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Short Communication

Comparative study of the fatty acid composition of five freshwater fish species from the region of Dezful, Iran

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Abstract

Fatty acid composition of fish is one of the key factors for the evaluation of fish nutritional value and it could be different based on fish species, habitat, nutrition and etc. The aim of the present study was to evaluate the fatty acid composition of five commercially important freshwater fish species taken from fisheries sites at Dez River, Iran. The fish samples included Heckel's Orontes barbell, *Luciobarbus pectoralis* (Heckel, 1843), Chub, *Squalius cephalus* (Linnaeus, 1758), Common carp, *Cyprinus carpio* (Linnaeus, 1758), Brond-snout, *Chondrostoma regium* (Heckel, 1843) and Longspine scraper, *Capoeta trutta* (Heckel, 1843). The determination of fatty acid contents of the fish fillets were conducted by means of Gas chromatography. Results showed that *Luciobarbus pectoralis* fillets had the highest amount of fatty acids (43.49%). *Cyprinus carpio* had the highest amount of saturated fat (SAF) (29.43%) whereas the *Luciobarbus pectoralis* fillets had the highest MUFA (Monounsaturated fatty acid) (18.51%). The *Squalius cephalus* fillets possessed the highest amount of PUFA (polyunsaturated fatty acid) (1.87%). The *Chondrostoma regium* fillets revealed the highest n-6 (1.1%) while the *Squalius cephalus* fillets had the highest omega 3 (1.87%). The results of the present study showed that these freshwater fish are good sources of n-3 fatty acids, especially EPA and DHA, and could be considered as a valuable nutritional source.

Keywords: fish, lipid content, n-6, n-3

Abbreviations: polyunsaturated fatty acids (PUFA); monounsaturated fatty acids (MUFA); saturated fatty acids (SFA)

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Introduction

Various foods have different ratios of saturated and unsaturated fat. Foods with a high ratio of saturated fats are such as cream, cheese, butter, and oil. Yet, unsaturated fats are those fats with at least one doubled bound in their fatty acid chain. There are two kinds of unsaturated fat in the fatty acid chain, single-unsaturated which has one doubled bound and multiple unsaturated which has several doubled bonds. These differences in their chemical structure cause differences in their effects on consumer's health (Joordens et al. 2014).

Single unsaturated causes a decrease in cholesterol and multiple unsaturated which is divided into n-3 and n-6 causes a decrease in blood pressure and cardiovascular diseases (Weaver et al. 2008). Fish are known as one of the best sources of fatty acids and food oils due to their body composition. It's been clear that marine fish are the best sources of such compounds especially omega 6. Hence, some cities have limitations in providing fresh marine fish due to distance from the seas, freshwater fish could consider as substitutes. Therefore, the aim of this study was to investigate the fatty acids profiles in some highly consumed freshwater fish species in Dezful, Iran.

Materials and Methods

Samples collection. Fish were taken from fisheries sites at Dez River, Iran, immediately after catching from the river and transferred immediately in ice box to the laboratory. Studied fish species were as follows: Heckel's Orontes barbell, *Luciobarbus pectoralis*, Chub, *Squalius cephalus*, Common carp, *Cyprinus carpio*, Brond-snout, *Chondrostoma regium* and *Longspine scraper*, *Capoeta trutta*. Ten samples of each fish species at the same weight and length were studied (mean total length was 35.0±1.5 cm and mean body weight was 1.5±0.3 kg).

Determination of fatty acids. In order to extract and determine the whole amount of fat, the Folch method was followed (Folch et al. 1957). Gas chromatography (GC) (Young Lin 6100) equipped with a BPX70 column (SGE Co.) (Dimensions: 60 m×0.25 mm×0.25 mm) was used to determine the fatty acids after methylation.

1g of each fish fillet sampled (at 0-4°C) immediately and 10 ml of D-petrol (D-petrol ether) was added to it in a tube sealed by parafilm. The mixture shook for 24 hours. 10 mg oil was picked and 10 ml normal hexane was added to it. Then, 100 ml KOH-Me OH was added to it. It was vortexes for 30 seconds and centrifuged for 15 minutes at 12000 rpm. 2 ml of the surface phase sampled kept in the refrigerator in 4ºC.

To determine the fatty acid composition of the studied fish by the GC, methylation of fatty acids was conducted and the available fatty acids in chromatogram compared with the standard curve.

Statistical analysis. Statistical analysis performed using SPSS 16.0. Normality was studied by the Kolmogorov-Smirnov test. The acquired data were statistically analyzed by the one-way ANOVA followed by LSD test at a 95% certainly level ($p < 0.05$).

Results and Discussion

According to the acquired data by GC, 22 fatty acids were found in the studied fish (Table 1). Results showed that among the studied species, *S. cephalus* and *C. regium* had the highest and lowest levels of the fatty acids, respectively.

The total levels of fatty acids in studied fish were as follow: *S. cephalus* > *L. pectoralis* > *C. trutta* > *C. carpio* > *C. regium* (Figure 1).

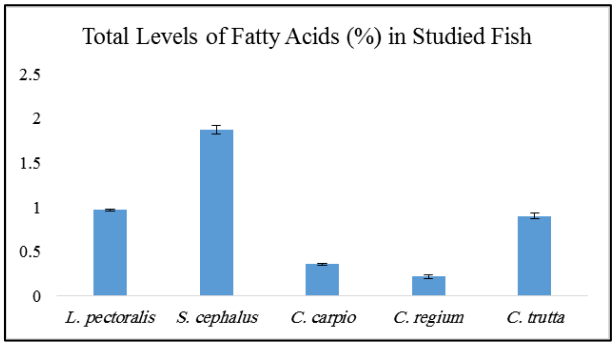

Figure 1. Total levels of fatty acids in studied fish

Results also showed that for levels of saturated fatty acids (SFA), *C. carpio* (29.42%) and *S. cephalus* (7.93%) had the highest and lowest levels, respectively. The levels of saturated fatty acids in

Table 1. Fatty acids detected in studied fish (Ten samples for each species)

Fatty acids (%)	Mixture of light and dark muscle without skin				
	Heckel's Orontes barbell *Luciobarbus pectoralis*	Chub, *Squalius cephalus*	Common carp, *Cyprinus carpio*	Brond-snout, *Chondrostoma regium*	Longspine scraper, *Capoeta trutta*
Caprylic acid (C8:0)	1.44±0.05	-	-	-	-
Capric Acid (C10:0)	-	0.48± 0.01	6.90±0.30*	1.71± 0.01	3.48±0.11
Undecanoic acid (C11:0)	8.15±0.40	9.96±0.50	0.12±0.01*	4.28±0.22	9.82±0.41
Lauric acid (C:12:0)	0.92±0.01	4.40±0.12	3.25±0.02	10.05±0.51*	2.98±0.05
Tridecanoic acid (C13:0)	2.14±0.04	0.38±0.01*	2.06±0.03	3.68±0.02	4.62±0.12
Myristic acid (C14:0)	6.52±0.31	5.21±0.21	18.51±0.63*	6.84±0.33	4.63±0.04
Myristic acid (C14:1)	1.64±0.0.1	0.09±0.00*	0.50±0.01	1.54±0.01	2.78±0.02
Pentadecanoic acid (C15:0)	0.85±0.02	0.69±0.00	1.11±0.05*	0.32±0.01	-
Pentanoic acid methyl ester (C15:1)	15.42±0.65*	2.46±0.06	8.39±0.53	6.88±0.41	3.25±0.11
Palmitoleic acid metyl ester (C16:1)	-	0.58±0.01*	-	-	1.00±0.01
Heptadecanoic acid (C17:0)	1.52±0.02	1.55±0.04	0.63±0.00*	0.58±0.01*	1.72±0.02
Heptanoic acid methyl ester (C17:1)	-	1.24±0.03	0.60±0.01*	0.81±0.01*	1.21±0.02
Stearic acid (C18:0)	-	-	0.20±0.01*	0.42±0.00	0.27±0.00
Octanoic acid methyl ester (C18:1n9t)	1.45±0.05	-	-	-	0.30±0.03*
Linoleic acid (C18:2n6c)	-	0.55±0.02*	-	-	1.03±0.01
Arachidic acid (C20:0)	1.12±0.03	-	-	-	-
Alpha linoleic acid (C18:3n6)	0.97±0.02*	0.26±0.01	0.36±0.00	0.22±0.02	0.39±0.01
Behenic acid (22:0)	-	0.26±0.00	-	-	-
Arachidonic acid(C20:4n6)	-	-	-	-	0.46±0.01
Tricosanoic acid (C23:0)	1.23±0.06*	0.64±0.02	0.59±0.01	0.53±0.01	-
Lignoceric acid (C24:0)	-	0.78±0.02	-	-	-
Nervonic acid (C24:1)	-	-	-	-	-
Total					
SFA	10.1±0.5	10.3±0.5	31.2±0.4	22±0.8	15±0.6
MUFA	18±0.4	17±0.3	11±0.5	10.2±0.4	11.1±0.2
PUFA	1.1±0.01	2.01±0.01	0.5±0.02	0.25±0.02	1.2±0.01
n-3 PUFA	1.01±0.02	2.1±0.05	0.5±0.03	0.25±0.02	1.1±0.02
n-6 PUFA	-	0.6±0.02	-	1.05±0.01	0.8±0.01
n-3 PUFA/ n-6 PUFA	-	0.25	-	5	2

The *shows significant differences ($p \leq 0.01$).

studied fish were as follow: *C. carpio* > *C. regium* > *C. trutta* > *L. pectoralis* > *S. cephalus* (Figure 2).

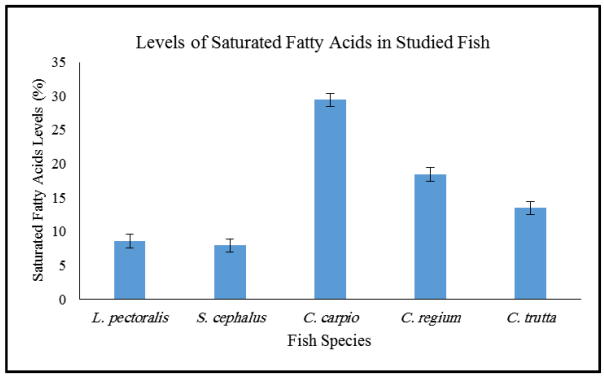

Figure 2. Saturated fatty acids levels according to percent in the studied fish fillets

Results showed that MUFAs levels in studied fish were as follow: *L. pectoralis* > *S. cephalus* > *C. trutta* > *C. carpio* > *C. regium*. The highest and lowest levels of MUFAs were observed in *L. pectoralis* (18.51%) and *C. regium* (9.23%), respectively. (Figure 3).

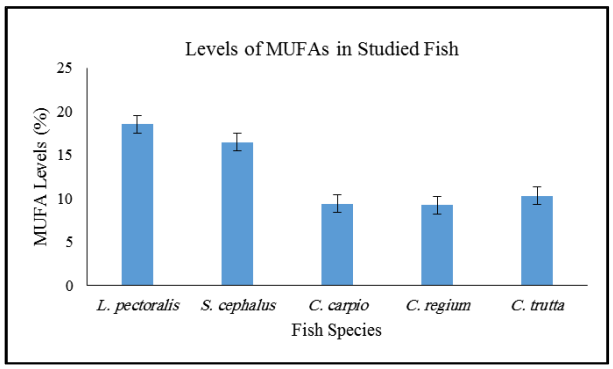

Figure 3. Mono-unsaturated fat acids levels according to the percent in the studied fish fillets

Results also showed that the highest and lowest level of UFAs in studied fish observed in *S. cephalus* (1.87%) and *C. regium* (0.22%), respectively. The levels of UFAs in studied fish were as follow: *S. cephalus* > *L. pectoralis* > *C. trutta* > *C. carpio* > *C. regium* (Figure 4).

Results showed that *S. cephalus* had the highest level of n-3 (1.87%) while *C. regium* had the lowest level of n-3 (0.22%). Results of the study of n-3 in studied fish were as follow: *S. cephalus* > *L. pectoralis* > *C. trutta* > *C. carpio* > *C. regium* (Figure 5).

Results also showed that the highest level of n-6 was observed in *C. regium* (1.1%) followed by *C. trutta* and *S. cephalus*. The minimum level of n-6 (0.01%) observed in *L. pectoralis* and *C. carpio* (Fig. 6).

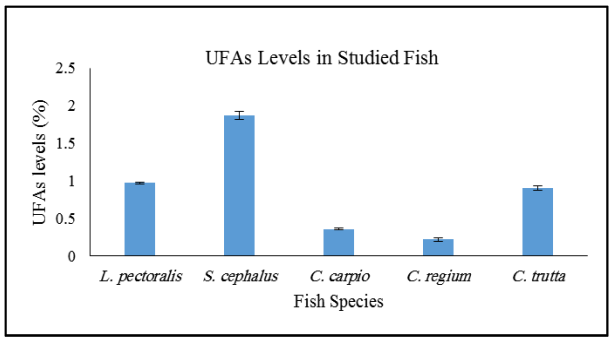

Figure 4. The unsaturated fat acids levels according to the percent in the studied fish

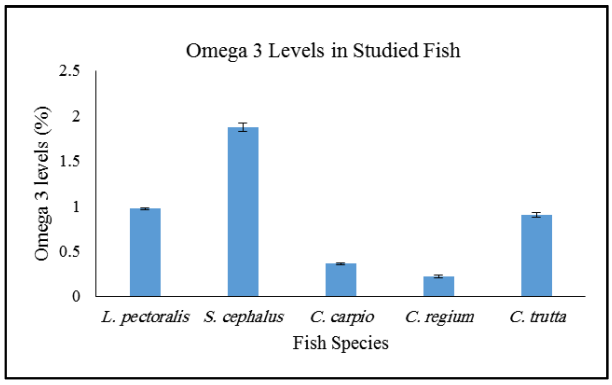

Figure 5. n-3 fatty acid level in the studied fish

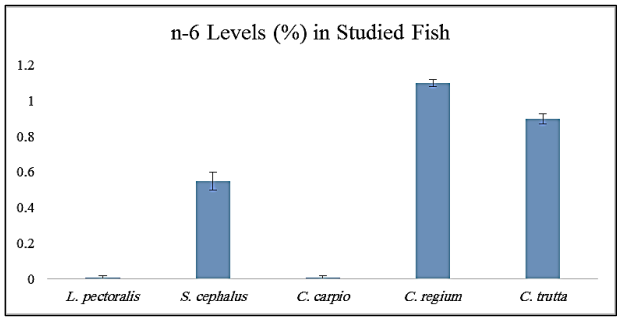

Figure 6. The n-6 fatty acid level in the studied fish

The ratio of n-6/n-3 has been calculated in studied fish, the highest ratio was determined in *C. regium*, followed by *C. trutta* and *S. cephalus*. The ratio for *C. carpio* and *L. pectoralis* was zero (Figure 7).

Previous studies demonstrated that fatty acids profiles of different fish species could be different

according to multiple parameters including species, habitat, diet, etc. The lipid content of several fish

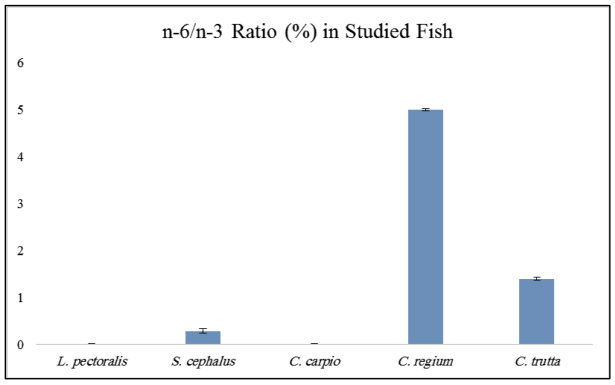

Figure 7. The n-6/n-3 ratio in the studied fish

species from Africa, Netherland, Indian Ocean, and the North Sea are reported as 3.3%, 0.5%, 2%, and 1.5%, respectively (Joordens et al. 2014), whilst the average fatty acids content of studied fish in the present study was 38.35% which is far higher probably due to the habitat of studied fish which was a cold freshwater river.

One of the key and important indexes to determine the fish fat nutrition value is n-6/n-3. Varieties of number have been mentioned in various researches for the favorable range of this ratio, for instance, in research by Weaver et al. (2008) in the US, the favorable ratio for n-6/n-3 for the filets was 0.07-0.16 and it was distinguished that all the studied fish had ideal ratios of n-6/n-3 (Weaver et al. 2008). Weaver et al. (2008) realized that *Tilapia* sp. filet has 20% omega 6 unsaturated long-ranged fatty acid, 5% n-3 fatty acid and the ratio of n-6/n-3 for *Tilapia* sp. which is the second most-consumed fish is more than 2 while n-6 and long-ranged unsaturated fatty acids amounts in bred Salmon and Trout in the US and Iran have been less than 10% and n-3 have been 25-30% (Ghomi et al. 2011).

In a research, Norbakhsh (2012) reported that the *Otolithes ruber* fatty acids profile, the ratio of n-6/n-3 fatty acids were reported as 0.24, this ratio compared with *Tilapia* sp. was more than 2 in Weaver et al. (2008) and Moradi et al. (2012). In a research on the carp's fatty acids profile, the ratios of n-6/n-3 in *Hypophthalmichthys molitrix*, *Hypophthal-michthys nobilis*, *Ctenopharyngodon idella*, and *Cyprinus carpio*, reported as 0.86, 0.49, 0.63 and 1.6, respectively (Jorjanee et al. 2013). In another research, Castro et al. (2005) reported oleic acid (C18:1 n-9) with 48.2% of the all fatty acids, oleic acid was the maximum fatty acid in the *Cyprinus carpio* and after that linoleic acid (C16:2 n-6) and palmitic acid (C16:0) were 16.6% and 13.9% respectively, these results are similar to the results of the present study.

In *Cyprinus carpio*, the amount of PUFA was less than MUFA. The high amount of PUFA and especially EPA and DHA are due to the type of nutrition. Emery et al. (2016) presents PUFA transition and especially EPA and DHA in the fish nutrition chain and states that generally Plankton eaters have the highest amount of PUFA and benthic carnivores which feed on invertebrates have the lowest amount of PUFA. There ore, with respect to the fact that *Cyprinus carpio*'s major food is the invertebrates at the bottom, have a low PUFA ratio to MUFA is obvious. In the sturgeon species (with a benthic eating diet), oleic acid has also the highest percent of fatty acids while anchovy (with a Plankton eating diet) has the highest fatty acid of DHA.

Conclusions

This study demonstrates that freshwater fish are good sources of n-3 fatty acids, especially EPA and DHA. Results of the present study demonstrate some freshwater fish species as suitable nutritional sources.

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