

## Proximate composition and fatty acids profile of the African Catfish *Clarias gariepinus*

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### Abstract

The proximate composition and fatty acids profile of the African catfish, *Clarias gariepinus*, from Lekki Lagoon fishing grounds in Lagos, south-western coast Nigeria, were investigated with a view to provide nutritional data for dietary planning. Mean values for the proximate composition (wet basis) were: protein 19.64%, lipid 1.15%, moisture 76.71% and ash 1.23%. There were no seasonal changes ( $P>0.05$ ) in the mean monthly proximate composition of the fish over two-year period. A total of twenty-seven different fatty acids were obtained in the muscle. The fish belonged to high-protein low-oil category. Palmitic and oleic acids were the main saturated and monounsaturated fatty acids respectively. The principal acids in the polyunsaturated group were linoleic, eicosapentaenoic and docosahexaenoic acids. *C. gariepinus* thus constitutes a source of high protein and polyunsaturated fatty acids, as well as an ideal dietetic fish food.

**Keywords:** African catfish, proximate composition, protein, fatty acids, polyunsaturated fatty acids, Lagos Lekki Lagoon

### Introduction

The relationship between pathogens and food intake has been elucidated by investigations into proximate composition and fatty acid contents of food items (Luzai *et al.*, 2003). The fatty acid content of a diet modulates the fatty acid profile of immune cells. This may be an effective way to regulate the functionality of normal cells through nutrition. Fuentes (1998) indicated that diets in which unsaturated fatty acids replace the saturated ones are associated with low incidence of coronary diseases. In order to reduce the risk of cardiovascular diseases, emphasis has now been placed on the increased consumption of fish and fish products, which are rich in polyunsaturated fatty acids (PUFA) of the omega ( $\omega$ ) -3 family, and poor in polyunsaturated fatty acids of  $\omega$ -6 family (Sargent, 1996).

Various studies have been carried out on the proximate chemical composition (Exler 1987, Chandrashekar & Deosthale, 1993, Eun *et al.*, 1994,) and fatty acids profiles of different fish species (Wanasundara & Shahidi, 1998; Uauy & Valenzuela, 2000). There is, however, dearth of accurate basic chemical composition data for fish species particularly from African and Asian sources (Schonfeldt, 2002). This

constitutes a barrier to development of the use of the resources. In Nigeria, our present knowledge of the chemical proximate composition of fish species from Nigerian water is very limited.

The African catfish, *Clarias gariepinus*, is easily cultured in Nigeria and of great economic interest. It is generally considered to be one of the most important tropical catfish species for aquaculture. It has an almost Pan African distribution, ranging from the Nile to West Africa and from Algeria to South Africa. This study was carried out for a period of 28 months to determine the proximate composition and fatty acid contents of *Clarias gariepinus* with a view to providing nutritional data for dietary planning.

### Materials and methods

#### Collection and preservation of specimens

Fresh catfish, *Clarias gariepinus* were purchased at a fish market in Epe, Lagos from fishermen from the Lekki Lagoon fishing grounds, Lagos, Nigeria. They were transported live to the Nigerian Institute for Oceanography and Marine Research laboratory, Victoria Island and sacrificed. Samples were collected on monthly basis for a period of 28 months (September 1997-December 1999). The samples were

packed in separate polyethylene bags, labelled and stored in the cold room at  $-20^{\circ}\text{C}$  pending laboratory analysis.

#### **Analyses**

Fish sample was gutted, washed, filleted, finely minced and homogenized for chemical analyses. Triplicate determinations were carried out on each chemical analysis.

#### **Protein determination**

The total nitrogen (crude protein) was determined by the Kjeldahl method (Vlieg, 1984). A known weight (0.5g) of prepared fish sample was weighed on a nitrogen-free paper. The paper was wrapped round the sample and dropped at the bottom of the Kjeldahl digestion flask together with 6-8 glass beads, 4-5 spatula full of granular mixture of  $\text{CuSO}_4$  and  $\text{K}_2\text{SO}_4$  as catalyst. 20ml of concentrated  $\text{H}_2\text{SO}_4$  was added carefully. The flask was gently heated on a Gerhardt heating mantle in an inclined position in a fume cupboard until full digestion (when the liquid changed from brown colour to colourless). The contents of the flask were transferred to a clean 100ml volumetric flask and made up to volume. 25ml aliquot was used for distillation. The total nitrogen was determined colorimetrically.

#### **Lipid determination**

Lipid determination was carried out using the modified Bligh and Dyer procedure (AOAC, 1994). Methanol and chloroform were used as solvents at ratio 1:1.

#### **Moisture determination**

The moisture content of each fish sample was estimated using the oven dry method (AOAC, 1994). 5g of the homogeneous mixture was placed in weighed crucibles maintained at  $100^{\circ}\text{C}$  in an oven until constant weights. The samples were transferred to a dessicator to cool to ambient temperature and reweighed. The difference in weights (weight-loss) indicates the moisture content.

#### **Ash determination**

Ash content of fish samples was determined by incineration in a carbolite Sheffield LMF3 muffle furnace at  $500^{\circ}\text{C}$  (AOAC, 1994). The difference in weight of the fish samples before and after heating was taken as the ash content.

#### **Fatty acids Determination**

The fatty acids were converted to their methyl esters and heptane. Internal standards were employed for

estimation of actual fatty acids in the fat. Identification and quantification of fatty acids was carried out by gas chromatography (AOAC 1994).

#### **Statistical Analysis**

Analysis of variance (ANOVA) was used to compare means of the proximate composition and fatty acid data. Further analysis was carried out where there was significant difference ( $P < 0.05$ ) (Sokal & Rohlf, 1987).

## **Results**

### **Proximate composition**

The results of the mean monthly proximate composition of *C. gariepinus* are presented in Table 1 & Fig. 1. The species had mean protein content of 19.64%, lipid 1.15%, moisture 76.71% and ash 1.23%. Protein content ranged from 18.34 to 20.32%, lipid from 0.71 to 1.84%, moisture 65.64 to 80.17% and the ash content from 1.00 to 2.92%. The sum of moisture and lipid varied from 66.91 to 81.41%. The range, mean and standard deviation of the proximate composition are summarized in Table 2.

There were no significant differences ( $P < 0.05$ ) in the mean monthly proximate composition contents of *C. gariepinus*.

### **Fatty acids composition**

The profiles and percentage composition of 27 different fatty acids in *C. gariepinus* are contained in Table 3. The sequence of the fatty acids are ordered according to their chromatographic retention times and the values are given as weight percentages of the total acid methyl esters. Palmitic acid (C16:0) and oleic acid (C18:1) were the main saturated and monounsaturated fatty acids respectively. Docosahexaenoic acid (DHA) was the dominant polyunsaturated fatty acid. The percentages of eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids were 1.0% and 3.0% respectively. The mean saturated, monounsaturated and polyunsaturated fatty acids of the lipid extract were 3.59g/100g, 3.14g/100g and 2.15g/100g respectively (Fig. 2).

## **Discussion**

The fish species examined belonged to high-protein (15-20%) low-oil (<5%) category. They contained lower calorie content per unit of protein than do fatty fish, meats or poultry, and were an ideal source of animal protein for use in controlling diets. The concentration of the protein content were within the range previously reported in *Tilapia zillii* (Zelibe, 1989) and freshwater fish from both temperate

(Henderson and Tocher, 1987) and tropical regions (Andrade *et al.*, 1995). Fishes with lipid content below 5% are considered lean (Stansby, 1982 & Ackman, 1989) and hence *Clarias gariepinus*. The lipid content also falls within the range previously detected in fish (Mendez *et al.*, 1996). The low concentrations of lipid in the muscles of this species could be due to poor storage mechanism and the use of fat reserves during spawning activities. Although slight mean monthly variations were observed for the dry and rainy seasons, protein levels were not statistically different in the fish. The high tissue protein content may result from the equally high protein content of their diets (fish items, crustaceans, molluscs, algae and diatoms).

Moisture content was within previously reported range in other fishes (Gallagher *et al.*, 1991). Usually, moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80% (FAO, 1999). This inverse relationship was not well defined in the present study because the species is a non-fatty fish.

The observed range of ash content indicated that the species is a good source of minerals such as calcium, potassium, zinc, iron and magnesium.

Fatty acid profiles showed that palmitic acid (C16:0) was the predominant saturated fatty acid in the *C. gariepinus*. Ackman (1988) observed that palmitic acid (C16:0) was a key metabolite in fish which level was not influenced by diet. Palmitic acid level (70% of saturated fatty methyl esters-FAME) observed in this study was higher than that reported for the Atlantic herring (Ackman, 1988). Oleic acid (C18:1), the major monounsaturated fatty acid in this species, was considered to be of exogenous origin and usually a reflection of the type of fish diet (Ackman, 1980). The principal acids in the polyunsaturated group were linoleic (C18:2), eicosapentaenoic (C20: 5, EPA) and docosahexaenoic (C22:6, DHA). The concentrations of DHA and EPA were similar to those of other marine fishes (Nair & Gopakumar, 1978). Similar studies on tropical (Clement & Lovell, 1994) and temperate (Ahlgen *et al.*, 1994) freshwater fishes indicated the dominance of these fatty acids in the tissue lipids of fish. In general, the fatty acid composition of the fish was similar to available data on other fish species (Ackman, 1980).

*C. gariepinus* is thus, a good source of high-protein low-lipid contents as well as *omega-3* polyunsaturated fatty acids, particularly EPA and DHA. The recommended daily intake of EPA and DHA is 1g/day (Barlow *et al.*, 1990). Reasonable amounts of the studied species fillets are needed to provide this dose. Sargent (1996) noted that n-3

polyunsaturated (PUFA), principally DHA, has a role in maintaining the structure and functional integrity

Table 1: Monthly mean proximate composition (%) of *C. gariepinus*

Period	Average Proximate Composition (%)				
	Protein	Lipid	Moisture	Ash	M+L
Sep-97	19.54	1.30	69.32	1.22	70.60
Oct	18.88	1.31	65.64	1.00	66.91
Nov	20.00	1.11	74.08	1.91	75.21
Dec-97	19.08	1.44	78.50	2.92	79.94
Jan-98	20.25	1.84	74.81	1.26	76.64
Feb	18.34	1.40	76.87	1.13	78.30
Mar	20.32	1.21	80.17	1.23	81.41
Apr	20.42	0.90	79.43	1.23	80.30
May	20.07	0.95	77.33	1.10	78.25
Jun	19.09	1.24	75.86	1.33	77.14
Jul	20.75	1.80	74.04	1.17	75.80
Aug	19.48	0.98	73.46	1.12	74.48
Sep	19.31	1.02	77.35	1.10	78.42
Oct	18.97	1.02	79.63	1.07	80.62
Nov	19.17	1.00	77.19	1.02	78.20
Dec-98	19.22	1.03	77.75	1.04	78.83
Jan-99	18.91	1.01	78.58	1.03	79.61
Feb	18.95	0.98	78.65	1.06	79.68
Mar	18.50	1.07	76.92	1.30	77.97
Apr	18.66	1.01	77.38	1.16	78.41
May	19.73	1.28	78.67	1.10	79.98
Jun	19.68	1.13	79.05	1.10	80.23
Jul	20.34	0.71	79.78	1.13	80.51
Aug	18.80	1.03	78.48	1.17	79.53
Sep	19.06	1.03	77.73	1.09	78.73
Oct	19.99	1.14	77.42	1.18	78.54
Nov	18.96	1.17	76.94	1.18	78.07
Dec-99	19.45	1.15	76.75	1.14	77.95

M+L: Sum of Moisture and Lipid

of fish cells. In addition, DHA has a specific and important role in neural (brain and eyes) cell

membranes. Moreover, DHA is considered a desirable property in fish for human nutrition and health.

The variation in the monthly mean proximate composition, in particular lipid (Sali, 1998; Zenebe *et al.* 1998), among individuals of the same species is a common phenomenon in fish. However, the differences were non-significant. These variations were attributed to factors such as the geographical area in which the fish was caught, age, sex and size.

*Clarias gariepinus* is an ideal dietetic food and its consumption would help prevent nutritional deficiencies.

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Table 2: Range proximate composition of *C. gariepinus*

	Protein	Lipid	Moisture	Ash	M+L
Min.	18.34	0.71	65.64	1.00	66.91
Mean±SD	19.64	1.15	76.71	1.23	77.87
	±1.42	±0.24	±3.12	±0.36	±2.02
Max	20.32	1.84	80.17	2.92	81.41

Fig. 1. Variation of proximate composition of *C. gariepinus* from Lagos state waters

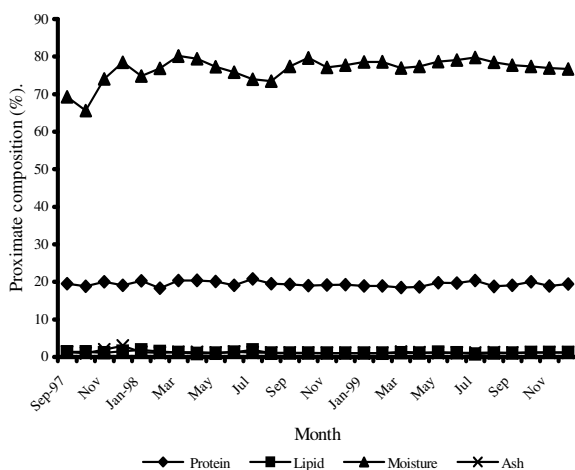
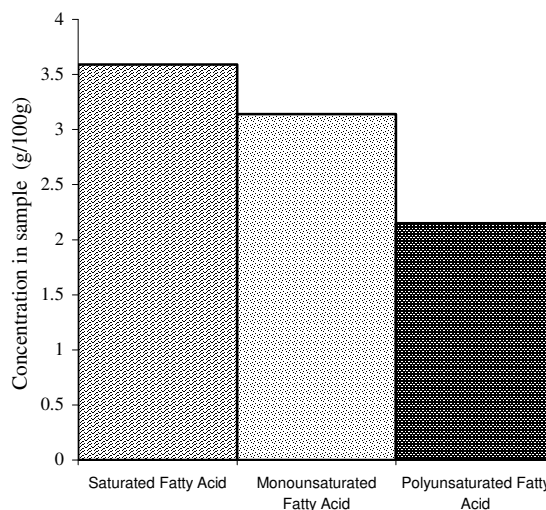


Table 3: Fatty acid composition (%) of *Clarias gariepinus*

No. of C atoms	Fatty Acids	% Composition
C8:0	Caprylic acid	-
C10:0	Capric acid	-
C12:0	Lauric acid	3.1
C14:0	Myristic acid	4.2
C14:1	Myristoleic acid	0.2
C15:0	Pentadecanoic acid	0.3
C16:0	Palmitic acid	22.0
C16:1	Palmitoleic acid	3.6
C17:0	Heptadecanoic acid	0.7
C17:1	Heptadecenoic acid	0.2
C18:0	Stearic acid	8.1
C18:1	Oleic acid	26.0
C18:2	Linoleic acid	12.3
C18:3	Linolenic acid (omega3)	1.0
C18:3	Linolenic acid (omega6)	0.6
C18:4	Octadecatetraenoic acid	1.6
C20:0	Arachidic acid	0.2
C20:1	Gadoleic acid	2.5
C20:2	Eicosadienoic acid	0.6
C20:3	Eicosatrienoic acid (omega3)	0.1
C20:3	Eicosatrienoic acid (omega 6)	0.6
C20:4	Arachidonic acid (omega 3)	0.3
C20:4	Arachidonic acid (omega 6)	0.6
C20:5	Eicosapentaenoic acid	1.0
C22:0	Behenic acid	0.1
C22:1	Cetoleic acid	1.3
C22:4	Docosatetraenoic acid	0.6
C22:5	Clupanodonic acid	1.0
C22:6	Docosahexaenoic acid	3.0
C24:0	Lingnoceric acid	-

Fig. 2. Saturated, Monosaturated and Polyunsaturated fatty acids of *Clarias gariepinus*



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