http://foodbulletin.net

FOOD BULLETIN
e-ISSN: 2979-9848

https://prensip.gen.tr

RESEARCH ARTICLE

Sensory Properties and Proximate Composition of Fish Soup from European Anchovy (*Engraulis encrasicolus* Linnaeus, 1758)

Emre Çağlak✉ • Barış Karslı • Fatma Delihasan Sonay • Özen Yusuf Öğretmen • Ayşe Kara • Orhan Kobya

Recep Tayyip Erdoğan University, Faculty of Fisheries, Department of Seafood Processing Technology, Rize/Türkiye

ARTICLE INFO

Article History
Received: 03.11.2023
Accepted: 12.12.2023
First Published: 31.12.2023

Keywords
Anchovy
Fish soup
Proximate composition
Sensory

ABSTRACT

This study investigated the proximate composition and sensory properties of fish soup prepared using European anchovy (*Engraulis encrasicolus*). According to the proximate composition analysis of fish soup, the crude protein, crude fat, crude ash, moisture, and carbohydrate values were found to be 5.04%, 6.22%, 1.46%, 82.05%, and 5.23%, respectively. In the sensory evaluation of fish soup, odor, oiliness, saltiness, bitterness, hardness, juiciness, aroma, appearance, overall acceptance, and purchase intent criteria were used. According to the sensory analysis results, it was seen that the panelists appreciated the anchovy soup. In the evaluation of overall acceptance, 46.66% of the panelists expressed "I liked it", 46.66% expressed "I liked it very much", and only 6.68% expressed "I liked it a little". Based on the expressed purchase intentions, it was unanimously declared by all panelists that they were inclined to get the fish soup. Considering the sensory analysis results, it has been shown that the fish soup obtained using anchovy can also be used industrially. Thus, these products are thought to contribute to increasing fish consumption and healthier food consumption.

Please cite this paper as follows:

Çağlak, E., Karslı, B., Delihasan Sonay, F., Öğretmen, Ö. Y., Kara, A., & Kobya, O. (2023). Sensory properties and proximate composition of fish soup from European anchovy (*Engraulis encrasicolus* Linnaeus, 1758). *Food Bulletin*, *2*(2), 37-43. https://doi.org/10.61326/foodb.v2i2.111

1. Introduction

Eating habits vary depending on the cultures that form the identity of a society. Although people's eating habits after birth vary over the years, it is one of the most important processes. After the first few years of ready-to-eat nutrition, the phase of consuming foods prepared in kitchens begins, and this phase continues throughout life unless something goes wrong. Culinary culture provides important information about societies in terms of eating and drinking. It is known that soup, which has an important place in Turkish culinary culture, is prepared from various fish and consumed with pleasure in the coastal regions of Türkiye. Soup is a primarily liquid food, generally served warm or hot that is made by combining ingredients of meat or vegetables with stock, milk, or water. Soup is an important food for healthy nutrition due to its nutritional properties, variety, taste, and juicy structure. Unlike other types of food, soups are not subject to influences such as seasonal characteristics, consumer age, and cultural differences in the preparation and consumption of soups (Köşker & Özbey, 2021; Özdemir Yaman, 2022). Soup, which has an important place, especially in the food culture of Turkish cuisine, has continued to be diversified and served on the tables from past to present (Çıtak & Sandıkcı, 2020).

✉Correspondence
E-mail address: emre.caglak@erdogan.edu.tr

The limited food resources and the change in ecological balance in the face of the increase in the world population raise the problem of nutrition, which is the most important element of human life, especially healthy nutrition. The terms nutrition and especially healthy nutrition reveal accessing sufficient protein sources and taking them in an amount appropriate for the body (Caglak & Karsli, 2023). In order of importance as a protein source, animal proteins come before plant proteins. Aquatic products contain significant amounts of both protein and fatty acids (Öğretmen, 2022). Fish among aquatic products and anchovy among fish have an important population and economic value worldwide, as well as in Türkiye (Karsli, 2021).

Consumption and eating habits of anchovy fish appear as an important food phenomenon with cultural, economic, and sociological effects throughout history. There are many different recipes for anchovy fish, which is consumed in different ways of presentation (Yerlikaya et al., 2005; Kilinc, 2010; Üstündağ, 2010; da Silva et al., 2013; Çağlak et al., 2022). However, it is important to determine the sensory properties and nutritional quality parameters of these culinary preparations. In this context, this study aimed to prepare a soup using anchovy, which has a rich nutritional content, and to determine the proximate composition and consumer appreciation of this soup.

2. Materials and Methods

2.1. Materials

The anchovy used in the present study was obtained from a local fisherman and brought to the laboratory on ice in a styrofoam box. The ingredients in the recipe were obtained fresh from the local market.

2.2. Preparation of Fish Soup

Anchovy soup was prepared according to the recipe in the book "Anchovy from Sea to Table" by Çağlak et al. (2022). The ingredients and their amounts used in making soup are presented in Table 1.

2.2.1. Method

(1) After melting 1 tablespoon of butter in a pot, finely chopped onion and garlic were added and lightly fried. (2) Finely chopped carrots were added to the pot and roasted for another 2-3 minutes. (3) Potatoes cut into cubes were added to this mixture and fried for another 2 minutes. (4) Then, 2 tablespoons of flour were added and roasting continued until the smell of the flour disappeared and 7 glasses of hot water were added. (5) Bay leaves, celery stalks, salt, and black pepper were added, and the vegetables were cooked until they softened. (6) After cleaning the internal organs and bones of the anchovies to be used in soup making, the anchovy fillets were cooked in a pan until the water was absorbed. (7) Following the cooling of the cooked anchovies, 1 tablespoon of butter was added and lightly fried. (8) Finally, the cooked anchovies were added to the soup and served hot with finely chopped parsley (Figure 1).

Table 1. Ingredients and quantities used in soup preparation.

For soup		For sauce	
Ingredients	**Quantity**	**Ingredients**	**Quantity**
Anchovy (filleted)	300 g	Milk	1 cup
Butter	2 tablespoons	Egg yolk	1 piece
Medium-sized onion	1 piece	Lemon juice	2 tablespoons
Medium-sized carrot	1 piece		
Medium-sized potato	2 pieces		
Parsley	half bunch		
Garlic	2 cloves		
Hot water	7 cups		
Flour	2 full tablespoons		
Bay leaf	1 piece		
Celery stalk	1 piece		
Salt	4 teaspoons		
Black pepper	1 teaspoon		

Figure 1. Anchovy soup (original).

2.3. Analyses

2.3.1. Crude protein

Protein analysis was performed according to AOAC (1980; Method 2.507). In the total crude protein analysis performed according to the Kjeldahl method, 0.5 g of homogenized sample was placed in Kjeldahl tubes. 1 tablet (K_2SO_4+Cu_2SO_4) and 25 ml concentrated H_2SO_4 were added into the tubes as a catalyst and then placed in the Kjeldahl combustion unit. The sample was subjected to burning at 420 ºC for 5-6 hours until it acquired a green-yellow transparent color. After the burning process, 50 ml of pure water was added to the tubes that were left to cool, and they were distilled with 10 N NaOH and pure water. This process continued until the total volume reached 150 ml in a graduated conical flask containing 50 ml of 4% boric acid in the resulting distillate. Then, 10 drops of the indicator solution containing methyl red and bromocresol green were added and the distillate was titrated with 0.1 N H_2SO_4. The % crude protein amount was calculated according to the formula (1) below.

$$\text{Crude protein (\%)} = \frac{V \text{ x } 0.14 \text{ x} 6.25}{W} \quad (1)$$

Where; V is the titration volume (mL) of 0.1 N H_2SO_4 used, and W is the weight of the sample (g).

2.3.2. Crude fat

For the fat analysis performed using the extraction method, 3 grams of dried sample were taken in extraction cartridges, and placed in the extraction device. Diethyl ether (70 ml) was added into the tared glass crucibles and the samples were subjected to oil extraction for 110 minutes (Automatic Soxhlet Analyzer, Velp SER 148/6). The fat obtained from the sample was collected in a glass crucible and kept in the oven for 30 minutes to evaporate the diethyl ether. Then, glass crucibles containing fat were weighed and the % crude fat content was calculated according to the following formula (2) (AOAC, 1980, Method 2.507).

$$\text{Crude fat (\%)} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Sample weight (g)}} \text{x} 100 \quad (2)$$

2.3.3. Moisture

Porcelain crucibles to be used in moisture analysis were dried in an oven at 105 °C for 2 hours and cooled in a desiccator. The tares of the cooled crucibles were taken and approximately 5 grams of sample was placed in them. Then, the crucibles were kept in an oven at 105 °C for approximately 24 hours until they reached a constant weight and were cooled in a desiccator. The cooled crucibles were weighed, and the moisture content was calculated with the following formula (3) (AOAC, 1995, Method 985.14).

Moisture (%) = [(Final weight– Initial weight) / Sample weight] x 100 (3)

2.3.4. Crude ash

For raw ash analysis, porcelain crucibles were burned at 550 ºC for 1 hour and the crucibles were cooled in a desiccator and tared. Approximately 2 g of the homogenized samples were placed into the tared crucibles. The crucibles were burned in a muffle furnace at 550 ºC for 5-6 hours and then cooled in a desiccator. Then, the cooled crucibles were weighed, and the % crude ash content was calculated according to the formula (4) below (AOAC, 1980, Method 7.009).

Crude ash (%) = [(Final weight– Initial weight) / Sample weight] x 100 (4)

2.3.5. Carbohydrate

The carbohydrate content of anchovy soup was calculated according to the formula (5) reported by Keskin et al. (2018).

Carbohydrate (%) = 100 - (crude protein + crude fat + crude ash +moisture content) (5)

2.3.6. Sensory analyses

Sensory properties of the fish soup samples were evaluated by a group of 20 volunteer panelists. Seventy-five percent of the panelists were male, and twenty-five percent were female. The average age of the panelists was established to be between 39 and 67. The evaluation was based on criteria such as odor, oiliness, saltiness, bitterness, juiciness, aroma, appearance, overall acceptance, and purchase intention. The form used for the sensory analysis of anchovy soup was revised from the MEB (2010) and Ulusoy et al. (2017) methods (Figure 2). Additionally, the purchasing intentions of the panelists were determined during the sensory evaluation.

Sensory Evaluation Form

Name:

Date: / /

Gender and Age:

Odor	Oiliness	Saltiness
1. Smell too strong to consume	1. Excessively oily	1. Too salty to consume
2. The smell is heavy	2. Too oily	2. Too salty
3. The smell of raw fish	3. A little oily	3. Slightly salty
4. No noticeable odor	4. Medium oiliness	4. Normal
5. Very faint smell of fried fish	5. Neither oily nor greasy	5. Slightly unsalted
6. Fried/steamed fish smell	6. Not oily	6. Too unsalted
7. Very distinct fried/steamed fish odor	7. Not oily at all	7. No salt
Bitterness	**Hardness**	**Juiciness**
1. Too bitter to consume	1. Too hard to beat	1.Extremely dry
2. Very bitter	2. Very Hard	2.Too dry
3. A little bitter	3. A little harsh	3.A little dry
4. Medium bitterness	4. Medium hardness	4.Medium dryness/wetness
5. Neither bitter nor not bitter	5. A little crunchy	5.A little watery
6. It's not bitter	6. Very crunchy	6.Very watery
7. It's not bitter at all	7. Super crunchy	7.Excessively watery
Aroma	**Appearance**	**Overall acceptance**
1. Not aromatic at all	1. I did not like at all	1. I did not like at all
2. Neither aromatic nor non-aromatic	2. I do not like	2. I do not like
3. Not aromatic	3. I neither liked nor disliked	3. I neither liked nor disliked
4. Slightly aromatic	4. I liked it very little	4. I liked it very little
5. Medium aroma	5. I liked it a little	5. I liked it a little
6. Very aromatic	6. I like	6. I like
7. In perfect aroma	7. I like it a lot	7. I like it a lot
*** Would you like to purchase this product?? Yes ( ) No ( )**		

Comments and suggestions::

Figure 2. Sensory evaluation form.

3. Results and Discussion

3.1. Proximate Composition

The proximate composition values of fresh anchovy and fish soup are given in Table 2. Crude protein, crude fat, crude ash, moisture, and carbohydrate values of fresh anchovy were found to be 16.80%, 7.20%, 1.53%, 73.52%, and 0.95%, respectively. A study was conducted to analyze the nutritional composition of anchovies, specifically focusing on Black Sea anchovies (*Engraulis encrasicolus*, Linne 1758) collected from the coastal regions of Türkiye, Georgia, and Abkhazia in the Black Sea. The study revealed that these anchovies exhibited similar levels of crude protein (16.1-17.9%), moisture (67.9-71.0%), crude fat content (8.23-12.2%), and crude ash (1.40-1.65%) (Öğretmen, 2022).

According to the present results, the crude protein, crude fat, crude ash, moisture, and carbohydrate values of fish soup were determined as 5.04%, 6.22%, 1.46%, 82.05%, and 5.23%, respectively. According to Kose et al. (2021), the values for moisture, crude protein, crude fat, crude ash, and carbohydrate content in the fish soup made from brook trout (*Salvelinus fontinalis*) were reported to be 87.79%, 8.18%, 2.89%, 0.62%, and 0.03%, respectively. Tufan et al. (2022) detected 7.22% crude protein, 87.56% moisture, 1.59% crude fat, 2.44% crude ash, and 0.07% carbohydrates in rainbow trout soup. Zhang et al. (2018) found that the moisture, crude ash, crude protein, and crude fat values of soups made from crucian carp (*Carassius auratus*) and snakehead (*Channa argus)* were 98.2-98.64%, 0.09-0.52%, 0.91-0.7%, and 0.17-0.13%, respectively. Compared to previous studies, it was determined that the moisture content of the anchovy soup in the present study was lower, and the crude protein (with the exception of Kose et al., 2021), crude fat, and carbohydrate contents were higher. It is thought that these differences may be due to the type of ingredients added to soup and their quantities, fish species, and cooking methods.

Table 2. Proximate composition of raw anchovy and fish soup (% wet weight).

Analyzes (%)	Raw anchovy	Fish soup
Crude protein	16.80±0.24	5.04±0.04
Crude fat	7.20±0.17	6.22±0.08
Crude ash	1.53±0.03	1.46±0.04
Moisture	73.52±1.86	82.05±0.82
Carbohydrate	0.95±0.05	5.23±0.12

3.2. Sensory Evaluation

Sensory analysis is one of the important criteria in the quality evaluation of seafood products, and criteria such as odor, color, texture, and appearance are evaluated by the human senses. For this reason, sensory analysis in quality control of seafood and other foods is of great importance for the consumer (Çağlak et al., 2015; Karsli et al., 2021).

In this study, an anchovy soup recipe was created to have a healthier and richer nutritional content. The sensory evaluation results of anchovy soup are shown in Table 3. Upon evaluating the odor criteria, it was determined that anchovy soup exhibited no adverse odor characteristics with regard to its consumability. In terms of odor, most of the panelists reported that they smelled “a very faint odor of fried fish” (53.33%), followed by “no noticeable smell” (40.01%). With regard to the oiliness criteria, most of the panelists (40.02%) stated that the anchovy soup was not oily. 26.66% of the panelists evaluated that the fish soup was “slightly oily”. The amount of salt used in the soup formulation was evaluated as “normal” by most of the panelists (86.68%). As determined by the bitterness values, the analysis revealed the absence of a prevailing bitter sensation in the anchovy soup, with a majority of the panelists (53.33%) selecting the “not bitter” choice. The hardness values of the anchovy soup were expressed by the panelists as between “extremely crispy” and “medium hard” criteria. Panelists expressed the juiciness of fish soup as “medium dryness/wetness” at a rate of 46.66%, followed by “a little watery (26.66%)”, “very watery (13.34%)”, and “excessively watery (13.34%)” options, respectively. The aroma characteristic of anchovy soup was expressed as “medium aroma” with 53.33%, “very aromatic” with 13.34%, and “excellent aroma” with 33.33%. The results of the anchovy soup in terms of appearance and overall acceptance were found to be similar, and 46.66% of the panelists chose the “I liked it” or “I liked it very much” options. After analyzing the purchase intent, all panelists claimed that they would be interested in purchasing the anchovy soup once it was made available on the market.

Some studies have been conducted in the literature on fish soup prepared using different fish species (Mol, 2005; Tolasa et al., 2012; Ulusoy et al., 2017; Zhang et al., 2018; Yavuzer, 2020; Kose et al., 2021; Tufan et al., 2022). Yavuzer (2020) prepared soup from the cooking water of different fish species (mackerel, bonito, and sea bass) and reported that all three fish soup groups received high scores according to the sensory analysis results. In addition, 80% of the panelists stated that there was no fishy odor/taste in the soup and 100% of the panelists who normally do not like to eat fish stated that they liked fish soup and could consume it regularly. In another study, Ulusoy et al. (2017) reported that adding monosodium glutamate to the low-sodium fish soup prepared from cultured sea bass improved the taste and flavor and that different flavors and additives could be used in product development.

When evaluated in general, even though both anchovy and different fish species were used, fish soup received high sensory appreciation from the panelists, as in this study. Soups are an indispensable product of the table with their quick preparation, economical, and satisfying properties. In this context, it is thought that the consumption of fish soup, as an alternative to the soups widely consumed throughout the world, especially in Türkiye, will make significant contributions in terms of both nutritional value and health.

Table 3. Sensory assessment results (%) of anchovy soup.

Evaluation Criteria and Results (%)					
Odor	**Results**	**Oiliness**	**Results**	**Saltiness**	**Results**
Smell too strong to consume	0	Excessively oily	0	Too salty to consume	0
The smell is heavy	0	Too oily	0	Too salty	0
The smell of raw fish	0	A little oily	26.66	Slightly salty	6.66
No noticeable odor	40.01	Medium oiliness	6.66	Normal	86.68
Very faint smell of fried fish	53.33	Neither oily nor greasy	26.66	Slightly unsalted	0
Fried/steamed fish smell	6.66	Not oily	40.02	Too unsalted	6.66
Very distinct fried/steamed fish odor	0	Not oily at all	0	No salt	0
Bitterness	**Results**	**Hardness**	**Results**	**Juiciness**	**Results**
Too bitter to consume	0	Too hard to beat	0	Extremely dry	0
Very bitter	0	Very Hard	0	Too dry	0
A little bitter	0	A little harsh	0	A little dry	0
Medium bitterness	0	Medium hardness	26.66	Medium dryness/wetness	46.66
Neither bitter nor not bitter	20.02	A little crunchy	26.66	A little watery	26.66
It's not bitter	53.33	Very crunchy	33.34	Very watery	13.34
It's not bitter at all	26.66	Super crunchy	13.34	Excessively watery	13.34
Aroma	**Results**	**Appearance**	**Results**	**Overall acceptance**	**Results**
Not aromatic at all	0	I did not like at all	0	I did not like at all	0
Neither aromatic nor non-aromatic	0	I do not like	0	I do not like	0
Not aromatic	0	I neither liked nor disliked	0	I neither liked nor disliked	0
Slightly aromatic	0	I liked it very little	0	I liked it very little	0
Medium aroma	53.33	I liked it a little	6.68	I liked it a little	6.68
Very aromatic	13.34	I like	46.66	I like	46.66
In perfect aroma	33.33	I like it a lot	46.66	I like it a lot	46.66
Purchase intent	**Results**				
Yes	100				
No	0				

4. Conclusion

In the present study, fish soup from anchovy with high nutritional content was prepared and the proximate composition and sensory quality parameters of the fish soup were evaluated. Based on the findings of the proximate composition analysis, it has been shown that anchovy soup has a noteworthy nutritional composition. The anchovy soup was highly appreciated sensory-wise, and all the panelists reported their desire to purchase the product. In this respect, it has been seen that anchovy soup will provide significant advantages in increasing healthy nutrition through different consumption methods for anchovy fish, which is the most important hunting product of Türkiye. Combining the consumption of anchovy with different tastes in regional cuisines will contribute to diversity. In addition, it is predicted that serving anchovy fish in the form of soup will make positive contributions to the consumption habits of people who are prejudiced against fish consumption and do not consume enough fish. Additionally, future studies to determine the amino acid and fatty acid composition of fish soup will provide more detailed information about the nutritional composition of fish soup.

Acknowledgment

This project was supported by Recep Tayyip Erdoğan University Scientific Research Projects Coordination Unit (Project Number: FBA-2020-1167).

Conflict of Interest

The authors have no conflict of interest to declare.

References

AOAC. (1980). *Official methods of analysis. (13th ed.). Official methods 7.009. and 2.507*. Association of Official Analytical Chemists (AOAC).

AOAC. (1995). *Official methods of analysis. Official methods 985.14*. Association of Official Analytical Chemists (AOAC).

Caglak, E., & Karsli, B. (2023). Use of dill extracts as a natural preservative on shelf-life extension of rainbow trout croquettes during refrigerator storage. *Food Science & Nutrition*, *11*(11), 7330-7340. https://doi.org/10.1002/fsn3.3658

Çağlak, E., Karslı, B., & Koral, S. (2015). Effects of different processing techniques on the carpet shell (*Ruditapes decussatus* Linnaeus, 1758). *Journal of Food Safety and Food Quality*, *66*(5), 141-148. https://doi.org/10.2376/0003-925X-66-141

Çağlak, E., Sonay-Delihasan, F., Karslı, B., Öğretmen, Ö. Y., Kara, A., & Kobya, O. (2022). *Denizden sofraya hamsi*. Nobel Akademik Yayıncılık. (In Turkish)

Çıtak, B., & Sandıkcı, M. (2020). Afyonkarahisar mutfağının yöresel çorbaları ve diğer şehirlerle karşılaştırılması. *AHBVÜ Turizm Fakültesi Dergisi*, *23*(2), 256-270. https://doi.org/10.34189/tfd.23.02.002 (In Turkish)

da Silva, B. B. C., de Lima, Â. G., Gularte, M. A., Santo, M. L. P. E., & Botelho, F. T. (2013). Acceptability of anchovy-based (*Engraulis anchoita*) preparations. *Demetra*, *8*(3), 379-395.

Karsli, B. (2021). Determination of metal content in anchovy (*Engraulis encrasicolus*) from Turkey, Georgia and Abkhazia coasts of the Black Sea: Evaluation of potential risks associated with human consumption. *Marine Pollution Bulletin*, *165*, 112108. https://doi.org/10.1016/j.marpolbul.2021.112108

Karsli, B., Caglak, E., & Kilic, O. (2021). Application of black cumin and green tea extracts and oils for microbiological, physicochemical, textural and sensorial quality of vacuum packaged rainbow trout fillets stored at 2±1°C. *Journal of Aquatic Food Product Technology*, *30*(3), 271-282. https://doi.org/10.1080/10498850.2021.1880511

Keskin İ., Kocatepe, D., Turan, H., Altan, C. O., Köstekli, B., Ceylan, A., & Candan, C. (2018). Marinasyon işlemi sırasında hamside (*Engraulis encrasicolus* L. 1758) meydana gelen renk değişiminin ve bazı kimyasal parametrelerin belirlenmesi. *GIDA*, *43*(4), 655-662. https://doi.org/10.15237/gida.GD18051 (In Turkish)

Kilinc, B. (2010). Preparation of liquid anchovy (*Engraulis encrasicolus*) soup and microbiological and sensory changes during refrigerated storage. *Journal of Muscle Foods*, *21*(3), 451-458. https://doi.org/10.1111/j.1745-4573.2009.00194.x

Kose, S., Pompe, M., Tufan, B., Veber, M., Kocar, D., & Petkovsek, E. (2021). Nutritional value of fish soup from cultured brook trout (*Salvelinus fontinalis*, Mitchill, 1814). *Ukrainian Food Journal*, *10*(1), 112-123. https://doi.org/10.24263/2304-974X-2021-10-1-10

Köşker, H., & Özbey, Z. (2021). Türk mutfak kültüründe çorba ve coğrafi işaretli çorbalar üzerine bir değerlendirme. *Gastroia: Journal of Gastronomy and Travel Research*, *5*(3), 471-489. https://doi.org/10.32958/gastoria.956548 (In Turkish)

MEB. (2010). *Gıda teknolojisi duyusal test teknikleri*. Milli Eğitim Bakanlığı (MEB). https://megep.meb.gov.tr/mte_program_modul/moduller_pdf/Duyusal%20Test%20Teknikleri.pdf (In Turkish)

Mol, S. (2005). Preparation and the shelf-life assessment of ready-to-eat fish soup. *European Food Research and Technology*, *220*, 305-308. https://doi.org/10.1007/s00217-004-1030-2

Öğretmen, Ö. Y. (2022). The effect of migration on fatty acid, amino acid, and proximate compositions of the Black Sea anchovy (*Engraulis encrasicolus*, Linne 1758) from Turkey, Georgia, and Abkhazia. *Journal of Food Composition and Analysis*, *105*, 104197. https://doi.org/10.1016/j.jfca.2021.104197

Özdemir Yaman, Z. (2022). Türk mutfak tarihinde çorba kültürü. In Y. Oğan (Ed.), *Gastronomi alanında tematik araştırmalar 1* (pp. 20-29). Çizgi Kitabevi Yayınları. (In Turkish)

Tolasa, S., Cakli, S., Kisla, D., & Dincer, T. (2012). Quality and shelf-life assessment of pasteurized trout soup during refrigerated storage. *Journal of Aquatic Food Product Technology*, *21*(4), 321-329. https://doi.org/10.1080/10498850.2011.595054

Tufan, B., Pompe, M., Veber, M, Kocar, D., & Köse, S. (2022). Nutritional value of fish soup from cultured rainbow trout (*Oncorhynchus mykiss*, Walbaum, 1792). *Journal of Anatolian Environmental and Animal Sciences*, *7*(3), 289-296. https://doi.org/10.35229/jaes.1077734

Ulusoy, Ş., Doğruyol, H., Alakavuk, D. Ü., & Tosun, Ş. Y. (2017). Monosodyum glutamatın balık çorbası ve balık köftesinin duyusal özellikleri üzerine etkisi. *Gıda*, *42*(4), 339-347. https://doi.org/10.15237/gida.GD16091 (In Turkish)

Üstündağ, E. (2010). İçinden hamsi çıkan kitaplar. *Aquaculture Studies*, *2010*(2), 18-24. https://doi.org/10.17693/yunus.83146 (In Turkish)

Yavuzer, E. (2020). Uskumru, palamut ve levrek balıklarının fırında pişirme işlemi sonrasında kalan balık sularının yağ asidi içeriğinin belirlenmesi ve balık suyu çorbası yapımında kullanımı. *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi*, *17*(2), 255-262. https://doi.org/10.25308/aduziraat.757938 (In Turkish)

Yerlikaya, P., Gokoglu, N., & Uran, H. (2005). Quality changes of fish patties produced from anchovy during refrigerated storage. *European Food Research and Technology*, *220*, 287-291. https://doi.org/10.1007/s00217-004-1035-x

Zhang, G., Zheng, S., Feng, Y., Shen, G., Xiong, S., & Du, H. (2018). Changes in nutrient profile and antioxidant activities of different fish soups, before and after simulated gastrointestinal digestion. *Molecules*, *23*(8), 1965. https://doi.org/10.3390/molecules23081965