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Fatty Acid Profiles of Livers from Two Marine Fishes Inhabiting Sudanese Red Sea Coast

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Abstract

Fish livers a good source of long-chain polyunsaturated fatty acids and omega 3, are usually discarded as a waste when fish are processed for human consumption in Sudan. Highly fresh *Triaenodon obesus* and *Hipposcarus harid* fish were purchased from Port Sudan fish central market during December 2014. The fatty acid profiles of the livers of these commercially important fish were determined. The polyunsaturated and saturated fatty acids ratio in the livers oil of *T. obesus* and *H. harid* was 1:2.2 and 1:1.38, respectively. The Palmatic (16:0), Pentadecenoic (12:0) and Arachidic acids were the highest in both species. The poly chain unsaturated fatty acids Linolenic (18:3n − 3), Eicosapentaenoic (20:5n − 3) and Docosahexaenoic (22:6n − 3) were detected in the liver of both species. The highest values of above poly chain unsaturated fatty acids were detected in *T. obesus.*

Keywords

Red Sea, Shark, Parrotfish, Liver Oil, Fatty Acids

1. Introduction

The Red Sea State is a semi-desert with poor agricultural and animal resources. Fish can be used to complement amino and fatty acids needs and promote the quality of the diet [1]. Hamza *et al.* [2] [3] examined fish consumption in Port Sudan and found that 93.8% of the population used to have fish in their diets. They found that the average fish consumption/capita at the Red Sea State reached 9.6 kg/year. This is about half the world/capita consumption of 18.9 kg per year [4].

The total oil and fatty acid composition of fish varies according to several factors, such as fishing season, geographical location, size, sex, and reproductive cycle period [5]. The omega-3 is mainly present in marine algae and fish. Fish

liver oil is in general rich in omega-3 fatty acids, including Alpha-linolenic acid (18:3), Eicosapentaenoic acid (20:5) and Docosahexaenoic acid (22:6), [6]. Humans can't synthesize fatty acids but rely on the food chain or tablets. Algae and fish are the best sources of long chain polyunsaturated fatty acids (n − 3 LCPUFAS) [7]. Marine fishes contain a significant amount of LC-PUFAs, particularly DHA (docosahexaenoic acid, C22:6ώ3) and EPA (Eicosapentaenoic acid, C20:5ώ3) [8]. Marine fishes possess a high proportion of total omega 3/omega 6 fatty acids [9]. According to Guil-Guerrero *et al.* [10] (2011) liver oil of marine fish species constitutes a rich source of n − 3 LCPUFA, especially of EPA and DHA.

Polyunsaturated fatty acids (mainly the n3 and n6 PUFAs) combat cardiovascular diseases, high blood pressure, cancers, Alzheimer's disease and neurodevelopment status in infants [11] [12]; promote immunity [13] and heath due to its richness in vitamins A and D [14].

According to Randall [15], sharks and parrotfishes are among the most important commercial fish stocks in Sudanese Red Sea waters. It is known that the locals extract the oil from livers of *T. obesus* and *H. harid* by exposing them to sun. The extract is used as a traditional medication for cough and sneezing especially in infants.

The objective of this work is to study the fatty acids profile of *T. obesus* and *H. harid* to lay a base line data for a pharmaceutical industry.

2. Materials and Methods

2.1. Samples Collection

Ten highly fresh specimens of *T. obesus* and of *H. harid* were purchased from Port Sudan fish central market during December 2014 and chilled in an ice box and immediately taken to the laboratory. The total length, standard length and body weight of each specimen was recorded.

The abdomen of each fish was open, and the liver was carefully removed and weighed to 0.1 g separately using an electrical balance. Each liver was kept frozen at −30˚C until analysis.

2.2. Fatty Acid Analysis

2.2.1. Extraction of Oil

Fish whole livers were thawed at room temperature. For each liver the water extracted with the oil was removed by centrifuging following Nuria *et al.* [16]. The percentage of oil yield was calculated as:

$$\text{Oil}(\%) = \frac{\text{Weight of extracted oil} \times 100}{\text{Weight of liver}}$$

Fatty acids of each liver specimen were determined based on the method of Farhat and Shakoor [17]. Methylation of fatty acids in oils was carried out according to Cocks and Rede [18].

2.2.2. Gas Chromatography (GC)

The FAME samples of each fish species were examined by Gas Chromatography (GC-2010) using Helium as a carrier gas and SGforte BPX 30 column (30 m × 0.25 mm ID × 0.25 μm film thicknesses). The initial temperature of the column was set and held at 50˚C for 1 min. The temperature then raised at 2˚C/min to 188˚C which was held for 10 min followed by an increase at the same rate to 250˚C where it was held for 4 min and then returned to the initial temperature. The extraneous combined FAME standard used to discover and identify the peaks. Fatty acids were measured by equating their peaks with the relevant peak areas of the corresponding standard fatty acids where each fatty acid then stated as a percentage of the total fatty acids measured [17].

2.3. Statistical Analysis

SPSS programme was used to analyze the data. The results presented as the mean ± standard error of the mean.

3. Results and Discussion

The present study, the first of its kind in Sudan, tapped the fatty acid profiles of the fish liver of *T. obesus* and *H. harid*. Fish livers, which are usually discarded when fish are processed in Port Sudan fish market, were found to be a potential source of LCPUFAs. The livers constitute a substantial portion of fish waste. According to Hamza *et al.* [3] the total fish waste is about 634 kg/day.

3.1. Morphometric Measurement

The averages of total length, standard length, body weight, the liver weight of *T. obesus* were 78.18 ± 3.15 cm, 55.8 ± 2.31 cm, 2669.6 ± 831.31 g and 78.18 ± 3.15 g, respectively. In *H. harid* the corresponding values were 29.25 ± 0.57 cm, 24.10 ± 0.35 cm, 385 ± 43.22 g and 15.88 ± 2.10 g, respectively (**Table 1**). The variation in morphometric parameters of two fish species is due to family and species differences.

3.2. Fatty Acids Profiles

The oil extracted from *T. obesus* and *H. harid* liver is yellow to brown with a

Table 1. Some parameters of *Triaenodon obesus* and *Hipposcarus harid*.

Parameter	Species	
	***T. obesus* mean ± SE**	***H. harid* mean ± SE**
Total length (cm)	78.18 ± 3.15	29.25 ± 0.57
Standard length (cm)	55.8 ± 2.31	24.10 ± 0.35
Body weight (g)	2669.6 ± 831.31	385 ± 43.22
Liver weight (g)	78.18 ± 3.15	15.88 ± 2.10
Total liver oil (%)	52.95 ± 1.75	58.56 ± 5.07

strong flavour and is insoluble in water. The weight of shark varies from 5% [19] to 20% [20] the shark's body weight. This calls for tapping liver oil from sharks in the Sudanese coast

The study showed that the percentage of the fat exceeds 50% of the liver weight thus offering a potential commercial source of fats (**Table 1**). According to Guil-Guerrero *et al.*, [10] fish fats content depends on season of capture, geographical location, water temperature, size and sex of the fish and its reproductive cycle at the time of capture.

The number of saturated fatty acids (SFAs) recorded in livers of *T. obesus* and *H. harid* were 12 and 6 with mean concentration 8.89% ± 1.89% and 13.78% ± 3.93%, respectively. Unsaturated fatty acid number were 10 and 8 with a mean concentration 19.54% ± 3.67% and 18.96% ± 4.05%, respectively (**Table 2** and **Table 3**). The percentages of unsaturated fatty acids (USFAs) were higher than saturated fatty acids (SFAs) in *T. obesus* and *H. harid* livers. This is in agreement with Gunstone and Norris [21].

The value of SFAs content in oil of *H. harid* was higher than in *T. obesus*. Vice versa holds true in case of USFAs. This may reflect differences in diet and bioaccumulation of fatty acids in the food chain. This is in line with Nelson *et al.* [22] and Nichols *et al.* [23].

The liver fatty acids profile in *T. obesus* and *H. harid* showed that C15:0, C16:0 and C20:0 were the main SFAs; C15:1, C16:1 and C17:1 were the main monounsaturated fatty acids; while C22:6n − 3 (DHA), C20:5n − 3 (EPA) and C18:3n − 3 (ALA) were the main PUFAs (**Table 2** and **Table 3**).

Table 2. Saturated fatty acid profiles of liver from *Triaenodon obesus* and *Hipposcarus harid*, BDL = Beyond Detection Limit.

FAMEs	*T. obesus* (%)	*H. harid* (%)
C10:0, Capric acid	BDL	31.5
C12:0, Lauric acid	5.3	BDL
C12:0, Undecanoic acid	4.4	BDL
C13:0, Tridecanoic acid	3.7	6.6
C14:0, Myristic acid	5.8	BDL
C15:0, Pentadecenoic acid	18.7	12.5
C16:0, Palmitic acid	17.9	16.7
C17:0, Heptadecenoic acid	15.8	BDL
C 18:0, Stearic acid	11.1	5
C 20:0, Arachidic acid	7.6	10.4
C 21:0, Heneicosanoic acid	14.9	BDL
C23:0, Tricosanoic acid	0.8	BDL
C24:0, Lignoceric acid	0.7	BDL
Mean ± SE	**8.89 ± 1.89**	**13.78 ± 3.93**

Table 3. Unsaturated fatty acid profiles of liver from *Triaenodon obesus* and *Hipposcarus harid* BDL = Beyond Detection Limit.

FAMEs	*T. obesus* (%)	*H. harid* (%)
C14:1 (5), Myristoleic acid	6.8	3
C15:1 (5), Cis-10-Pentadecenoic acid	5.3	17.7
C16:1 (7), Palmitoleic acid	24.2	25.7
C17:1 (7), Cis-10-Heptadecenoic acid	5	6.4
C18:2 (6, 9), Linoleic acid	28.2	30.1
C18:3 (3, 6, 9), Alpha-Linolenic acid	35.7	36
C20:4 (6, 9, 12, 15), Arachidonic acid	15.4	BDL
C 20:5 (3, 6, 9, 12, 15), Eicosapentaenoic acid	25.3	20.5
C22:6 (3, 6, 9, 12, 15, 18), Docosahexaenoic acid	15.5	12.3
C24:1 (15), Nervonic acid	34	BDL
Mean ± SE	**19.54 ± 3.67**	**18. 96 ± 4.05**

Saturated Palmitic and Pentadecenoic acid showed high percentages in oil fraction of *T. obesus* and *H. harid* which is useful for formulations based on fish oil. Fishes from warm waters tended to show high levels of Palmitic and Stearic acids compared with those from cold waters. This is probably due to environmental metabolic differences [24]. In *T. obesus* and *H. harid* ALA recorded high value followed by EPA confirming Gunstone and Norris [21] who stated that ALA and EPA are the dominant fatty acids in oil of marine fishes. High values of LCPUFAs especially EPA and DHA except ALA were detected in *T. obesus* when compared with *H. harid* (**Table 3**). Sargent *et al.* [25] and Saito *et al.* [26] attributed such variations to the species habitat, diet and ecological conditions.

The PUFAs:SFAs ratio in livers oil of *T. obesus* and *H. harid* were 1:2.2 and 1:1.38, respectively. *Triaenodon obesus* showed the highest level of USFAs, EPA and DHAs, and the lowest level of SFAs. Such levels seem beneficial to human health [27]. According to Wetherbee and Nichols [28] the composition of the liver lipids of sharks varies according to species, season and other biological factors.

4. Conclusion

The liver of *T. obesus* and *H. harid* contain high concentrations of lipids exceeding 50% of its wet weight. The value of UFAs in the liver oil in *T. obesus* and *H. harid* were higher when compared with SFAs. *Triaenodon obesus* showed the highest level of UFAs, EPA and DHA and the lowest level of SFAs. The liver of the two species is a rich source of n − 3 LCPUFA, especially EPA and DHA and ALA. The findings call for joint research between fish biologists, chemists and pharmacists to tab the medication opportunities of marine fish livers from Sudanese Red Sea.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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