

Fatty Acids Profile, Atherogenic (IA) and Thrombogenic (IT) Health Lipid Indices in *Leiognathusbindus* and *Upeneussulphureus*

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Abstract

In this study, the fatty acids composition and the related health lipid indices (IA, atherogenic and IT thrombogenic) of Orange fin pony fish (*Leiognathusbindus*) and sulphur goatfishes (*Upeneussulphureus*) were studied in fall and spring in Mahshahr port in south of Iran. Fatty acids were analyzed by Gas Chromatograph (FID). The fatty acid composition of *Leiognathusbindus* and *Upeneussulphureus* showed a relevant proportion (26.95% and 25.34% respectively) of poly-unsaturated fatty acids (PUFAs) with a prevalence of the n – 3 series. The IA and IT indices resulted comparable in spring and fall. The ratio of W3/W6 was different in fall and spring for both species.

Keywords: *Leiognathusbindus*; *Upeneussulphureus*; Atherogenic; Thrombogenic

Introduction

Recently great interest has been devoted to the study of the lipid composition of fish and fish products which are recognized as important sources of n-3 fatty acids. In fact a wide class of health beneficial fatty acids characterizes their nutritional value and their therapeutic effects are raising the commercial interest of this food mainly for its high content of healthy fatty acids [1,2].

The lipids of marine fish have gained attention because they are rich in fatty acids, especially docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), which are predominant. Among the essential fatty acids are important for the human health. Most fatty acids can be synthesized in the body, however a human body lacks the enzymes required to produce the two essential fatty acids EPA and DHA. These fatty acids must be taken from the diet [3].

The lipid content of fish is highly variable between and within species. Many factors appear to contribute to this variability, including food availability; catch location, fish size, and maturity stage, biological variations, sampled tissue, ration size and starvation [4].

In this study we selected two marine fish; goat fish and pony fish because they are trash fish in our trawlers and the world total catch of them is 31757 and 217506 ton respectively [5]. They were distributed in many country and those species commonly used as Surimi raw materials, their production trends and their abundance in the Southeast Asian waters were identified [6] Even though these species have less demand in fresh condition, there is considerable market for dry fish and also as fishmeal especially in poultry industry. *Upeneussulphureus* (sulphur goatfishes) is from Mullidae family in the order Perciformes [7] that distributed from Red Sea, Persian Gulf, Madagascar, Seychelles, Réunion, Pakistan, India, Sri Lanka, Andaman Sea, Indonesia, New Guinea, Fiji, New Caledonia, Philippines and southern Japan [8].

Leiognathusbindus (Orange fin pony fish) known as slip mouths or slimy are a small family, Leiognathidae, of fishes in the order Perciformes [9]. They reported in the Red Sea (Port Sudan), Persian Gulf, coasts of India and Sri Lanka, and elsewhere in the eastern Indian Ocean; eastward to the western Central Pacific [5].

Fishery, distribution, biology and population dynamics of them have been studied in detail [10-20]. Since no detailed information is

available on fatty acid profile from these species so the objective of this study was to determine fatty acid profiles goatfish and pony fish and to compare their nutritional content in fall and spring season in Mahshahr port.

Materials and Methods

Samples

Goat fish and pony fish were obtained from Fishermen at Mahshahr port randomly in spring and fall season. Number of fish was 30 from each species. The fish were caught the night before the procedure, kept in ice and transferred to the laboratory for analyses. The fishes were weighed, deheaded, eviscerated and cleaned prior to freezing. In an attempt to obtain a homogeneous sample from each species, their flesh were removed from their backbones, minced, blended and immediately extracted. The mean weights and total length of the fishes were: 78.25 g and 17 cm for goat fish and 13.25 g and 6.5 cm for pony fish.

Lipid extraction

Lipid extractions were performed on minced fish samples (25 g each) using the extraction methods and chloroform-methanol. Methylene chloride (100 µL) and 1 mL 0.5 M NaOH in methanol were added to oil extracts in a test-tube and heated in a water bath at 90°C for 10 min. The test tubes were removed from the water bath and allowed to cool before addition of 1 mL 14% BF₃ in methanol. The test tubes are heated again in a water bath for 90°C for 10 min, and cooled to room temperature. One mL distilled water and 200-500 µL hexane was added to the test tubes and then FAME was extracted by vigorous shaking for about 1 min. Following centrifugation, the top layer was transferred into a sample bottle for GC analysis [21].

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Fatty acids analysis

Fatty acid analyses were carried out using the IUPAC II.D.19 method. Fatty acids were analyzed using a HP Agilent 5890 system Gas Chromatograph equipped with SP-2330 and a flame ionization detector (FID). Separation of fatty acid methyl esters was achieved by using fused silica capillary column (30 m×0.25 mm×0.20 µm film thickness). The oven temperature was set at 120°C for 2 min then reached to 220°C with a ramp rate of 5°C/min, and then held for 15 min. The injector and detector temperatures were maintained at 155°C and 260°C, respectively. The carrier gas was helium 10 psi with a split ratio of 1/50. The air and hydrogen of pressure were 338 ml/min and 45 ml/min respectively. Results were expressed as the percentage of each fatty acid with respect to the total fatty acids [22,23].

Indexes of lipid quality

The saturated/unsaturated fatty acids (SFA/UFA) ratios were calculated including trans fatty acids in the UFA group. The atherogenicity (AI) and thrombogenicity (TI) indices were also calculated according to the following equations [24].

From the data on the fatty-acid composition, the following were calculated:

1) Index of atherogenicity (IA): indicating the relationship between the sum of the main saturated fatty acids and that of the main classes of unsaturated, the former being considered pro-atherogenic (favoring the adhesion of lipids to cells of the immunological and circulatory system), and the latter anti atherogenic (inhibiting the aggregation of plaque and diminishing the levels of esterified fatty acid, cholesterol, and phospholipids, there- by preventing the appearance of micro- and macro- coronary diseases).

$$IA = \frac{4 \times C14:0 + C16:0 + C18:0}{\sum MUFA + \sum PUFA - n6 + \sum PUFA - n3}$$

2) Index of thrombogenicity (IT): showing the tendency to form clots in the blood vessels. This is defined as the relationship between the pro-thrombogenic (saturated) and the anti-thrombogenic fatty acids (MU-FAs, PUFAs - n6 and PUFAs - n3) [1,23].

The following equation was applied:

$$IT = \frac{C14:0 + C16:0 + C18:0}{0.5MUFA + 0.5PUFA - n6 + 3PUFA - n3 + PUFA - n3 / PUFA - n6}$$

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's test. Statistical analysis was performed with SPSS. Significance was established at P<0.05.

Results

Fatty acid profile

The fatty acid composition of goatfish and pony fish are shown in Table 1. The amount and number of fatty acid were different in fall and spring for each species (Figure 1). A total of 24 fatty acids in goatfish and 26 fatty acids for pony fish were identified in this study in fall. The determination of the fatty acid compositions of goatfish and pony fish were performed by GC. The composition of saturated (SFA), monounsaturated (MUFA), polyunsaturated fatty acid (PUFA) and high unsaturated fatty acid (HUFA) of goatfish were found to be 52.4%, 23.5%, 18.9% and 15.47% in fall, while those of pony fish were found

Fatty acid	<i>Leiognathus bindus</i>		<i>Upeneus sulphureus</i>	
	fall	spring	fall	spring
(12:0)	0.1	--	0.25	-
(14:0)	5.49	5.95	2.9	2.45
(15:0)	0.47	---	0.34	-
(16:0)	29.57	33.97	27.49	39.7
(17:0)	1.04	1.36	0.92	1.76
(18:0)	10.75	10.25	16.41	11.97
(20:0)	0.15	1.78	1.97	---
(21:0)	0.43	---	0.53	---
(22:0)	0.6	1.06	---	1.8
(23:0)	0.084	---	---	---
(24:0)	1.32	---	1.59	---
(14:1)	1.57	1.08	1.36	0.89
(16:1)	9.59	13	5.27	6.97
(18:1)	12.09	18.4	15.40	24.45
(20:1)	0.71	1.11	0.83	---
(22:1)	0.080	---	0.35	---
(24:1) ω9	0.87	---	0.29	---
(18:2) ω6	0.66	0.8	1.12	0.85
(20:2) ω6	0.29	---	0.25	---
(18:3) ω3	0.36	0.61	0.29	0.33
(18:3) ω3	1.07	0.47	1.54	0.5
(20:3) ω6	0.27	---	0.23	---
(20:4) ω6	2.99	---	4.58	---
(22:5) ω3	-	1.66	1.74	0.46
EPA ω3	5.7	4.63	4.65	2.43
DHA ω3	3.35	3.78	4.5	4.33
SFA	50.004	54.37	52.4	57.68
MUFA	24.919	33.59	23.5	33.31
PUFA	17.27	11.95	18.9	8.9
HUFA	14.62	10.07	15.47	7.22

Table 1: Fatty acid profile (%) of *Leiognathus bindus* and *Upeneus sulphureus* in fall and spring.

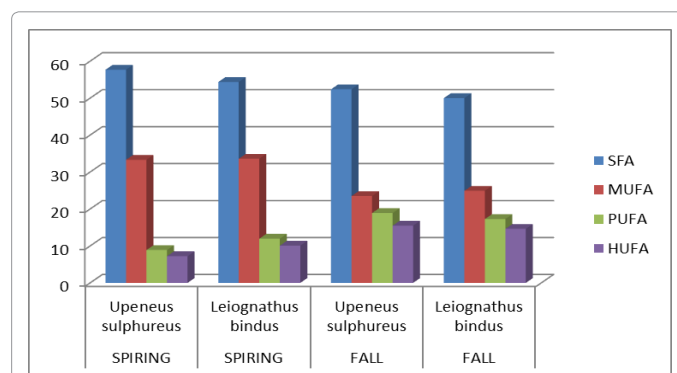


Figure 1: Fatty acid profile (%) of *Leiognathus bindus* and *Upeneus sulphureus* in fall and spring.

to be 50.004%, 24.919%, 17.27% and 14.62%, respectively. Accordingly, the SFA level in gold band goatfish and the MUFA level in striped red mullet were the highest among the other fatty acid groups. The PUFA/SFA ratios for goatfish and pony fish were 0.36 and 0.34 respectively in fall.

Lipid quality indices

Table 2 and Figure 2 show total lipids IA and IT values for *Leiognathus bindus* and *Upeneus sulphureus* fat. IT values were significantly higher in *Upeneus sulphureus* than *Leiognathus bindus* in spring. The ratio of

Species/indices	spring		fall		W3/W6	
	IT	IA	IT	IA	IT	IA
<i>Leiognathus bindus</i>	0.886	0.810	1.493	1.476	7.47	3.01
<i>Upeneus sulphureus</i>	1.154	0.852	1.445	1.308	6.54	2.02

Table 2: IA and IT indices of *Leiognathus bindus* and *Upeneus sulphureus* in fall and spring.

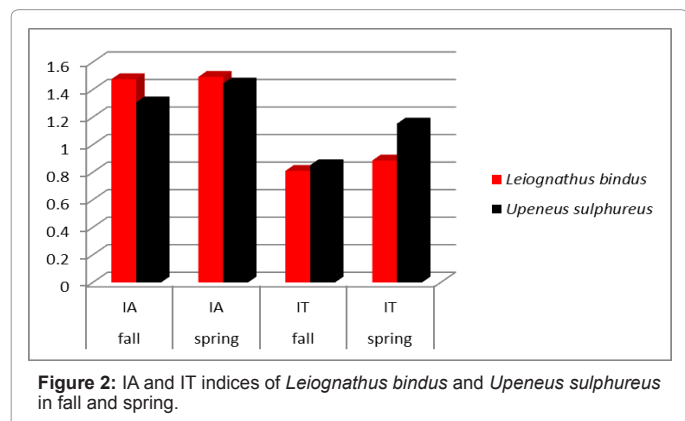


Figure 2: IA and IT indices of *Leiognathus bindus* and *Upeneus sulphureus* in fall and spring.

W3/W6 was different in fall and spring for both species. IA value for *Upeneus sulphureus* was the lowest.

IA=Index of Athero-genicity; IT=Index of Thrombogenicity

Discussion

Fish consumption is increasingly recommended by health authorities, not only for its high-quality protein content, but also for being a source of fatty acids considered highly beneficial for human health (n3 and n6). Therefore, it is not surprising that there is higher demand for fish with a growing concern for the health aspects of the diet [25].

In conclusion *Leiognathus bindus* and *Upeneussulphureus* showed a considerable amount of saturated and unsaturated fatty acids in both fall and spring. Polyunsaturated fatty acids (PUFA) are found to be one of the highest compounds found in these fishes and n-3 PUFA is studied extensively in both types of fishes. The n-3 polyunsaturated fatty acid which is primarily docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) was found in appreciable amounts and would be suitable for inclusion in the formulation of highly unsaturated low-fat diets and to help prevent diseases.

The AI and IT values obtained are higher than those reported for reared and wild sharp snout sea bream, *Diploduspuntazzo* [4].

In view of the tissue fatty acid composition, depending on the time of the year or the season, reared fish could be more suitable than wild fish for human consumption.

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