Rev. Biol. Trop. 50(1): 253-257, 2002
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Lipid composition of the fishes *Heterotis niloticus, Brycenus nurse, Gnathonemus cyprinoides* and *Sarotherodon galilaeus* from a small lake in Nigeria

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Received 08-I-2000. Corrected 18-VI-2001. Accepted 27-VII-2001.

Abstract: Lipid composition of *Heterotis niloticus*, *Brycenus nurse*, *Gnathonemus cyprinoides* and *Sarotherodon galilaeus*, which vary in scale thickness, were studied. *Heterotis niloticus* (very thick scales) had the lowest lipid content (13%), while *G. cyprinoids* (light scales) had the highest lipid content (26%). The common neutral lipids were cholestrol, free fatty acids and cholesterol esters, while diphosphatidyl glycerol, phosphatidyl glycerol and phosphatidyl ethanolamine were the most predominant phospholipids.

Key words: Pisces, scales, lipids, neutral and phospholipids.

Fish lipids vary considerably in their fatty acid composition and fish oil has a high percentage of unsaturated fatty acids. This makes fish oil more reactive than oil from most land animals and plants (Clucas and Ward 1996). Most animals and some fish are known to store fat under the skin to provide protection, thermal insulation against heat loss and to store energy when dietary requirements are not met. Some fishes store fat in the liver while others store fat in the peritoneum (Deuel 1957, Clucas and Ward 1996).

Scales are an outstanding feature of fish skin. They vary in types and shapes. Structurally there are two types of fish scales, placoid and non-placoid. Bony-rigde scales are typically thin, translucent and non-placoid, lacking both dense enameloid and dentinal layers. Scales are either cycloid or ctenoid and they characterize living species of bony fishes (Osteichthyes) (Lagler *et al.* 1977).

The main features which affect the quantity and quality of the fish oil are fish species, food, spawning cycle, water and temperature (Deuel 1961, Huss 1988, Clucas and Ward 1996). Lipids provide a concentrated energy source. In bonefish *Albula* sp. larvae, lipid catabolism accounted for about 80% of the total energy production during metamorphosis (Padron *et al.* 1996). Murray and Burt (1969) showed differences in the lipid composition of marine fishes; in the blue whiting (*Micromesistus poutassou)* the lipid content was 1% to 3.8%, in the cod (*Gadus morhua)* the lipid content ranged from 0.1 to 0.9%, in the salmo (*Salmo trutta)* the lipid content was 1.2 to 10.8% and in the white herring (*Clupea harengus*) the lipid content ranged from 0.4 to 22%. *Clarias gariepinus* adults had a lipid content of 1.32%, while fingerlings had a lipid content of 1.04% (Ayinla 1993). Omotosho and Olu (1995) showed that lipid content decreased with frozen storage in *Tilapia zilli*, *Clarias lazera, Channa obscura* and *Synodontis schall*. Soriguer *et al.* (1996) classified fish into low fat and fatty, and stated that the classification depended on the time of the year the fish was caught; for example, the horse-mackerel

Scomber scombrus in spring had the same fat content as the sole *Soles vulgaris* which is generally considered as a low fat fish.

Heterotis niloticus, *Brycenus nurse*, *Gnathonemus cyprinoides* and *Sarotherodon galilaeus* are commercially important to freshwater fisheries in Nigeria, and they constitute a major part of the landing and sources of animal protein. There is paucity of knowledge on the lipid composition of these freshwater fishes. This work aims at elucidating the lipid composition in these fishes and the relationship between scales and lipid composition in these fish species.

MATERIALS AND METHODS

Fish used in this study were collected from a small man-made lake in Ilorin Nigeria using gill nets. They were selected based on the external morphology. They are categorized into thick, moderately thick and light scales (Table 1).

TABLE 1
Classification and types of scales of fish species

Order	Family	Fish species	Nature of scale
Osteoglossiformes	Osteoglossidae	*H. niloticus*	Thick
Cyprinformes	Characidae	*B. nurse*	Moderate
Perciformes	Cichlidae	*S. galilaeus*	Moderate
Mormyriformes	Mormyridae	*G. cyprinoides*	Light

Two size groups were used: juvenile and adult based on standard body length. Standard laboratory measurements were taken: total weight, total length, standard length. The fish were dried in the oven at 60ºC to a constant weight. The total lipid was determined using the soxhlet extraction method of A.O.A.C. (Anonymous 1980). The composition of the lipid was determined using thin layer chromatography (TLC) according to Wilson and Walker (1996). Neutral lipids were separated using petroleum ether, diethyl ether, and acetic acid, in a proportion 80/20 v/v/v. The phospholipids were resolved with the solvent system chloroform, methanol and water, in a proportion of 62/25/4 v/v/v.

RESULTS

The various size groups of the fishes studied are shown in Table 2. There was variation in the lipid content of *B. nurse, H. niloticus, G. cyprinodes* and *S. galilaeus* as indicated in Table 3. The lowest percentages of lipids were obtained in both juvenile and adult *H. niloticus*, which had very thick scales, while the highest lipid content was obtained in *G. cyprinoides* with light scales, and it was closely followed by *B. nurse* and *S. galilaeus* with moderate scales.

The neutral lipid composition showed that free fatty acids and cholestrol were more abundant (Table 4). Cholesterol and free fatty acids were more abundant in the neutral lipids in both juveniles and adults while the phospholipids were more abundant in adults than in juveniles. The phospholipid composition is shown in Table 5. Diphosphatidyl glycerol was the most abundant, followed by phosphatidyl glycerol and phosphatidyl ethanolamine which were mostly observed in juveniles. Phosphatidyl choline was detected only in *H. niloticus*.

DISCUSSION

Deuel (1961, Clucas and Ward 1996) showed that factors such as nutrition and fish species tend to affect the oil content of the fish. Deuel (1961) suggested that fat depot was entirely composed of neutral lipids, while phospholipids were more abundant in organs than in muscle. In the present work only the

TABLE 2

Range, mean of standard length and weight of fish species

Fish species	Size group	No. of specimens	Range and mean of standard length (cm)	Range and mean of total weight (g)
B. nurse	Juvenile	5	12.3 – 13.5	38.3 – 47.9
			13.0 ± 0.5	43.0 ± 4.4
	Adult	3	15.0 – 19.0	71.8 – 156.4
			16.5 ± 2.2	99.6 ± 48.8
G. cyprinoids	Juvenile	5	12.5 – 17.0	25.1 – 55.3
			14.6 ± 1.8	36.6 ± 12.9
	Adult	2	26.6 – 27.1	236.0 – 273.0
			26.8 ± 0.4	253.5 ± 26.1
H. niloticus	Juvenile	2	27.0 – 27.4	270.8 – 276.5
			27.2 ± 0.2	273.2 ± 4.5
	Adult	1	53.0	1626.0
S. galilaeus	Juvenile	3	11.1 – 13.5	43.7 – 95.8
			12.4 ± 1.2	73.3 ± 22.6
	Adult	2	17.0 – 18.6	220.5 – 302.8
			17.8 ± 1.1	261.0 ± 52.7

TABLE 3

Lipid content of Heterotis niloticus, Brycenus nurse, Sarotherodon galilaeus *and* Gnathonemus cypinoides

Fish species	Size group	Range	Percentage mean	Lipid (w/w) S.D.
H.niloticus	Juvenile	2.74 – 3.48	3.11	0.52
	Adult	13.4 – 13.6	13.48	0.32
B. nurse	Juvenile	18.94 – 1948	19.21	0.38
	Adult	19.74 – 23.4	21.56	2.60
S. galilaeus	Juvenile	13.96 – 15.7	14.83	1.23
	Adult	18.20 – 20.10	19.15	1.34
G. cyprinoides	Juvenile	10.54 – 11.42	10.98	0.62
	Adult	25.52 – 26.48	26.00	0.68

TABLE 4

Neutral lipid composition of Heterotis niloticus, Brycenus nurse, Sarotherodon galilaeus *and* Gnathonemus cyprinoides

Fish species	Size groups	Monocyglycerol	Diacyglecerol	Cholesterol	Free fatty acid	Triacyglycerol	Cholesterol ester
H. niloticus	Juvenile		*	*	*		*
	Adult			*	*	*	*
B. nurse	Juvenile			*	*	*	*
	Adult				*	*	*
S. galilaeus	Juvenile			*	*	*	*
	Adult			*	*		*
G. cyprinoides	Juvenile			*	*	*	
	Adult			*	*	*	*

***** Present in the fish.

TABLE 5

Phospholipid composition of Heterotis niliticus, Brycenus nurse, Sarotherodon galilaeus *and* Gnathonemus cyprinoides

Fish species	Size groups	Phosphatidyl serine	Phosphatidyl inositol	Sphingomyelin	Phosphatidyl choline	Phosphatidyl ethanolamine	Phosphatidyl glycerol	Phosphatidic acid	Diphosphatidyl glycerol
H. niloticus	Juvenile			*	*	*	*		*
	Adult								*
B. nurse	Juvenile		*			*		*	*
	Adult						*	*	*
S. galilaeus	Juvenile					*			*
	Adult						*		*
G. cyprinoides	Juvenile								*
	Adult						*		*

* Present in the fish.

muscle were examined. Padron *et al*. (1996) demonstrated in *Albula* sp. that neutral lipid constituted about 64.2%, while polar lipid constituted 35.8%. They further showed that triacyglycerol, the principal neutral lipid of all metamorphic stages, accounted for about half the decrease of the total lipid; in the present study, triacyglycerol was present in the juvenile of almost all the fishes except *H. niloticus*.

Padron *et al*. (1996) demonstrated that in *Albula* sp. the level of phosphatidyl ethanolamine in early larvae decreased by more than 50% during metamorphosis. Phosphatidylcholine increased in adult of *Albula* sp. The lipid composition of the fish species in this study showed much variation which can be attributed to physiological changes in the body of the fish and other factors in the environment.

RESUMEN

Se estudió la composición de lípidos de *Heterotis niloticus*, *Brycenus nurse*, *Gnathonemus cyprinoides* y *Sarotherodon galilaeus*, los cuales varían en el grosor de las escamas. *Heterotis niloticus* (escamas muy gruesas) tuvo el contenido de lípidos más bajo (13%), mientras que *G. cyprinoides* tuvo el más alto (26%). Los lípidos neutrales comunes fueron el colesterol, los ácidos grasos libres y los ésteres del colesterol, mientras que el difosfatidil glicerol, el fosfatidil glicerol y la fosfatidil etanolamina fueron los fosfolípidos más predominantes.

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