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Review / Derleme

Tilapia Culture and Its Problems in Turkey

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Özet: ***Türkiye'de tilapia yetiştiriciliği ve sorunları.*** Tilapialar, yetiştiricilik için arzu edilen birçok olumlu özelliğe sahip olmaları nedeniyle önemli türler arasındadırlar ve 100'den fazla ülkede yetiştiriciliği yapılmaktadır. Amerika ve Avrupa önemli tilapia ihracat merkezleridir. Ancak tilapia yetiştiriciliğinde, orijinal olarak bulundukları tropikal bölgeler de dahil olmak üzere, bir takım sorunlarla karşılaşılmaktadır. Tilapialar Türkiye'de ilk defa 1975 yılında Burdur Gölü'ne aşılanmışlardır. Fakat tüm balıklar ölmüştür. Aşılamadan sonra, tilapialar adapte edilmiş ve ülkenin Çukurova Bölgesi'nde kültüre alınmışlardır. Yetiştiriciliğinde var olan sorunlara ek olarak, ülkemizde yetiştirilebilecekleri bölgelerdeki yetiştirme periyodunun kısalığının da etkisiyle genellikle porsiyonluk balık ortalama ağırlığına ulaşamamaktadır. Bu nedenle istenilen kalitede ürün elde edilememektedir. Ayrıca, elde edilen ürüne bağlı olarak da oluşabilen tüketici talep azlığı, tilapia üretimini sınırlandıran etmenler arasındadır. Bu çalışmayla, akuakültürün geliştirilmesi gereken ve istenilen ülkemizde, üretimin artırılmasına katkı sağlamak amacıyla, dünya kültür balığı üretiminde önemli bir yer tutan tilapiaların Türkiye'deki yayılımı, yaygınlaştırılamamış yetiştiriciliğinin nedenleri ortaya konulmaya çalışılmış ve getirilen önerilerle sorunların çözümüne katkı sağlanması amaçlanmıştır.

Anahtar Kelimeler: Tilapia Kültürü, Türkiye, Aşılama, Yayılım, Tüketici İsteği.

Abstract: Tilapias are among the important fishes for aquaculture because of many positive characteristics and have been cultured in more than 100 countries. United States of America and many European Countries are important tilapia export centers. However, it has been met some problems in tilapia culture even in their tropical native regions. Tilapias transplanted to Turkey (to Lake Burdur) in 1970 firstly. But all the fish died. Later transplanted tilapias were adapted and taken the culture in Çukurova Region of the country. Besides to general problems observed their culture, they do generally not reach the body weight in order to market as a result of short culturing period in the regions where tilapias can be cultured in our country. So, product in demanded quality has not been able to be obtained. Minority in consumer demand because of lower quality product is among the factors restricted tilapia culture. This study was carried out with the aim of contributing to be increased of tilapia production in our country where aquaculture development was demanded and required. Distribution and reasons not to be propagated culture in Turkey of tilapias, which have a big important part among the fishes cultured in the world, were tried to be exposed. Some suggestions were made to contribute to solve the problems.

Key Words: Tilapia Culture, Turkey, Transplante, Distribution, Consumer Demand.

Introduction

Tilapia is common name given to a group of fishes within the family Cichlidae. Tilapias have 1524 species (Eli, 2004). Their original areas are from the south of Africa and Land of Madagascar to Northern Syria. They were seen out of their original regions firstly by transferring to Java Land by unknown persons in 1939. After this date, Japanese transplanted tilapias to Lands in Pacific Bay during the period of 2nd War. Additionally, Food Agricultural Organization (FAO) introduced them to many places in South of Pacific as a solution of problem which animal protein necessity of human could not be met because fishermen could not work in their regions due to constraint of Japanese and milkfish production decreased. Then, they were introduced to many countries because importance of tilapias was realized. Now, they are widespread in a lot of natural or artificial water reservoirs in many countries especially having tropical and subtropical climates as the results of their transferring as conscious or chance and have been cultured in more than 100 countries (Tekelioğlu, 2000).

Economically important species as table fish belong to three genera (*Tilapia, Oreochromis,* and *Sarotherodon*). In addition to their alimentary importance, some species are useful for controlling of water plants. Some researchers reported that tilapias have been cultured for 2500 years (Chapman, 2000), while the others implied that they have cultured for 4000 years (Suwanasart, 1972; Balarin and Hatton, 1979; Ramnarine, 2005). Great attention has been paid to tilapia culture in recent years Their culture is being practiced in most of the tropical and subtropical regions (El-Sayed, 2002). Tilapias are arguably the ideal candidate for culture and have been heralded as culture species of the 21st century and referred to as 'aquatic chicken' (Ramnarine, 2005).

Because tilapia needs very warm water, production has concentrated in the tropics. But advances in indoor aquaculture are making year-round tilapia cultivation feasible in cold regions (Morisson, 1988).

Tilapias are among the most resistant fishes known against to diseases and relatively bad environmental conditions such as high stocking density of fish, lower water quality, organically pollutant water, and low dissolved oxygen level of the water

(less than 0. 5 mg l^{-1}). They have tolerance to salinity in wide range and are suitable for maintaining and feeding conditions in culture (Cruz and Ridha, 1994). They reproduce easily, have short food chain in feeding, evaluate and convert remaining food and domestic wastes into high quality protein and grow fast, and are delicious. These characters provide the farmers its relatively low cost of production and make tilapias among the excellent fishes for culture (Yi *et al,* 1996; de Graaf *et al*, 1999; Penña-Mendoza, 2005).

It is known that more than 20 tilapia species have been cultured in especially developing countries, which have lack of animal protein (Guerrero, 1982). Schoenen (1982) informed that 8 tilapia species (*O. macrochir* (Boulenger, 1912), *O. aureus*

(Steindachener, 1864), *O. hornorum* (Trewavas, 1866), *O. mossambicus* (Peters, 1857), *O. niloticus* (Linnaeus, 1758), *Sarotheredon galilaeus* (Haselguits, 1758), *Tilapia rendalli* (Boulenger, 1896) and *T. zilli* (Gervais, 1848)) were more suitable for culturing, although there are 10 species cultured commonly (Stickney, 1986). Additionally, two species (*O. niloticus* and *O. mossambicus*) and their hybrid are the most popular among tilapias. *O. niloticus* is the main cultured species and responsible for the significant increase in global tilapia aquaculture production. The other species gaining recognition because of their adaptability to cold water and saline water are *O. aureus* and *O. spilurus*, respectively (Gupta and Acosta, 2004).

Tilapia culture has been carried out in different culture systems (earthen pond, concrete tank, super-aerated pond, raceway and cage), management strategies (extensive, semi-intensive or intensive, monoculture, polyculture, monosex, and mixed sex) and in different environment (fresh water and saline water).

World tilapia production has increased steadily by the years during the period of 1991- 2002. In 2002, its culture production reached to 1.5 million tones in a year when the global fish production was almost 51.4 million tons (Figure 1 and 2) (Ramnarine, 2005). Totally, 1.27 million tons of tilapia was produced from aquaculture in 2000; 85.9 % of the production was from freshwater environment, while 14.1 % was from brackishwater (FAO, 2002). The most quantity of tilapia in the world has been obtained from Asia (1 million ton / year). Approximately 47 % of tilapia production of the world was from China (Dey, 2001).

In Egypt, tilapia production recently surpassed the production of common carp and thus tilapia has become the pre- eminent culture fish species (Essa and Salama, 1994). Nowadays, the major producers of tilapia in the world are (in decreasing order of production) China, Thailand, the Philippines, Indonesia, Taiwan, Egypt, Colombia, Cuba, Mexico and Israel. In recent years, tilapias have also been begun to be used as alternative to fishes such as whiting and codfish which have been benefited from their fillets in big restaurant chains of developed countries such as United States of America (USA) and some of European countries (Fitzsimmons, 2001). That is the reason of increasing import quantity (from 27.8 thousand tons in 1998 to 90.2 thousand tons in 2003) of tilapias to especially USA (Anonymous, 2005).

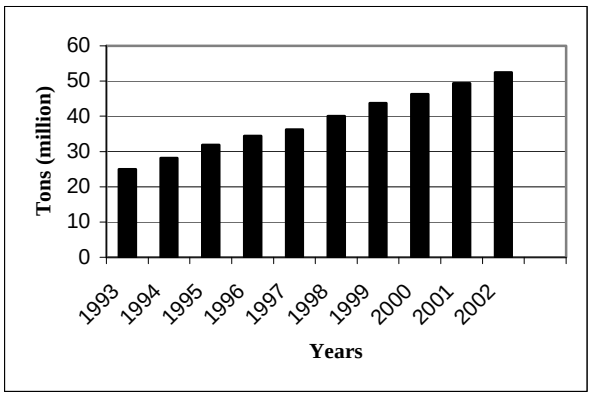

Figure 1. Global fish production from aquaculture (Ramnarine, 2005).

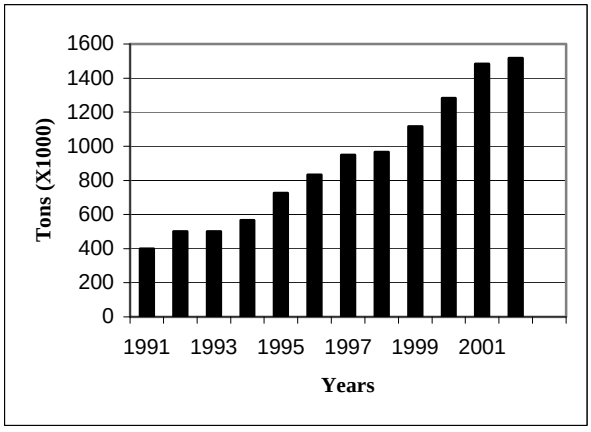

Figure 2. Tilapia production of the world (Ramnarine, 2005).

However especially costal regions of Mediterranean Sea and Aegean Sea of Turkey have suitable climatic conditions for biological necessities of tilapias even so seasonally, tilapia farming could not be developed in this country because of some problems met in their culture.

In this study, they are aimed to be explained the general problems in tilapia culture of the world, present status and problems of them in Turkey and to be made some suggestions for solution.

General Problems and Solutions in Tilapia Culture of the World

Although tilapias are useful for aquaculture with a lot of positive properties mentioned above, they can be cultured restrictedly in especially subtropical regions since they cannot tolerate cold water.

When water temperature decreases (generally to 13-14°C but to lower than this for some species), tilapias die in

few days as depending on species, because physiological changes occur. Additionally, even at water temperature being few degrees over of lethal limit, some fungal, viral, bacterial and parasitic infections such as saprolegniasis (Zaijie et al, 2006), lymphocystis, columnaris, hemorrhagic septicemia and whirling disease (Pompa and Masser, 1999) begin to be appeared that results in high mortality even though the temperature does not decrease more.

In subtropics, they are overwintered by using warm water (thermal effluents, geothermal springs or cooling water used some industries if there is) or keeping the fish in green house or inside ponds due to unresistence of them to cold water (Tekelioğlu, 2000)

The second problem is that tilapias reach sexual maturation in early age and short total length (in 2-3 months old and 10-12 cm total length), and then reproduce with the intervals of 4-6 or 8 weeks as depending on species and environmental conditions thus number of fish begin to increase, which disorders the maintenance and feeding conditions in the ponds. That is not desired in the culture because disordering the culture programme causes high feed conversion rate, low growth rate of the fish and harvesting of undeveloped tilapias having low economic importance (Guerrero, 1982; Chervinski, 1982). This result appears as a serious problem when associated with the short growth period in the regions where they need overwintering.

Different methods have been developed in order to inhibit reproduction or to control overpopulation of tilapias (Figure 3). The most reliable and economic method is to produce all male tilapia that grow faster and have more standard size than female. All male tilapia can be produced by the methods such as separating the sex manually via visual examination (or hand sexing), sex reversal with hormone treatment, hybridization or production of super male by applying last two methods of them.

The first method is the oldest and carried out when fish is about 20 or 30g body weight. It takes time, is tiring, and cannot give true results every time due to human error. Currently, hand sexing of tilapia is practiced by only a limited number of fish farmers in underdeveloped countries.

The other method is to apply artificial androgens either into the food (oral administration) or tank water of newly hatched tilapia fries during approximately two or four weeks. Because gonadal differentiation in tilapia typically occurs between 8 to 25 days post-hatch, dependent upon environmental conditions (Johnson, 2004).

In this method, succession at the rate of 100 % cannot be obtained in each application as depending on efficiency of hormone, dosage, method of administration, time and duration of treatment, and species. Recent studies have shown that hormonal sex reversal using 17α- methyletestosterone is more effective at higher water temperatures (Balarin and Haller, 1987). There is serious inconvenience on subject the hormone treatment to table fish because of being possibility of hormone residue in fish meat. So hormone applications in fish farming have been forbidden in some countries (such as Turkey). However, oral administration of 17α-methyletestosterone is best suited for successful tilapia production in the United States (Johnson, 2004). Non-hormonal chemicals (acriflavine and tamoxifen) have also been studied to produce all male populations (Ramnarine, 2005; Hines and Watts, 1995).

Hybridization between the certain species (for example male *O. aureus* or *O. hornorum* X female *O. niloticus;* male *O. hornorum* X female *O. mossambicus*) can give all male progeny even though result is not as desired (at the rate of 100 % male) as depending on strains of species and ambient conditions in each treatment. The recently developed technique for obtaining monosex population is by producing supermales (YY) through genetic manipulation. In this technology, female tilapias sex reversed from male using estrogens such as estradiol are crossed with normal males and the result is YY males. When these supermales are bred with normal females, all the progeny will have a Y chromosome and will therefore be males (Chapman, 2000; Ramnarine, 2005; Gupta and Acosta, 2004). In a breeding program in *O. niloticus*, this technology produces genetically male tilapia with an average sex ratio of > 95 % male and 40 % increase in yield. Using of supermales can be accepted as biologically the best method (Mair et al., 1997).

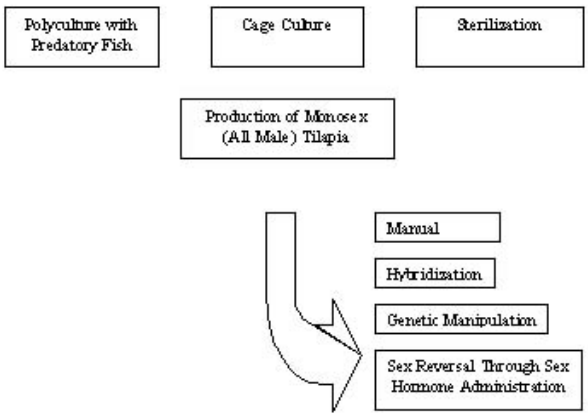

Figure 3. The methods used for inhibiting reproduction or controlling overpopulation of tilapias.

Suitabilities of these methods standing in line are in different levels for practice. For this reason, although some of them are used in fish farming, the others are studied in order to develop by universities and some foundations such as Food and Drug Administration Department in USA.

Despite the great potential of tilapia culture, shortage of fry production to meet the increased global demands remains one of the main obstacles limiting the expansion of intensive culture of these fishes (El- Sayed, 2002).

There are also generally meat quality problems of tilapias such as muddy odour and flavour in fish meat occurring as depending on culture conditions and high bone rate (if fish is in small size) in harvest time (Chapman, 2000; Dey, 2001).

Bringing Tilapias to Turkey and Their Distribution

O. niloticus is present naturally in river Asi (Hatay, Turkey) passing through Syria (Gürlek, 2004). According to Gürlek (2004) Kosswing (1979) reported that tilapias were brought firstly to Turkey in 1970's for the aim of transplanting the fish to Lake Burdur. There, all tilapias died in a short time.

Tilapia species brought the second times to Turkey (Çukurova Region) from Syria by Fisheries Department of Sixth Regional Directorate of State Hydraulic Works

(DSI), Adana in 1975 were *O. niloticus* and *T. zilli.* A quantity of individuals belonging to these species was transplanted to Seyhan Dam Lake in 1976 (personal communication with Sağat, 2005 in DSI, Adana). Scientifically studies on their adaptation and culture carried out by Ercan Sarıhan, Özer Toral and Nazmi Tekelioğlu in either Fisheries Research Station, Animal Science Department of Agricultural Faculty of Çukurova University (ASDAF) or DSI. Afterwards, total species counts were reached to 5 with *T. rendalli*, and *T. galileus* brought from Scotland to ASDAF in 1978 by FAO and with *O. aureus* brought from Israel in 1989 by researchers of ASDAF. Later, counts of species in Çukurova Region decreased to four because existence of *O. galileus* could not be maintained (Sarıhan and Toral, 1980; Tekelioğlu, 2000).

Tilapias have propagated into many places of Çukurova Region with either their entering to river from exit of Seyhan Dam Lake and reaching to drainage channel of DSI or escaping from drainage channel of ponds in Fisheries Research Station of Fisheries Faculty of University of Çukurova (FRS) and from tilapia culture cages in Seyhan Dam Lake since bringing to Turkey (for about 30 years). They also have been transferred to several Fisheries Faculties and other research units in several cities

(Antalya, Antakya, Çanakkale, Eğirdir, Sinop, Trabzon, İzmir, Eskişehir, Mersin and Muğla) of Turkey. Tilapias were also sold to fish farmers in different regions such as especially Yumurtalık, Silifke and Antalya, and even stocked to some lakes (Reyhanlı, Gölbaşı, Kırıkhan) by FRS (Tekelioğlu, 2000). *Tilapia spp.* is present in Köyceğiz Lagoon (Akın et al., 2005). These fishes maintain their life even during winter in relatively deep-water bodies having appropriate temperatures for their biological demands.

Tilapia Culture in Turkey

Tilapias have been cultured semi intensively only in few farms belonging to government and farmers in Turkey. They have been cultured in the ponds of DSI (in Adana) in small scale (with the aiming of maintenance the presence of tilapias) and in the ponds of Fisheries Faculty of University of Çukurova. Additionally, *O. niloticus* had been polycultured (3- 4 tons / year) together with *Cyprinus carpio* (carp) and *Mugil spp*. (mullet) in a farming in Kırmızıdam Village (Karataş, Adana) until 2002. Tilapia had been polycultured in Silifke (Mersin) and İskenderun (Antakya). There were no records about their production quantity.

They can be kept outside ponds even winter in DSI because water at unvarying temperature can be supplied from a well. In FRS, tilapia fries swimming in schools and consumed yolk newly (in zero age) are collected from broodstock ponds and stocked to the rearing ponds enriched with plankton as from end of the spring (in the last two weeks of May or beginning of June) when water temperature is about 20-22 ºC. Fish is grown until middle of September Afterwards fish growth decreases until beginning of October (around 19 ºC) and stop in the middle of the month (around 16-17 ºC). As from this time, tilapias are begun to be harvested before fish death appears due to the cold water. However, tilapias can gain mean 100-140 g body weight under good feeding and maintaining conditions; male specimens can reach nearly 270-350 g during approximately 5 months.

In this manner, although tilapia reach maturation sexually at the end of the rearing period because of stocking to the ponds after resorbing yolk sac, they cannot reproduce in harvest time because water temperature does not permit their reproduction. It can be considered as an advantage for tilapia culture in Çukurova Region.

Problems and Suggestions for Solution

Tilapia culture in Turkey has not been widespread by a number of factors mentioned below.

They are warm water fishes. Reproduction period of the fish begins at the last half of May in conditions of Mediterranean and Aegean Regions. This restricts tilapia culture period within 4.5 and 5 months as related to water temperature in the country. Extending this period is unavoidable in order to grow and harvest the fish into bigger size at the end of the culture season. Heating of the water of broodstocks' pond to reproduce the fish and than producing fingerlings earlier indoors are more available in order to maximize the grow-out season.

Because of short rearing period, one of the main problems met in tilapia culture is to be overwintered of broodstock fishes and fries. Tekelioğlu (2000) suggest that the building green houses or hibernation ponds can meet their heating necessity. These applications are available not only for surviving during the winter but also maintaining the relatively growth of tilapias.

Using of this method results in additional expenditure in each tilapia farm. So, to be established the farms for only tilapia reproduction in certain places as trout hatchery farm then to be sold the fries to other tilapia farms can be more useful. This application will make fries possible to be taken for growth in earlier time than that in nature.

Tilapias will have bigger sizes in harvest if overwintered fish (about 15 cm total length and 10 g body weight) are used in stocking carried out as from May (when water temperature begins to increase). Its disadvantage is that fish lay their eggs in culture period, because they already reach to sexual maturation when they are stocked to the rearing ponds. As the results of this, the fries become different length and weight and do not develop more and the fish stocked for rearing cannot reach to maximum size for market in harvest. The only way to get out of this problem is to collect the fries

continuously from the ponds after hatching, otherwise they become partner to fish stocked for growing out by consuming feed and using the environment in the ponds. Collecting the fries is relatively easy because they are in schools throughout the walls of the ponds in the morning (7 and 9 a.m.).

Carp feed is used for tilapia in Turkey and it cannot meet nutritional requirement of the fish. For example, the adding vitamin E to carp feed (64.75 mg/ kg) decreases the mortality at the rate of % 22 and increases twofold the fish growth. Moreover, given feed during sexually maturation is spent for not only growth of the fish but also development of gonads that are not consumed by humans. It is not possible to abolish this case occurring as depending on biological properties of tilapias. To be carried out studies will be useful for determining quantities of the nutrients especially vitamins, which become slower the gonad development but do not affect fish growth (Çelik, 2005).

Tilapias have been grown in mixed sex and in concrete or earthen pond in the country. It is suggested to increase yield that fish can be reared in male gender and in cages as well (Altun, 2003).

It is unknown clearly that, tilapias in Turkey belong to which strain because there is no evidence about their origins supplied from countries where they were brought. Moreover, becoming crossed possibilities of tilapias in the regions where they were transported and propagated are to be taken into consideration. So, to be determined strains and characters as genetically of tilapias is necessary in Turkey. It gains importance for being determined also that which tilapia strains are more resistant to cold water, have higher feed conversion rate, and have other positive properties for their culture.

Different studies have been carried out on determining the cold resistant strains of tilapias in recent years (Behrensd et al., 1990; Sifa et al., 2002; Charo-Kariska, 2005). Some species such as *S. andersonii* (grow as much as 120 g in two months), S. *spilurus*, *O. aureus* are more resistant to cold than the others (Balarin and Haller, 1987). Besides, there are more cold resistant strains of *O. aureus*. Some species such as *O. mossambicus* and *O. spilurus* can grow well in high salinity (20 ‰ or upper). Turkey has seas and several brackish water reservoirs (Tekelioğlu, 2000). It will be useful to be transplanted these species and cold resistant strains of tilapias to Turkey.

Marketing time of tilapias in Turkey is middle of the autumn (last half of October and first half of December). In this time, fishing prohibition in the country finishes and sea fishes begin to sell in the markets. It is seen that Turkish people especially in Mediterranean Region prefer sea fishes to food. So tilapias have not found enough marketing possibilities for selling in fish markets. For this reason, advertising of tilapias to Turkish people is important. Besides, it can be find new markets to export.

Tilapias having much more bigness in size have been angled at more quantity in the waters of Çukurova Region and sold cheaper than culture tilapias. This results in decreasing much more the marketing probability of tilapias obtained from aquaculture, which results in losing the culture attractiveness of tilapias indirectly in the region.

Very few amount of tilapia in Turkey has been presented freshly to the markets. Processed tilapias can take part in the markets easily. To produce the processed tilapia will provide increase its culture production indirectly.

To increase the production quality in order to meet increasing market demands of tilapia has become unavoidable. The following alternatives can be presented by considering of criticisms coming from importer countries.

Tilapia should be produced in all male population. Culturing the fish in cages instead of ponds and using the high quality feed will be useful in order to remove bad or muddy odor and taste and to improve the meat quality.

Conclusion

Tilapia culture gains importance increasingly in the world. Although especially costal zones of Mediterranean and Aegean Regions of Turkey have climatic and hydrologic properties to culture tilapias, their cultures in the country have not been widespread. The suggestions made for tilapia culture provide increasing the production. In addition to the existing suggestion, it can be available to be carried out researches on solving the problems met in Tilapia culture because tilapias culture will supply economical benefit of the country.

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