Caspian J. Env. Sci. 2014, Vol. 12 No. 1 pp. 119-128

CJES

Caspian Journal of Environmental Sciences

[Research]

Chemical composition and fatty acid profile of common Kilka , *Clupeonella cultriventris caspia,*

S. Jorjani[1]*; A.A. Khanipour[2] and A. Ghelichi[1]

1-Department of fisheries, Azadshahr Branch, Islamic Azad University, Azadshahr, Iran.
2-Natinal Fish Processing Research Center,Bandar anzali, Guilan, Iran.
** Corresponding author's E-mail: sarahjorjani@yahoo.com*

(Received: Nov. 27. 2012, Accepted: Apr. 29. 2013)

ABSTRACT:

The objective of the present study was to determine chemical composition and fatty acid profile of common Kilka ,*Clupeonella cultriventris caspia,* in the Caspian Sea. The chemical analysis revealed that the protein and lipid content of common Kilka were 15.05 and 6.5% of the fresh weight, and total MUFA, PUFA and SFA were found to be 37.00, 32.89 and 29.03% respectively. Palmitic acid (16:0) among total SFAs, oleic acid (18:1n-9) among MUFAs, Docosahexanoid acid (DHA) (22:6n-3) among n-3 PUFAs and linoleic acid (LA) (18:2n-6) among n-6 PUFAs were the most abundant fatty acids. The obtained results revealed that common Kilka is a better source of ω-3 PUFAs than ω-6. DHA and eicosapentaenoic acid (EPA) were the major components of ω-3 PUFAs. Levels of DHA and EPA were 20.79% and 6.97% respectively. The PUFA/SFA ratio was 1.13 in common Kilka. This ratio was more than the recommended minimum value (0.45).The EPA/DHA ratio was 0.34 in common Kilka. The present study suggests that common Kilka is rich in essential unsaturated fatty acids of the ω-3 family, especially DHA which may be considered nutritionally attractive for human.

Keywords: *Fatty acid profile, Chemical composition, PUFA, Clupeonella cultriventris caspia, Caspian Sea*

INTRODUCTION

Fish has long been recognized as a valuable source of high-quality protein in human diet (Weber et al., 2008). In recent years, fish lipids have also assumed great nutritional significance because of their high polyunsaturated fatty acid levels. Currently there has been a major emphasis on effects of including n-3 fatty acids PUFA in diet (Yashodhara et al., 2009). Eicosapentaenoic acid , 20:5n-3 (EPA) and docosahexaenoic acid, 22:6n-3 (DHA) appears to play a key role in ontogenesis, especially neural development, functioning of cardiovascular system and immune system (Gladyshev et al., 2006; Broadhurst et al., 2002). Regular consumption of food with an appropriate content of EPA and DHA provides prevention and treatment of depression, cardiovascular and some other diseases. Aquatic organisms are known to be the main source of PUFAs; thereby humans obtain principle EPA and DHA by consuming fish, aquatic invertebrates and macro algae (Arts et al., 2001). Fatty acid components of fish oil vary with several factors such as sex, nutrition, catching season, species, maturity, temperature, etc. (Hedayatifard and Moeini, 2003; Üstün et al., 1996). A good source of omega-3 fatty acids is from oily fish. The most abundant fishes of the Caspian Sea are the small clupeids known as Kilka including the common Kilka (*Clupeonella cultriventris caspia*), anchovi (*C. engrauliformes*) and large eyed Kilka (*C. grimmi*) (Svetovidov, 1963). It is a native species of the Caspian Sea and is found in all parts of the Sea especially along the coastal line. Kilka belongs to pelagic fish and they feed on zooplankton. From 2002 onwards, the frequency of common Kilka increased and reached 24,400 mt in 2009. The common Kilka (*C. c. caspia*) is the predominant species of the southern Caspian Sea comprising 97% of total catches of clupeids in the southern parts of the Sea in 2009. Only the stocks of common Kilka have remained stable, following the severe impacts of *Menemiopsis* (Fazli, 2011). Unfortunately, only a small portion of the Kilka catch is used by human (4%) due to its small size, easy deterioration, impossibility of gutting right away after catching, difficulties in hygienic preservation, packaging, and supply, and the rest is used as fish meal for poultry and in aquaculture (Khoshkhoo et al., 2010; Shabanpour et al., 2007). Noteworthy, clupeids present few positive qualities as well, such as their abundance in the Caspian Sea, low finishing costs, and easy scaling without scaling equipment; therefore, clupeids can be utilized as raw material in the conversion industry. Kilka can be processed into salted , smoked, pickled, sausage, canned, dried and frozen fish. In Iran, Kilka products in market are canned, packed in frozen shape and fresh (Martin, 1994).

A few studies have been conducted on the chemical composition and omega-3 fatty acid content of some commercially important fish species from the south Caspian Sea (Pirestani et al., 2010; Hajirostamloo and Hajirostamloo, 2010; Hedayatifard and Jamali, 2008; Hedayatifard et al., 2002), but there is not enough information in details about the fatty acid content of these fish. Therefore, considering the abundant resources of common Kilka in the Caspian Sea, this study was conducted to investigate the level of fatty acids with special emphasis on omega-3 essential fatty acid and chemical composition of common Kilka.

MATERIALS AND METHODS

Fresh Kilka fish were bought from special lantern net equipped Kilka fishing boats in Anzali quay, Guilan province (Iran) and then transferred to the National Research Seafood Processing Center in Chilled Sea Water tanks with 60% fish, 25% ice and 15% marine water. The fish were immediately deheaded and gutted and then rinsed with cold hygienic water. The moisture content was determined using an oven at 105˚C (AOAC, 2002).The amount of ash was measured by drying the sample in an electrical kiln at 550˚C (AOAC, 2002).The amount of crude protein was determined by Kjeldahl method (AOAC, 2002) and crude fat was measured using the Soxhlet method (AOAC, 2002). Chemical composition was analyzed for fifteen samples. Lipid was extracted by the method of Bligh and Dyer (1959) and was used for lipid quantification and for determination of the fatty acid profile. Fatty acid methyl esters (FAMEs) were determined following the methodology described by Metcalf et al. (1996). The fatty acid composition of fish samples was determined using a gas chromatograph (Unicam-4600) equipped with a flame ionization detector (FID) and a 30 mm long×0.25 mm internal diameter capillary column PB×70. The oven temperature was 160 ºC for 6 min, followed by an increase to 180 ºC at a rate of 20 ºC /min and held for 9 min at 180 ºC. This was followed by an increase to 200 ºC at a rate of 20 ºC/min and then was held for 5 min at 200 ºC. The injection split ratio was 1:10. The temperatures of the injection port and detector were 250 ºC and 280 ºC, respectively. Helium was used as the gas carrier. The fatty acids were expressed as percentage of the total fatty acid content. Fatty acids were analyzed in triplicate for fifteen samples and Results were expressed as the percentage of each fatty acid with respect to the total fatty acids. The data obtained were statistically analyzed through analysis of variance using SPSS software.

RESULTS AND DISCUSSION

The results of proximate analysis of common Kilka are shown in Table 1.

Table 1. Proximate composition of fresh common Kilka (gr/100 gr)

Chemical composition	Moisture (%)	Crude fat (%)	Crude protein (%)	Ash (%)
Mean ±SD	75±0.28	6.5±1.14	15.1±0.28	3.0±0.28

Data presented as mean ±SD of common Kilka of fifteen fish, each one in triplicate

Lipid content was 6.5±1.14 % in common Kilka. Pirestanni *et al.,* (2010) and Motalebi and Seifzadeh (2011) found 10.2% and 4% lipid content in common Kilka, respectively. Fish can be grouped into four categories according to their fat content: lean fish (≤2%), low fat (2-4 %), medium fat (4-8%) and high fat (≥8%) (Ackman, 1989). Common Kilka in this study was categorized in the medium fat group which differed from the findings of Pirestanni *et al.* (2010) who categorized common Kilka as a high fat fish with 10.23% lipid content. This difference may be due to sampling location, sampling season, environmental conditions, size, age of fish and etc.

The protein content is important when considering quality and texture of the fish muscle. Fish muscles that contain small amounts of protein tend to lose much water upon cooking, which ruins the texture of the meat (Afkhami *et al*., 2011). In the present study, amount of protein in common Kilka was 15.05±0.28% which was in agreement with the results of Motalebi and Seifzadeh (2011). Also the amount of ash in this study was 3.00%. Pirestsni *et al*. (2011) and Seifzadeh *et al*. (2009) reported 3.3% and 2.87% ash in common Kilka, respectively. Several studies showed that chemical compounds in fish muscles in different species or even in one species are different and depend on the species, ration and diet composition, size, age, reproductive cycle, salinity, temperature, geographical region, fishing season and genetic factors (Afkhami *et al*., 2011; Bayir *et al*., 2006).

In the present study, twenty eight fatty acids in muscle of common Kilka were identified and evaluated. The fatty acid compositions of common Kilka are shown in Table 2. In addition, the averages of its fatty acids series are shown in Table 3.

MUFA, PUFA and SFA were found to be 37.00, 32.89 and 29.03%, respectively. Distribution of fatty acid contents in common Kilka was MUFA> PUFA> SFA.

The fatty acid content pattern for common Kilka reported by Naseri *et al* (2010) followed the relative pattern MUFA= PUFA> SFA. They found 32.9, 32.9, and 27.3% of MUFA, PUFA and SFA, respectively, but Pirestani *et al*. (2010) showed a different pattern of fatty acids profile for common Kilka (MUFA>SFA>PUFA) which is a response to specificity of the local aquatic ecosystem.

The major fatty acids of common Kilka were oleic acid (C18:1 ω-9 cis), palmitic (C16:0), DHA (C22:6 ω-3) and EPA (C20:5 ω-3). Results of this study showed that the level of Palmitic acid (C16:0) was 19.14%. It was the dominant saturated fatty acid, contributing to approximately 65% of total saturated fatty acids of common Kilka. It occurs naturally in fish, being a source of metabolic energy for their growth (Sargent *et al*., 2002). Stearic acid (C18:0) was the second major constituent of saturated fatty acids. Naseri *et al* (2010) showed that palmitic acid was the dominant saturated fatty acid in common Kilka and constitutes about 20.14% of the fatty acid content. Also Gutierrez and Silvi (1993) found that palmitic acid was the predominant saturated fatty acid in both marine and fresh water fish.

Table 2. Fatty acid composition of common Kilka (g/100g lipid)

Fatty acid	Name	concentration%	SD
Saturated			
C14:0	Myristic acid	2.6800	0.014
C15:0	Pentadecanoic acid	0.7613	0.001
C16:0	Palmitic acid	19.149	0.014
C17:0	Heptodecanoic acid	0.8109	0.014
C18:0	Stearic acid	4.0267	0.014
C20:0	Arashidic acid	1.3809	0.141
C22:0	Behenic acid	0.2232	0.014
Monoenoic			
C14:1	Myristoleic acid	0.2971	0.001
C15:1	Pentadecanoic acid	0.1676	0.001
C16:1 ω-7	Palmitoleic acid	3.9520	0.001
C17:1	Heptadecanoic acid	0.6324	0.014
C18:1 ω-9trans	Elaidic acid	0.1071	0.001
C18:1 ω-9cis	Oleic acid	26.8892	0.141
C18:1 ω-7cis	Vaccenic acid	2.1300	0.014
C20:1 ω-9	Eicosenoic acid	2.0202	0.014
C22:1 ω-9	Erucic acid	0.1510	0.014
C24:1 ω-9	Nervonic acid	0.6500	0.014
Polyenoic			
C18:2 ω-6 trans	Linolelaidic acid	0.1505	0.014
C18:2 ω-6 cis	Linoleic acid (LA)	2.1243	0.136
C18:3 ω-3	α- linolenic acid(ALA)	0.2536	0.014
C20:2 ω-6	Eicosadienoic acid	0.28	0.014
C20:3 ω-3	Eicosatrienoic acid	0.1511	0.001
C20:4 ω-6	Arachidonic acid(AA)	0.6300	0.012
C20:5 ω-3	Eicosapentaenoic acid(EPA)	6.9709	0.141
C21:5 ω-3	Heneicosapentaenoic acid	0.22	0.015
C22:4 ω-6	Docosatetraenoic acid	0.63	0.010
C22:5 ω-3	Docosapentaenoic acid(DPA)	0.6293	0.014
C22:6 ω-3	Decosahexaenoic acid(DHA)	20.7959	0.142

Data presented as mean ±SD of common Kilka of fifteen fish, each one in triplicate

Table 3. Average of fatty acids series in common Kilka (g/100gr lipid)

Fatty acids series	Concentration (%)	SD
Saturated fatty acids(SFA)	29.03	0.156
Mono unsaturated fatty acids(MUFA)	37.00	0.189
Poly unsaturated fatty acids(PUFA)	32.89	0.561
PUFA/SFA	1.13	0.161
MUFA+PUFA (UFA)	69.89	0.751
MUFA+PUFA/SFA	2.41	0.014
Omega-3 series (ω-3)	29.02	0.311
Omega-6 series (ω-6)	3.87	0.136
Omega-9 series (ω-9)	29.83	0.120
EPA+DHA	27.76	0.283
DHA/EPA	2.98	0.121
ω-3/ω-6	7.50	0.721

Data presented as mean ±SD of common Kilka of fifteen fish, each one in triplicate

Levels of monoenoic fatty acids, such as oleic acid (C18:1 ω-9) and palmitoleic acid (C16:1ω-7) in common Kilka were 26.88% and 3.95% respectively. Oleic acid was the most abundant of mono unsaturated fatty acids in common Kilka and palmitoleic acid was the second major MUFA. Gutierrez and Silva (1993) reported that oleic acid is the prominent MUFA and it was found in higher levels in fresh water fish than in marine fish. The obtained results revealed that common Kilka is more of ω-3 series of PUFA than ω-6 series and their amounts were 29.02 % and 3.87% for ω-3 PUFA and ω-6 PUFA, respectively. Therefore, common Kilka is a better source of ω-3 PUFA than ω-6 PUFA. The most abundant ω-6 PUFA was linoleic acid (LA; C18:2 ω-6) about 2.12%, followed by arachidonic acid (AA; C20:4 ω-6) and docosatetraenic acid (C22:4 ω-6). DHA and EPA were the major components of ω-3 PUFA. Levels of DHA and EPA were 20.79% and 6.97% respectively. DHA was the prominent PUFA ω-3 in common Kilka and the ratio of DHA/HPA was 2.98. Gutierrez and Silva (1993) analyzed fatty acid composition of nine marine fish and found that in all marine fish except sardines, level of DHA was higher than EPH. DHA is one of the most useful polyunsaturated fatty acids (PUFA) with pharmaceutical potential and importance for the prevention and control of various human diseases and disorders such as cardiovascular disease, inflammation, allergy, cancer, immune response, diabetes, hypertension and renal disorders. DHA is also known as "brain food" as it is highly concentrated in the membranes of brain cells and retinal cells of eye (Youdim*et al.*, 2000; Uauy and Valenzuela, 2000). While EPA is the most important EFA of the ω-3 series in human diet, it is the precursor to the 3-series ecosanoids and has been recognized as beneficial for human health by reducing the risk of cardiovascular disease (Hall *et al.*, 2008). The obtained results on evaluation of fatty acid contents of common Kilka revealed that common Kilka is a principle dietary source of ω-3 PUFA especially DHA. EPA and DHA are usually synthesized de novo by algae, while higher trophic organisms such as zooplankton and fish obtain these important molecules through bioaccumulation or by converting PUFA ω-3 precursors to DHA and EPA via elongation and desaturation (Sargent and Whittle 1981). There are two specific essential fatty acids: linoleic acid (LA; C18:2 ω-6) and alpha-linolenic (ALA; C18:3 ω-3). It is from these two "parent" essential fatty acids that ω-3 and ω-6 fatty acid "families" are derived through a series of enzyme catalyzed desaturation and elongation reactions, that generally take place in the cell cytosol and mitochondria. ALA is metabolized to DHA via EPA and docosapentaenoic (DPA), whereas LA is metabolized to arachidonic acid via gamma (γ)- linoleic acid (GLA) or eicosadienoic acid (C20:2ω-6) as two pathways are active. But this bioconversion is slow and usually does not meet the physiological demands of the organisms (Sargent and Whittle, 1981). According to Sargent *et al*. (1989) marine fish have limited abilities to convert shorter fatty acid chains to elongated and desaturated chain. This suggests that marine fish should meet a major part of their essential fatty acid (ω-3 PUFA) demand through their diet. This means that common Kilka probably obtained high levels of ω-3 PUFA through their diet by eating zooplankton that has fed on marine algae. Marine algae are primary synthesizers of omega3 fatty acids. The importance of micro algae as a resource of PUFA has been recently reviewed (Patil *et al*., 2005). Therefore, levels of EPA and DHA increase in common Kilka through bioconversion of PUFA n-3 precursors and specially bioaccumulation of them. EPA and DHA play a vital role in the development and functioning of nervous system, photoreception and the reproductive system (Pirestani *et al*., 2010). The level of EPA+DHA is important in human diet and health and its levels is 27.76% in common Kilka. Also the total content of EPA and DHA in 100g of muscle tissue of common Kilka was 1.81 g. The recommended daily dose of EPA and DHA for a healthy person is 0.5 g (Polak Juszczak and Komar-Szymczak, 2009) that is contained in 27.6 g of common Kilka. For cardiovascular patients, this dose should be two fold higher. Our results showed that the content of ω-9 was 29.83% in common Kilka. The ω -9 fatty acids are effective in decreasing LDL cholesterol blood and also for increasing HDL cholesterol blood. They also have better capability for increasing HDL than ω-3 and ω-6 and also the capability to impede the production of eicosanoid structure (stimulants causing cancer in animal tests) (Suseno *et al*., 2010).The ω-3/ω-6 ratio is a good index for comparing relative nutritional value of fish oils (Pigott and Tucker, 1992). For the well-being of human health, the consumption of fish and fish products rich in ω-3 PUFAs and poor in ω-6 PUFAs is essential. An increase in the human dietary ω-3/ω-6 fatty acid ratio is essential in the diet to help prevent coronary heart disease by reducing plasma lipids and to reduce cancer risk (Kinsella *et al*, 1990). The ω-3/ω-6 ratio was found to be 7.5 in common Kilka. This is similar to the results of Naseri *et al.* (2010) who found this ratio to be more than 7.6 for common Kilka. Also, in the present study, the ratio of ω-3/ω-6 PUFAs was within the range found for marine fish. The ratio of ω-3/ω-6 PUFAs in total lipids of fresh water fish varies mostly between 0.55 and 5.6 whereas it ranges between 4.7 and 14.4 in marine fish (Henderson and Tocher, 1987; Hearn *et al*., 1987; Cengiz *et al*., 2010)

In most industrial western societies, ratio of ω-3/ω-6 is currently about 1:15-20 (Simopoulos, 2002) whereas nutrition experts recommend a ω-3/ω-6 ratio of more than 1:4 (Valencia *et al*., 2006). Another useful key factor for evaluation of fish nutrition quality is PUFA/SFA ratio. Values of PUFA:SFA ratios greater than 0.45 are recommended (HMSO, 1994). The PUFA:SFA ratio was 1.13 in common Kilka which was more than the recommended minimum value. Naseri *et al*. (2010) showed that ratio of PUFA: SFA was 1.21

in *C. c. caspia* which is similar to our findings. However Hajirostamloo and Hajirostamloo (2010) found it to be 0.53 in *C. c. caspia* The present study suggests that common Kilka may be a preferable and valuable food owing to its high DHA and EPA for human consumption.

Therefore, considering the abundant resources of common Kilka in the Caspian Sea and high levels of omega-3 fatty acids in this invaluable species, it seems very necessary to increase human consumption of this species rather than use it for fish meal production.

REFERENCES

Ackman, R.G (1989) Nutritional composition of fats in seafood in progress. *Food and Nutrition Science*, 13: 161-241.

Afkhami, M., Mokhlesi, A., DarvishBastami, K., Khoshnood, R., Eshaghi, N. and Ehsanpour, M (2011) Survey of some chemical composition and fatty acids in cultured common carp (*Cyprinuscarpio*) and grass carp (*Ctenopharyngodon idella*), Noshahr. Iran. *World Journal of Fish and Marine Science*, 3(6): 533-538.

AOAC (2002) *Official method of analysis.* (17thed.). Washington, DC: Association of Official Analytical Chemists.

Arts, M.T., Ackman, R.G. and Holub, B.J (2001) Essential fatty acids in aquatic ecosystem: a crucial link between diet and human health and evolution. *Canadian Journal of Fisheries and Aquatic Science*, 58: 122-137.

Bligh, E.G. and Dyer, W.J (1959) A rapid method of total lipid extraction and purification. *Canadian Journal of Biochemistry and Physiology*, 37: 911-917.

Broadhurst, C.l., Crawford, M.A., Cunnane, S.C., Parkigton, J.E. and Schmidt, W.F (2002) Brain-specific lipids from marine, lacustrine, or terrestrial food resources: potential impact on early African *Homo sapiens*. *Comparative Biochemistry and Physiology*, 131: 653-673.

Cengiz, E.I., Enlu, E. and bashan, M (2010) Fatty acid composition of total lipids in muscle tissues of nine fresh water fish from the River Tigirs (Turkey). *Turkish Journal of Biology* 34: 433-438.

Fazli, H (2011) Some environmental factors effects on species composition, catch and CPUE of Kilkas in the Caspian Sea. *International Journal of Natural Resources and Marine Sciences*, 1(2): 157-164.

Gladyshev, M.I., Sushchik, N.N., Gubanenko, G.A., Demirchieva, S.M. and Kalachova, G.S (2006) Effect of way of cooking on content of essential polyunsaturated fatty acids in muscle tissue of humpback salmon (*Oncorhynchus gorbuscha*), *Food Chemistry*, 96: 446-451.

Gutierrez, L.E. and da Silva, R.C.M (1993) Fatty acid composition of commercially important fish from Brazil. *Scientia Agricola (Piracicaba, Brazil)*, 50(3): 478-483.

Hajirostamloo, B. Hajirostamloo, M (2010) The omega-3 fatty acid s content of some Iranian fresh water fish species. *Word Journal of Fish and Marine Sciences*. 2(4): 285-290.

Hall, W.L., Sanders, K.L. and Chowienczyk, P.J (2008) A high-fat meal enriched with eicosapentaenoic acid reduces postprandial arterial stiffness measured by digital volume plus analysis in healthy men. *Journal of Nutrition*, 138: 287-291.

Hearn, T.L., Sgoutas, S.A., Hearn, J.A. and Sqoutas, D.S (1987) Polyusatyrated fatty acid and fat in fish flesh for selecting species for health benefits. *Journal of Food Science*, 52: 1209-1211.

Hedayatifard, M. and Moin, S (2003) Quantitative and qualitative identification of fatty acids in Persian sturgeon (*Acipenser persicus*) tissue and effect of long term freezing on them. *Journal of Agricultural Science*, 14: 123-132.

Hedayatifard, M. and Jamali, Z (2008) Evaluation of omega-3 fatty acids composition in the Caspian Sea pike-perch (*Sander lucioperca*). *International Journal of Agriculture & Biology*, 10: 235-237.

Hedayatifard, M., Moin, S., Keyvan, A. and Yousefian, M (2002) The qualitative and quantitative identification of fatty acids in muscle of golden mullet "*Liza aurate*". *Iranian Journal of Marine Science*, 1: 73-77.

Henderson, R.J. and Tocher, D.R (1987) The lipid composition and biochemistry of fresh water fish. *Progress in Lipid Research*, 20: 281-346.

HMSO, UK., *Nutritional aspects of cardiovascular disease (report on health and social subjects,* 1994. No.46) London: HMSO.

Khoshkhoo, Z., Motalebi, A., Khanipour, A.A., KarimiFirozjaee, H., Nazemi, M., Mahdabi, M (2010) Study on changes of protein and lipid of Fish Protein Concentrate (FPC) produced from Kilka in VP and MAP packages at light and darkness condition during six months. *International Journal of Environmental Science and Development*, 1(1): 101-106.

Kinsella, E., Lokesh, B. and Stone, R.A (1990) Dietary n-3 polyunsaturated fatty acids and amelioration of cardiovascular disease: possible mechanisms. *American Journal of Clinical Nutrition*, 52(1): 1-28.

Martin, A.M (1994) *Fisheries processing*. Chapman and Hall. Biotechnological Applications. London 1 st ED.

Metcalf, J.A., Mansbridge, R.J. and Blank, J.S (1996) Potential for increasing the efficiency of nitrogen and phosphorus use in lactating dairy cows. *Journal of Animal Science*, 62: 6-16.

Motalebi, A.A. and Seifzadeh, M (2011) Effects of whey protein edible coating on bacterial, chemical and sensory characteristics of frozen common Kilka (*Clupeonella delitula*). *Iranian Journal of Fisheries Sciences.* 11(1): 134-144.

Napier, J.A. and Sayanova, A (2005) The production of very-long-chain PUFA biosynthesis in transgenic plants: towards a sustainable source of fish oils. *Proceedings of the Nutrition Society*, 64: 387-393.

Naseri, M., Rezaei, M. and Abasi, M (2010) Lipid changes during long-term storage of canned common Kilka (*Clupeonella cultriventris*). *Journal of Fisheries, Iranian Journal of Natural Resources* 63(3): 229-242. (In Persian)

Patil, V., Reitan, K.I., Knutsen, G., Mortensen, L.M., Kallqvist, T., Olsen, E., Vogt, G. and Gislerod, H.R (2005) Microalgae as source of polyunsaturated fatty acids for aquaculture. *Current Topics in Plant Biology*. 6: 57-65.

Pirestani, S., Sahari, A., Barzegar, m. and Seyfabadi, S.J (2009) Chemical compositions and minerals of some commercially important fish species from the South Caspian Sea. *International Food Research Journal*, 16: 39-44.

Pirestani, S., Sahari, M.A. and Barzegar, M (2010) Fatty acid changes during frozen storage in several fish species from south Caspian Sea. *Journal of Agricultural Science and Technology* 12: 321-329.

Polak-Juszczak, L. and Komar-Szymczak, K (2009) Fatty acid profiles and fat contents of commercially important fish from Vistula lagoon. Polish *Journal of Food and Nutrition Sciences,* 59(3): 225-229.

Sargent, J.R. and Whittle, K.J (1981) Lipids and hydrocarbons in the marine food web. In: Longhurst AR (ed). *Analysis of marine ecosystems,* Academic Press, London, pp. 491-533.

Sargent, J.R., Henderson, R.J. and Tocher, D.R (1989) The lipids. In: *Fish Nutrition,* Academic Press, New York: pp. 154-218.

Sargent, J.R., Tocher, D.R. and Bell, J.G (2002) The lipids, In *Fish Nutrition.* 3th edition, pp. 181-257. Sandiego: Academic Press.

Seifzadeh, M., Motallebi, A.A. and Mazloumi, M.T (2009) Application of sodium alginate cover in frozen and cleaned common carp and its quality evaluations by bacterial, chemical and sensory tests. *Iranian Scientific Fisheries Journal,* 19(3): 61-76. (In Persian)

Shabanpour, B., Shabani, A., Moini, S., Hamedi, M. and Poorkabireh, M (2007) The effect of different washing methods on chemical and jell forming properties of Kilkasurimi. *Pajouhesh & Sazandegi*, 72: 84-92. (In Persian)

Simopoulos, A.P (2002) The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomedicine and Pharmacotherapy*. 56: 365-379.

Suseno, S. H., Tajul, A.Y., Nadiah, W.A., Hmdah, Asti and Ali, S (2010) Proximate, fatty acid and mineral composition of selected deep sea fish species from Southern java Ocean Western Sumatra Ocean, Indonesia. *International Food research Journal*, 17: 905-914.

Svetovidov, A.N (1963) *Fauna of U.S.S.R fishes* Vol. II. N0 1 Clupeidae, IPST, Jersalem.

Uauy, R. and Valenzuela, A (2000) Marine oils: The health benefits of n-3 fatty acids. *Nutrition*, 16 (7-8): 680-684.

Üstün, G., Akova, A. and Dandik, L (1996) Oil content and fatty acid composition of ommercially important Turkish fish species. *Journal of American Oil Chemisty Society* 73: 389-391.

Valencia, I., Ansorena, D. and Astiasaran, I (2006) Nutritional and sensory properties of dry fermented sausages enriched with n-3 PUFAs. *Meat Science,* 72: 727-733.

Weber, J., Bochi, V.C., Ribeiro, C.P., Victorio, A.M. and Emanuelli, T (2008) Effect of different cooking methods on the oxidation, proximate and fatty acid composition of silver catfish (*Rhadia quelen*) fillets. *Food Chemistry*, 106: 140-146.

Yashodhara, B.M., Umakanth, S., Pappachan, J.M., Bhat, S.K., Kamath, R. and Choo, B.H (2009) Omega-3 fatty acids: A comprehensive review role in health and disease. *Postgraduate Medical Journal*, 85: 84-90.

Youdim, K.A., Martin, A. and Joseph, J.A (2000) Essential fatty acids and the brain: possible health implication. *International Journal of Developmental Neuroscience*, 18(4-5): 383-399.

بررسی ترکیبات شیمیایی و پروفایل اسید چرب ماهی کیلکای معمولی (*Clupeonella cultriventris caspia*)

س. جرجانی*[1]، ع. ا. خانی‌پور[2]، ا. قلیچی[1]

[1]گروه شیلات، دانشگاه آزاد اسلامی واحد آزادشهر، آزادشهر، ایران

[2]مرکز ملی تحقیقات فرآوری آبزیان، بندرانزلی، گیلان، ایران

(تاریخ دریافت: 91/9/ 7 - تاریخ پذیرش: 92/2/9)

چکیده:

هدف از انجام مطالعه حاضر تعیین ترکیب شیمیایی و پروفایل اسیدهای چرب بافت عضلانی ماهی کیلکای معمولی (*Clupeonella cultriventris caspia*) بود. آنالیز تقریبی عضله ماهی کیلکا معمولی نشان داد که مقدار پروتئین و چربی به ترتیب 15/05 و 6/5 درصد می‌باشد. میزان اسیدهای چرب تک غیراشباع (MUFA)، اسیدهای چرب چندغیراشباع (PUFA) و نیز اسیدهای چرب اشباع (SFA) در ماهی کیلکا به‌ترتیب 37/00، 32/89 و 29/03 درصد بود. پالمتیک‌اسید (16:0)، اولئیک‌اسید (18:1n-9)، دکوزاهگزانوئیک اسید (22:6n-3) (DHA) در بین اسیدهای چرب اشباع، اسیدهای چرب تک‌غیراشباع و نیز اسیدهای چرب چند غیراشباع فراوان‌ترین اسیدهای چرب بودند. نتایج حاصله نشان داد که کیلکای معمولی منبع سرشاری از اسیدهای چرب ω-3 است. دکوزاهگزانوئیک‌اسید و ایکوزاهگزانوئیک‌اسید مهمترین اسیدهای چرب از گروه ω-3 بود. مقدار DHA و EPA به ترتیب 20/79 و6/97 درصد بود. نسبت ω-3/ω-6 در ماهی کیلکای معمولی 7/5 بود. همچنین نسبت PUFA/SFA در این ماهی برابر 1/13 بود. این نسبت بیشتر از نسبت توصیه شده (0/45) می‌باشد. نتایج حاصل از این تحقیق نشان داد که ماهی کیلکای معمولی از نظر اسیدهای چرب چندغیراشباعی امگا-3 و به ویژه DHA منابع غذایی و شیلاتی بسیار ارزشمند بوده و در کاهش ابتلا به بیماری‌های قلبی و عروقی موثر می‌باشد.

*مولف مسئول