Turk J Vet Anim Sci
29 (2005) 891-895

Research Article

Nutritional Value of Sea Bass (*Dicentrarchus labrax*) Fillets during Frozen (-18 °C) Storage

Gülsün BEKLEVİK*, Abdurrahman POLAT, Fatih ÖZOĞUL
Department of Fishing and Fish Processing Technology, Faculty of Fisheries, Çukurova University,
Balcalı, 01330, Adana - TURKEY
*e-mail: beklevik@cu.edu.tr

Received: 02.07.2004

Abstract: Changes in proximate composition and amino acid content of frozen (-18 °C) wild sea bass (*Dicentrarchus labrax*, L. 1758) fillets were investigated during 9 months of storage. Initial protein and lipid contents were 19.75% and 1.22%, respectively, and changed to 19.31% and 3.58% in the 9th month of storage. Amino acid analyses were performed at intervals in the initial, third, sixth and ninth months of storage. The initial ratio of essential/nonessential amino acid (g amino acid/16 g N) was 0.75. The reduction of the ratio was 0.01 in the 3rd month, 0.05 in the 6th month and 0.08 in the 9th month of frozen storage. The most abundant amino acids in sea bass fillets were aspartic acid, glutamic acid and lysine. Methionine, tyrosine and histidine were in lower concentrations than the other amino acids during the frozen storage.

Key Words: Sea bass, amino acid, lipid, frozen storage, proximate composition

Dondurularak (-18 °C) Depolanan Deniz Levreği (*Dicentrarchus labrax*) Filetolarının Besinsel Değeri

Özet: Araştırmada, -18 °C'de 9 ay süreyle depolanan deniz levreği (*Dicentrarchus labrax*, L. 1758) filetolarında amino asit kompozisyonu ve temel besin madde bileşenlerinde meydana gelen değişimler incelenmiştir. Ham protein ve lipit oranları depolama başlangıcında sırasıyla % 19,75 ve % 1,22, depolamanın dokuzuncu ayında ise % 19,31 ve % 3,58 olarak saptanmıştır. Depolamanın başlangıç, üçüncü, altıncı ve dokuzuncu aylarında yapılan amino asit analizlerinde, başlangıçta 0,75 olan Esansiyel Amino Asit/Esansiyel Olmayan Amino Asit (g amino asit/16g N) oranının depolamanın üçüncü ayında 0,01, altıncı ayında 0,05 ve dokuzuncu ayında 0,08 oranında azaldığı saptanmıştır. Levrek filetolarında tüm depolama boyunca baskın olan amino asitlerin aspartik asit, glutamik asit ve lisin olduğu; metiyonin, tiyrosin ve histidin miktarlarının ise diğer amino asitlere göre daha düşük seviyelerde olduğu belirlenmiştir.

Anahtar Sözcükler: Deniz levreği, amino asit, lipit, dondurularak depolama, besin kompozisyonu

Introduction

Wild sea bass (*Dicentrarchus labrax*), which is an economically important fish, is generally preserved through frozen storage and exported by Turkey (1). Frozen storage is a commonly used method for preserving fish. However, the texture, flavour and colour of fish flesh change during long-term frozen storage. Quality loss of fish flesh takes place due to a variety of changes caused by hydrolysis, polymerization, deamination, decarboxylation and oxidative process during the frozen storage (2-5).

The quality of fish protein is very high due to the essential amino acid composition. In order to assess the trend and degree of freeze-induced denaturation of any fish or seafood material, there are numerous well-known methods, such as determination of basic volatile nitrogen, K-value, and ATPase assay. Although there are reports on the amino acid composition of fish (6-9), little information is available on changes of amino acid content of sea bass fillets stored as frozen (10,11). Storage of sea bass at -18 °C is of great importance for the amino acid requirements of humans, especially in the prohibited fishing season. Therefore, the main aim of this study was to investigate the changes in amino acid and proximate composition of frozen (-18 °C) sea bass fillets over nine months. Another aim of the study was to investigate the protein quality of sea bass in terms of amino acid profile for human consumption.

Materials and Methods

Sample Preparation

Sea bass (349.17 ± 52.21 g) were captured in the Yelkoma Lagoon, the north-eastern Mediterranean cost of Turkey in February 2001 and were kept in ice inside a styrofoam box. The number of the total sea bass used was 82. They arrived at the laboratory within 7 hours of capture and were immediately headed, eviscerated, and filleted. The fillets were shocked at -40 °C for 17 h and glazed in 0-3 °C cold water. Approximately, 550 g fillets (~10-12 fillets) were packaged in a foam plate and wrapped in cling film, and then stored at -18 °C. Analyses of amino acid content and proximate composition of the frozen sea bass fillets were carried out in the 0, 3rd, 6th and 9th months of storage. For the analyses, 4 fillets were taken out randomly from frozen storage, thawed at 4 °C overnight, and then homogenized. All observations were performed in triplicate for obtaining the arithmetic means of the analyses.

Proximate Composition Analyses

Moisture content of sea bass was determined by the method of Ludorf and Meyer (12), the ash content was analyzed by AOAC 935.47 (13), protein content was determined by AOAC 981.10 (14) method and lipid content was analyzed according to Bligh and Dyer's (15) procedures. All data were subjected to analysis of variance (one-way ANOVA), at 5% confidence level using Duncan's (16) multiple range test.

Amino Acid Analyses

For amino acid analyses, 4 fillets were removed randomly from frozen storage, well extracted and hydrolyzed in 6 N HCl at 110 °C for 24 h. The hydrolyzed solution was subjected to an Eppendorf LC 3000 (Eppendorf, Germany) automatic amino acid analyzer.

Results

The proximate composition of frozen (-18 °C) wild sea bass fillets is shown in Table 1.

The initial moisture and crude ash contents decreased significantly ($P < 0.05$) from 77.38% and 1.17% to 75.42% and 1.06%, respectively, at the end of the storage period. There was also a significant difference ($P < 0.05$) in the protein content of sea bass, decreasing from 19.75% to 19.31%. Lipid content also increased significantly from 1.22% to 3.58% at the end of storage. Changes that occurred in the content of moisture and lipid of sea bass fillets are shown in Figure 1.

Amino Acid Composition

Changes in the amino acid profile of wild sea bass fillets during frozen (-18 °C) storage can be observed in Table 2.

The ratio of essential (E, g amino acid/16 g N)/nonessential (NE, g amino acid/16 g N) amino acid was observed to be 0.75 at the beginning of the storage. It decreased to 0.74 in the 3rd month, 0.70 in the 6th month and 0.67 in the 9th month of frozen storage (Figure 2).

Discussion

In the present study, the contents of moisture, crude ash, protein and lipid of sea bass fillets were found to be similar to the findings of Alasalvar et al. (17) and Orban et al. (18). Slight differences may be due to the differences in the catching season, geographical location and fish size. Initial moisture content was 77.38%, and it decreased to 75.42% at the end of 9 months. Generally, glazing and packaging systems were applied during frozen storage to prevent the loss of moisture. Although

Table 1. Proximate composition of the sea bass fillets during frozen storage at -18 °C.

Months	Initial	3	6	9
Moisture (%)	77.38 ± 0.36^{b}	75.78 ± 0.01^{a}	75.79 ± 0.09^{a}	75.42 ± 0.08^{a}
Ash (%)	1.17 ± 0.01^{c}	1.01 ± 0.02^{a}	1.08 ± 0.01^{b}	1.06 ± 0.02^{ab}
Protein (%)	19.75 ± 0.17^{bc}	19.96 ± 0.02^{c}	19.59 ± 0.01^{ab}	19.31 ± 0.12^{a}
Lipid (%)	1.22 ± 0.05^{a}	2.28 ± 0.03^{b}	2.86 ± 0.02^{c}	3.58 ± 0.06^{d}

*Means followed by different letters are significantly different ($P < 0.05$)
The values are expressed as mean ± standard deviation, n = 4

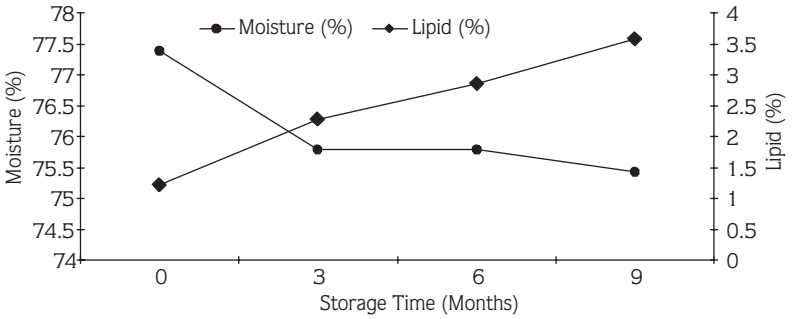

Figure 1. Changes in moisture and lipid contents (%) of sea bass fillets during frozen storage at -18 °C.

Table 2. Changes in amino acid composition in sea bass fillets during frozen storage at -18 °C (g amino acid/16 g N)

Amino Acids (g amino acid/16 g N)	Frozen Storage Period			
	Initial	3rd Month	6th Month	9th Month
Aspartic acid	8.25	8.44	9.35	7.30
Threonine*	4.17	4.03	4.16	3.06
Serine	5.46	4.68	4.73	2.77
Glutamic acid	9.44	9.89	10.30	10.74
Proline	2.58	5.27	6.03	2.90
Glycine	4.15	4.97	3.38	3.39
Alanine	3.94	6.20	5.01	4.32
Valine*	5.43	5.19	4.05	3.80
Methionine*	2.66	3.24	2.93	2.31
Isoleucine*	4.35	3.85	3.73	3.26
Leucine*	5.44	6.91	6.59	5.39
Tyrosine	2.13	2.34	2.08	2.68
Phenylalanine*	3.77	3.69	3.49	3.04
Histidine	2.56	2.80	1.90	2.00
Lysine*	7.43	9.77	8.61	6.58
Arginine	5.68	5.11	4.89	4.80
E/NE	0.75	0.74	0.70	0.67

* Essential amino acid for humans.
Tryptophan was not determined.

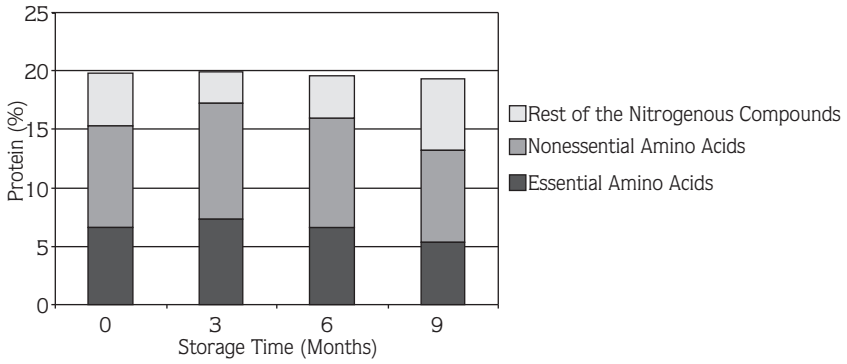

Figure 2. Changes in protein, essential and nonessential ratio (E/NE) of sea bass fillets during frozen storage at -18 °C.

glazing can prevent loss of moisture and lipid oxidation, sublimation of ice can lead to the loss of moisture. Drip loss during the thawing process might be the reason for the decrease in the whole moisture, ash and protein contents. The initial content of protein was 19.75% for sea bass, which decreased to 19.31% at the end of the storage. Tokur (19) also determined a decline in protein content during the frozen storage of trout fillets coated with and without vegetable sauce. Decrease in the protein may be due to the changes of the proportion of chemical composition and protein breakdown. It is not desirable to have low protein content owing to long-term storage, causing a decrease in the nutritional value of fish meat.

At the beginning of the storage period, the initial content of lipid was 1.22%, which increased to 3.58% at the end of the storage period (9th month). It is due to the fact that there is an inverse relationship between the moisture and lipid contents of fish flesh (Figure 1). According to the results of the study by Ben Gigirey et al. (20), the lipid ratio of tuna fillets was 0.88% at the beginning of the storage and it was reported as 1.17%, 0.61%, 1%, 0.77% and 3.71% in the 1st, 3rd, 8th, 9th and 12th months, respectively. Tokur (19) also stated that an increase in lipid content occurred during frozen (-18 °C) storage of rainbow trout.

Table 2 shows the amino acids profile of sea bass stored as frozen at -18 °C. Methionine, tyrosine and histidine were in lower concentrations than the other amino acids (aspartic acid, glutamic acid and lysine). Most researchers have reported that the main amino acids in fish are glutamic acid, aspartic acid, lysine and leucine (6-9). A decrease in the ratio of lysine and methionine (their presence is limited in natural food) was observed. Similar results were reported by Alvarez et al. (11), who reported that lysine diminished in hake (*Merluccius* sp.) muscle stored in -12 °C for 4 months. They stated that a decrease in lysine ratio during the storage can display a reaction of lysine with formaldehyde in muscle, especially in lean fish species, and lysine can be transformed to formyllysine (11). Wesselinova (10) studied the effects of frozen storage time on amino acid composition of fish meat and reported a decrease in the ratio of methionine owing to the transition of methionine to methionine-sulfoxide. It was also reported by the same scientist that other essential amino acids were decreased at the end of the storage period.

The ratio of E/NE was determined as 0.71 for cod (*Gadus morhua*) by Jhaveri et al. (21), 0.77 for sea bream (*Pagrus major*), 0.77 for mackerel (*Scomber japonicus*), 0.71 for mullet (*Mugil cephalus*), 0.69 for sardine (*Sardina melonosticta*), 0.74 for herring (*Clupea pallasi*), 0.75 for chum salmon (*Oncorhynchus keta*) and 0.77 for Pacific flounder (*Paralichthys olivaceus*) by Iwasaki and Harada (9). In this study, the initial E/NE ratio of sea bass was 0.75. However, at the end of the frozen storage of sea bass, this value had decreased to 0.67 (Table 2). It was also found that in the fillets of the sea bass amino acid levels determined during frozen storage were still relatively close to the values given for amino acid requirements of humans (22), even after 9 months of storage. McLarney et al. (22) determined the requirement of amino acid (g/100 g protein) for 2-5 years, 10-12 years and adults as follows: histidine 1.9, 1.9 and 1.6; isoleucine 2.8, 2.8 and 1.8, leucine 6.6, 4.4 and 1.9; lysine 5.8, 4.4 and 1.6; methionine + cystine 2.5, 2.2 and 1.7; phenylalanine + tyrosine 6.3, 2.2 and 1.9; threonine 3.4, 2.8 and 0.9 and valine 3.5, 2.5 and 1.3, respectively.

The results obtained from this study show that the amino acid content of frozen sea bass fillets maintained its quality during 9 months of storage and can cover the amino acid requirements of 10-12 years and adults. However, small decreases in the concentrations of several amino acid contents of frozen sea bass were observed at the end of 9 months. These values were lower for amino acid requirements of 2- to 5-year-old children. It can be concluded that sea bass stored at -18 °C for nine months has great advantages, especially when fishing is prohibited, and for the amino acid requirements of humans. Further research is needed to investigate the effects of frozen storage on the nutritional value of fish in terms of amino acid content.

References

1. SIS: State Institute of Statistics Prime Ministry Republic of Turkey, Fisheries Statistics, 2001, publication number, 2736

2. Sylvia, G., Morrissey, M.T., Graham T., Garcia, S.: Organoleptic qualities of farmed and wild salmon. J. Aquatic Food Prod. Tech., 1995; 4: 51-64.

3. De Koning, A.J., Mol, T.H.: Quantitative quality test for frozen fish: Soluble protein and fatty acid content as quality criteria for hake (*Merluccius capensis*) stored at -18 °C. J. Sci. Food Agric., 1991; 54: 440-458

4. Grosch W.: Reaction of hydroperoxides-products of low molecular weight. In Chan, H.W.S., Ed. Autoxidation of unsaturated lipids, Academic Pres., 1987; 95-139

5. Blinski, E., Jones, R.E.E., Lau Y.C.: Chill storage and development of rancidity in frozen pacific herring, *Clupea harengus pallasi.* J. Fish. Res. Board Can., 1978; 35: 473-477

6. Farmanfarmaian, A., Sun, L.Z.: Growth hormone effects on essential amino acid absorption, muscle amino acid profile, n-retention and nutritional requirements of striped bass hybrids. Genet. Anal.-Biomol. E., 1999; 15: 107-113

7. Seo, H.S., Endo, Y., Muramoto, K., Fujimoto, K., Moku, M., Kawaguchi, K.: Amino acid composition of proteins in myctophid fishes in the sub arctic and tropical Pacific Ocean. Fish. Sci., 1988; 64: 652-653

8. Manthey, M., Hilge, V., Rehbein, H.: Sensory and chemical evaluation of three catfish species (*Silurus glanis, Ictalurus punctatus, Clarias gariepinus*) from intensive culture. Arch. Fiscf. Wiss., 1988; 38: 215-227

9. Iwasaki, M., Harada, R.: Proximate and amino acid composition of the roe and muscle of selected marine species. J. Food Sci., 1985; 50: 1585-1587

10. Wesselinova, D.: Amino acid composition of fish meat after different frozen storage periods. J. Aquatic Food Prod. Technol., 2000; 9: 41-48

11. Alvarez, C., Huidobro, A., Tejada, M., Vázquez, I., De Miguel, E., Gómez De Segura, I.A.: Consequences of frozen storage for nutritional value of hake. Food Sci. Tech. Int., 1999; 5: 493-499

12. Ludorf, W., Meyer, V.. Fische und fischerzeugnisse. Paul Parey Verlag, Berlin und Hamburg, 1973; 309 p.

13. A.O.A.C., 935.47: Official Methods of Analysis 14th Ed. Association of Official Analytical Chemists, Washington, DC, USA. 1984.

14. A.O.A.C., 981.10: Official Methods of Analysis 14th Ed. Association of Official Analytical Chemists, Washington, DC, USA. 1984.

15. Bligh, E.G., Dyer, W.J.: A rapid method of total lipid extraction and purification, Can. J. Biochem. Physiol., 1959; 37: 911-917

16. Duncan, D.B. Multiple range and multiple f test. Biometrics. 1955; 11: 1-42.

17. Alasalvar, C., Taylor, K.D.A., Zubcov, E., Shahidi, F., Alexis, M.: Differentiation of cultured and wild sea bass (*Dicentrarchus labrax*): Total lipid content, fatty acid and trace mineral composition. Food Chem., 2002; 79: 145-150

18. Orban, E., Di Lena, G., Nevigato, T., Casini, I., Santaroni, G., Marzetti, A., Caproni, R.: Quality characteristics of sea bass intensively reared and from lagoon as affected by growth conditions and the aquatic environment. J. Food Sci., 2002; 67: 542-546

19. Tokur, B.: The quality changes of trout fillets (*Oncorhynchus mykiss*) with vegetable sauce during frozen storage. PhD Thesis, Ege Univ. Natural Sci. Inst., İzmir, 2000

20. Ben-Gigirey, B., De Sousa, J.M.V.B., Villa, T.G., Barros-Velazquez, J.: Chemical changes and visual appearance of albacore tuna as related to frozen storage. J. Food Sci., 1999; 64: 20-24

21. Jhaveri, S.N., Karakoltsidis, P.A., Montecalvo, J., Constantinides, S.M.: Chemical composition and protein quality of some southern New England marine species. J. Food Sci., 1984; 49: 110-113

22. McLarney, M., Pellett, P.L., Young, V.R.: Pattern of amino acid requirements in human: An interspecies comparison using published amino acid requirement recommendation. J. Nutr., 1996; 126: 1871-1882.