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Fatty Acid and Amino Acid Compositions of Cultured and Wild Sea Bass (*Dicentrarchus labrax* L., 1758) from Different Regions in Turkey

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Abstract: The main aim of this research is to determinate the fatty and amino acid alternations of cultured and wild sea bass (*Dicentrarchus labrax*) flesh obtained from different regions of Turkey. The major fatty acids of sea bass flesh were observed to be palmitic acid (16:0), oleic acid (18:1ω-9), Eicosapentaenoic Acid (EPA, 20:5ω3) and Docosahexaenoic Acid (DHA, 22:6ω-3). The amounts of ω-3/ω-6 ratio of sea bass flesh obtained from Mugla, Ordu, Sinop (cultured) and wild were determined as 2.66, 4.01, 1.18 and 3.43 wet weight, respectively. In addition, the major amino acids in sea bass flesh were determined to be aspartic acid, glutamic acid and lysine. Methionine, tyrosine and histidine composition of the flesh were lower than those of the other amino acids in all samples. The ratios of Essential (E)/Nonessential (NE) amino acids were observed to be 1.052 for Mugla, 0.712 for Ordu, 0.778 for Sinop and 1.329 for wild. Results showed that, the meat quality of the cultured sea bass fillets are as valuable as wild sea bass fillets.

Key words: *Dicentrarchus labrax*, cultured and wild sea bass, fatty acids, amino acids, aspartic acid, essential

INTRODUCTION

Sea bass (*Dicentrarchus labrax*) is an economically important cultured fish species in the Mediterranean and its importance is growing rapidly in the Black Sea. The market demand and as a result, the price for fresh sea bass has increased markedly over the past decade due to the desirable aroma and quality attributes of this fish; consequently, its farming is deemed to be a profitable business (Alasalvar *et al*., 2002). Thus, many fish farmers on the Mediterranean and Black Sea have gradually expanded their annual production from 1200 m tons in 2001 to 628 m tons in 2005 (TUIK, 2006). On the other hand, intensive production of sea bass has raised concerns over the quality of cultured fish in comparison with that of the wild fish.

Fish lipids are well known to be rich in long-chain ω-3 polyunsaturated fatty acids (ω-3 PUFA), especially Eicosapentaenoic Acid (EPA, 20:5ω-3) and Docosahexaenoic Acid (DHA, 22:6ω-3). These fatty acids play a vital role in human nutrition, disease prevention and health promotion (Horrocks and Yeo, 1999; Kinsella, 1987; Lees and Karel, 1990; Simopoulos, 1991; Staessen *et al*., 1998). ω-3 PUFA cannot be synthesized by humans and must be obtained from the diet. Studies have confirmed that the fatty acid compositions of cultured and wild fish are different and diet has been identified as the main reason for the observed differences (Grigorakis *et al*., 2002; Alasalvar *et al*., 2002; Smith *et al*., 2004). There is evidence suggesting that long-chain ω-3 polyunsaturated fatty acids also have beneficial effects on human health (Steffens, 1997). Therefore, the effects of water temperature and seasonal changes on the fatty acid composition of fish flesh have been studied on several species (Yildiz *et al*., 2006; Erdem, 2006). In addition, sea bass flesh includes all of the essential amino acids.

The protein quality of food depends on its digestibility and its ability to provide all the essential amino acids. It is well known that fish is a perfect protein source. However, the composition of amino acids of fish, which is main component of protein is strictly in-flounced by intrinsic (species, size and sexual maturity) and extrinsic factors (food resources, fishing season, water salinity and temperature) (Borresen, 1992).

The fatty acid content of fish flesh is effected by lots of factors such as fishing season (Deng *et al*., 1976; Bandarra *et al*., 1997; Ozyurt and Polat, 2006), fishing location (Deng *et al*., 1976; Celik *et al*., 2005), fish size (Caponio *et al*., 2004), maturity stage (Mourente *et al*., 2002) and starvation (Jezierska *et al*., 1982).

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The main aim of the present study is to determine and compare the fatty and amino acid composition of wild and cultured sea bass flesh.

MATERIALS AND METHODS

Cultured sea bass (29.28±0.590 cm, 289.14±21.239 g, n = 30) were captured from Mugla (Aegean), Sinop (West Bleak Sea) and Ordu (East Black Sea) in the 1st week of June 2002 and were kept in ice inside a styrofoam box. Mean time wild sea bass (40.9±3.218 cm, 762±42.318 g, n = 4) were captured in Sinop coast at the same time. They were brought to the laboratory within 15 h of capture and were immediately headed, eviscerated and filleted.

Fatty acid analysis: Fatty acid analysis were determined by the esterification of purified lipids using BF_3 methanol following hydrolysis by 0.5 N sodium hydroxide and analyzed using a Perkin Elmer Autosystem XL Gas Chromatograph equipped with SP-2330 and a Flame Ionization Detector (FID). Separation of fatty acid methyl esters was achieved on fused silica capillary column (30 m ×0.25 mm ×0.20 μm film thickness). The oven temperature was 120°C for 2 min and programmed to 220°C at heating rate of 5°C min^{-1}, then held of this temperature for 15 min. The injector and detector temperatures were maintained at 240 and 250°C, respectively. The carrier gas was helium 10 psi with a split ratio of 1/50. The air and hydrogen of pressure were 338 and 45 mL min^{-1}, respectively. Results were expressed as the percentage of each fatty acid with respect to the total fatty acids (IUPAC, 1987).

Amino acid analysis: For amino acid analysis, 10 fillets were removed randomly from frozen storage, well extracted and hydrolyzed in 6 N HCl at 110°C for 24 h. The hydrolyzed method was subjected to phenomenen EZ fast GC-FID hydrolyzed amino acid analysis kids, amino acid analyzer: varian GC, CP-3800 GC.

Statistics: SigmaStat was used to normalize the data, Analysis of Variance (ANOVA) performed and differences in mean values determined using Turkey's procedures of a statistical analysis system (Sümbuloglu and Sumbuloglu, 2000).

RESULTS AND DISCUSSION

In this study, cultured sea bass (*Dicentrarchus labrax*) was gleaned from different areas, with wild sea bass was fishing in Sinop region were investigated fatty acids and amino acids alternation.

The fatty acids profiles of muscle lipids of farmed and wild sea bass are shown in Table 1. The percentage of total Saturated Fatty Acids (SFA) was similar ($p \geq 0.05$) in

Table 1: The fatty acids profiles of muscle lipids of cultured and wild sea bass (total fatty acids (%))

	Cultured			
Fatty acid	Mugla	Ordu	Sinop	Wild (Sinop)
12:0	0.05±0.001	0.06±0.000	0.05±0.001	0.07±0.000
14:0	4.55±0.007^{a}	4.30±0.015^{b}	4.20±0.008^{b}	3.21±0.019^{c}
16:0	17.56±0.016^{a}	17.33±0.006^{ab}	17.67±0.033^{c}	18.90±0.088^{d}
18:0	3.49±0.011^{a}	2.83±0.006^{b}	3.77±0.007^{c}	3.68±0.007^{c}
20:0	Tr	Tr	Tr	Tr
22:0	0.09±0.001^{a}	0.08±0.001^{a}	0.10±0.001^{a}	0.11±0.003^{a}
ΣSFA	25.74±0.024^{b}	24.60±0.007^{a}	25.79±0.009^{b}	25.97±0.023^{b}
14:1ω-7	0.09±0.001	0.08±0.001	0.10±0.001	0.11±0.003
16:1ω-9	0.20±0.000^{a}	0.17±0.000^{b}	0.13±0.001^{ac}	0.20±0.002^{d}
18:1ω-9	18.89±0.012^{a}	23.89±0.057^{b}	19.24±0.003^{c}	21.34±0.092^{d}
20:1ω-9	1.39±0.013	0.81±0.005	0.61±0.003	0.53±0.012
ΣMUFA	20.57±0.007^{a}	24.95±0.158^{c}	20.09±0.002^{a}	22.18±0.027^{d}
18:2ω-6	5.85±0.003^{a}	4.46±0.005^{b}	9.46±0.003^{c}	3.18±0.021^{d}
18:3ω-6	1.52±0.001^{a}	1.09±0.003^{b}	1.39±0.002^{c}	0.81±0.009^{d}
20:2ω-6	0.39±0.001^{a}	0.38±0.001^{a}	0.48±0.003^{b}	1.07±0.014^{c}
20:3ω-3	0.09±0.005	0.08±0.004	0.08±0.000	0.16±0.007
20:4ω-6	Tr	Tr	Tr	Tr
20:5ω-3	7.77±0.034^{a}	7.18±0.034^{b}	7.08±0.018^{c}	5.01±0.053^{d}
22:2ω-3	0.76±0.003	0.76±0.002	0.87±0.002	1.59±0.018
22:6ω-3	11.99±0.036^{a}	15.78±0.139^{b}	12.62±0.137^{c}	12.65±0.065^{cd}
ΣPUFA	28.37±0.012	29.73±0.027	31.98±0.085	24.44±0.019
Σ ω-3	20.61±0.019	23.80±0.045	20.68±0.011	17.37±0.054
Σ ω-6	7.74±0.002	5.94±0.003	11.33±0.003	5.07±0.015
Σ ω-3/ω-6	2.66±0.011	4.01±0.024	1.83±0.007	3.43±0.035
Total fatty acid	74.68±0.014	79.28±0.064	77.89±0.008	72.59±0.023

$^{a-c}$Mean±SD followed by the same letters, within a row are significantly different ($p<0.05$)

both groups (wild-cultured) of fish. Total Polyunsaturated Fatty Acids (PUFA) was higher ($p \leq 0.05$) in the wild sea bass compared with farmed ones, while its total Monounsaturated Fatty Acids (MUFA) content was lower ($p \leq 0.05$) (Table 1).

Maximum total PUFA was found to be 31.98±0.085 at cultured fish captured from Sinop. EPA and DHA amount is considerably rich at all samples. Total MUFA in sea bass flesh at Mugla, Ordu, Sinop and wild were determined as 20.57, 24.95, 20.09 and 22.18%, respectively.

Sea bass have dietary requirements for the PUFA, Arachidonic Acid (ArA, 20:4n-6), Eicosapentaenoic Acid (EPA, 20:5n-3) and Docosahexaenoic Acid (DHA, 22:6n-3). Generally, marine fish have low or no capacity to synthesize Highly Unsaturated Fatty Acids (HUFA) from stearic acid (C18:0) fatty acids. Therefore, EPA, DHA and ArA are considered EFA in the diets for normal growth and development of most marine fish (Smith *et al*., 2004). EPA and DHA are the predominant ω-3 fatty acids in the lipids of marine fish species. There is evidence suggesting that long-chain ω-3 polyunsaturated fatty acids also have beneficial effects on human health (Steffens, 1997) (Fig. 1).

EPA at the cultured fish flesh were found to be 7.77±0.034, 7.18±0.034 and 7.08±0.018 mg/100 g for Mugla, Ordu and Sinop, respectively and there were significant differences between each other ($p<0.05$). The amount of EPA was lower at wild sea bass flesh (5.01±0.053 mg/100 g) compared with cultured ones and significantly differs from that ($p<0.05$). The maximum DHA level was found at sea bass flesh cultured at Ordu and it was significantly differed from those captured from Mugla and Sinop ($p<0.05$), but it is observed that there is no significant difference between cultured and wild sea fish.

It has been declared that the kinds and amounts of fatty acids are directly related to the food consumed by fish and there is a relation between DHA and the level of linolenat in foods (Aggelousis and Ratnayabe, 1991; Agius *et al*., 2001; Mendez *et al*., 1992; Pickova *et al*., 1999; Saglik and Imre, 2001).

The percentage of total SFA and PUFA was higher in wild compared with cultured sea bass, whereas its total monounsaturated content was lower (Alasalvar *et al*., 2002). This is probably due to the high content of monoenoic fatty acids in the feed of the cultured fish. It has been reported that assimilation patterns of dietary fatty acids in fish muscle reflect the content of the dietary lipid sources (Grigorakis *et al*., 2002; Pirini *et al*., 2000). The major fatty acids identified in both fish were 16:0 (palmitic), 18:0 (stearic), 18:1n-9 (oleic), 20:5n-3 (EPA) and 22:6n-3 (DHA). Cultured sea bass contained significantly

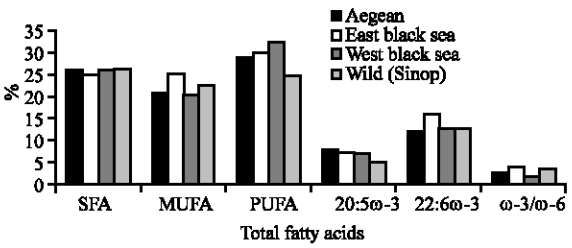

Fig. 1: SFA, MUFA, PUFA, EPA (20:5ω-3) and DHA (22:6ω-3) amount and of cultured and wild sea bass (%)

($p<0.05$) higher proportions of 14:0, 20:0, 18:1n-9, 20:1n-9, 22:1n-9, 18:2n-6 and 20:3n- 6 and lower proportions of 16:0, 18:0, 20:4n-6, 20:5n-3, 22:4n-3, 22:5n-3 and 22:6n-3 than wild sea bass. Palmitic acid was the primary SFA, contributing approximately 70% to the total SFA content of the lipids for three cultured and wild sea bass. Similar results for sea bass (Krajnovic-Ozretic *et al*., 1994) have also been reported in the study.

The ω-3/ω-6 ratio in wild fish is higher than in farmed fish (Van Vliet and Katan, 1990). In this study, ω-3/ω-6 ratio was determined wild sea bass 3.43 and three groups mean in cultured fish 2.83 ($p<0.005$).

The sea bass were examined in relation to the amounts of amino acids and according to all results, it is found that Essential amino acids (E) amounts are higher in wild sea fish than in cultured fish growed in Aegean, Ordu and Sinop. Amino acids, which are Not Essential (NE) were found in the sea bass grown in Ordu with maximum 20610.6 mg/100 g. The maximum E\EN rate was identified in wild sea bass and between all the groups statically significant differences were calculated. In a research, the ratio of E\EN was found 0.69 and in another research, it was stated that as 0.77. This account is higher than Sinop sea bass, equal to ordu sea bass and lower than Aegean and wild sea bass.

The ratio of E/NE amino acids was observed to be cultured Aegean fish 1.052, Ordu 0.712, Sinop 0.778 and wild fish 1.329 (Table 2, Fig. 2). Results shown that the basic amino acids for sea bass fillets were aspartic acid, glutamic acid and lysine. The level methionine was low since pre-oxidation treatment was at applied. Iwasaki and Harada (1985) similarly reported that the main amino acids in fish muscle were aspartic acid, glutamic acid and lysine. The changes in amino acid contents in fish muscle were affected by spawning period and feeding psychology of fish and some parts of protein was used by fish for spawning, resulting in an increase the level of protein in fish eggs (Ozyurt and Polat, 2006).

Table 2: Changes in amino acid composition in sea bass fillets Mugla, Ordu, Sinop (wild-cultured) region (mg/100 g)

Amino acids	Mugla	Ordu	Sinop	Wild
Aspartic acid	5450.0±4.87^a	7217.7±6.53^b	3954.5±12.12^c	2779.6±5.92^d
Alanine	1362.3±3.38^a	2646.0±6.75^b	2774.7±2.25^c	1446.8±4.51^d
Glutamic acid	1919.8±0.17^a	3725.9±4.25^b	1497.2±8.21^c	3538.8±5.22^d
Glycine	1283.0±0.39^a	2481.6±0.96^b	2251.6±9.15^c	1325.9±8.85^a
Histidine	566.8±1.33^a	774.2±8.32^b	608.8±1.13^c	1125.3±7.44^d
Isoleucine*	1470.1±5.67^a	2703.5±2.42^b	1512.1±4.26^c	4051.8±4.36^d
Leucine*	6399.4±4.84^a	2314.5±4.97^b	2043.1±6.00^c	4014.8±4.51^d
Lysine*	2039.7±5.30^a	3208.4±5.10^b	1276.1±5.69^c	4182.0±6.40^d
Methionine*	296.9±5.86^a	Tr	259.8±3.91^c	221.3±1.93^d
Phenylalanine*	1193.6±0.81^a	2257.7±6.200^b	1281.1±1.81^c	4163.0±3.67^d
Threonine*	1056.0±2.06^a	1667.7±12.07^b	1084.3±5.08^a	1317.5±12.37^d
Proline	850.7±0.44^a	1344.8±2.160^b	793.2±0.97^c	1797.4±0.90^d
Serine	653.8±0.43^a	1256.9±1.249^b	614.9±3.50^c	797.6±3.73^d
Tyrosine	1008.4±3.68^a	1163.5±2.060^b	1046.7±6.94^c	1768.2±6.54^d
Valine*	1321.0±1.68^a	2513.1±0.700^b	3082.0±2.64^c	1422.4±2.65^d
E	13776.7±0.00^a	14664.9±0.00^b	10538.5±0.00^c	19372.8±0.00^d
NE	13094.8±0.00^a	20610.6±0.00^b	13541.6±0.00^a	14579.6±0.00^c
E/NE	1.052±00^a	0.712±00^b	0.778±00^b	1.329±0.0^c

*Essential amino acid for humans; Means followed by different letters within the same row are significantly different ($p<0.05$); The values are expressed as mean±SD (n = 2)

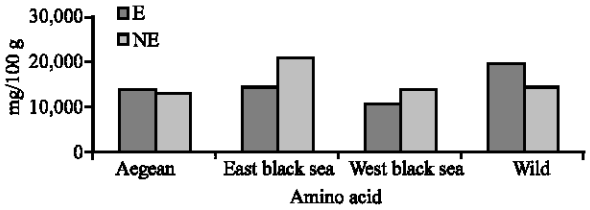

Fig. 2: Essential amino acids (E) and Not Essential amino acids (NE) profiles of muscle lipids of cultured and wild sea bass (mg/100 g)

Wesselinova also reported that the amounts and types of amino acids in fish muscle were affected by catching time and location. The ratio of E/NE was determined as 0.77 for sea bream (*Pagrus major*), 0.77 for mackerel (*Scomber japonicus*), 0.75 chum salmon (*Oncorhynchus keta*) and 0.77 and Pacific flounder (*Paralichthys olivaceus*) by Iwasaki and Harada (1985). The results obtained from this study shown that sea bass fillets have well-balanced and high-quality protein source in the respect of E/NE ratio in all regions.

CONCLUSION

According to the results of research, it was stated that the sea bass obtained by the way of farming from different coasts of Turkey and caught by natural ways from Sinop were in good quality in view of total fatty acids and amino acids. Furthermore, the ΣMUFA, ΣPUFA, EPA, DHA and ω-3/ω-6 amounts shown important differences in wild and cultured sea bass found in different regions. Together with this, the rate of E\NE shown differences according to the regions and wild or cultured sea bass. Cultured fish have as valuable flesh quality as wild sea fish.

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