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**Research**

# 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 (*w) -3* family, and poor in polyunsaturated fatty acids of *w*-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.

## Material 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$^0$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 $CuSO_4$ and $K_2SO_4$ as catalyst. 20ml of concentrated $H_2SO_4$ 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$^0$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$^0$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 lo-

*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

wer 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, 19-

*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*

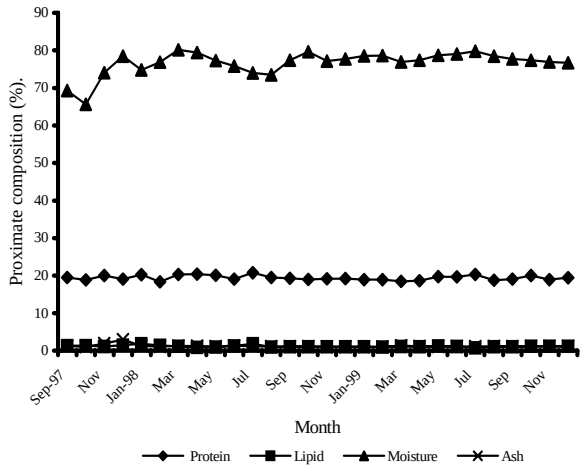
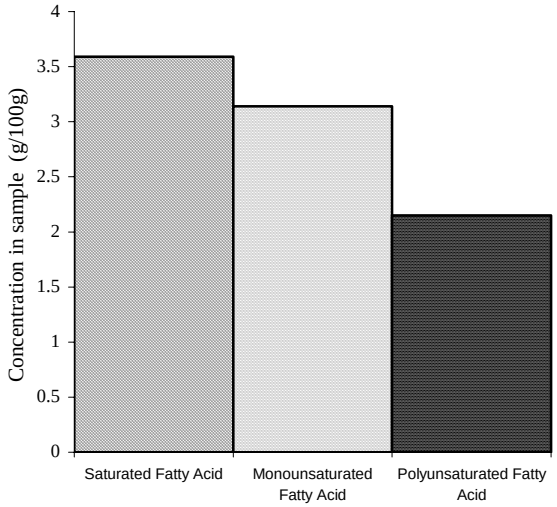



*Table 3: Fatty acid composition (%) of Clarias gariepinus*

| 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*




89) 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 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 particularly lipid (Ssali, 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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## References

Ackman, R. G. 1980. Fish Lipids, part 1. In: J. J. Connell, ed. *Advances in Fish Sciences and Technology*. pp. 86-103. Fishing News Books Ltd. Farnham, Surrey.

Ackman, R. G. 1988. Concerns for utilization of marine lipids and oils. *Food Technology* **42**: 151-155.

Ackman, R. G. 1989. Nutritional composition of fats in seafoods. *Prog. Food Nutr Sci.* **13**: 161-241

Ahlgren, G., Blomquist, P., Boberg, M. & Gustafsson, I-B. 1994. Fatty acid content of the dorsal muscle - an indicator of fat quality in fresh water fish. *Journal*

*of Fish Biology* **45**: 131-157.

Andrade, A. D., Rubira, A. F., Matsushita, M. & Souza, N. E. 1995. n-3 fatty acids in freshwater fish from South Brazil. *Journal of the American Oil Chemists' Society* **72**: 1207-1210.

Association of Official Analytical Chemists, 1994. *Official Methods of Analysis of the Association of Official Analytical Chemists*, Vols. I & II, Association of Analytical Chemists, Arlington. 1298pp.

Barlow, S. M., Young, F. V. K., & Duthie, I. F. 1990. Nutritional recommendations for n-3 polyunsaturated fatty acids and the challenge to the food industry. *Proceedings of the Nutrition Society* **49**: 13-21.

Chandrashekar, K. & Deosthale, Y. G. 1993. Proximate composition, amino acid, mineral, and trace element content of the edible muscle of 20 Indian fish species. *Journal of Food Composition and Analysis* **6** (2): 195-200.

Clement, S. & Lovell, R. T. 1994. Comparison of processing yield and nutrient composition of Nile tilapia (*Oreochromis niloticus*) and catfish (*Ictalurus punctatus*). *Aquaculture* **119**: 299-310.

Eun, J. B., Chung, H. J. & Hearnsberger, J. O. 1994. Chemical composition and microflora of channel catfish (*Ictalurus punctatus*) roe and swim bladder. *Journal of Agricultural and Food Chemistry* **42** (3): 714-717.

Exler, J. 1987. Composition of foods: Finfish and shellfish products. US Department of Agriculture, Agriculture handbook. Pp 9-15.

Food and Agriculture Organisation 1999. World production of fish, crustaceans and mollusks by major fishing areas. Fisheries Information Data and Statistics Unit (FIDI), Fisheries Department, FAO Rome. 33pp.

Fuentes, J. A. G. 1998. Que alimentos convem ao coracao ? *Hig. Aliment.* **12**(53): 7-11.

Gallagher, M. L., Harrell, M. L & Rulifson, R. A. 1991. Variation in Lipid and Fatty Acid Contents of Atlantic Croakers, Striped Mullet, and Summer flounder. *Transactions of the American Fisheries Society* **120**: 614-619.

Henderson, R. J. & Tocher, D. R. 1987. The lipid composition and biochemistry of freshwater fish. *Progress in Lipid Research* **26**: 281-347.

Luzia, L. A., Sampaio, G. R., Castellucci, C. M. N. & Torres, E. A. F. S. 2003. The influence of season on the lipid profiles of five commercially important species of Brazilian fish. *Food Chemistry* **83**: 93-97.

Mendez, E., Gonzalez, R. M., Inocente, G., Giudice, H. & Grompone, M. A. 1996. Lipid content and fatty acid composition of fillets of six fishes from the Rio de la Plata. *Journal of Food Composition and Analysis* **9**(2): 163-170.

Nair, P. G. V. & Gopakumar, K. 1978. Fatty acid compositions of 15 species of fish from tropical waters. *Journal of Food Science* **43**: 1162.

Sargent, J. R. 1996. Origins and functions of egg lipid. In: N. R. Bromage & R. J. Roberts (eds.), *Broodstock management and egg and larval quality* pp. 353-372. Oxford: Blackwell.

Schonfeldt, H. C. 2002. Food composition program of AFRO FOODS. *Journal of Food Composition and Analysis* **15**: 473-479.

Sokal, R. R. & Rohlf, F. J. 1987. Introduction to biostatistics. W.H. Freeman and Company, New York. 363 pp.

Ssali, W. M. 1988. Chemical composition data for nile perch (*Lates niloticus)* and its application to the utilization of the species. FAO Fisheries Report 400, supplement, pp 17-23 In: Proceedings of the FAO Expert Consultation on fish Technology in Africa

Stansby, M. E. 1982. Properties of fish oils and their application to handling of fish and to nutritional and industrial use. In: Martin, R. E., Flick G. J., Hebard, C. E., & Ward, D. R. Eds *Chemistry and Biochemistry of Marine Food Products*. pp. 75 – 92. Avi Publishing Co., Westport, CT.

Uauy, R., & Valenzuela, A. 2000. Marine oils: the health benefits of n-3 fatty acids. *Nutrition* **6**(7/8): 680-684.

Vlieg, P. 1984. Proximate composition of New Zealand slender tuna Allothunnus fallai. *New Zealand Journal of Science* **27**(4): 427-433.

Wanasundara, U. N. & Shahidi, F. 1998. Lipase-assisted concentration of n-3 polyunsaturated fatty acids in acylglycerols from marine oils. *Journal of the American Oil Chemist's Society* **75**(8): 945-951.

Zelibe, S. A. A. 1989. Body composition of a population of Tilapia zillii (Gervais): Distribution of chemical components. *Bioscience Research Communications* **1**(1): 55-60.

Zenebe, J., Ahlgren, G. & Boberg, M. 1998. Fatty acid content of some freshwater fish of commercial importance from tropical lakes in the Ethopian Rift Valley. *Journal of Fish Biology* **53**: 987-1005.