Original Article

Omega-3 Fatty Acid Content in Various Tissues of Different Persian Gulf Fish

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Background: To investigate the level of omega-3 fatty acids in different kind of fish head, muscle and liver from 30 species of fish collected from Persian Gulf.
Material and Methods: In this experimental study, the fish were collected by hunting from Boushehr and Hormozgan sea ports. Their head, muscle and liver fatty acids were determined on their methylated fatty acids dissolved in N-hexin. Quantitative analysis of fatty acids was performed by gas chromatography (GC) with methylmyristate used as the reference material in this analysis and the qualitative analysis of fatty acids was done by gas chromatography and mass spectrometer (GC- mass) and cod liver oil which contained all of omega-3 fatty acids used as standard.
Results: Our study showed that some fish were good sources of omega-3 fatty acids and Trout (Ghezel-ALA), Bartail flathead (Zaminkan-e-domnavari), Malabar blood snapper (Sorkhoo malabari) had maximum levels of omega-3 in all body tissues. Other types of fish were rich in omega 3 fatty acids in separate organs, such as liver in Bartail flathead (Zaminkan-e-domnavari), head in Sillago Sihama (Shoort) and muscle in Trout (Ghezel-ALA). In contrast, lesser amount of omega 3 fatty acids is found in tissues of other species of fish such as Silver pomfret (Halva sefid), Longfin trevally (Gish-e-derazbale) and Xiphophorus Hellerii (Dom-shamshiri).
Conclusion: This research showed that the liver of fish had the highest level of omega-3 fatty acids and fish muscle contained more omega-3 fatty acids than the head and all fish tissues can be served.

Key words: Omega-3, Fatty Acids, Fish

Introduction

Omega-3 and omega-6 are essential fatty acids for humans which cannot synthesize them and must be supplied by diet. Omega-3 is called “good fats” and is found mostly in seafood and flaxseed products. Omega-3 fatty acids are long-chain carbon compounds that include Alpha-linolenic Acid (ALA), Eicosapentaenoic Acid (EPA), and Docosahexaenoic Acid (DHA).[1] EPA and DHA are found in fish. ALA is present in certain plants such as flaxseed, walnut and canola. Omega-3 free fatty acid is an energy source, a component of membranes, modulator of gene expression and precursor for eicosanoids, preventive agent for cardiovascular disorders, autoimmune disease and cancers, modulator of inflammation and thrombosis and it is important for brain development and visual acuity. The daily use of EPA, DHA (0.5 – 1.8 gr) reduces the risk of heart disease.[2] Thus American Heart community suggests to use fish at least twice a week. As different researches have shown that the most important source of omega-3 fatty acid is fish, we set out to explore whether

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the same amount of this fatty acid is present in different species of fish in Persian Gulf area or the same amount of this fatty acid is found in different tissues of fish. A comparison between freshwater and saltwater fish clearly established that some fresh water fish are good sources of EPA and DHA; two types of omega-3 fatty acids.[3] Consumption at least two meals of fish per week is recommended by the American heart association (AHA) to achieve cardioprotective effects. The fish are the largest and the most varied group of aquatic vertebrates. There are various species of fresh water fish in Iran including 13 types and 25 families.[4] the same amount of this fatty acid is present in different species of fish in Persian Gulf area or the same amount of this fatty acid is found in different tissues of fish. A comparison between freshwater and saltwater fish clearly established that some fresh water fish are good sources of EPA and DHA; two types of omega-3 fatty acids.[3] Consumption at least two meals of fish per week is recommended by the American heart association (AHA) to achieve cardioprotective effects. The fish are the largest and the most varied group of aquatic vertebrates. There are various species of fresh water fish in Iran including 13 types and 25 families.[4] The aim of this study is to determine omega-3 fatty acid content in various tissues of different Persian Gulf fish.

Materials and Methods

In this experimental study, the fishing was carried out in the area near Persian Gulf. Fishing of thirty species was done in cool season in hunting area of Boushehr and Hormozgan and with coordination of native fishermen the catch was transferred to the freezer within an hour. The frozen fish were transported to Shiraz Fisheries Research Laboratory, Natural Resource and Agricultural Research Center for identification. Their heights and weights were measured and 3 kilograms from each species of fish were prepared, labeled and transferred to basic sciences laboratory of Shiraz veterinary college. Using cod liver oil as standard, we prepared methylated fatty acids of the fish. Sample fatty acids were separated and methylated according to the general guideline method and injected the fatty acids into gas chromatograph (GC) apparatus.

The extraction of fat from the samples before preparation and injection into GC chromatography apparatus was achieved at five stages, for all samples as outlined below. Preparation of sample

I. Preparation of samples
II. Extraction of fats from samples
III. Extraction of fatty acids from samples
IV. Methylation of acids
V. Injection into GC

1-At first, the fish kept on ice block in the refrigerator was dissected at room temperature and their tails and heads were separated. Also liver and muscle were fully excised. The head was crushed in a grinder, and liver was fully squashed in a mortar. Three samples of muscle, head and liver pulps were ready for processing in the next stage.

2-After weighting of samples, each was placed in a separate beaker containing 40 cc of a mixture of chloroform-met (2:1) and passed through filter paper. The preparation was poured into a separating funnel, mixed for 2 minutes and maintained in a stationary position for five minutes to separate two phases. The lower phase was added to the previously separated portion and the upper phase was discarded. Some of this solution was used for measuring fat and fatty acids. To this was added 15ml of a mixture of chloroform-ethanol solution and the sample was collected in

a wrapped-tube and kept in the refrigerator.

3-At first, three samples were poured into a separate vessel containing 50 ml of Potass-Alcohol solution (10%) and magnetically stirred for 4 hours. To this was added 50 ml of distilled water and thoroughly mixed for 2 minutes. Under this condition non-soapy substances were dissolved. Lower phase was added to the previously collected solution and the upper phase was washed out with ethanol-alcohol and water. To separate free fatty acids, 30 ml of 50% HCl was added to the solution. 50 cc of Petroleum benzene and diethyl ether at the same proportion was divided and it was mixed for 2 minutes completely. At this stage, fatty acids is placed at the upper phase. The lower phase is thrown and the upper phase is poured at balloon.

4-After adding 2 ml of sulfuric acid (4%) and methanol alcohol to the fatty acids preparation, it was then placed at 75-80º C water bath for 30 minutes. Subsequently 20 ml of petroleum benzene was added to this preparation and mixed thoroughly, and by discarding the aqueous phase (water), the upper phase was collected. For dehydration one gram of sodium carbonate was added to this product, mixed and passed through filter-paper and then 1 gram of sodium sulfate was added to the filtrate, mixed and filtered. The

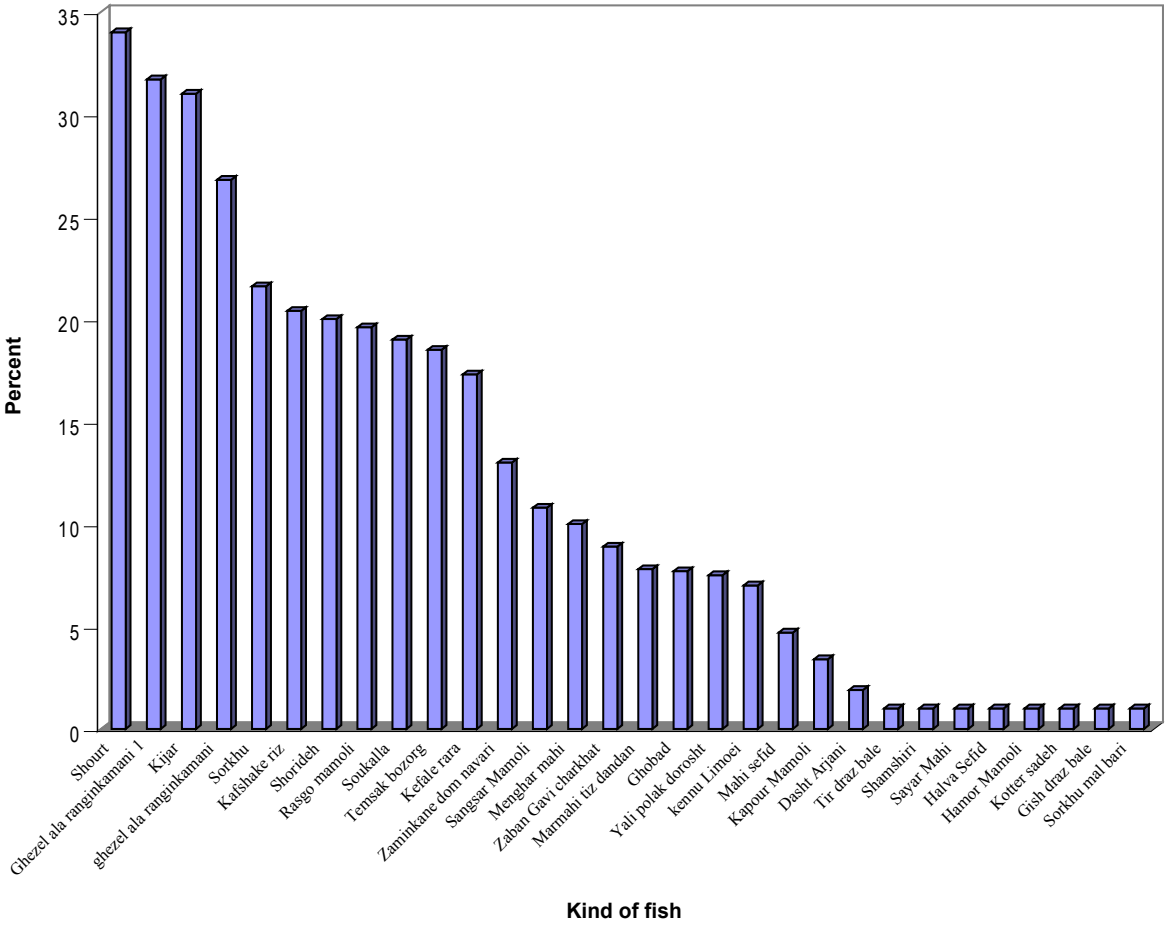

Figure1. Comparison of omega-3 fatty acids in head of 30 fish species

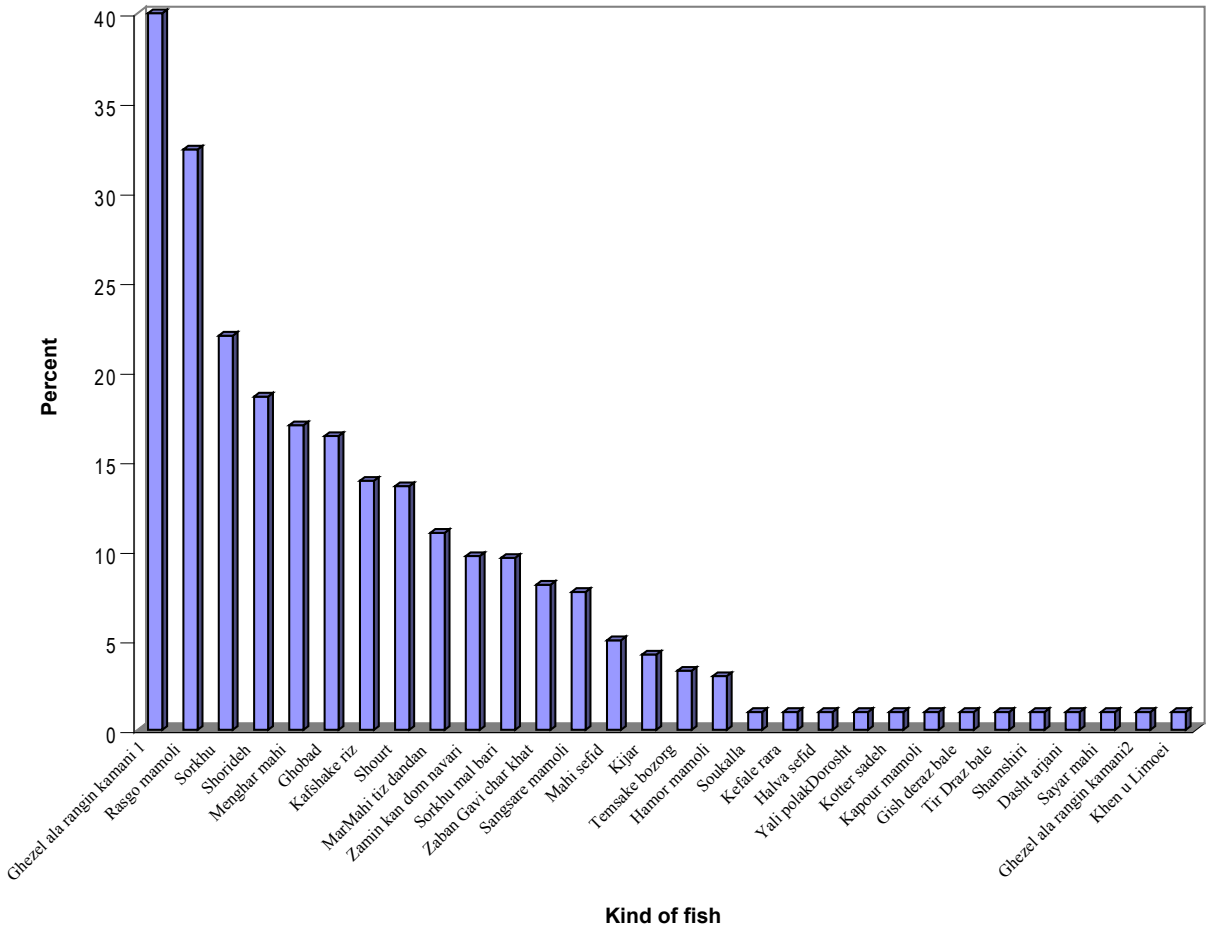

Figure 2. Comparison of omega-3 fatty acids in muscle of 30 fish species

solution thus prepared was transferred to a small tube and evaporated at 45ºC, 1ml of N-Hexin was then added to it and the tube was tightly sealed and ready for injection into GC apparatus.

5-All stages were done with 90 samples (30 fish species).

Results

The result of qualitative investigations, according to the definition of GC mass library, showed that there were 8 peaks of which 5 represented unsaturated fatty acids, and 3 included linolenic acid ω-3 fatty acid, EPA and DHA. The results of quantitative studies of omega-3 fatty acids and non omega-3 are shown in Figs. 1-3 where the data of fatty acids for head, muscle, and liver are separately presented. In this connection, the fatty acids which were not mixed with standard sample and not identified by GC mass system were considered as undefined. Scientific and local names of fish are presented in Table 1.

Our study showed that some fish were good sources of omega-3 fatty acids and Trout (Ghezel-ALA), Bartail flathead (Zaminkan-e-domnavari), Malabar blood snapper (Sorkhoo malabari) had maximum levels of omega-3 in all body tissues. Other types of fish were rich in omega 3 fatty acids in separate organs, such as liver in Bartail flathead (Zaminkan-e-domnavari), head in Sillago Sihama (Shoort)

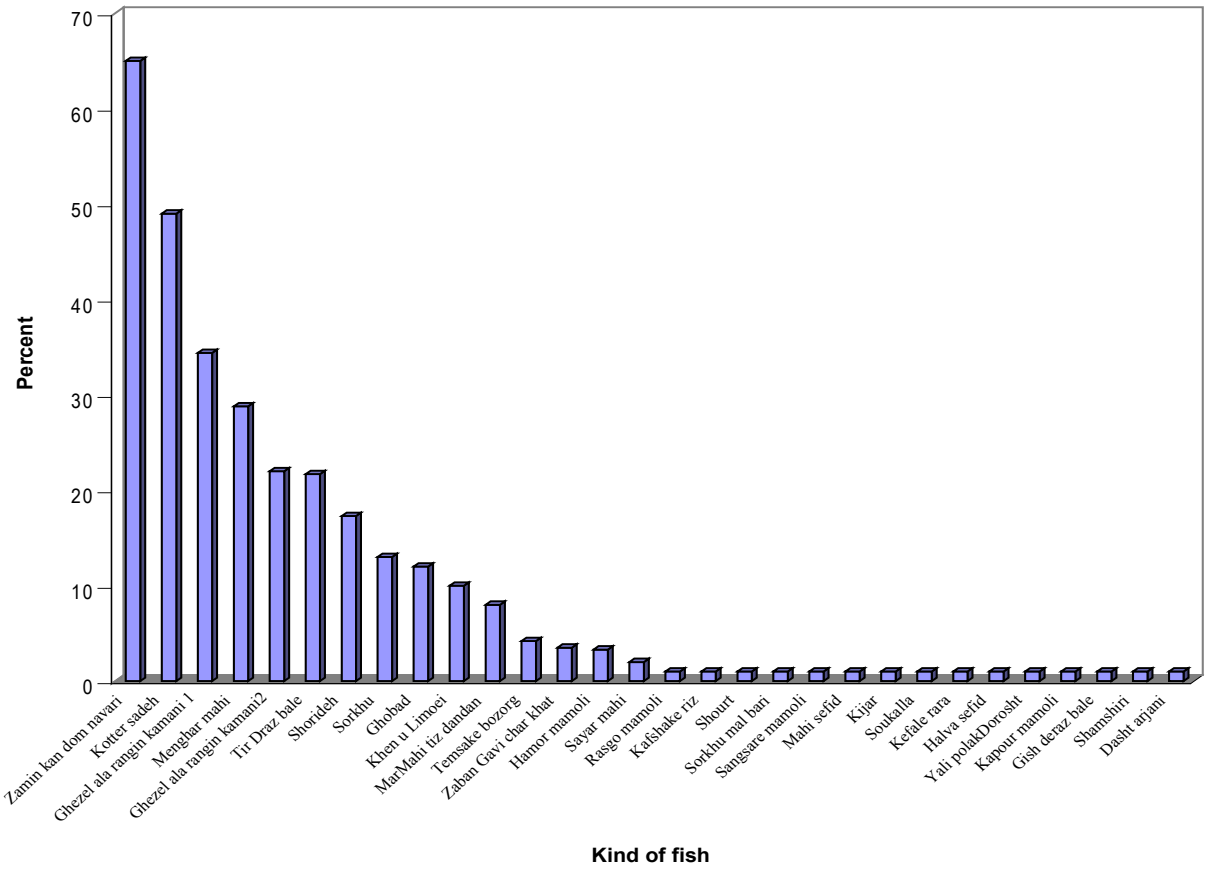

Figure 3. Comparison of omega-3 fatty acids in liver portion of 30 species fish

and muscle in Trout (Ghezel-ALA). In contrast, lesser amount of omega 3 fatty acids is found in tissues of other species of fish such as Silver pomfret (Halva sefid), Longfin trevally (Gish-e-derazbale) and Xiphophorus Hellerii (Dom-shamshiri).

Discussion

In this research the percentage of different types of omega-3 fatty acids, and non-omega 3 in thirty types and different tissues, such as head, muscle and liver, of fish were determined in Persian Gulf area in cold season. According to this study, head in Shourt, Oncarhynchus mgkiss and Saurida tumbip, had the highest amount of omega 3. Fliger in 1997 did not show any differences in the contents of omega 3 fatty acids in head and muscle of antractic fish[5]. We have found the maximum amount of omega 3 fatty acids in total body of Trout (ghezel-ALA), Bartail flathead (Zaminkan-e-dom navari) and Malabar blood snapper (Sorkhoo-malabari). Many investigators showed that large numbers of popular fish are poor sources of omega-3 fatty acids.[3, 6] In our study, fish species including Silver pomfret (Halva sefid), Longfin trevally (Gish-e-deraz bale) and Xiphophorus Hellerii (domshamshiri) were poor source of omega-3 fatty acids. Nonetheless fish is one of the valuable sources of fatty acids and the liver tissues of Trout (Ghezel-ALA), Pickhandle barracuda (Kotr-e-sade), Bartail flathead (Zaminkan-e-dom navari) contained the highest amount of omega 3 fatty acids. This is

Table 1. Scientific and local names of 30 fish species.

Family name	English name	Iranian name	Picture
LUTJANIDAE	Malabar blood snapper	Sorkhoo malabari	
PLATYCEPHALIDAE	Bartail flathead	Zaminkan-e-dom navari	
HAEMULIDAE	Javelin grunter	Sangsar-e-maamooli	
LUTJANIDAE	John's snapper	Sorkhoo-e-maamooli	
CYNOGLOSSIDAE	Fourlined tongue-sole	Zabangavi-e-chaharkhat	
HAEMULIDAE	Lemon sweetlips	Khannoo limooei	
CARANGIDAE	Talang queenfish	Sarm-e-dahan bozorg	
CLUPEIDAE	Bigeye ilisha	Shamsak-e- bozorg	
STROMATEIDAE	Silver pomfret	Halva Sefid	
TERAPONIDAE	Largescaled ter-apon	Yalli-e-dorosht poolak	
SALMONIDAE	Trout	Ghezel ala	
SILLAGINIDAE	Silver sillago	Shoort	
SPHYRAENIDAE	Pickhandle bar-racuda	Kotr-e-sadeh	
SCOMBRIDAE	Indo-pacific king mackerel	Qobad	
SERRANIDAE	Orange-spotted grouper	Hamoor maamooli	
RACHYCENTRIDAE	Cobia	Sookalla	
SCIAENIDAE	Tigertooth croaker	Shoorideh	
BELONIDAE	Hound needlefish	Menghar- mahi-e-shek-archi	
CARANGIDAE	Longfin trevally	Gish-e-deraz bale	
MURAENESOCIDAE	Daggertooth pick conger	Mar-mahi-e-tiz dandan	
PSETTODIDAE	Indian spiny tur-bot	Kafshak-e-tiz dandan	
POECILIDAE	Xiphophorus hel-lerii	Dom shamshiri	

Table 2. Fatty acid composition from 30 fish spp.

Percentage of w-3 FA from experimental samples					
Name in Persian	**Tissue**	**Linoleic acid**	**DHA a**	**EPA b**	**Percentage summation c**
	Head	24	10		34
SHOURT	Liver				0
	Muscle	13.6			13.6
	Head	22.1		9.6	31.7
GHEZEL ALLA	Liver	23	11.4	2	34.4
	Muscle	40			40
	Head	31			31
KIJAR MAHI	Liver	0			0
	Muscle	4.2			4.2
	Head	17	7.2	9.8	26.8
GHEZEL ALLA RANGINKA-MANI	Liver	13	7	2	22
	Muscle	0			0
	Head	17.7		3.9	21.6
SORKHU	Liver	13			13
	Muscle				0
	Head	20.4			20.4
KAFSHAKE RIZ	Liver				0
	Muscle	13.9			13.9
	Head	20			20
SHOURIDE	Liver	17.3			17.3
	Muscle	18.6			18.6
	Head	19.6			19.6
RASGU MAAMULI	Liver	0			0
	Muscle	22			22
	Head	19			19
SOUKALA	Liver	0			0
	Muscle				0
	Head	12.8		5.7	18.5
TEMSAKE BOZORG	Liver	4.2			4.2
	Muscle	3.3			3.3
	Head	17.3			17.3
KAFALE RAH RAH	Liver	0			0
	Muscle				0
	Head	13			13
ZAMIN KANE DOM NA-VARI	Liver	65			65
	Muscle	9.7			9.7
	Head	10.8			10.8
SANGSAR-E-MAAMOOLI	Liver				0
	Muscle	7.7			7.7
	Head	10			10
MENGAR MAHI	Liver	11		17.8	28.8
	Muscle	17			17
	Head	8.9			8.9
ZABANGAVI-E-CHA-HARKHAT	Liver	3.5			3.5
	Muscle	8.1			8.1
	Head	7.8			7.8
MAR MAHI TIZ DANDAN	Liver	8			8
	Muscle	11			11
	Head	4.7		3	7.7
GHOBAD MAHI	Liver	7		5	12
	Muscle	12		4.4	16.4
	Head	2	5.5		7.5
YALI POULAK DOROSHT	Liver				0
	Muscle				0
	Head	7			7
KHENNU LIMUI	Liver	10			10
	Muscle				0
	Head	4.7			4.7
MAHI SEFID	Liver				0
	Muscle	5			5

Table 2 continued...

Percentage of w-3 FA from experimental samples					
Name in Persian	**Tissue**	**Linoleic acid**	**DHA**	**EPA**	**Percentage summation**
	Head		3.4		3.4
Kapour maamuli	Liver				0
	Muscle				0
	Head			1.9	1.9
Dashte arjani	Liver				0
	Muscle				0
	Head				0
Tir deraz bale	Liver	21.7			21.7
	Muscle				0
	Head				0
shamshiri	Liver				0
	Muscle				0
	Head				0
Saiiar mahi	Liver		1		1
	Muscle				0
	Head				0
Halva sefid	Liver				0
	Muscle				0
	Head				0
Hamour maamuli	Liver	3.3			3.3
	Muscle	3			3
	Head				0
Kotere sade	Liver	49			49
	Muscle				0
	Head				0
Gishe deraz bale	Liver				0
	Muscle				0
	Head				0
Sorkhu mal bari	Liver				0
	Muscle	9.6			9.6

consistent with the results of another study that showed fish liver had the highest quantity of fatty acids compared with other organs.[5] In 1988 Yotaka, demonstrated a direct relationship between the degree of environment's low temperature and the rate of unsaturated fatty acid EPA.[7,8] There is a difference between biological condition of Persian Gulf with other water in different parts of the world, and this causes differences in the rate of omega-3 fatty acids in one special species of Persian Gulf with other measuring the rate of these omega-3 fatty acids, in cool season has been the main purpose of our study. This study showed that the liver portion of fish had maximum level of omega-3 and in muscle it was more than head. Thus for achieving maximum amount of omega-3 it is advised to eat all the fish tissues other than muscle alone; similar results have been obtained in other assessment too.

Acknowledgements

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