Journal of Agricultural Sciences (Tarim Bilimleri Dergisi) 2021, 27 (4) : 441 - 448 DOI: 10.15832/ankutbd.753691

Journal of Agricultural Sciences
(Tarim Bilimleri Dergisi)

J Agr Sci-Tarim Bili
e-ISSN: 2148-9297
jas.ankara.edu.tr

JAS

Proximate Composition, Fatty Acid and Amino Acid Profiles of Narrow-Barred Spanish Mackerel (*Scomberomorus commerson*) Fillets from İskenderun Bay in The North-Eastern Mediterranean Sea

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ARTICLE INFO
Research Article
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Received: 16 June 2020 / Revised: 30 July 2020 / Accepted: 03 August 2020 / Online: 04 December 2021

ABSTRACT
The present study aims to determine the proximate, fatty acid and amino acid profiling of consumed fresh narrow-barred Spanish mackerel (*Scomberomorus commerson*). Landed fish were freshly sampled (total length 33.7-48.7 cm and weight 617-1260 g) from the Yumurtalık Bay (north-eastern Mediterranean Sea) in Turkey during January, February and March. The protein values were highest in January (22.89%) while the and lowest in February (21.38%) and March (21.73%). Lipid and ash values were not significantly differencing among sampling time. The fatty acid data revealed that the saturated fatty acid values were found higher than the polyunsaturated and monounsaturated fatty acid values. In general, the fillets were abundant in palmitic acid (C16:0), stearic acid (C18:0), oleic acid (18:1n-9) and docosapentaenoic acid (C22:6n-3; DHA) values, regardless of the sampled months. DHA value was recorded as 315.08 mg $100g^{-1}$ in January, while it increased to 327.55 mg $100g^{-1}$ in the March samples. A total of 16 amino acids were determined from the fresh fillets. Compared with the other essential amino acids, the concentration of lysine and leucine were found to be higher in the fillet. At the same time, the lower rates of tryptophan were detected in examined samples for all months. Consequently, this study shows that the narrow-barred Spanish mackerel as a finfish (commercially valuable) from the north-eastern Mediterranean Sea has precious nutritional values that of the protein, fatty acids and amino acids during the sampling period. This fish can be recommended in terms of detected essential fatty acid and amino acid profile that completely nutritious for the human as well as other organisms' dietary requirements.

Keywords: Essential amino acids, Fatty acids, Proximate composition, *Scomberomorus commerson*

1. Introduction

Narrow-barred Spanish mackerel is a member of the Scombridae family, and it is usually found in a large area centered in world especially Southeast Asia and the fish migrate to the eastern Mediterranean Sea via the Suez Canal and move westward toward Tunisia (Froese & Pauly 2019). In the Mediterranean Sea, the presence of narrow-barred Spanish mackerel was first recorded in Palestine (Hornell 1935), whereas its presence has been known in the Mersin and Iskenderun Bays, Turkey, since 1981 (Gücü et al. 1994). Moreover, the presence of this fish was last recorded in the northern Aegean Sea in Izmir Bay in 2018 (Akyol and Tosunoğlu 2019). This immigrant fish species is consumed by hunting. This pelagic fish is increasingly being caught by commercial fisheries, and it has often been reported to be caught by the local fisheries of Güllük, Gökova and Mersin Gulfs (Gücü et al. 1994; Torcu et al. 1997).

Fish are an important source of protein, play an important role in human nutrition and possess high digestibility, biological and growth-promoting values. Fish are also the source of essential elements, particularly n-3 polyunsaturated fatty acids (n-3 PUFAs). Such fatty acids present in fish, especially docosahexaenoic acid, are beneficial for the development of the brain and visual system in infants as well as for reducing the incidence of various disorders in adults, including high cholesterol levels, stroke and heart diseases (Von Schacky et al. 1999; Connor 2000; Arts et al. 2001; Lauritzen et al. 2001; Nordov et al. 2001; Silvers & Scott 2002).

During the last two decades, PUFAs have attracted a great interest among scientists for their medicinal and nutritional properties. The abundance of unsaturated fatty acids is the most valuable characteristic of the fish (Nordov et al. 2001; Türkmen et al. 2008). Polyunsaturated fatty acids of the ω-6 and ω-3 families in particular are recognized as essential biochemical components of the human diet (Aktaş & Halperin 2004). Therefore, the approximate biochemical composition of one species helps evaluate its nutritional and edibility in terms of energy units in comparison with those of other species. Information about the biochemical composition of *Scomberomorus commerson* is of great importance in assessing its nutritional value, but it also

facilitates quality assessment and optimum use of this natural resource. However, no information is available regarding the biochemical composition of *S. commerson*. This study was aimed at determining the changes in the proximate fatty acid (FA) and amino acid composition in fillets of fish whose prevalence continues to rapidly increase in the Yumurtalık Bay, Adana, Turkey. To the best of our knowledge, this is the first report to investigate the proximate composition, fatty acid and amino acids profile of these fish species from İskenderun Bay in The North-Eastern Mediterranean Sea caught during the consumption months.

2. Material and Methods

The research was conducted from January to March 2019. Sampling of mackerel fish was performed in Yumurtalık Bay, Adana, Turkey. Narrow-barred Spanish mackerel were caught by professional fishermen at the coast of the Mediterranean of Turkey (Figure 1). The months when the fish were caught at the Mediterranean shores were January, February and March (İsmail Kamburlu (fishermen), pers comn.). Six samples of the fish species caught during each of these three months in 2019 (18 samples) were placed in styrofoam in box with ice and brought to the laboratory within 2 hours and stored at -20 °C until analysis. The min-max length and weight of the narrow-barred Spanish mackerel were 33.7-48.7 cm (40.83±1.15) and 617-1260 g (935.16±62.52), respectively. The muscle tissues of fish were homogenized, manually separated and analyses in triplicate with regard to nutritional value, fatty acid composition and amino acid composition.

Figure 1- Map of the fish catching area

2.1. Chemical analyses

The samples were thawed at +4 °C and 6 fish fillet samples from each month were homogenized using a blender. Proximate composition analysis (moisture, ash, lipid, and crude protein) of the homogenized samples was determined using the standard procedures of AOAC (1995).

Moisture content was measured by drying samples to constant weight at 103 °C for 24 h. Ash content was determined by burning the samples at 600 °C for 5 h. Protein (N × 6.25) content was determined using an automated Kjeldahl Kjeltec 2200 (Foss Tecator, Högans, Sweden).

2.2. Analytical methods

Lipids were extracted according to the procedure described by Folch et al. (1957). Following lipid extraction, fatty acid methyl esters (FAME) were prepared according to the method described by Metcalfe and Schmitz (1961) and analysed as previously described (Czesny and Dabrowski 1998) with some modifications. Briefly, FAME obtained were separated in a gas chromatographic column (Agilent 6820 A), which was equipped with a flame ionization detector and fitted with a DB 23 capillary column (60 m, 0.25 mm i.d. and 0.25 µm). The injector temperature program involved maintenance of 190 ºC for 35 min, followed by temperature increase at a rate of 30 ºC min-1 to 220 ºC where it was maintained for 5 min. Carrier gas was hydrogen (2 mL min-1), with a split ratio of 30:1. The individual fatty acids were identified by comparing their retention times with that of a standard mix of fatty acids (Supelco 37 component FAME mix). Amino acid composition analysis of the fish fillet samples was conducted using the Ultra-Fast Liquid Chromatography system equipped with a UV detector (Gheshlaghi et al. 2008).

Fatty acids per 100 g of total lipid (TL) require to be the derivation of a reasonable factor (F) correlating the total quantity of fatty acids to a given quantity of total lipid (Weihrauch et al. 1977). Fatty acids in fish muscle levels (mg $100g^{-1}$) were converted with them following formula:

$$FA\ (mg\ 100g^{-1}) = (F\ X\ FA \cdot TL) \cdot 10^{3}$$

In these conversions, F indicates fatty acid conversion factor (0.90 for fish with 5% fat; for fish with <5% fat, it is calculated from the equation F = 0.933 - (0.143 - TL)). FA represents fatty acids. TL represents the total lipids.

The atherogenicity index (AI), thrombogenicity index (TI) and peroxidisability index (PI) were calculated by following the equation suggested by Ulbricht and Southgate (1991) and making slight modifications to it as described by Canto et al. (2015). The hypocholesterolaemic to hypercholesterolaemic ratio (H/H) was calculated using the formula developed by Santos-Silva et al. (2002).

2.3. Statistical analysis

The proximate compositions of amino acids and fatty acids (n=6) have been reported as mean ± standard deviation values. Data were analyzed using the one-way analysis of variance (ANOVA) test at a significance level of 0.05% after confirmation of normality and homogeneity of variance. When significant differences were detected, data were subjected to Student-Newman-Keuls post hoc test for identifying homogeneous subsets. All computations were performed using SPSS16.0 (SPSS Inc. Chicago, IL, USA).

3. Results and Discussion

3.1. Proximate composition of narrow-barred Spanish mackerel

Caught during the consumption months of the narrow-barred Spanish mackerel are given in Table 1. Landed fish were during the months of January, February and March, and statistical differences (P<0.05) were noted for moisture and protein value. The value of moisture in fish fillet usually determines its nutritional taste and value (Gökoğlu et al. 2004). Comparisons made among the groups of narrow-barred Spanish mackerel caught on each of the months revealed that the highest moisture value was found in the February and March samples (73.36 and 73.97%, respectively), and the lowest value was found in the January sample (72.64%). Moisture value in fish effects of the textural properties are very high, the fish will have a soft and mushy texture (Lazo et al. 2017). Moreover, measurement of ash value is mostly dependent on the mineral values in each fish sample as well as the feeding patterns, growth phase, seasons and habitat or environment of the fish species (Suryaningrum et al. 2010). Moisture value in the samples will also have a large impact on the protein value measured in the fish and the higher protein value in the samples will result in a lower moisture value than in fresh samples (Gökoğlu et al. 2004; Sebranek 2009). Protein value was the highest in the January sample (22.89%) compared with that in the other 2 months, followed by the February (21.39%) and March (21.73%) samples. Bandarra et al. (2001) and Çelik (2008) found similar results and reported the protein content of horse mackerel. Reduction of muscle protein in adult fish has been mentioned in cases of mobilization under prolonged fasting (Love, 1992). However, there have been some cases where seasonal protein changes have been reported for wild fish populations (Gökçe et al. 2004; Patrick et al. 2008).

Table 1- Proximate composition (%) of narrow-barred Spanish Mackerel during the sampling periods

Proximate Composition	*Sampling Time*		
	19- January	*19- February*	*19- March*
Moisture	72.64± 1.09^{b}	73.36± 0.42^{a}	73.97± 0.56^{a}
Ash	3.01± 0.21	2.97± 0.10	2.99± 0.13
Protein	22.89± 0.63^{a}	21.39± 0.38^{b}	21.73± 0.91^{b}
Lipid	2.06± 0.10	2.11± 0.20	2.06± 0.01

For the data relative to fish fillet, values are mean ± SD. (n= 6; number of fishes per sampling time), and values in the same row with different superscript letters indicate statistically significant difference (P<0.05)

Monthly sampling did not significantly (P>0.05) affect the lipid value in the flesh. All the other species exhibited fillet fat of < 1%, which would categorize them into low-fat species (Huynh and Kitts 2009). The lipid value of fish is also attributed to environmental factors like nutritional supply and food sources and directly affects odor and flavor density (Puwastien et al. 1999; Lazo et al. 2017; Vijayan et al. 2016).

3.2. Fatty Acid Composition of narrow-barred Spanish mackerel

The fatty acid composition of narrow-barred Spanish mackerel caught during the consumption months is shown in Table 2. At all sampling time, narrow-barred Spanish mackerel showed the highest levels of total saturated fatty acids (SFAs), followed by PUFAs and monounsaturated fatty acids (MUFAs). In agreement with our results, Rajaram et al. (2018) and Osman et al. (2001) reported similar predominant FAs as well as equivalent SFA–PUFA–MUFA patterns in Spanish mackerel fillets. The fatty acid

compositions varied during the sampling time. The fatty acid composition of fish flesh in March samples had the highest ($P<0.05$) levels of total saturates. The SFA value of narrow-barred Spanish mackerel in the March sample was 286.95 mg $100g^{-1}$ followed by 261.53 and 255.79 mg $100g^{-1}$ in the January and February samples, respectively; moreover, the MUFA value was 317.16, 309.34 and 288.32 mg $100g^{-1}$ in February, January and March. In this study, the highest PUFA level among those caught in consumption months was found in February and March (548.06 and 550.96 mg $100g^{-1}$). The results of this study were consistent with the results of various studies in the northeastern Mediterranean (Ozogul et al. 2009; Durmuş 2018; Köşker 2020) There is a common view of the positive effects of PUFAs on human health (Lunn and Theobald 2006; Fung et al. 2009; Hellberg et al. 2012). The accumulation of fatty acids in fish muscle is affected by various factors such as diet and genetics, as well as sexual maturity, geographical location and hunting season (Horn et al. 2018).

In general, viewed individually fatty acids, including palmitic acid, stearic acid, oleic acid and DHA were abundantly found in narrow-barred Spanish mackerel flesh, independent of the sampling time. Prato and Biandolino (2012) also reported oleic acid as the most abundant of the MUFAs in most marine fishes. MUFA and SFA are used as metabolic energy sources for these species, and long chain n-3 fatty acids are essentially essential for structural purposes, namely as components of membrane phospholipids. Moreover, MUFA are more efficiently transformed into energy via the process of β-oxidation than n-6 PUFA (Turchini et al. 2007). This observation can be explained by the fact that SFA and MUFA are largely represented in neutral lipids and are more prone to migration (Turchini et al. 2007).

Table 2- Fatty acids (mg/100g) composition of narrow-barred Spanish Mackerel

Fatty Acids	*Sampling Time*		
	19- January	*19- February*	*19- March*
C14:0	11.35 ± 1.65	11.81 ± 1.56	11.23 ± 0.41
C15:0	7.44 ± 1.73	7.39 ± 1.08	8.98 ± 0.14
C16:0	373.08 ± 5.89^{b}	429.50 ± 5.41^{a}	398.32 ± 5.52^{ab}
C18:0	261.53 ± 5.78^{b}	255.79 ± 4.84^{b}	$286,95^{a} \pm 4.16^{a}$
C20:0	10.81 ± 0.07^{b}	15.14 ± 0.80^{a}	10.58 ± 0.17^{b}
C22:0	11.88 ± 0.43^{a}	10.54 ± 0.37^{b}	10.98 ± 0.17^{b}
C24:0	1.68 ± 0.01^{ab}	2.25 ± 0.19^{a}	1.10 ± 0.20^{b}
SFA	685.68 ± 10.37^{b}	741.00 ± 9.06^{a}	735.97 ± 10.04^{a}
C14:1	1.95 ± 0.17	2.00 ± 0.37	2.01 ± 0.01
C15:1	2.89 ± 0.17^{b}	3.49 ± 0.48^{a}	2.78 ± 0.01^{b}
C16:1	58.90 ± 2.30^{b}	64.88 ± 0.62^{a}	61.46 ± 0.45^{ab}
C17:1	6.44 ± 0.65^{b}	7.99 ± 0.07^{a}	5.85 ± 0.09^{b}
C18:1n9	158.85 ± 3.85^{a}	147.53 ± 0.07^{b}	131.16 ± 5.85^{c}
C18:1n7	58.33 ± 3.92	61.52 ± 3.39	61.66 ± 3.14
C20:1n9	9.45 ± 0.57^{c}	16.23 ± 1.04^{a}	10.75 ± 0.17^{b}
C22:1n9	4.37 ± 0.13	4.93 ± 0.47	4.40 ± 0.07
C24:1n9	7.03 ± 0.48	7.63 ± 0.07	7.16 ± 0.43
MUFA	309.34 ± 3.72	317.166 ± 1.76	288.32 ± 8.90
C18:2n6	17.19 ± 0.01^{c}	17.22 ± 0.01^{b}	17.48 ± 0.02^{a}
C18:3n6	$7.47^{a} \pm 1.33^{ab}$	$7.67^{a} \pm 1.47$	5.94 ± 0.09^{b}
C18:3n3	75.55 ± 4.71	77.39 ± 3.87	77.37 ± 2.04
C20:2n6	3.49 ± 0.26	3.50 ± 0.26	3.61 ± 0.02
C20:3n6	11.43 ± 0.07	11.73 ± 0.10	10.41± 1.10
C20:4n6	3.01 ± 0.00^{a}	3.10 ± 0.03^{a}	2.91 ± 1.11^{b}
C20:5n3	67.32 ± 4.66	67.62 ± 3.79	68.44 ± 4.74
C22:5n3	26.48 ± 1.49	27.40 ± 1.25	25.11 ± 0.38
C22:6n3	315.08 ± 9.38^{b}	322.76 ± 2.78^{ab}	327.55 ± 3.94^{a}
PUFA	535.04 ± 1.35^{b}	548.06 ± 4.97^{a}	550.96 ± 7.66^{a}
EPA+DHA	382.40 ± 8.22^{b}	391.37 ± 5.11^{a}	392.42 ± 3.15^{a}
PUFA/SFA	0.78 ± 0.04	0.74 ± 0.01	0.74 ± 0.04
n6	42.60 ± 1.18^{a}	43.19 ± 1.82^{a}	39.83 ± 0.54^{b}
n3	484.43 ± 11.41^{b}	496.26 ± 1.87^{a}	497.94 ± 4.14^{a}
n6/n3	0.09 ± 0.01	0.10 ± 0.01	0.10 ± 0.00
n3/n6	11.39 ± 0.95	11.51 ± 0.53	12.36 ± 0.04
DHA/EPA	4.68 ± 0.12	4.76 ± 0.17	4.82 ± 0.29
IA	0.81 ± 0.04	0.86 ± 0.01	0.87 ± 0.05
IT	0.29 ± 0.02	0.31 ± 0.00	0.31 ± 0.02
PI	1.02 ± 0.06^{a}	0.91 ± 0.04^{b}	0.99 ± 0.04^{a}
HH	1.62 ± 0.11^{a}	1.41 ± 0.02^{b}	1.49 ± 0.07^{b}

For the data relative to fish fillet, values are mean ± SD. (n= 6; number of fishes per sampling time); and values in the same row with different superscript letters indicate statistically significant difference ($P<0.05$)

In the fatty acid analyses of narrow-barred Spanish mackerel, the predominant SFAs were palmitic acids and stearic acid. Generally, the palmitic acid value in fish was considerably higher than the stearic acid value at all sampling time. Oleic acid was the most abundant fatty acid of the MUFAs in flesh of fish and statistically different in those caught in consumption months, the highest amount was found in January (158.85 mg $100g^{-1}$). No significant differences in vaccenic acid (C18:1n-7) were found among the fish samples of each month. Linoleic acid (C18:2n-6) value in fish was significantly higher in the March sample (17.48 mg $100g^{-1}$) compared with its value at all other sampling times (February, 17.22 mg $100g^{-1}$ and January, 17.19 mg $100g^{-1}$). Osman et al. (2001) also reported high linoleic acid values in comparison with other n-6 fatty acids for fish species with low fat contents from tropical marine waters. In addition, linoleic acid and α-linolenic acid (18:3n-3) PUFAs are essential nutrients that must be obtained from food (Das 2006).

There were no significant differences in either the α-linolenic acid or EPA value among all sampling times (Table 2). The EPA value of narrow-barred Spanish mackerel was almost the same at all sampling times and EPA ratios in the range of 67.32 and 68.44 (mg $100g^{-1}$) were determined. Contrastingly, the DHA value, which significantly affected the change in the total PUFA value, were influenced by the month in which the fish were caught. DHA value decreased to 315.08 mg $100g^{-1}$ in January, while it increased to 327.55 mg $100g^{-1}$ in March. The difference between months is thought to accumulate DHA found to increase gradually in the body by getting used to the ambient conditions during the stay in the same bay in this fish, which is a migratory species. Seafood contains high and balanced amounts of polyunsaturated fatty acids, especially EPA and DHA (Lunn and Theobald 2006; Ozogul et al. 2009, 2018). Both EPA and DHA are known to be important for human health (Cooner 2000). It was found that this species meets 250-500 mg daily EPA and DHA intake against the risk of cardiovascular disease recommended by EFSA (2012) during the caught in consumption months, Briefly, PUFA value of flesh fish in the March samples (550.96 mg $100g^{-1}$) were significantly higher than that in other sample months. Furthermore, fish need PUFA to adapt to lower water temperatures, and cold-sea fish are rich in n-3 fatty acids (Chanmugam et al. 1986).

The n3/n6 ratio in narrow-barred Spanish mackerel fluctuated within the range of 11.39-12.36 and PI, AI and TI values were calculated to determine lipid quality based on fatty acid data. No significant differences in PI, AI and TI values were found among the monthly samples. The AI and TI ratios across the months ranged from 0.81 to 0.87 and from 0.28 to 0.31, respectively (Table 2). PI values fluctuated within the range of 1.02-0.91 in narrow-barred Spanish mackerel. The n-3/n-6 ratio is a good index to compare the relative nutritional value of fish oil. A higher rate is essential to reduce coronary heart disease, plasma lipid levels and cancer risks (Kinsella et al. 1990). SFAs, MUFAs, and n-6 PUFAs, are TI and AI that these lipids index show potential effects on dietary quality and coronary artery diseases. (Jankowska et al. 2010; Görgün & Zengin 2015). The findings of many other researchers also have seasonal changes, species, gender, size, food availability, geographic location; breeding status, water temperature and salinity rate affect the amount of fatty acids in other fish species (Vlieg & Body 1988; Saoud et al. 2008).

3.3. Amino acids composition of narrow-barred Spanish mackerel

The amino acid profile of the fresh sample was examined. In the fresh sample, 16 amino acids, including 8 essential amino acids (EAAs) and 9 nonessential amino acids (n-EAA) were detected (Table 3). The amino acids in fish have been very important in terms of nutrition and flavor (Antoine et al. 2001).

When the first sampling results were evaluated, among all the detected amino acids, glutamic acid value was the highest (3.81%) and tryptophan value was the lowest (0.22%) in January. In the January sample, EAA concentrations from the highest to lowest were as follows: lysine (2.23%), leucine (1.56%), valine (1.31%), histidine (1.22%), isoleucine (1.21%), threonine (1.05%), phenylalanine (1.02), methionine (0.58%) and tryptophan (0.19%). Among all the EAAs in the fish fillet samples, the concentrations of lysine and leucine were the highest at 2.23% and 1.56%, respectively, while the concentration of tryptophan was the lowest. Similar results on amino acid content were reported by Paratama et al. 2017. These results are Peng et al. (2013) shows that the highest leucine and lysine in the yellow fin tuna from the Serranidae family. Amino acid composition determines the quality of a protein, which is among the most important macronutrients in human diet. Leucine, valine, isoleucine and lysine are categorized as EAAs because a human body cannot produce them s on its own; these EAAs are derived from various external food sources and it is well known that each of the amino acids contributes to the basic taste of a product. Among the n-EAAs in the fish fillet samples, the concentrations of glutamic acid and aspartic acid were the highest at 3.81% and 2.23%, respectively (Table 3). In February, during the second sampling, the concentrations of only some amino acids were changed. The total value of methionine (0.64%), leucine (1.86%) and lysine (2.67%) were increased, and that of histidine (1.12%) and isoleucine (1.01%) was decreased in the fresh fillet; these values were significantly different across the sampling times. Among the n-EAAs in fish fillet samples from February, there was a significant difference in the concentrations of glutamic acid and aspartic acid, which decreased and increased at 3.43% and 2.63%, respectively. Data analysis revealed that the concentrations of histidine (1.25%), methionine (0.74%), isoleucine (1.38%) and leucine (1.93%) increased, whereas that of lysine (2.02%) decreased significantly ($P>0.05$) in the March samples. On the other hand, the n-EAAs, glutamic acid (2.01%) and aspartic acid (2.10%), significantly decreased in the March samples (Table 3). The presence of glycine, alanine, valine, leucine, tyrosine and phenylalanine in the peptides also gives a bitter taste, since proline mostly gives the bitter taste of peptides. The taste of glycine and alanine are active ingredients, and it is well known to have sweetness in various seafood (Pratama et al. 2017). Aspartic acid and glutamic acid have an important role in enzyme active cores, and maintain the solubility properties of proteins (Sikorski et al. 1990; Belitz et al. 2001). Glutamate gives umami taste when its concentration in the foodstuff rises above the taste threshold, and this may be

an indicator of protein intake (Kawai et al. 2009; Zhao et al. 2016). Also, the less glutamic acid contained in fish meat it would result in less savory taste of the fish meat (Suryaningrum et al. 2010). Non-essential amino acids can be synthesized by transferring an amino group to α-keto acids that can be derived from non-protein sources such as glucose (Webster and Lim 2002; Litwack 2017). This may be the cause of non-essential amino acids that increase at sampling times.

Table 3- Amino Acids Composition of narrow-barred Spanish Mackerel

Amino Acids	*Amino Acids profile of mackerel (%)*		
	19-January	*19 -February*	*19- March*
Histidine	1.23±0.21^{a}	1.12±0.29^{b}	1.25±0.10^{a}
Threonine	1.05±0.01	1.04±0.08	1.04±0.14
Methionine	0.58±0.03^{b}	0.64±0.11^{ab}	0.74±0.01^{a}
Valine	1.30±0.18	1.30±0.18	1.35±0.18
Phenylalanine	1.02±0.04	1.02±0.01	0.99±0.10
Isoleucine	1.31±0.32^{a}	1.01±0.02^{b}	1.38±0.32^{a}
Leucine	1.56±0.26^{b}	1.86±0.06^{a}	1.93±0.17^{a}
Lysine	2.23±0.08^{ab}	2.67±0.06^{a}	2.02±0.16^{b}
Tryptophan	0.22±0.01	0.24±0.01	0.24±0.01
Serine	1.88±0.03	1.86±0.03	1.81±0.93
Glycine	1.13±0.02	1.16±0.0	1.13±0.12
Aspartic Acid	2.23±0.00^{ab}	2.63±0.00^{a}	2.10±0.44^{b}
Glutamic Acid	3.81±0.02^{a}	3.43±0.02^{b}	2.01±0.75^{c}
Arginine	1.29±0.20	1.26±0.14	1.26±0.90
Alanine	1.42±0.10	1.40±0.10	1.40±0.10
Tyrosine	0.78±0.12	0.76±0.12	0.77±0.12

For the data relative to fish fillet, values are mean ± SD. (n= 6; number of fishes per sampling time); and values in the same row with different superscript letters indicate statistically significant difference (P<0.05)

In conclusion, the present study demonstrates that narrow-barred Spanish mackerel, which are caught and landed in the north-eastern Mediterranean Sea, have a commercial value and are rich in proteins, fatty acid and amino acids during the sampling time. Moreover, the amounts of EPA and n3/n6 were not significantly different at all sampling times. This species has been found to meet the daily intake of 250-500 mg of EPA and DHA against the risk of cardiovascular disease recommended by EFSA (2012) caught during the months of consumption. This fish can be recommended in terms of detected essential fatty acid and amino acid profile that completely nutritious for the human as well as other organisms' dietary requirements.

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