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THE CURRENT STATUS AND THE ECONOMIC ASSESMENT OF THE SAND SMELT (*Atherina boyeri* Risso, 1810) INTRODUCED INLAND WATER OF TURKEY

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ABSTRACT

In this study, it is emphasized that the current situation and economical evaluation of the sand smelt, a species of Mediterranean origin, in Turkey. In recent years, sand smelt, has entered into many natural and artificial lakes in different parts of Turkey by fishing. Although, it is not consumed in the domestic market, it is exported and has become an important species both for the region's and Turkey's economy. Thus, fishing this species has substantially increased both in the natural and the artificial lakes. Due to over fishing of sand smelt and the lack of fish-ban application in the Turkish freshwaters, although there is a heavy fishing pressure on the species, the species continues to form high populations in the Turkish freshwaters. Thus, it is thought that this species will cause negative effects in terms of freshwater ecosystems and fishing. Therefore, this species should be removed from the Turkish lakes by heavy fishing. The caught fish can be utilized in different ways including fish flour, fish feed, marinade production and can contribute to the Turkish economy.

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INTRODUCTION

A marine species, sand smelt, have formed crowded populations in recent years in Turkish freshwaters by increasing its area of distribution. This species is naturally found in the Northeast Atlantic, the Mediterranean, the Black Sea, the Aegean, the Marmara and the Caspian Sea. In Turkey, as their natural distribution area, it is located in Akyatan and Tuzla

lagoon (Adana), Bafa Lake (Aydin), Köyceğiz Lake (Mugla), Gediz River (river-mouth), Büyükçekmece and Küçükçekmece Lakes (Istanbul), Paso Lake (Edirne), Sapanca Lake (Sakarya) and in the river-mouths of some rivers in the Eastern Black Sea region (Yeşilırmak, Karadere). In addition, in recent years, it has entered Turkey's many natural and artificial lakes for fish stocking in those areas. In Turkish freshwaters, sand smelt was first detected at Lake Sapanca. In recent years, it has been determined that sand smelt has concentrated in the Hirfanlı and Kapulukaya Dam lakes on the Iznik Lake and Kizilirmak [1-2]. Also, in the study by [3], it was reported that it was found in Eğirdir and Beyşehir lakes, while it was reported by [4] that it was found in Eşen River (Muğla).

Sand smelt has economic value, however it is regarded as an invasive species in Turkey. Because of the wide variety of food and habitat preferences, the species is very well adapted to the environment it enters, grows rapidly and creates large populations. In recent years, records on the presence sand smelt have been reported in many natural and artificial lakes in different regions of Anatolia, especially in Sakarya, Aksu, Asi and Kizilirmak basins [2]. (Figure 1).

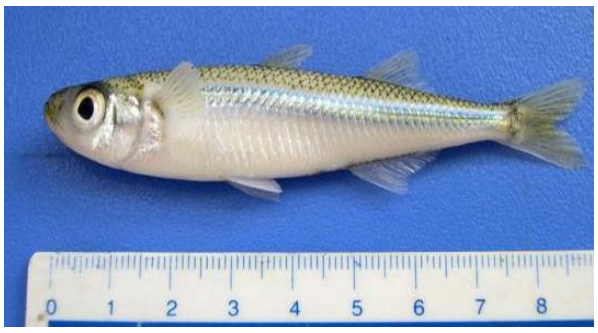

Figure 1. Sand smelt (*A. boyeri*) [5]

These natural lakes and dam lakes are isolated freshwater environments that are remote from the sea and have no direct connection to the sea. Sand smelt populations in freshwaters are

rapidly multiplying by showing high reproductive success, and as a result, they can become dominant species by invading empty pelagic niches. Depending on the life cycle characteristics such as short life span, early sexual maturity and long reproduction period, this species has a serious invasive species potential for Turkish freshwaters [1]. The predation pressure of sand smelt on zooplanktons, its competency with endemic species living in the environment and fish species with economic importance are the reasons for its adverse effects on biodiversity and ecosystem. The distribution area of sand smelt populations in Turkish freshwaters are rapidly increasing [2]. (Figure 2).

Sources: Altun (1991); Anonim (2005); Balik et al. (2005); Ozulug et al. (2005); Ekmekci et al. (2006); Kucuk et al. (2006); Ozulug (2008); Becer Ozvarol et al. (2009); Oguzkurt and Beklioglu Yerli (2009).

Figure 2. The distribution of sand smelt in Turkish freshwaters [2]

Fishing and Market Status

Sand smelt populations have increased in the Turkish freswaters since the 2000s. Although, it is not consumed in the domestic market, it is exported and has become an important species both for the region's and Turkey's economy. However, developing sense of globalization and urbanization, consumers, faced with a product change while benefiting from fishery products as an alternative protein sources [6]. Thus, fishing this species has substantially increased both in the natural and the artificial lakes. Especially since the early 2000s, the amount of sand

smelt caught from the Turkish freshwaters is higher than the amount caught from the sea. According to the TUIK data, the amount of sand smelt caught in Turkish freshwaters was 6540 tons in 2007 and 4640 tons in 2016; while the amount of fish caught from the seas ranged from 999 tons in 2006 to 516.5 tons in 2016 [7]. According to researches, first degree major problem of the vessel owners are; marketing, decrease in demand, price instability and insufficiency of aquaculture industry [8].

Table 1. The amount of freshwater fish caught in Turkey (Tons) [7]

Fish	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sand smelt	6 540.0	6 630.0	6 184.0	4 438.0	6 705.2	3 608.5	5 012.3	6 471.0	4 930.0	4 640.0
Total	**43 321.0**	**41 011.0**	**39 187.0**	**40 259.0**	**37 096.8**	**36 120.0**	**35 074.4**	**36 134.0**	**34 176.0**	**33 856,0**

Sand Smelt Utilization Methods

The sand smelt was found and caught in many water sources in Turkey. It is demanded by the EU countries as frozen or paneed frozen products [9]. This species is marketed by drying with its visceral organs. In some countries, other members of this genus are processed by traditional drying methods. In addition, it is utilized as chips or marinated products.

Use as fish feed

The sand smelt are frequently used as fish feed. Due to various factors such as the decrease in stocks due to overfishing, climatic change, fish flour production remains at a limited level. On the other hand, demand for fish flour increases and consequently aquaculture industry is having trouble to meet this demand for the fish oil and fish flour [10].

The aim of researchers and producers for fish flour is always to obtain the best quality production with the minimum costs. Therefore, the search for low-cost protein and energy procurement is increasing. Due to the high cost of fish feed used in aquaculture, the small-scale producers should be encouraged to produce their own feeds. In this manner, sand smelt flour can be a good alternative.

As the caught sand smelts are not commonly consumed by the public, they are utilized either as fish feed or as export products. Therefore, sand smelt has an important potential for the Turkish local fish production. In addition to the high nutritional value of sand smelt, its low price indicates that it is an important alternative raw material source for economical fish feed production [11-12].(Figure 3).

Figure 3. (a) Fish flour, (b) Fish oil, (c) Fish feed [11]

Using Sand Smelt in Marinade

Fishes can be processed in different methods including drying, salination, smoking, cooling and freezing, thermal processing and non-thermal processing. Among these methods, marination is a non-thermal conservation process [13]. Marinade is produced by the non-thermal ripening of the fish using vinegar and salt [14] and the addition of sugar, spices, brine, sauce and vegetables [15]. [16] conducted a study on marinade production from sand smelt caught from Eğirdir Lake and its nutritional characteristics, and, as a result, it was determined

that sand smelt was suitable for marinade production (3% acetic acid and 10 % salt) technology (Figure 4). [17] have reported that, since the early 1980s, marinated marine products have been produced in Europe, especially in Italy, and these products were semi-conservated products, and sand smelts, sardines and anchovies have been used for this purpose.

Figure 4. Marination process steps of sand smelt [16]

Use in Drying Technology

In many countries in the world, drying technique is a process method that has been widely used in marine products. Sand smelt is a species hard to process due to its small-size. Generally, it is marketed by direct drying with its visceral organs.

[18] investigated the nutritional composition and lipid quality during the sun-drying process of sand smelt, and determined the moisture as 73.39- 22.37 %, protein as 15.73- 46.24 %, and lipid as 8.13-21.18 % and ash as 2.229-6.38 %. [19] conducted a study on *Atherina lagunae* individuals, a sand smelt species, dried in two different methods. In the same study, it was stated that sand smelt lived in brackish waters, sea and freshwaters and have rich protein and lipid content. Also, it was stated that in Tunisia, *A. lagunae* species had been dried in 4-5 days at the coastlines by traditional methods.

[20], in their study on *A. boyeri*, investigated the effects of drying on the biochemical composition. In the study, it was determined that *A. boyeri* is a good protein and PUFA source and, nutritionally, the best drying method was at 30 % humidity and 2 m/ s air flow at 50 ^{o}C.

CONCLUSION

Due to over fishing of sand smelt and the lack of fish-ban application in the Turkish freshwaters, although there is a heavy fishing pressure on the species, the species continues to form high populations in the Turkish freshwaters. Thus, it is thought that this species will cause negative effects in terms of freshwater ecosystems and fishing. Therefore, this species should be removed from the Turkish lakes by heavy fishing. The caught fish can be utilized in different ways including fish flour, fish feed, marinade production and can contribute to the Turkish economy.

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