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The Lipid Quality Assessment of *Schizothorax zarudnyi* and *Schizocypris altidorsalis* by Fatty Acid Analysis

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Abstract: The proximate and fatty acid composition of two locally important freshwater fish, *Schizothorax zarudnyi* and *Schizocypris altidorsalis*, from Sistan Province in Iran were investigated for their nutritional value. The protein and lipid content in the *S. zarudnyi* were 14.67 and 6.36%, respectively. In *S. altidorsalis*, protein and lipid content were 13.03 and 4.52%. There was quantitative difference between individual fatty acids of these two fish. Totally 18 fatty acids were found. In *S. zarudnyi*, DHA was the highest among the poly-unsaturated fatty acids with 42.85%, followed by EPA with 29.62% of the total poly-unsaturated fraction. In *S. altidorsalis*, EPA was the highest among the poly-unsaturated fatty acids with 45.05%, followed by DHA with 27.87% the total poly-unsaturated fraction. The n-6/n-3 ratio was 0.26 and 0.20 for *S. zarudnyi* and *S. altidorsalis*, respectively. High n-3 fatty acids content in these fish revealed that they have high nutritional value. *Schizothorax zarudnyi* showed better nutritional value in comparison to protein and lipid content of *S. altidorsalis*.

Key words: *Schizothorax zarudnyi*, *Schizocypris altidorsalis*, freshwater fish, fatty acid composition, polyunsaturated fatty acids

INTRODUCTION

Schizothorax zarudnyi (Mahi Khajo or Shir Mahi or Sefidak) and *Schizocypris altidorsalis* (Anjak), are belonging to Cyprinidae family, That are commercially important freshwater fish and indigenous of Sistan region in Iran, which are favorite fish for Sistan residents (Abdoli, 1999).

Fish is an excellent source of high quality protein that contains sufficient amounts of most of the essential amino acids required for human (Mahmoud *et al*., 2007). Also, the content and properties of food lipids, especially seafood, are very important due to their health benefits (Bakar *et al*., 2008). The effects of fish lipid on coronary heart diseases, stroke, kidney disorders, arthritis and many other diseases are well established. These benefits are related to polyunsaturated fatty acids especially EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) (Uauy-Dagach and Valenzuela, 1996). Fish lipids are characterized by long chain polyunsaturated fatty acids with up to 6 double bonds, such as EPA and DHA (Jittrepotch *et al*., 2006; Stolyhwo *et al*., 2006) that differ from mammalian lipids. These 2 fatty acids are the precursors for the biosynthesis of eicosanoids and docosanoids with multiple health benefits (Güner *et al*., 1998).

The chemical composition and fatty acid profile vary between fish species, different sexes and ages and due to environment, food intake, migratory swimming and sexual changes in connection with spawning (Saito *et al*., 1997; Sigurgisladóttir and Pálmadóttir, 1993).

The body composition is a good indicator of the physiological condition of fish and nutrient quality of food is very important for the human consumers. As *Schizothorax zarudnyi* and *Schizocypris altidorsalis* are one of the main food resources in Sistan area and there is not any scientific report regarding to their nutritional value, this study was carried out to determine their chemical composition and fatty acid profile to compare their nutritional value with other cultural species.

MATERIALS AND METHODS

Sample preparation: Thirty whole fresh fish of *S. zarudnyi* and *S. altidorsalis*, weighing approximately 53.82 g and of 20.58 cm length and 47.10 g and 15.66 cm, respectively, were purchased from a local wet market from Zahak City. The duration of time between catching and arrival of the fish at the laboratory was less than 12 h where they were always kept in ice. Upon arrival, the whole fish were washed under running tap water, headed, gutted, cleaned and rewashed. The fish meat were

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separated from skin and bone, mixed and analyzed. The project was conducted in spring 2008. The proximate analysis and extraction of oil was done in fishery laboratory of university of Zabol and samples send to Tarbiat Moddarres University for fatty acid profile analysis.

Proximate composition: The moisture content was determined by drying the meat in an oven at 105°C until a constant weight was obtained (Mahmoud *et al*., 2007). Crude protein was calculated by converting the nitrogen content determined by Kjeldahl's method. Crude lipid was determined by ether extraction using a Soxhlet method. Ash content was determined by drying the samples in a furnace at 550°C for 18 h (Mahmoud *et al*., 2007).

Total lipid extraction for fatty acid profile determination: The procedure used for the lipid extraction was based on Kinsella *et al*. (1977) as mentioned by Bakar *et al*. (2008).

Fatty acid analysis: Lipid samples were converted to their constituent fatty acid methyl esters by the method of Metcalfe *et al*. (1966). Analysis of fatty acid methyl esters was performed on a Unicam 4600 with a bp×70 capillary colunın (30.0 m×0.25 mm i.d) and quantified by FID detector. The split ratio was 10:1. The GC conditions were as follows: injection port temperature was 300°C, flame ionization detector temperature was 350°C. Oven temperature program was set at an initial temperature of 160°C for 6 min, then raised to 180°C at 20°C min^{-1} and held for 9 min and again the temperature was raised to 190°C at 20°C min^{-1} and held for 14 min. The carrier gas was heliunı. The column flow rate was 1.9 mL min^{-1}. In the detector, heliunı gas flow was 30 mL min^{-1}. The sample size injected for each analysis was 1 μL. Samples were manually injected into the GC port. Compounds were identified in comparison to retention times of known standards.

Statistical analysis: The data were analyzed using the one way analysis of variance test (ANOVA) to compare between two kinds of fish. The significance of results was at 1%. The software used was Minitab, release 13. Triplicate measurements were made for each analysis.

RESULTS

Data on moisture, protein, fat and ash content, expressed as g/100 g edible portion, of the schizothorax and schizocypris are presented in Table 1. As it showed, the water content of Schizocypris muscle is significantly ($p<0.01$) higher than Schizothorax and instead the protein and lipid content in later one is more than Schizocypris, although the difference in protein content in not significant. The ash content is also significantly ($p<0.01$) higher in Schizothorax than Schizocypris muscle. The chemical composition results in this study are similar to that of Robards *et al*. (1999) for Pacific sand lance in different season. Comparing with carp and some other freshwater fish conducted by Puwastien *et al*. (1999) and Mahmoud *et al*. (2007) these two fish are characterized by lower protein content.

Totally 18 fatty acids were found in both fish of SFA, MUFA and PUFA groups (Table 2). Generally the fatty acid profile found in the present work agrees with the results reported by Rahman *et al*. (1995) for katla (*Catla catla*) and also Türkkan *et al*. (2008) for sea bass (*Dicentrarchus labrax*) with higher amount of MUFAs, which was followed by SFAs and then PUFAs, although they found SFAs and PUFAs in a greater percentage.

Both fish showed high content of palmitic acid (C16:0), palmitolic acid (C16:1), oleic acid (C18:1 c) (Table 2). These findings are in agreement with those obtained for some fish by Rahman *et al*. (1995) and for *Salmo trutta* by Akpinar *et al*. (2009).

Table 1: Muscle chemical composition (g/100 g) of *S. zarudnyi* and *S. altidorsalis* in Spring

Fish	Water	Protein	Lipid	Ash
	----------(g/100 g)----------			
S. zarudnyi	77.33±0.31	14.67±0.74	6.36±0.16	1.75±0.12
S. altidorsalis	80.25±0.18	13.03±0.98	4.52±0.14	1.10±0.08

Values are expressed as Mean±SD

Table 2: Fatty acid composition (g/100 g of total fatty acids) of *S. zarudnyi* and *S. altidorsalis*

Fatty acids	*S. zarudnyi*	*S. altidorsalis*
	---------(g/100 g) of total fatty acids----------	
C14:0	3.524b±0.041	3.899a±0.019
C16:0	22.714b±0.285	25.118a±0.252
C16:1	18.995a±0.094	18.508b±0.059
C17:0	1.847b±0.136	3.262a±0.021
C17:1	0.678a±0.113	0.788a±0.010
C18:0	3.429b±0.136	4.164a±0.048
C18:1 c	18.052b±0.252	21.510a±0.291
C18:1 t	3.474a±0.192	0.153b±0.033
C18:2 n-6	1.824a±0.223	0.970b±0.020
C18:3 n-3	1.223a±0.030	0.759b±0.071
C20:0	0.667a±0.042	0.650a±0.044
C20:1	1.339b±0.029	1.475a±0.033
C20:2	0.443b±0.012	1.010a±0.005
C20:4 n-6	2.567a±0.052	1.527b±0.029
C20:5 n-3	6.514b±0.108	7.098a±0.116
C23:0	0.193a±0.007	0.118b±0.013
C24:0	3.087a±0.042	2.597b±0.044
C22:6 n-3	9.425a±0.389	4.391b±0.740
∑ SFA	35.461	39.809
∑ MUFA	42.538	44.424
∑ PUFA	21.996	15.755
n-6 FA	4.391	2.497
n-3 FA	17.162	12.248
n-6/n-3	0.256	0.204

Values are expressed as Mean±SD of triplicates. Mean with the same letter(s) within a row were not significantly different at $p<0.01$ level

Palmitic acid (C16:0) was the highest among the fatty acids with 22.714 and 25.118 g/100 g for *S. zarudnyi* and *S. altidorsalis*, respectively. The myristic acid (C14:0) and stearic acid (C18:0) with 3.52 and 3.43 g/100 g were the second and third highest fatty acids by content among the saturated fatty acids in *S. zarudnyi*. In *S. altidorsalis* second and third steps were belonging to stearic and myristic acids, respectively. The content of C14:0, C16:0 and C18:0 was significantly ($p<0.01$) higher in *S. altidorsalis* than *S. zarudnyi*. The highest concentration of MUFAs is related to palmitolic acid with 19.00 and oleic acid with 18.05 g/100 g in *S. zarudnyi* and oleic acid with 21.51 and palmitolic acid with 18.51 g/100 g in *S. altidorsalis*.

In *S. zarudnyi*, DHA (C22:6 n-3) was the highest among the poly-unsaturated fatty acids (PUFA) with 42.85 g/100 g, followed by EPA (C20:5 n-3) with 29.62 g/100 g of the total poly-unsaturated fraction. Comparing with common carp mentioned by Mahmoud *et al.* (2007) and *Salmo trutta* mentioned by Akpinar *et al.* (2009), these two fish is characterized by higher content of DHA and EPA. In this fish, n-6 FAs comprise 19.963 and n-3 comprises 78.02 and totally 97.99 g/100 g of total poly-unsaturated fatty acids. In *S. altidorsalis*, EPA was the highest among the poly-unsaturated fatty acids with 45.05 g/100 g, followed by DHA with 27.87 g/100 g the total poly-unsaturated fraction. In this fish, n-6 Fas comprise 15.85 g/100 g and n-3 Fas comprise 77.74 g/100 g and totally 93.59 g/100 g of total poly-unsaturated fatty acids. These findings are in agreement with those obtained for some fish by Rahman *et al.* (1995) and Zuraini *et al.* (2006).

The n-6/n-3 ratio was 0.26 and 0.20 for *S. zarudnyi* and *S. altidorsalis* (Table 2), respectively. These findings are in agreement with those obtained by others in lean and fatty fish. Pigott and Tucker (1990) suggested that the n-6/n-3 ratio is a better index in comparing relative nutritional value of fish oil for different species. Comparing with common carp mentioned by Mahmoud *et al.* (2007) and *Salmo trutta* mentioned by Akpinar *et al.* (2009), these two fish are characterized by higher n-3 fatty acids content and very good n-6/n-3 ratio. García-Arias *et al.* (2003) have reported a four time higher content of n-3 fatty acids than n-6 for *Sardina pilchardus*. Osman *et al.* (2001) have also reported n-6/n-3 ratio for some selected Malaysian marine fish from 0.24 to 0.66. Pepping (1999) pointed out that the human body's optimal balance between omega-6 and omega-3 fatty acids is a 2:1 to 4:1 ratio. Akpinar *et al.* (2009) also found a two-three times higher content of n-3 fatty acids than n-6 for *S. trutta*. Many studies showed that the risk of heart attack and many common disorders can be significantly lowered by an increasing intake of seafood rich in EPA and DHA.

The EPA and DHA content was 15.94 g/100 g for *S. zarudnyi* and 11.49 g/100 g for *S. altidorsalis* of total fatty acids, respectively. Results indicate that the content of long-chain n-3 fatty acids, especially DHA is different in *S. zarudnyi* with higher lipid content (Table 1) and *S. altidorsalis*. *S. zarudnyi* has much higher content of DHA than *S. altidorsalis*.

DISCUSSION

As it mentioned the body composition is a good indicator of the physiological condition of fish. The results showed that the protein content (which is a nutritive indicator) in these two fish is lower than common carp and some other freshwater fish (Puwastien *et al.*, 1999; Mahmoud *et al.*, 2007). This could be related to environmental conditions specially, food intake in water resources in Sistan region. Also, migratory swimming and sexual changes in connection with spawning can cause this phenomenon in chemical composition of fish.

The palmitic acid content was in high levels in both fish which has been described as a characteristic of freshwater fish (Ackman, 1980). The polyunsaturated fatty acids content in *S. zarudnyi* is significantly higher than *S. altidorsalis*. Sigurgisladóttir and Pálmadóttir (1993) have also stated that the larger, longe-lived species, such as cod and haddock, appear to accumulate more DHA than EPA in their lipids. But fish such as capelin (shorter-living species feeding directly on or near the marine phytoplankton food base, where EPA is prevalent among the fatty acids) accumulate EPA in their depot fat and only a portion is extended to DHA.

CONCLUSION

High n-3 fatty acids content and very good n-6/n-3 ratio in these fish revealed that they have high nutritional value for human consumption. Due to high levels of PUFA, these types of fish can be used as nutritional supplement especially as a source of n-3 fatty acids. *Schizothorax zarudnyi* showed better nutritional value in comparison to protein and lipid content of *S. altidorsalis*.

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