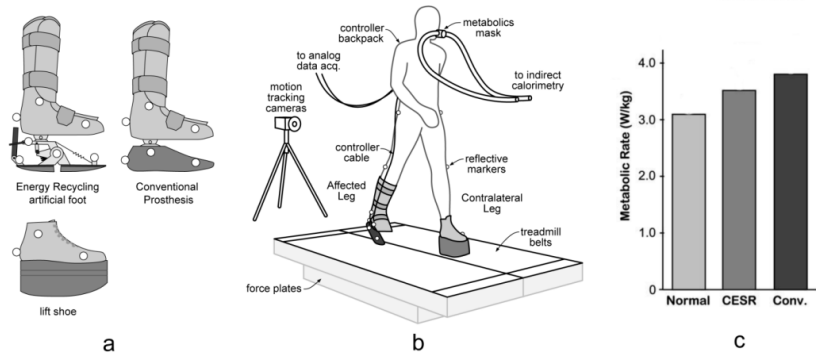

Figure 5. Experimental setup (Collins, 2009).
(A: The energy recycling device, conv. prost. and the lift shoe, B: Experimental setup, C: Experimental results)

Applications on the Active Prostheses

Currently used lower limb prostheses manufactured with modular components cannot properly provide the expected functions and the needs of daily living activities due to their passive structure. In order to contribute to the developments of new kinds of prosthetic system and to remove the insufficient properties of the prostheses,

a force controlled elastic prosthesis mechanism that can be utilized as artificial ankle and knee joints for active lower extremity prostheses was designed and produced as a mechanism consisting of brushless dc-servomotor, ball-nut and screw, elastic component, measuring elements, guide columns, ball bearings and bushes. The force output of the elastic mechanism is calculated by measuring the displacement of the spring with the linear potentiometer. An above-knee prosthesis consisting of this elastic mechanism was also designed and produced. General view of this above-knee prosthesis, and the principle of application on human body are shown in Fig. 6.

Although substantial effort has been made in the field of developing active prostheses, these devices have not adequately become widespread because of the necessity of carrying large and heavy batteries which must have been charged frequently. This system has to carry its power generating system consisting motor component and battery set, which is heavy and bulky. Our system consists of the 220 W servomotor and Li-ion battery set. Mobile energy requirement is the most crucial difficulties faced in the externally powered artificial orthopaedic devices. Therefore, in order to solve this difficulty, utilizing the studies mentioned above is proposed [a mechanism converting the mechanical energy from the vertical movement of carried suspended-load in backpack to electricity (see Rome, 2005); an energy harvester mounted at the knee joint which generates electricity (see Donelan, 2008); an energy recycling device (Collins, 2009)]. To meet a portion of the energy requirement for amputees wearing the active lower limb prosthesis, and for individuals having high electricity demands in rural areas are aimed with the harvested energy.

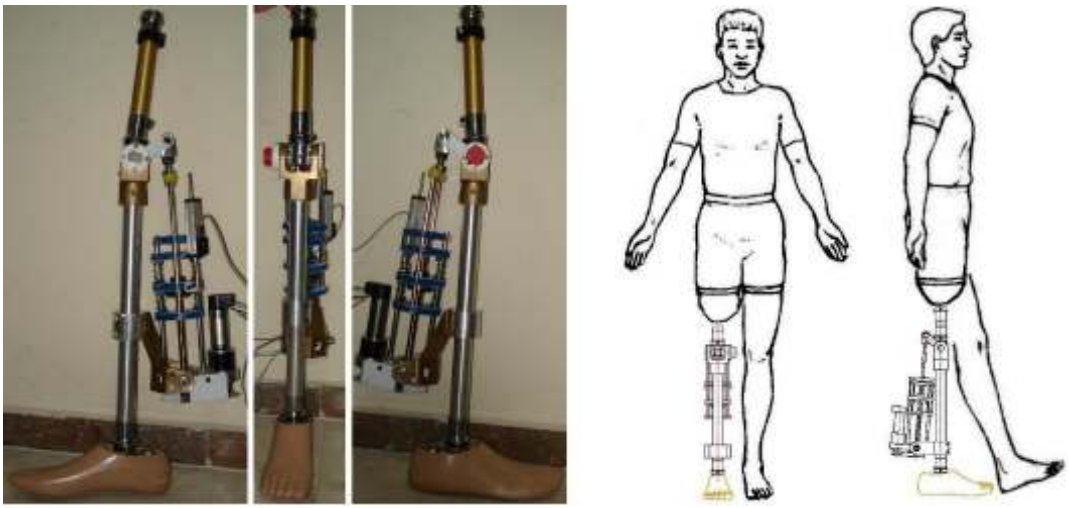

Figure 6. General view of the active above-knee prosthesis, and the principle of application on human body (Kapti, 2009).

Acknowledgements

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A Computer Based Flexible Real Time Fuel Controller System Implementation for Four-Cylinder Internal Combustion Engines

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Abstract: In this study, a computer and microcontroller based fuel control system for four-cylinder internal combustion engines has been designed and some applications have been implemented. Fuel control system designed for real time control the amount of fuel in alternative fuel applications. System is suitable to use with both diesel and petrol engines. A Graphical User Interface has been designed in computer side. The pc programme uses Fuzzy Logic, Neural Networks and Curve Fitting calculation methods. The percentage of the fuel to be sprayed has been defined according to the engine speed, load and fuel rack or throttle position got from the engine. These physical signals have been controlled and read by microcontroller based electronic circuit. Communication has been set using RS232 standard between PC and microcontroller.

Introduction

Energy as the most important input for economic and social development, has been took place in all world countries as an important agenda about 1970's (Tekin et al.,2004). Having limited amount of oil resources, which is decreasing rapidly, economic and political differences, dependence on foreign countries and the air pollution are important problems for all countries. To reduce the dependency on oil and to minimize the problems about potential oil crisis in the future has brought up the researches about alternative fuels (Çetinkaya et al.,1997, Salman et al, 1990). Using of fossil fuels and environmental awareness, has made the engineers and scientists to oriented develop of clean, renewable and sustainable energy system (Yüksel et al., 2002, Borat et al., 1992)

The reduction of harmful and pollutant emissions and the improvement of the engine performance are today's most popular research subjects. For this purpose, many studies are performed by researchers and automotive manufacturers. Lots of researches can be found in literature about using alternative fuels instead of petrol or using alternative fuels with petrol. These researches have such aim like fuel costs lowering, increasing engine performance with the same cost and eliminating or lowering percentage of exhaust gases, harmful to atmosphere . These alternative fuels or substances are mostly alcohol, alternative fuels, liquefied petroleum gas (LPG), biomass, natural gas, hydrogen, water and water vapour. These substances are alcohol, LPG, natural gas, hydrogen, and biodiesel for engine performance and emissions are widely used as an alternative fuel.

While using the substances mentioned above, the effects on engine performance and engine emissions should be well analyzed. According to the various researches it is clear that to have good results, it is very important to use the correct fuel mixture amount or spray correct amount of fuel.

In other application, the alternative fuels are sprayed with a nozzle to the intake manifold by vacuum effect. Unlike other studies, an injection system supported by on electronic programme has been developed to spray alternative fuels with a certain rate. This system uses solenoid injectors to spray the fuel. It is targeted that,

to build a such compatible fuel control system for all four-cylinder engine using alternative fuel. Since using alternative materials in the engine is not dependent on a single parameter linearly. The injection signal cannot be produced by a mechanical way. Because of nonlinear engine operating conditions and dependency of these conditions more than one variable makes difficult to produce the injection signal by a typical electronic circuit without a programme. In the system, the calculation methods, Fuzzy Logic, Neural Networks and Curve Fitting, have been used to achieve high accuracy for all working conditions

The general structure of the system

The fuel control system designed consists of a computer programme and an electronic circuit controlled by a 8051 based microcontroller. The connection between the microcontroller and the PC is provided with RS232 serial protocol. Reading and controlling the physical data are carried out by the microcontroller. Calculating of the fuel amount, the injection signal's length and timing are performed by the computer programme. Block diagram of designed system can be seen in Figure 1.

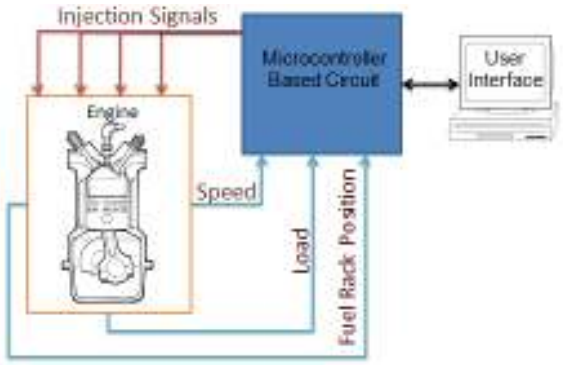

Figure 1: Block diagram of the fuel control system

During the operation, mcu reads the inputs load, speed and fuel rack position momentarily and sends them to the programme. According to these three values, the fuel amount is calculated and the injection signal's timing and length will be determined by considering the injector parameters and advance angle and sent to the mcu. After data is received mcu will constitute the injection signal related to angle read from encoder. So that the desired amount of fuel is sprayed.

For determining the correct amount of fuel to be sprayed, it is very important to read momentarily working conditions such as engine speed, fuel rack position and engine load. Measurement of this data has been done by the microcontroller with a number of sensors. Angular velocity has been measured by digital absolute encoder fitted to crank of engine. At the working conditions, the instant measurement and control of angle are needed to provide a real time system. While the engine is running, encoder also has functions to determine upper dead point and to produce the right signal to spray the fuel on start and end at the correct angles. Position of the fuel rack of the engine has been measured with a potentiometer by mcu's ADC unit. Potentiometer's analogue output voltage is been changing linearly according to fuel rack position. Engine load has been measured with a load cell fitted to the engine dynamometer. Data acquired from the load cell have been read by mcu's ADC unit and digitally filtered by mcu programme.

Defining injector parameters

For a high precision control of fuel timing and amount, an injection signal must be produced according to the parameters of the injectors. System is designed to be used with solenoid injectors. As known there are opening and closing time delays in solenoid injectors caused by injectors coil windings (Zhao et al., 1999) These delays causes a problem in which to construct the right injection signal length and spray the fuel with the right advance angle. These delays must be well defined for the injectors. While the system is running for applying the fuel to the engine in the right advance angle, it has to produce the injection signal before the real advance angle.

There is no linear correlation between injection signal length and sprayed fuel amount (Zhao et al., 1999). In this work, it is aimed to control the amount of fuel as massively by a fuel control system. Hence, the correlation between sprayed fuel mass and signal length must be well known.

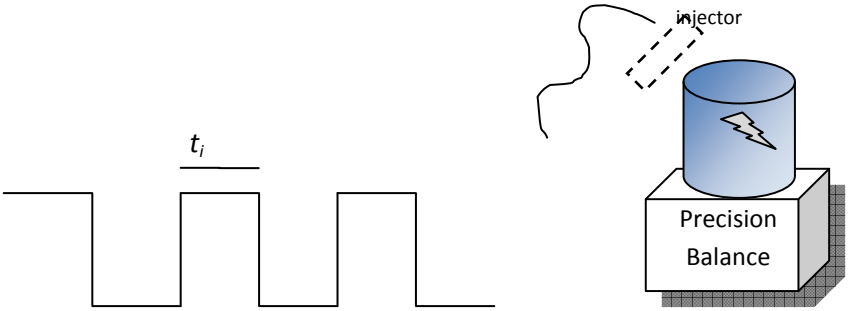

Figure 2: Injection signal and injector parameter measurement

While the system was designed, a set of experiments has been done for injector parameters measurement. The system is designed to work under 3 bar standard fuel pressure. Experiments for measuring injector parameters have been done under same conditions. For measuring correlation between the signal length and the fuel amount, the injection signal having 50 mS period, has been applied in 1000 times. When the engine is running on 1200 rpm single revolution takes 50 mS. Therefore, this period was accepted to fit the real working conditions. During the tests, injection signals increased step by step. After finishing every step sprayed fuel weight measured and divided to 1000 to find fuel consumption for each period (Fig. 2). The test results shown in Figure 3 give the correlation between the injection signal length and the sprayed fuel amount.

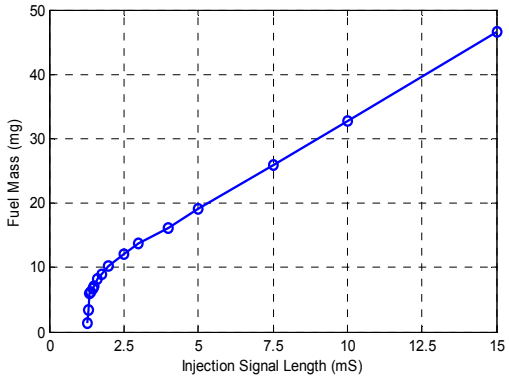

Figure 3: Correlation between the signal length and the fuel amount for a solenoid injector

While the system is running, the computer programme calculates the fuel amount with a selected calculation method. Finally the signal length has been calculated by using the injector parameters obtained by these results as shown in Figure 4. To produce the injection signal in a right time, the opening delays of the injectors have also been used by the system.

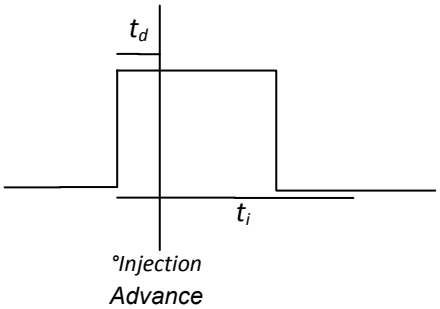

Figure 4 Produced injection signal, t_d corresponds injector delay, t_i corresponds injection signal length

User Interface

The core functions of the user interface is the setting a communication between pc and mcu and providing a practical and visual platform to the user. The user interface designed can be seen in Figure 5.

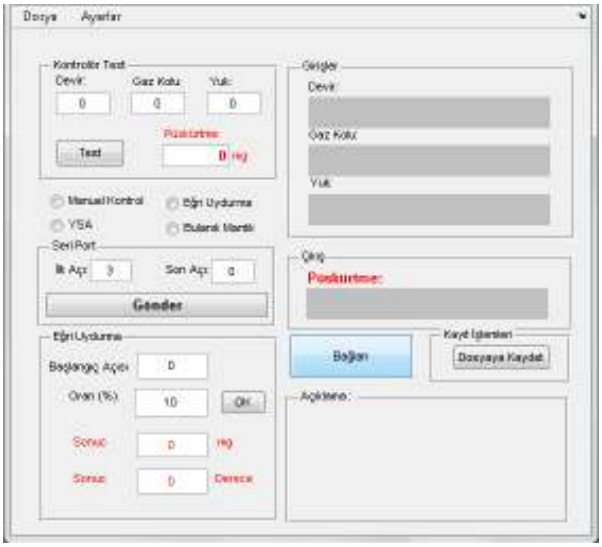

Figure 5: The User interface for the designed fuel control system.

Interface instantly shows input and output values in graphics to increase functionality and user interaction. In the operation, these graphs are always updated for each input and output data pair.

Engine's fuel consumption which can be found from engine catalogue data or obtained by experimental analysis, is a basis for all calculation methods. The user interface, designed uses fuzzy logic, neural networks and curve fitting methods to perform calculations. Calculation method can be selected by the user. After calculation, the fuel amount can be applied to the engine with different percentages defined by the user. However, it has a manual control option to apply the fixed amount of fuel, entered by the user. The user can also enter the injection advance. During the operation, the injection signal is generated according to the injector parameters and the advance angle.

Received input values and calculated data are displayed on the user interface are also updated for each input and output data pair. A test section, has been located on the user interface to test calculation method results without sending them to the microcontroller. User can check whether the calculation method gives expected results or not. Received input values and calculated data can be saved to the computer automatically by user interface and they can be used for evaluating of results. Serial port connection settings, the injector parameters and the engine fuel consumption data set can be changed by using the settings section of user interface. To use the system with another engine and injector, user only need to enter new injector's parameters and engine fuel consumption data set from settings section. Therefore the designed fuel control system can easily be adapted to all 4 cylinder engines.

The system is ready for use after entering settings and choosing desired control options. The system can be connected to mcu unit and started to control the fuel with real time data flow by clicking to connect button.

The calculation methods

In the designed fuel control system three different calculation methods have been used. All methods have been designed to adapt themselves to new values when the engine fuel consumption data set changed. In the calculation, artificial neural networks, fuzzy logic and curve fitting methods have been applied. All these methods have been tried to produce an output corresponding to the three input values. As mentioned previously, engine speed, load and fuel rack position are used as inputs. It is expected that the calculation methods will determine the fuel amount for every new input value with minimum error based on the engine's fuel consumption data set.

Engine Speed	Load(kg)	Fuel rack position	Fuel Consumption (mg)
1000	3,43	50	17,43
1000	4,45	77	29,24
1000	5,61	100	34,6

Table 1: Fuel Consumption Data set example

The above examples in Table 1 are part of the example fuel consumption data set. The fuel consumption data set can be obtained by the experiments that have been on the engine. The data set should be carefully obtained because of the nonlinear relationship between the engine fuel consumption and input values. Engine load and fuel rack position input are two values that can be changed by user. While data set is obtained by changing these two values step by step, so as to cover minimum and maximum values of them. The smaller step size the calculation method's error rate will be. Curve fitting method directly uses this data set to find what interim values. Neural Networks use this data set as training data and estimate this data with minimum error. This data set will be used for determining fuzzy logic rules by ANFIS method.

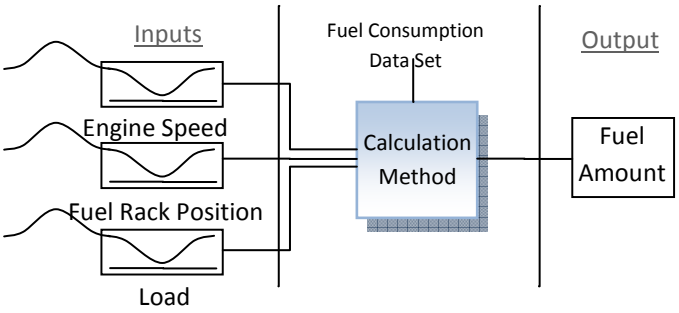

Figure 6: Calculation Methods

The fuzzy logic controller for the system is designed with the Sugeno fuzzy inference method in common structure, shown in Figure 6 .The designed fuzzy logic controller has three membership functions for engine speed input, three membership functions for fuel rack position input and four membership functions for load input. Fuzzy logic rules, for the controller have been determined by ANFIS method according to the engine fuel consumption data set mean absolute error of. $2x10^{-4}$ was obtained with the controller from a four-cylinder diesel engines date set. By experimental analysis it is achieved that the controller can find the values which are not been in fuel consumption data set with mean absolute error of 0.02. According to this explanation given above, the controller's accuracy has been accepted as suitable for this work.

The neural network controller for the system is designed in Feed Forward Back Propagation structure. Like other controllers the Neural Network controller has three inputs and one output. The Neural Network Controller has three hidden layers in a structure of 8,13,7. For neural network controller training Levenberg-Marquardt algorithm is preferred. Training was conducted with an error of 10^{-5} from a four-cylinder diesel engines data set.

As another option for calculation method, 3. order curve fitting algorithm has been used in the system. Corresponding fuel for interim input values, which are not in the fuel consumption data set, can be calculated with curve fitting method.

Conclusions and Evaluation

For testing the system, ethanol as an alternative has been fuel applied to diesel engine It is known that if ethanol is applied to diesel engines with appropriate percentages it reduces NO_X emissions(Jiang, Q. et al). During the experiments ethanol applied in a percentage of 3.75 %, 7.5%, 11.25% to the engine while the engine was running in maximum position of fuel rack. Measured NO_X emissions with ethanol injection and standard NO_X emissions are shown in the Figure 7. It can be seen that NO_X emissions have been reduced by ethanol injection as expected.

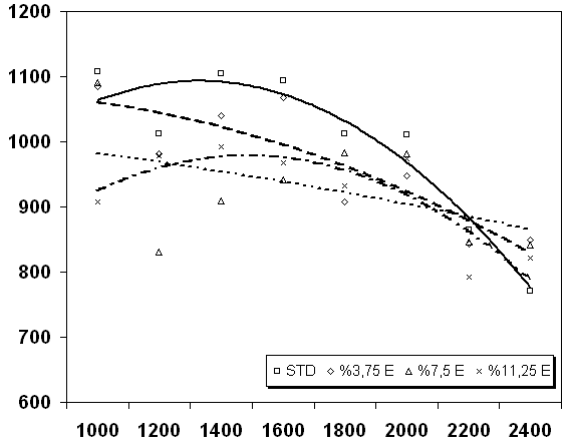

Figure 7: Ethanol applied and standard NO_X emissions

It is observed that the system can keep the fuel amount in fair values for optimum emissions and the engine performance. In addition suitability of system for all alternative fuel applications on both diesel and gasoline engines is another good result of this study.

To enhance the efficiency and accuracy of the system it will be better to transfer instant information such as measured emission values and specific fuel consumption to the user interface. In such a structure, the computer programme could be designed to optimize error rate in real time. Therefore it will not be required to create a training set, so that a higher-performance and more practical fuel control system can be obtained.

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Nonlinear Transverse Vibrations of a Slightly Curved Beam Carrying Multiple Concentrated Masses: Primary Resonance

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Abstract: In this study, nonlinear vibrations of curved Euler-Bernoulli beams carrying arbitrarily placed concentrated masses have been investigated. Sag-to-span ratio of the beam, which was assumed to have sinusoidal curvature function at the beginning, was taken as 1/10. Equations of motion were obtained by using Hamilton Principle. Cubic nonlinear terms aroused at the mathematical model because of the elongations occurred during the vibrations of the simple-simple supported beam. Method of multiple scales, a perturbation technique, was used for solving the equations of motion about analytically. Natural frequencies were obtained for different numbers, sizes and locations of the masses as control parameters. Analytical solutions were found for primary resonance case. Frequency-amplitude and frequency-response graphs were drawn using different control parameters for these resonance cases. Stability of the solutions was investigated in detail.

Keywords: curved beam, nonlinear vibrations, concentrated mass.

Introduction

Many engineering problems such as bridges, rails, automotive industries, work pieces and machine elements can be modeled as curved beams. Before proceeding to our investigation on these beams, some researches made on the beam vibrations, both linear and nonlinear, must be mentioned. Some of these studies are such that, Rehfield (1974) derived the equations of motion of a shallow arch with an arbitrary rise function and studied the free vibrations approximately. Singh and Ali (1975) studied a moderately thick clamped beam with a sinusoidal rise function by adding the effects of transverse shear and rotary inertia. Nayfeh *et al*. (1979) developed a new method, which is a combination of perturbation method and numerical method, to be used in the analysis of forced vibrations. Using two beam elements one has three degree-of-freedom and other four, Krishnan and Suresh (1998) studied static and free vibration of curved beams. Taking account into the effect of shear deformation and rotary inertia, they determined frequencies of these beams. For a general state of non-uniform initial stress, Chen and Shen (1998) derived the virtual work expressions of initially stressed curved beams. They investigated the influence of arc segment angles, elastic foundation, and initial stresses on natural frequencies. Oz *et al*.(1998) examined a simply supported slightly curved beam resting on an elastic foundation with cubic non-linearities. Considering free-undamped and forced-damped vibrations, he analyzed the effects of the elastic foundation, axial stretching and curvature on the vibrations of the beams. Tarnopolskaya, De Hoog and Fletcher (1999) examined the vibrational behavior of beams with arbitrarily varying curvature and cross-section in the lower region of the spectrum. For a particular type of beam curvature and cross-section, they examined whether or not the mode transition takes place. Lacarbonara *et al*. (2002) developed open-loop nonlinear control strategy, and applied it to a hinged-hinged shallow arch. They assumed the beam subjected to a longitudinal end-displacement with frequency twice the frequency of the second mode (principal parametric resonance). Tien *et al.* (1994) studied the dynamics of a shallow arch subjected to harmonic excitation. In the presence of both external and 1:1 internal resonance, he examined the bifurcation behavior of the shallow arch system. Lacarbonara, Yabuno and Okhuma (2003) investigated experimentally the principal parametric resonance of the second mode of a simply supported first-mode buckled beam. By considering axial loads slightly above the first buckling load, they examined the frequency-response curves for different excitation amplitudes and the space-time characteristics of the nonlinear resonant motions. Nayfeh *et al*. (1999) studied to construct the nonlinear

normal modes of a fixed-fixed buckled beam about its first post-buckling mode. Abe (2006) studied the validity of nonlinear vibration analysis of continuous systems with quadratic and cubic nonlinearities. Lee, Poon and Ng (2006) studied to derive the equations of motion for a clamped–clamped curved beam subjected to transverse sinusoidal loads. Taking into account the effects of beam mid-plane stretching and damping Nayfeh and Pakdemirli (1994) investigated the nonlinear vibrations of a beam-mass-spring system. In their analysis frequency-response and force-response curves shows that the nonlinearity arouses due to stretching and location of nonlinear spring supporting the mass. Posiadala (1997) presented the solution of the free vibration problem of a Timoshenko beam with additional attached elements. By using the Lagrange multiplier formalism, he showed the influence of the various parameters on the frequencies of the combined system. Ozkaya *et al.* (1997) studied nonlinear vibrations of a beam-mass system under different boundary conditions. For different boundary conditions, locations and magnitude of the masses, he examined the effects of mid-plane stretching on the beam vibrations. Assuming simply supported end conditions, Ozkaya (2001) studied an Euler–Bernoulli beam carrying concentrated masses. He investigated the effects of mid-plane stretching on free-undamped and forced-damped vibrations of the beam in detail. Under assumption of simply supported end conditions Ozkaya (2002) studied nonlinear vibrations of an Euler–Bernoulli beam carrying concentrated masses. He investigated free-undamped and forced-damped vibrations of this beam–mass system for different locations, magnitudes and number of the masses. Adessi *et al.* (2005) studied the regime of high pre-stressed beams. Considering a lumped mass that is rigidly clamped to the beam at an arbitrary point along its span and assuming different boundary conditions(simply supported and hinged-hinged), they examined post-buckling configurations of the beam. The effect of the point concentrated mass on the large amplitude free vibrations of beam under symmetric configuration was investigated. Zhou and Ji (2006) studied free vibration characteristics of a non-uniform beam with arbitrarily distributed spring-mass. For the special cases of the proposed solution, they investigated the coupled vibrations of a beam and distributed spring-mass in detail. Hassanpour *et al.* (2007) investigated the vibrations of a beam with a concentrated mass within its interval length subjected to a quasi-static axial force. By choosing the location of the concentrated mass arbitrarily, they studied the transient and steady state behavior of the resonator in the time domain. Maiza *et al.* (2007) studied to describe the determination of the natural frequencies of a Bernoulli–Euler beam with general boundary conditions at the ends and carrying a finite number of masses at arbitrary positions, by considering their rotatory inertia. To present a general solution of the problem, they used translational and rotational springs at both ends as well as elastic restraints. Sochacki (2008) considered a simply supported beam loaded by both a longitudinal force and a concentrated mass in a chosen position along the beam length. He investigated the influence of additional mass and elasticity as well as an undamped harmonic oscillator on the position of the solutions on the stability chart. By considering, a continuous beam attached spring–mass systems and using directly differential equation of motion, Lin and Tsai (2007) obtained the natural frequencies and associated mode shapes of the vibrating system. They used FEA and thus made no other assumptions. Yesilce and Demirdag (2008) studied the multi-span uniform Timoshenko beam carrying multiple spring-mass systems with/without axial force effect. They described the determination of the natural frequencies and mode shapes of vibration as well as the effect of axial force. Finally, nonlinear transverse vibrations of a slightly curved Euler Bernoulli beam carrying a concentrated mass has been studied by E. Ozkaya *et al*. (2009)

In this study, nonlinear vibrations of curved beams carrying multiple concentrated masses were investigated. For the beam which is of Euler-Bernoulli type, it was assumed firstly that the beam had the form of sinusoidal rising function and was constricted from both ends by the immovable simply supports. The method of multiple scales (MMS), a perturbation method, was used in order to seek analytical solutions for the derived mathematical model. The primary resonance was investigated. Natural frequencies were calculated according to different control parameters such as number, magnitude and position of the masses. Amplitude and phase modulation equations were derived. Effects of the addition of nonlinear terms to the natural frequency were searched via frequency-amplitude and frequency-response graphs. Experiencing different control parameters, responses to the excitations were investigated. Having obtained solutions, the stable and unstable regions of the system were determined by using the stability analysis.

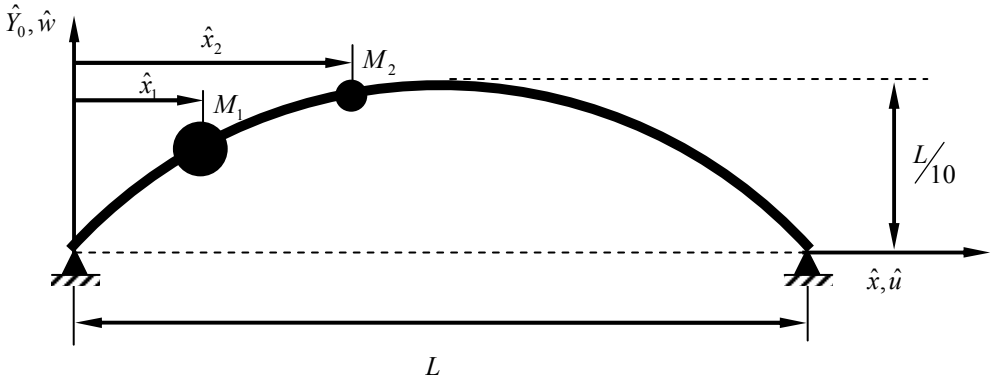

Figure 1. The curved beam carrying multiple concentrated masses.

Equations of motion

In Fig. 1, for the beam constricted at both ends with immovable supports, $\hat{w}_m$ and $\hat{u}_m$ denote transversal and longitudinal displacements, respectively. Assuming that ratio of the maximum amplitude of the beam to its projected length L is equal *1/10*, let us keep in mind the curvature function of the beam to be in the form of sinusoidal variation as given below:

$$Y_0(\hat{x}) = \frac{L}{10}.\sin\left(\pi.\frac{\hat{x}}{L}\right) \tag{1}$$

Let us assume that n number of concentrated masses is attached on the beam. The following equation and boundary conditions providing this equation can be written:

$$\rho.A.\ddot{\hat{w}}_{m+1} + E.I.\hat{w}_{m+1}'''' = \frac{E.A.}{L}\left[\sum_{r=0}^{n}\int_{\hat{x}_r}^{\hat{x}_{r+1}}\left\{\hat{Y}_0'.\hat{w}_{r+1}' + \frac{1}{2}\hat{w}_{r+1}'^2\right\}.d\hat{x}\right].\left(\hat{Y}_0'' + \hat{w}_{m+1}''\right), \qquad m = 0, 1... n. \tag{4.a}$$

$$\hat{w}_p\big|_{\hat{x}=\hat{x}_p} = \hat{w}_{p+1}\big|_{\hat{x}=\hat{x}_p},\ \hat{w}_p'\big|_{\hat{x}=\hat{x}_p} = \hat{w}_{p+1}'\big|_{\hat{x}=\hat{x}_p},\ \hat{w}_p''\big|_{\hat{x}=\hat{x}_p} = \hat{w}_{p+1}''\big|_{\hat{x}=\hat{x}_p},\ E.I.\left(\hat{w}_p''' - \hat{w}_{p+1}'''\right)\Big|_{\hat{x}=\hat{x}_p} = M_p.\ddot{\hat{w}}_p\big|_{\hat{x}=\hat{x}_p}$$

$$\hat{w}_1\big|_{\hat{x}=\hat{x}_0} = \hat{w}_1''\big|_{\hat{x}=\hat{x}_0} = \hat{w}_{n+1}\big|_{\hat{x}=\hat{x}_{n+1}} = \hat{w}_{n+1}''\big|_{\hat{x}=\hat{x}_{n+1}} = 0, \qquad p = 1, 2... n. \tag{4.b}$$

where M is the concentrated mass attached on the beam, $\hat{x}$ is the distance from the immovable end at left-hand side, E is the Young's modulus, ρ is the density, A is the cross sectional area of the beam, I is the moment of inertia of the beam cross-section with respect to the neutral axis. $(\dot{})$ and $(')$ denote differentiations with respect to the time t and spatial variable x, respectively.

Eq. (4.a) is the equation of motion for the system and consists of $n+1$ equations. Equations of the motion and the boundary conditions are dependent on the size of the system and the material used. These equations can be made independent from the dimensional parameters by making the following definitions:

$$w_p = \hat{w}_p/r,\quad Y_0 = \hat{Y}_0/r,\quad x = \hat{x}/L,\quad \eta_p = \hat{x}_p/L,\quad t = \sqrt{E.I/\rho.A.L^2}.\hat{t},\quad \alpha_p = M_p/(\rho.A.L),\quad I = r^2.A \tag{5}$$

where r is the radius of gyration of the beam cross section, α is the ratio between the concentrated mass and the mass of the beam, η is the dimensionless displacement variable.

Adding dimensionless damping and forcing terms after non-dimensionalization, Eq. (4) can be rewritten as follows:

$$\ddot{w}_{m+1} + w_{m+1}^{iv} + 2.\vec{\mu}.\dot{w}_{m+1} = \left[\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}\left\{Y_0'.w_{r+1}' + \frac{1}{2}w_{r+1}'^2\right\}.dx\right].\left(Y_0'' + w_{m+1}''\right) + \vec{F}_{m+1}.\cos\Omega.t\,, \tag{6.a}$$

$$w_p\big|_{x=\eta_p} = w_{p+1}\big|_{x=\eta_p},\ w_p'\big|_{x=\eta_p} = w_{p+1}'\big|_{x=\eta_p},\ w_p''\big|_{x=\eta_p} = w_{p+1}''\big|_{x=\eta_p},\ \left(w_p''' - w_{p+1}'''\right)\Big|_{x=\eta_p} = \alpha_p.\ddot{w}_p\big|_{x=\eta_p},$$

$$w_1\big|_{x=\eta_0} = w_1''\big|_{x=\eta_0} = w_{n+1}\big|_{x=\eta_{n+1}} = w_{n+1}''\big|_{x=\eta_{n+1}} = 0\,.\quad \eta_0 = 0\,,\ \eta_{n+1} = 1\,. \tag{6.b}$$

where μ is the dimensionless damping coefficient, F and Ω are the amplitude and frequency of the dimensionless external forcing term, respectively. In a similar way, the curvature function of the beam can be written in the following non-dimensional form:

$$Y_0(x) = sin(\pi.x) \tag{7}$$

Perturbation Analysis

In this section, approximate solutions to the system will be searched. Method of multiple scales (MMS), a perturbation technique, will be applied to the partial differential equations and corresponding boundary conditions directly. Eq. (6) is assumed to have a solution as a series expansion of the form below:

$$w_{m+1}(x,t;\varepsilon) = \sum_{j=1}^{3} \varepsilon^j.w_{(m+1)j}(x,T_0,T_1,T_2) + ... \tag{8}$$

where ε is a small bookkeeping parameter artificially inserted into the equations. Taking this parameter as *1* at the end, we obtain a weakly nonlinear system. In this expansion, $T_0=t$ is the fast time scale, and $T_1=\varepsilon t$ and $T_2=\varepsilon^2 t$ are the slow time scales in MMS. Derivatives with respect to time are written as:

$$d/dt = D_0 + \varepsilon.D_1 + \varepsilon^2.D_2 + ..., \qquad d^2/dt^2 = {D_0}^2 + 2.\varepsilon.D_0.D_1 + \varepsilon^2.({D_1}^2 + 2.D_0.D_2) + ... \quad D_n \equiv \partial/\partial T_n, \tag{9}$$

First order (ε^1) of the expansion in Eq. (9) corresponds to the linear problem of the system. Other orders constitutes nonlinear problem of the system. In order to counter the effects of the nonlinear terms, the forcing and damping terms are ordered as follows:

$$\vec{\mu} = \varepsilon^2.\mu, \qquad \vec{F}_{p+1} = \varepsilon^3.F_{p+1} \tag{10-11}$$

Let us assume that the curvature function is of order *1* (ε^0). In this case, substituting Eqs. (8-11) into Eq. (6) and separating each order of ε, one obtains the following equations:

order ε (j=1):

$${D_0}^2.w_{(m+1)1} + {w_{(m+1)1}}^{iv} = \left\{ \sum_{r=0}^{n} \int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)1}' dx \right\}.Y_0'' \tag{12.a}$$

$$w_{p1}\big|_{x=\eta_p} = w_{(p+1)1}\big|_{x=\eta_p}, \quad w_{p1}'\big|_{x=\eta_p} = w_{(p+1)1}'\big|_{x=\eta_p}, \quad w_{p1}''\big|_{x=\eta_p} = w_{(p+1)1}''\big|_{x=\eta_p}$$

$$\left(w_{p1}''' - w_{(p+1)1}''' = \alpha_p.{D_0}^2.w_{p1} \right)\Big|_{x=\eta_p}, \quad w_{11}\big|_{x=\eta_0} = w_{11}''\big|_{x=\eta_0} = w_{(n+1)1}\big|_{x=\eta_{n+1}} = w_{(n+1)1}''\big|_{x=\eta_{n+1}} = 0, \tag{12.b}$$

order ε^2 (j=2):

$$\begin{aligned} {D_0}^2.w_{(m+1)2} + {w_{(m+1)2}}^{iv} = -2.D_0.D_1.w_{(m+1)1} + \left\{ \sum_{r=0}^{n} \int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)2}' dx \right\}.Y_0'' + \frac{1}{2}.\left\{ \sum_{r=0}^{n} \int_{\eta_r}^{\eta_{r+1}} {w_{(r+1)1}'}^2 dx \right\}.Y_0'' \\ + \left\{ \sum_{r=0}^{n} \int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)1}' dx \right\}.w_{(m+1)1}'' \end{aligned} \tag{13.a}$$

$$w_{p2}\big|_{x=\eta_p} = w_{(p+1)2}\big|_{x=\eta_p}, \quad w_{p2}'\big|_{x=\eta_p} = w_{(p+1)2}'\big|_{x=\eta_p}, \quad w_{p2}''\big|_{x=\eta_p} = w_{(p+1)2}''\big|_{x=\eta_p}$$

$$\left(w_{p2}''' - w_{(p+1)2}''' = \alpha_p.\left({D_0}^2.w_{p2} + 2.D_0.D_1.w_{p1}\right) \right)\Big|_{x=\eta_p}, w_{12}\big|_{x=\eta_0} = w_{12}''\big|_{x=\eta_0} = w_{(n+1)2}\big|_{x=\eta_{n+1}} = w_{(n+1)2}''\big|_{x=\eta_{n+1}} = 0 \tag{13.b}$$

order ε^3 (j=3):

$$D_0^{\,2}.w_{(m+1)3} + w_{(m+1)3}^{\,iv} = -2.\mu.D_0.w_{(m+1)1} - 2.D_0.D_1.w_{(m+1)2} - (D_1^{\,2} + 2.D_0.D_2).w_{(m+1)1} + F_{m+1}.\cos\Omega t$$

$$+\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)3}'\,dx\right\}.Y_0'' + \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} w_{(r+1)1}'.w_{(r+1)2}'\,dx\right\}.Y_0'' + \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)2}'\,dx\right\}.w_{(m+1)1}'' \qquad (14.a)$$

$$+\frac{1}{2}.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} w_{(r+1)1}'^{2}.dx\right\}.w_{(m+1)1}'' + \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.w_{(r+1)1}'\,dx\right\}.w_{(m+1)2}''$$

$$w_{p3}\big|_{x=\eta_p} = w_{(p+1)3}\big|_{x=\eta_p},\quad w_{p3}'\big|_{x=\eta_p} = w_{(p+1)3}'\big|_{x=\eta_p},\quad w_{p3}''\big|_{x=\eta_p} = w_{(p+1)3}''\big|_{x=\eta_p}$$

$$\left(w_{pj}''' - w_{(p+1)j}'''\right)\Big|_{x=\eta_p} = \alpha_p.\left(D_0^{\,2}.w_{p3} + 2.D_0.D_1.w_{p2} + \left(D_1^{\,2} + 2.D_0.D_2\right)w_{p1}\right)\Big|_{x=\eta_p},$$

$$w_{13}\big|_{x=\eta_0} = w_{13}''\Big|_{x=\eta_0} = w_{(n+1)3}\big|_{x=\eta_{n+1}} = w_{(n+1)3}''\Big|_{x=\eta_{n+1}} = 0, \qquad (14.b)$$

Primary Resonance Case

Primary resonance occurs in case that the forcing frequency is close to one of the natural frequencies of the system. Thus, a sudden arise in the vibration amplitude happens. In order to solve linear problem in Eq. (12), we assume the solutions at order ε as of the following form:

$$w_{(m+1)1}(x,T_0,T_1,T_2) = \left[A(T_1,T_2).e^{i.\omega.T_0} + cc\right]Y_{m+1}(x) \qquad (15)$$

where cc is the complex conjugate of the preceding terms, and ω is the natural frequency, Y_{m+1} are the functions describing the mode shapes. Inserting Eq. (15) into Eq. (12), following differential equations and boundary conditions can be obtained:

$$Y_{m+1}^{\,iv} - \omega^2.Y_{m+1} = \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.Y_{r+1}'\,dx\right\}.Y_0'' \qquad (16.a)$$

$$Y_p\big|_{x=\eta_p} = Y_{p+1}\big|_{x=\eta_p},\quad Y_p'\big|_{x=\eta_p} = Y_{p+1}'\big|_{x=\eta_p},\quad Y_p''\big|_{x=\eta_p} = Y_{p+1}''\big|_{x=\eta_p},\quad \left(Y_p''' - Y_{p+1}''' + \alpha_p.\omega^2.Y_p\right)\Big|_{x=\eta_p} = 0,$$

$$Y_1\big|_{x=\eta_0} = Y_1''\Big|_{x=\eta_0} = Y_{n+1}\big|_{x=\eta_{n+1}} = Y_{n+1}''\Big|_{x=\eta_{n+1}} = 0 \qquad (16.b)$$

In order to obtain the solutions at order ε^2 of the perturbation series, it is required that a solvability condition such as $D_1A(T_1, T_2) = 0$ must be satisfied. Thus, the amplitude $A=A(T_2)$ does not depend on T_1. For obtaining the solution resulting from non-secular terms, Eq. (15) must be inserted into Eq. (13). In this case, equations at order ε^2 accept solutions of the form as below:

$$w_{(m+1)2}(x,T_2) = \left[A^2.e^{2.i.\omega.T_0} + cc\right]\phi_{(m+1)1}(x) + 2.A.\bar{A}.\phi_{(m+1)2}(x) \qquad (17)$$

Inserting Eq. (17) into Eq. (13), differential equations and boundary conditions can be written as follows:

$$\phi_{(m+1)1}^{\,iv} - 4.\omega^2.\phi_{(m+1)1} = \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.\phi_{(r+1)1}'\,dx\right\}.Y_0'' + \frac{1}{2}.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_{r+1}'^{2}\,dx\right\}.Y_0'' + \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.Y_{r+1}'\,dx\right\}.Y_{m+1}'' \qquad (18.a)$$

$$\phi_{p1}\big|_{x=\eta_p} = \phi_{(p+1)1}\big|_{x=\eta_p},\quad \phi_{p1}'\big|_{x=\eta_p} = \phi_{(p+1)1}'\big|_{x=\eta_p},\quad \phi_{p1}''\big|_{x=\eta_p} = \phi_{(p+1)1}''\big|_{x=\eta_p},$$

$$\left(\phi_{p1}''' - \phi_{(p+1)1}''' + 4.\alpha_p.\omega^2.\phi_{p1}\right)\Big|_{x=\eta_p} = 0,\quad \phi_{11}\big|_{x=\eta_0} = \phi_{11}''\Big|_{x=\eta_0} = \phi_{(n+1)1}\big|_{x=\eta_{n+1}} = \phi_{(n+1)1}''\Big|_{x=\eta_{n+1}} = 0, \qquad (18.b)$$

$$\phi_{(m+1)2}^{\,iv} = \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.\phi_{(r+1)2}'\,dx\right\}.Y_0'' + \frac{1}{2}.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_{r+1}'^{2}\,dx\right\}.Y_0'' + \left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}} Y_0'.Y_{r+1}'\,dx\right\}.Y_{m+1}'' \qquad (19.a)$$

$$\phi_{p2}\Big|_{x=\eta_p}=\phi_{(p+1)2}\Big|_{x=\eta_p},\quad \phi_{p2}'\Big|_{x=\eta_p}=\phi_{(p+1)2}'\Big|_{x=\eta_p},\quad \phi_{p2}''\Big|_{x=\eta_p}=\phi_{(p+1)2}''\Big|_{x=\eta_p},$$

$$\left(\phi_{p2}'''-\phi_{(p+1)2}'''\right)\Big|_{x=\eta_p}=0,\quad \phi_{12}\Big|_{x=\eta_0}=\phi_{12}''\Big|_{x=\eta_0}=\phi_{(n+1)2}\Big|_{x=\eta_{n+1}}=\phi_{(n+1)2}''\Big|_{x=\eta_{n+1}}=0 \tag{19.b}$$

At order ε^3 of the perturbation series, having substituted Eqs. (15-17) into Eq. (14), the resulting equation will accept the solution of the following form:

$$w_{(m+1)3}(x,T_0,T_2)=\varphi_{m+1}(x,T_2).e^{i.\omega.T_0}+W_{m+1}(x,T_2)+cc \tag{20}$$

where $W_{m+1}(x,T_2)$ corresponds to the solution for the non-secular terms, and cc to the complex conjugate of the preceding terms.

Excitation frequency is taken close to any natural frequency of the system as below:

$$\Omega=\omega+\varepsilon^2.\sigma \tag{21}$$

where σ is the detuning parameter denoting closeness of the forcing frequency to the natural frequency. Under this assumption, inserting Eq. (20) into Eq. (14) and eliminating the secular terms, the following differential equations and boundary conditions can be obtained:

$$\varphi_{m+1}^{\,iv}-\omega^2.\varphi_{m+1}-\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.\varphi_{r+1}'\,dx\right\}.Y_0''=-2.i.\omega.\left(\dot{A}+\mu.A\right).Y_{m+1}+\frac{1}{2}F_{m+1}.e^{i.\sigma.T_2}+\left[\frac{3}{2}.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_{r+1}'^{2}.dx\right\}.Y_{m+1}''\right.$$

$$+\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_{r+1}'.\phi_{(r+1)1}'\,dx\right\}.Y_0''+2.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_{r+1}'.\phi_{(r+1)2}'\,dx\right\}.Y_0''+\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.\phi_{(r+1)1}'\,dx\right\}.Y_{m+1}'' \tag{22.a}$$

$$\left.+2.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.\phi_{(r+1)2}'\,dx\right\}.Y_{m+1}''+\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.Y_{r+1}'\,dx\right\}.\phi_{(m+1)1}''+2.\left\{\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.Y_{r+1}'\,dx\right\}.\phi_{(m+1)2}''\right].A^2.\overline{A}$$

$$\varphi_p\Big|_{x=\eta_p}=\varphi_{p+1}\Big|_{x=\eta_p},\quad \varphi_p'\Big|_{x=\eta_p}=\varphi_{p+1}'\Big|_{x=\eta_p},\quad \varphi_p''\Big|_{x=\eta_p}=\varphi_{p+1}''\Big|_{x=\eta_p}$$

$$\left(\varphi_p'''-\varphi_{p+1}'''+\alpha_p.\omega^2.\varphi_p\right)\Big|_{x=\eta_p}=2.i.\alpha_p.\omega.Y_p\Big|_{x=\eta_p},\quad \varphi_1\Big|_{x=\eta_0}=\varphi_1''\Big|_{x=\eta_0}=\varphi_{n+1}\Big|_{x=\eta_{n+1}}=\varphi_{n+1}''\Big|_{x=\eta_{n+1}}=0 \tag{22.b}$$

The solvability condition for Eq. (22) can be written as follows:

$$2.i.\omega.\left[k.\dot{A}+\mu.A\right]+A^2.\overline{A}.\Gamma=\frac{1}{2}.f.e^{i.\sigma.T_2} \tag{23}$$

where normalization process and coefficients f, k, Γ are as below:

$$\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_{r+1}^{\,2}.dx=1,\qquad f=\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}F_{r+1}.Y_{r+1}.dx,\qquad k=1+\sum_{r=1}^{n}\alpha_r.Y_r\Big|_{x=\eta_r}^{\,2} \tag{24-26}$$

$$\Gamma=\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}\left\langle Y_{r+1}'.\phi_{(r+1)1}'+2.Y_{r+1}'.\phi_{(r+1)2}'\right\rangle dx.Y_0''+\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}\left\langle\frac{3}{2}.Y_{r+1}'^{2}+Y_0'.\phi_{(r+1)1}'+2.Y_0'.\phi_{(r+1)2}'\right\rangle dx.Y_{m+1}'' \tag{27}$$

$$+\sum_{r=0}^{n}\int_{\eta_r}^{\eta_{r+1}}Y_0'.Y_{r+1}'dx.\left[\phi_{(m+1)1}''+2.\phi_{(m+1)2}''\right]$$

Let the complex amplitudes A be written as follows:

$$A(T_2)=\frac{1}{2}.a.e^{i.\theta},\qquad \overline{A}(T_2)=\frac{1}{2}.a.e^{-i.\theta},\qquad \theta=\theta(T_2) \tag{28-29}$$

where a is the real amplitude and θ is the phase. Inserting these definitions into Eq. (23), and separating real and imaginary parts, one obtains the following phase-modulation equations: