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Structural and Economic Analysis of Turkish Fishmeal and Fish Oil Industry

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Abstract

The structure of fishmeal and oil manufacturers and their challenges and opportunities in Turkey was examined in this study. The research data was collected from both fishmeal and oil manufacturers (12) by using questionnaires and stakeholders of the industry via SWOT analysis. Research results showed that fishmeal and oil manufacturers produced 174 kg of fishmeal and 117 kg of fish oil by processing one ton of anchovy while that of sprat was 140kg and 40kg, respectively. Research results also showed that the strength of the fishmeal and oil sector were the short marketing channel and high profitability while the weaknesses were insufficient fish stock and difficulties in finding fish as a raw material. The most important opportunities and threats were the increasing demand for aquaculture and the lack of data about the stocks of anchovy and sprat, respectively. The four main problem areas in the sector are the difficulties in providing fish, the absence of an effective decision support system developed by using macro and micro level data, infrastructure problems and legislation issues. Contributions to the solution of the problems in this industry include the sustainable use of the fish stock in the Black Sea and increasing the amount of captured fish by focusing on international seas. In addition, designing an information system in the sector, the establishing of laboratories and the necessary facilities for compliance with the standards of food production, the implementation of filter systems for the odor problem, solving the electrical problems, and effective implementation of the legal regulations with the minimum height and catch quota, and the promotion of the qualifications of the managers may enhance the competitive power of the sector.

Keywords: Fishmeal, fish oil, economic analysis, Turkey.

Türkiye'deki Balık Unu ve Yağı Üretimi Yapan İşletmelerin Yapısal ve Ekonomik Analizi

Özet

Bu çalışmada Türkiye'de balık unu ve yağı üretimi yapan işletmelerin yapısı, tehditleri ve fırsatları incelenmiştir. Araştırma verileri balık unu ve yağı üreten 12 işletmeden anket yoluyla ve sektör temsilcilerinden SWOT analizi yardımıyla elde edilmiştir. Araştırma sonuçları bir ton hamsiden ortalama 174 kg balık unu, 117 kg balık yağı elde edildiğini, çaçada ise balık unu ve yağı randımanın sırasıyla %14 ve %4 olduğunu göstermiştir. Araştırmada Türkiye balık unu ve yağı sektörünün en güçlü yönünün pazarlama kanalının kısalığı ve kar oranının yüksek olması ve en zayıf yönünün hammadde yetersizliği ve hammadde temininde yaşanan güçlükler olduğu tespit edilmiştir. Türkiye'de kültür balıkçılığına olan talebin artması sektörün en önemli fırsatı iken, Karadeniz'deki hamsi ve çaça stokunun bilinmemesi en önemli tehdit unsurudur. Sektörün hammadde teminindeki güçlükler, veri yetersizliği, altyapı sorunları ve mevzuat kaynaklı sorunlar olmak üzere dört ana sorun alanı bulunmaktadır. Bu sorunların çözümünde, Karadeniz'deki hammadde stokunun planlanması ve uluslararası sularda avlanma olanakları ilehammadde miktarının arttırılması çalışmaları olumlu katkılar sağlayabilir. Bununla birlikte sektördeki veri sorunun çözülmesi, gıda üretim standartlarına uygunluk için laboratuar ve tesisler kurulması, koku problemi için filtre sistemlerinin uygulanması, elektrik kesintilerin önlenmesi ve boy sınırı ile av kotası uygulamasında etkin yasal düzenlemelerin yapılması ve işletme mesul müdürünün niteliklerinin gözden geçirilmesi yararlı olabilecektir.

Anahtar Kelimeler: Balık unu, balık yağı, ekonomik analiz, Türkiye.

Introduction

The fishmeal and oil industry has processed such kinds of fish every year and produced fishmeal and oil, which is used in fish farming as a feed. There are 400 fishmeal and oil manufacturers all over the world and they have produced approximately 6 million tons of fish meal and 1 million tons of fish oil by

processing 33 million tons of fish (FIN, 2007). Peru, Chile and Thailand constitute half of the total world fishmeal production. Peru is the most important supplier of fishmeal and oil in the world. Peru has 28% of the world's fishmeal production and 29% of the world's fish oil production. Peru and Chile export their fishmeal and oil production. China, Norway, Japan and Denmark were the main importers of fishmeal.

Similarly, the number of manufacturers that process seafood has increased in Turkey over the last decade. Fishmeal and oil produced from anchovies is the most important processed seafood in Turkey due to fishmeal and oil being the basic ingredients of fish feed, which is the basic input of fish farming. Other processed seafood is frozen sea products, bloater and frozen sea bass, marinade, surimi, sea snails and frog legs (TURKSTAT, 2015). In Turkey, the production of fishmeal and oil is concentrated in the Black Sea Region which is the main anchovy supplier. During the time period of 1983-1995, the number of fishmeal and oil manufacturers has reached to 25 with the contribution of the government support. Following, the number of manufacturers has decreased due to anchovy crisis occurred in 1987-1988 season (Yıldırım, 2006). Nowadays, there are 12 fishmeal and oil manufacturers located in the Samsun (3), Rize (1), Sinop (5) and Trabzon (3) provinces of Turkey. In Turkey, the main raw material for fishmeal and oil is the anchovy. However, sprat is also one of the raw materials used to produce fishmeal and oil in order to use the idle plant capacity in the fishmeal and oil industry. Either the captured fish are bad quality and smaller than the marketable size, or in periods when the fish supply exceeds the fresh fish demand, they transfer the excess to fishmeal and oil manufacturers. Nowadays, half of the total caught anchovy is processed to produce fishmeal and oil in Turkey. The prices of anchovies for fresh consumption and for processing to fishmeal and oil were $767 and $200, respectively. The price of anchovies is increasing, while the reverse is the case for the quantity of anchovies caught. The value of fresh and processed anchovy is approximately 103 million US dollars. The amount of sprats caught has increased 40 times over the last few decades due to the short anchovy season, resulting in the increasing price of sprat.

Fish are not the only raw material for the fishmeal and oil industry, but also fresh food for people. However, the opportunity cost between fresh consumption and processing to fishmeal and oil is not clear due to the lack of good quality of data. There is very limited information about the structure of the fishmeal and oil manufacturers and firm level production and marketing characteristics in Turkey. The lack of good quality firm level data and the increased protein added feed demand of fish farming motivated the study to explore the fishmeal and oil industry, which is the bridge between fish farming and sea fishing.

Up to now, several pieces of research have been conducted focusing on outlining the aquaculture that exists all over the world (Üstündağ *et al*., 2000; Jagger and Pender, 2001; MD, 2014; Samsun at al., 2006; Diffey, 2007; Demir, 2008; Yıldırım, 2008; Yavuzcan *et al*., 2010; Kara, 2010; Köse *et al*., 2010; Mol and Ulusoy, 2010; Paterson and Mann, 2011). Most of the previous studies on the aquaculture and seafood industry in Turkey have been based on the macro level data (Üstündağ *et al*., 2000; Bozoğlu *et al*., 2006; Kutlu and Mısır, 2007; Atılgan, 2008; Aydın and Sayılı, 2009; Bozoğlu and Ceyhan, 2009a,b; Tatlıdil *et al*., 2009; Mol and Ulusoy, 2010; Üstündağ, 2010; Kara, 2010; Yavuzcan *et al*., 2010; Köse, S. *et al*., 2010; Şahin, 2011, Paterson and Mann, 2011). These studies have focused on either outlining the aquaculture sector or solely on seafood. Limited studies have focused on detail firm level economic analysis in the sector (Bozoğlu and Ceyhan, 2009b; Aydın and Sayılı, 2009).

Similarly, there has been very limited study on the economic aspect of fishmeal and oil manufacturers in Turkey (Yıldırım, 2006; Köse *et al*., 2010), as well as other parts of the world (Zaldivar, 2004; Shepherd, 2007, 2010; Tacon, 2008; Shamshak and Anderson, 2009; Chamberlain, 2011; IFFO, 2011). Researches related with the technical side of fish meal and oil have focused on the physical condition of the plants, the contents of fishmeal and oil such as protein, oil etc. and the effects of fishmeal and oil on health all over the world (Miles and Jacob, 1997; Kutlu and Mısır, 2007; Turan *et al*., 2007; Karalazos, 2007; Korkut *et al*., 2007; Altan, 2009). On the other dimension, some researchers have been interested in the relationship between the fishmeal and oil sector and the feed industry. The research conducted by Erteken (2005), Schipp (2008) and Altan (2009) are samples of these kinds of study. The case is nearly the same in Turkey. The pioneer studies that focused on the fishmeal and oil industry were research conducted by Yıldırım (2006) and Köse *et al*. (2010). However, these pioneering studies ignored the economic detail of the fishmeal and oil production due to the difficulties in gathering firm level data. The purposes of this study, therefore, are (i) to explore the structure of the fishmeal and oil manufacturers, (ii) to examine the production and marketing characteristics of fishmeal and fish oil production, (ii) to reveal the strengths, weakness, opportunities and threats of the fishmeal and oil manufacturers and (iv) to develop strategies and policies to combat the problems of the fishmeal and oil industry in Turkey.

Methodology

Research Data

The research data was collected from both fishmeal and oil manufacturers (12) by using a questionnaire and stakeholders of the industry such as

representatives of the manufacturers, academicians, specialist, representatives of non-government organizations and the government via SWOT analysis. In addition, the data available at the Turkish Statistical Institution (TURKSTAT), the Food and Agricultural Organization (FAO), the International Fishmeal and Fish Oil Organization (IFFO) and the Fishmeal Information Network (FIN) related to the fishmeal and fish oil sector was also used in the research.

The research was based on firm level variables such as the structural features of the manufacturers (the date and place of establishment, legal status, area, ownership, the number of workers and physical facilities etc.) and the characteristics of fishmeal and oil production and marketing (physical capacity, yield of fishmeal and fish oil, waste management, market characteristics, market research, price, marketing channel, marketing type etc.) collected from fishmeal and oil manufacturers during the production year of 2011.

SWOT analysis was used in the meeting to evaluate the strengths, weaknesses, opportunities and threats of the fishmeal and oil industry in Turkey. The representatives of the fishmeal and oil manufactures, fishermen, governmental institutions, and non-governmental organizations participated in the meeting accompanied by a moderator. The characteristics of the fishmeal and oil industry that gives it an advantage and disadvantage over others were used to outline the strengths and weakness of the industry. The elements that the fishmeal and the fish oil industry could exploit to its advantage were defined as the opportunities, while the elements in the environment that could cause trouble for the fishmeal and fish oil industry were indicators of the threats.

Calculation the Cost of Fishmeal and Fish Oil Production

The production cost, income and profit for fishmeal and oil produced from one ton of anchovy were calculated. Production cost of fish meal and oil was calculated by using opportunity cost approach. The production cost items in fish meal and oil production were classified as a variable and fixed cost. The cost of fish, transportation, energy, labor, marketing cost, interest cost and other variable costs such as antioxidants etc. were included in the variable cost. Fixed costs included the administrative cost, maintenance, depreciation, land rent and real interest cost for fixed assets. Straight line method was used for calculating depreciation of asset(FAO, 1986, Kıral *et al*., 1999). When calculating production cost, it was assumed that the administrative cost was 3% of the total variable cost and nominal and real interest rate were 10% and 5%, respectively.

Since fishmeal and fish oil were a joint product for the manufacturers and 174kg fishmeal and 117kg fish oil were produced by using one ton anchovy, 1.5kg of fishmeal and 1kg fish oil was assumed as one production unit when calculating the cost of unit production. Similarly, the output price was calculated for the same production unit.

Regarding the profitability of fishmeal and oil production, the measures of gross margin and economic profit were used. Gross margin was calculated by subtracting variable cost from the income gained from one ton of anchovy, which was 174kg fishmeal and 117kg fish oil. The difference between the income gained from one ton of anchovy and all of the production costs was attributed to the economic profit of the manufacturers.

SWOT Analysis

In the meeting to evaluate the strengths, weaknesses, opportunities and threats of the fishmeal and fish oil industry, 20 different stakeholders of the industry were included. 4 academicians from Universities, 3 specialist from the Middle Black Sea Development Agency, 2 specialist from the East Black Sea Development Agency, 2 senior executive from the Ministry of Food, Agriculture and Livestock, 1 specialist from the EU Foreign Relationship Directory, 1 specialist from the Agriculture and Rural Development Support Institution, 2 senior executives from the Aquaculture Cooperatives, and 5 representatives of the fishmeal and oil manufacturers participated in the meeting.

At the beginning of the meeting, the findings of the field research were presented to the participants. After, the two stage SWOT analysis was performed by a moderator who is an expert in the area. In the first stage, not just the strengths, weaknesses, opportunities and the threats of the fishmeal and fish oil industry in Turkey were explored, but also the main problem areas to reach the strategic targets together with intuitional measures and regulatory framework were looked into. In the second stage, the most important problems in fishmeal and oil and their effects were elicited based on the point of view of participants about the production and marketing of fishmeal and oil and the problems and futures of the fishmeal and oil industry.

Statistical Analysis

Descriptive statistics such as mean, median, standard deviation, percentage etc. were used to outline the prevailing situation of the fishmeal and oil industry. When revealing the factors affected the selection of the establishment place, Friedman One Way Variance Analysis was performed. Multiple comparisons among the factors were made using the Wilcoxon test.

The ranking of the issues at the fishmeal and oil industry and exploring the impact of the problems to the sector were analyzed statistically by using Kruskal-Wallis H and Mann-Whitney U tests.

Results and Discussions

General Characteristics of Fishmeal and Fish Oil Manufacturers

Based on the results of the firm level research, the examined fishmeal and oil manufacturers conducted their activities on 2 hectares of land in Turkey. 58% of them were Joint Stock Company, while the rest were limited companies. One of the examined companies was quoted on the stock market. They considered the supply of anchovy and sprat, government incentives, infrastructure and the amount of initial investment, the distance to labor sources and the distance to the market, respectively when deciding the establishment place (χ^2=10.968; P<0.05). Regarding the initial stage of the establishment, the following feasibility report was at an unsatisfactory level in the industry. Only 44% of the manufacturers prepared the financial feasibility report before establishment. The initial investment of the examined manufacturers was mainly based on the equity. Only one third of the fishmeal and fish oil manufacturers used credit when establishing the plant. All managers indicate that theprofit level was at the satisfactory level in the production of fishmeal and fish oil.

All of the manufacturers designed their plant and organized their machinery such as steamers, dryers and stokehold with the help of domestic firms. Separators, decanters and waste treatment facilities were established by international professional companies from Germany, Denmark and USA. Research and development activities in the industry were not common. Only 2 companies conducted R&D activities. Surprisingly, manufacturers were not aware of the government incentive related to the fishmeal and fish oil industry. That is why the benefit of the incentives was at an unsatisfactory level. All manufacturers measured the degree of humidity of the fishmeal in their laboratory or outside the firms and the mean humidity inside the fishmeal was 5-6%.

In the fishmeal and fish oil industry, human sources were moderate. The firms employed, on average, one manager, 30 permanent and 16 temporarily workers in their plants. In general, the managers of the examined firms were co-partners of the firms. Only one firm was managed by professional managers. All of the managers know foreign languages; English, German, French and Russian were the more common languages. The firms paid approximately $540 per month for blue collar workers, while that of white collar workers was $1300 per month.

Main Characteristics, Costs and Income of Fishmeal and Fish Oil Production

The research findings showed that the production capacity of the examined manufacturers varied from 150 tons per day to 1600 tons per day, and was 829 tons per day, on average. According to the recent statistics, Turkish manufacturers processed 198 thousand tons of anchovy and 87 thousand tons of sprats to produce fishmeal and oil (TURKSTAT, 2015). Initial investment of per ton of raw material capacity was approximately $5307 in the Turkish fishmeal and oil industry. Machinery and equipment costs constituted 71% of total investments, while the share of buildings and other costs such as installation, insurance in total investment were 15% and 14%, respectively. Initial investment of per ton of raw material capacity in Turkey was higher than the figures reported by FAO (1986). FAO (1986) suggested that investment cost per ton was $4222. In the examined firms, 174kg of fish meal and 117kg of fish oil were produced by processing one ton of anchovy. The yield of fishmeal varied from 15% to 18%, while that of fish oil between 10%-12.78%. Limited manufacturers gained extra fishmeal (2-3%) via waste treatment facilities.

The manufacturer's suggested that the most important factor affecting the production of fishmeal and fish oil was the amount of fish caught. Therefore, many manufacturers compromised their fleet and created a special contract with fishermen to ensure the amount of anchovy they need. Since the competition was very heavy in the industry, many manufacturers paid money in advance before the season opened to the fishermen to sustain their position in the industry. Heavy competition made the manufacturers establish vertical integration among fishing, the fishmeal and oil industry and the feed industry.

The mean price of fish oil and fishmeal per ton was approximately $1500 and $1400, respectively. If the fish oil was marketed for human needs directly, the price of fish oil per ton would increase to $2000. The price of anchovy and sprat as raw materials was $115 and $83 per ton, respectively.

Turkish fishmeal and oil firms gained $314 per ton of anchovies. The shares of fishmeal and oil in total income were 58% and 42%, respectively. Cost analysis showed that the total cost of processing per ton of anchovy was $268 and the annual production cost per ton of fishmeal/oil was $549, on average. The most important cash cost was the fish payment with a share of 43%. Cash cost such as transportation, energy cost, interest payment for current debt and labor followed it, respectively. Land cost and the general administrative costs were the most important non-cash costs. Depreciation and maintenance cost were the other non-cash costs (Table 1). These research findings were parallel with the findings reported by FAO (1986). FAO (1986) stated that the annual production cost per ton of fishmeal/oil was $480 and the most important production cost was the raw material, which was 42%.

Based on the results of the cost analysis, the calculated unit cost of 1.5kg of fishmeal and 1kg fish oil was $2.29. Considering the market price, which

Table 1. Cost and revenue of fishmeal and oil production (per ton fish)

	Value ($)	%
	Revenue	
Fishmeal (174 kg)	182,70 (67,66)	58,12
Fish oil (117 kg)	131,63 (52,23)	41,88
Total	314,33 (104,78)	100,00
	Cost	
Variable cost	205,02 (73,86)	*76,46*
Fish (anchovy)	116,03 (48,35)	43,27
Transportation	23,33 (7,82)	8,70
Energy (electricity, coal etc.)	21,22 (8,01)	7,91
Labor	13,21 (4,12)	4,93
Interest payment for working capital	21,25 (10,63)	7,92
Marketing cost	5,00 (1,95)	1,86
Other variable cost (antioxidant, package vb.)	4,98 (1,85)	1,86
Fixed cost	63,13 (26,98)	*23,54*
General administrative cost	17,50 (4,90)	6,53
Depreciation	10,62 (3,21)	3,96
Maintenance	8,33 (2,69)	3,11
Interest payment for non-current assets	2,43 (0,95)	0,91
Land	24,25 (11,03)	9,04
Total production cost	268,15 (127,69)	100,00

*Figures in the parenthesis are the standard deviation.

was $2.69, it was clear that the profitability of fishmeal and fish oil production was at a satisfactory level. The gross margin and economic profit of the examined manufacturers was $109 and $46 per ton, respectively. These firms gained $1.17 from one US dollar expenditure in fishmeal and oil production, indicating that profitability was at a satisfactory level. In general, manufacturers covered their variable costs by revenue sourced from fishmeal sales and oil sales constituted the net profit (Table 1). It was estimated that based on the research findings, minimum amount of anchovy and sprat every year required by Turkish manufacturers were approximately 85 thousand tons and 53 thousand tons, respectively, under the prevailing condition of manufacturers.

Characteristics of Fishmeal and Oil Market

The fishmeal and oil market has been typically an oligopoly in Turkey due to the existing limited number of manufacturers that were affected from the move of their competitors and the controlled entry to the market. The strategies and policy of the firms have affected all the other manufacturers in the market. Therefore, manufacturers have monitored the information belonging to their competitors such as the quantity of processed fish, technology, number of employees and their salary and the price of fishmeal and oil. Therefore, manufacturers have tried to differentiate their product in order to increase their competitive power. Efforts to produce fish oil for human consumption have been initiated by pioneer firms in Turkey.

In general, fishmeal and oil were marketed to domestic firms; 90% of the total production was marketing to domestic firms, while 10% of it was exported to overseas countries. In Turkey, fishmeal and oil manufacturers preferred to sign special contracts with the fish feed industry. Sometimes, a fish feed company designed the contracts before the season to ensure their fishmeal and oil as raw materials of fish feed. The examined manufacturers used different package material when marketing fishmeal. In general, the package varied from 45kg to 1500kg. Approximately 50g of antioxidants were added into the package in order to avoid spoilage when packing the fishmeal. Since the competition was really strong in the industry, 8% of the examined firms established vertical integration. Vertically integrated firms caught the fish and produced the fishmeal and fish oil. Then, they produced fish feed by using their fishmeal and fish oil. Finally, they not only marketed some fish feed to fish farmers, but also used their feeds in their fish farms.

Regarding foreign trade, Norway was the most important importer of fishmeal and oil, while Peru was the leading nation in terms of fishmeal and oil exports. Based on TURKSTAT's recent trade statistics, there has been a foreign trade deficit in Turkey. The trade gap in fishmeal is 60 thousand tons, while that of fish oil is more than 20 thousand tons. Currency losses for fishmeal and fish oil are 90 million US dollars and 50 million US dollars in Turkey. The export price of fishmeal is higher than that of the import price of fishmeal, while the case is the reverse for fish oil. The export and import prices of fish oil were 1447 $/ton and 1529 $/ton, respectively. In Turkey, prices of fishmeal were lesser that those of fish oil. The export and import prices of fishmeal were 1449 $/ton and 1377 $/ton, respectively. In spite of the fact that Turkey is a net importer, some Turkish manufacturers have exported fishmeal and oil due to the quality of the product. In general, Turkish exporters preferred the ports of

Greece and the Netherlands.

The Strengths and Weakness of Turkish Fishmeal and Fish Oil Industry

Based on the results of the SWOT analysis, the biggest strengths of the fishmeal and oil industry are the short marketing channels and the high profitability. In the fishmeal and oil industry, there is no commissioner and direct marketing is common. The produced fishmeal and oil are marketed completely in a year. The quality of the fishmeal and oil is the other strength of the industry. Since anchovies have high levels of protein, minerals, vitamins and oil, the quality of Turkish fishmeal and oil is better than that of rivals. The third strength of the industry is the high level of domestic demand due to increasing fish farming requirements. The fourth strength is the existence of the physical processing capacity of the industry, which easily meets domestic demand. In the current situation, the physical capacity of the fishmeal and oil industry has been 9950 tons of fish per day. The industry would produce 1731 tons of fishmeal and 1164 tons of oil per day. When considering fishmeal and fish oil imports, which are 65 thousand tons and 25 thousand tons, respectively, the Turkish fishmeal and oil industry has the capacity to cover these gaps in a month. This mostly depends on the quantity of anchovies and sprat. Of course, the industry should consider the sustainability of fishing and avoid overfishing. The last two strengths are the limitation to entry to the industry and existence of vertical integration in the industry (Table 2).

The SWOT analysis showed that there are 9 different weaknesses in the industry. The scarcity of fish and the difficulties in fish supply is the first weakness of the industry. The working period of the manufacturer is shortened due to the short fishing season for anchovy. The fishmeal and fish oil manufacturers tend to use sprat as an alternative raw material to increase the capacity use ratio. The second weakness is having limited information about the real stocks of anchovy and sprat in the Black Sea. Insufficient information creates problems when estimating the fishing season and calculation of opportunity cost between fresh fish consumption and processing in the fishmeal and oil industry. Therefore, it is really difficult to develop efficient planning in the sector when allocating the anchovies to human consumption and processing in the fishmeal and oil industry. The third weakness is the absence of an efficient decision support system. Decision makers and the other stakeholders demanded both macro level and micro level data related to the industry. In addition, there is an absence of data related to fishing. The fourth weakness is the inappropriate production structure of firms to produce fish oil as a food. The fish meal and oil manufacturers have to adapt their firms by investing money to replace the plant, optimizing the production process and standardizing the fish oil in order to be a food producer. However, the manufacturers need extra time to adapt their firms. Not establishing the auditing mechanism in the fish meal and oil sector is another weakness of the industry. Auditing is especially very weak in the fishing level and the definite amount of fish caught is

Table 2. Strengths, weakness, opportunities and threats of the Turkish fishmeal and fish oil industry

Strengths	Weakness
1. Short marketing channel and high profitability. 2. High quality of fishmeal and fish oil. 3. High level of domestic demand. 4. Existence of the physical processing capacity of the industry 5. Existence of vertical integration 6. Closeness to the raw material. 7. Government control on entering into the industry.	1. Scarcity of fish and the difficulties in fish supply 2. Unknowing the stocks of anchovy and sprat in the Black Sea. 3. Absence of efficient decision support system. 4. Inappropriate production structure of firms to produce fish oil as a food. 5. Inefficient auditing mechanism in the fish meal and fish oil sector. 6. Weak relationship among firms 7. Inharmonious environmental management criteria 8. Weak competitive power in the international market. 9. Existing financial problems
Opportunities	**Threats**
1. Increasing derived demand to fish feed due to developing fish farming. 2. Increasing foreign demand due to quality of anchovy based fish oil. 3. Increasing consumer interest in fish oil as a food. 4. Suitable technological infra-structure in the industry 5. Presence of the international fishing possibilities.	1. Additional responsibilities to adopt EU legislations and new Turkish food regulations. 2. Reducing anchovy transferred to the fishmeal and fish oil industry due to development of the cold chain. 3. Probability of opening the Black Sea to international fishing 4. Sea pollution due to environmental factors 5. Existing very limited sea organisms in the Black Sea. 6. Insufficient knowledge on adverse effects of fish farms established on the river to the nutrient level of Black Sea. 7. Presence of illegal fishing.

not known by the authorities. In general, authority audits on a factory level, which is ineffective for the sector. Hence, the real fishmeal and oil production is not estimated in a healthy way. A weak relationship among fishmeal and fish oil manufacturers is the sixth weakness of the sector. It would be attributed to strong competition among firms in the fish supply stage. The seventh weakness is inharmonious with the environmental management criteria. The prevailing conditions of the fishmeal and oil firms are inharmonious with environmental management criteria according to the regulation of water pollution control enacted by the government in 2010. The last two weaknesses of the sector are weak competitive power in the international market and the existence of financial problems in firms (Table 2).

The Opportunities and Threats of Turkish Fishmeal and Fish Oil Industry

Based on the results of the SWOT analysis, the most important opportunity of the fishmeal and fish oil industry is increasing the derived demand of fish farming and poultry. Increasing the foreign demand due to the quality of anchovy based fish oil is the other opportunity of the sector. Other opportunities of the Turkish fishmeal and fish oil industry are increasing consumer interest in fish oil as a food, a suitable technological infra-structure in the industry and the presence of the international fishing possibilities (Table 2).

Regarding the threats of the industry, they have been summarized into seven groups. Additional responsibilities facing the fishmeal and oil industry to adopt EU legislations and new Turkish food regulations are the first threats. According to the EU legislation, fishing limitation enforcement for sprat began in the Black Sea due to the accession of Bulgaria and Romania to the EU in 2007. It is expected that these limitations would be current in Turkey after completion of the EU accession. The suggested amount of maximum fishing by the Scientific, Technical and Economic Committee for Fisheries of EU (STECF) for sprat and anchovy are 64000 tons and 142000 tons, respectively. The current amount of captured anchovy and sprat, which is 227000 tons and 87000 tons, exceeded the suggested amount in Turkey in 2013. It is clear based on the upper figures that there has been some doubt on the future fishing quantity of anchovy and sprat, resulting in the occurrence of uncertainty in the production of fishmeal and oil. The second threat is reducing the number of anchovy transferred to the fishmeal and oil industry due to the development of the cold chain. Nowadays, increasing the cold chain capacity led to an increase in human consumption of anchovy and reduced the amount of anchovy to process in the industry. The probability of opening the Black Sea to international fishing, illegal fishing, sea pollution due to environmental factors, existing very limited sea organisms in the Black Sea and insufficient knowledge on adverse effects of fish farms established on the river to the nutrient level of the Black Sea are the other threats of the Turkish fishmeal and fish oil industry (Table 2).

Potential Strategies for Turkish Fishmeal and Oil Industry

Based on the results of the SWOT analysis, the basic problem areas of the fishmeal and oil industry can be summarized into four broad groups such as providing fish, the absence of an efficient decision support system, infra-structure problems and legislation problems related to the sector. The largest problem of the sector is supplying enough fish as a raw material. Since the sector is mainly based on the anchovy, fishmeal and oil production fluctuate associated with the amount of captured anchovy. In addition, the lack of knowledge of the anchovy stock in the Black Sea disrupts the designing of efficient sector planning. Over the last 5 years, many stakeholders observed that fishing season was shortened by technological progress in fishing methods, reducing the anchovy stocks in the Black Sea and climatic parameters such as temperature, wind etc. The increasing numbers of establishments of fishmeal and oil plants in the Black Sea Coastal region of Georgia, some with Turkish investment, also increases the pressure on anchovy stocks. The fishing size in Turkey is 9cm while that of Georgia is 7cm; this indicates that the anchovy supply problem is increasing in the Black Sea. In spite of the fact that fishmeal and oil manufacturers tend to use sprat as an alternative raw material in order to eliminate the risk sourced by the dependency on anchovies and to increase the capacity use ratio, this is not a good approach due to the existence of limited fishing areas for sprat and the obtaining of low levels of fishmeal and fish oil quality from sprat. On the other hand, since the prevailing technology used by the industry is not sufficient to process other fish type, the sector highly depends on anchovy and sprat in order to produce fishmeal and oil in Turkey (Table 3).

The absence of an effective decision support system developed by using macro and micro level data is the second order problem area in the sector. However, most stakeholders are aware of the importance of collecting and disseminating the healthy data related to the sector in order to design an efficient management plan, a decision support system has not been developed yet in Turkey. The disorganization of institutions responsible for collecting data related to the sector, using inappropriate collection methods and the nonexistence of standardization and definitions in variables intended to be measured and collection methods, the unwillingness of respondents to share their data and being indifferent to sharing the data with stakeholders are the sources of the absence of the decision support

Table 3. Strategies for eliminating the weakness and threats of the Turkish fish meal and oil industry

	Strengths	Weakness
Opportunities	OS strategies	OW strategies
	Increase the profit margin by using opportunities of increasing demand for fishmeal and fish oil, and diversification.	Using international fishing possibilities may reduce the scarcity of the fish and the difficulties in fish supply and financial problems of manufacturers and increase international competitive power
	Increase international investment via international fishing opportunities.	Increasing demand for fish oil as food may increase the velocity of adapting EU food standards
		Suitable technological infra-structure to future development may simplify the adaptation to environmental management criteria.
Threats	TS strategies	TW strategies
	Planning the industry based on the scientifically determined stocks of anchovy and sprat in the Black Sea and opportunity costs of the fishmeal and fish oil may minimize the effects of losing profit.	Conducting the scientific research to explore the real stock of anchovy and sprat may reduce the risk of raw material.
	Support the manufacturers to adapt the industry to EU legislation related food production and design strategies to minimize the effects of opening the Black Sea to international fishing may decrease the adverse effects of threats.	Designing an efficient decision support system and effective auditing in ports may increase the sustainability of the industry.
		Increasing the value added of fish oil may increase the power of manufacturers to provide fish.
	Balancing the direct human consumption and industry requirements based on the opportunity cost between domestic production of fishmeal and fish oil import or direct human consumption may decrease the effects of import increase threat.	Research and development activities related to the international fishing in the Black Sea may enhance the competitive power of manufacturers.

system (Table 3).

The other problem in the fishmeal and oil industry is the problem of infra-structure. Paying less attention to activities related to the adaptation of the sector to food production standards, contagious odor of the plants and the uncertain cutting of electricity are the main infra-structural problems of the fishmeal and fish oil industry in Turkey (Table 3).

Problems sourced by legislation are the last problem area in the sector. These problems can be summarized into three groups which are: problems sourced by the arrangement of fish size limitations in fishing and fishing quota, arrangements related to waste-environment relationship and the definition of the responsible manager. The fish size arrangements vary associated with the province and cause serious problems in practical life. However many authors have suggested that the fishing quota application begin, prevailing regulations do not cover the necessary provision to start it. Based on the results of the discussion at the meeting, most manufacturers think that the current responsibilities and standards related to water pollution are not applicable in the short term. According to the Turkish water pollution regulation, the discharged standard of liquid waste of the food industry is less than 140mg, or equals 140mg. The definition of a responsible manager in the fishmeal and fish oil industry is the last problem related with government regulation. According to the current regulation, a responsible manager must be a veterinary. However, if the expert comes from a fish and aquaculture background, it is more suitable in practice.

Conclusion

Based on the research findings, the scarcity of fish together with difficulties in the supply of fish and uncertainty about the stocks of anchovy and sprat are the most important problems for the fishmeal and fish oil sector. Optimizing and managing the anchovy and sprat stocks in the Black Sea and increasing the efforts to enhance the international fishing opportunity may reduce the adverse effects of the insufficient fish supply. Conducting scientific research to explore the real stock of anchovy and sprat may reduce the risk of raw materials. Organizing a meeting with fishermen to manage the stocks efficiently may also contribute positively. Effective auditing at ports should be enhanced to planning the stocks efficiently. Since the transportation of the fish from far places affects the quality of the fish, banning

the transportation of fish from far ports may reduce the deterioration of fish. Establishing a special branch for the fishmeal and fish oil industry in the Fisheries Directorate may increase the productivity of the sector and efficiency of the auditing. Selecting experts for port audits should be encouraged. Either effective government control or encouraging the self-control simultaneously at the fishing sector to stop over-fishing may increase the likelihood of the success of management and planning. Support of non-governmental organizations at the sector may increase the likelihood of success.

Making amendatory legislation and establishing the independent deputation to determine the maximum amount of fish processed at the fishmeal and fish oil manufacturers may balance the stocks in the Black Sea.

Increasing the international fishing capacity may reduce the risk of supplying fish as a raw material. However fishermen should plan themselves based on the research results related to international fishing. Conducting the research to reveal the investment need, cost and revenue of international fishing by the Fisheries Directorate may contribute to the sector.

An efficient decision making system should be designed not only on the national level but also on the firm level. Data produced by the decision making system should be shared with a related person and institution. Designing software to produce all related standard data from ports to the marketing stage may increase the efficiency of the fisheries sector. Improving the data collection by standardizing the collection methods and variables via education programs should be beneficial. Taking the opinions of all stakeholders in the sector by using well designed meetings about decision-making system may increase the efficiency of the system.

Establishing the reference laboratory to control the suitability to food production criteria, using a filter system to reduce the odor problem and solving the energy supply problems may be beneficial to cope with the infra-structure related problems in the industry.

For combating the legislation related problems at the sector, efficient regulation related quota and length should put into practice. Controlling the length of the fish at ports rather than at the firms may reduce the amount of inappropriate fish reaching the fishmeal and fish oil plants. Designing special quota for bulk fish transferred fishmeal and fish oil plants may be beneficial. Suitable technological infra-structure to future development may simplify the adaptation to the environmental management criteria.

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