



EFFECTS OF DIFFERENT PRESERVATION METHODS ON THE NUTRITIONAL QUALITY OF *Clarias gariepinus* FROM CALABAR RIVER, SOUTH EAST NIGERIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Author JAP wrote the first draft of the manuscript designed the study and performed the statistical analysis. Author AAB managed the literature searches. Author EVO managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to determine the effect of different preservation methods on the nutritional quality and shelf life of the African Catfish *Clarias gariepinus* from the Calabar River, Nigeria. A total of forty five (45) samples of *C. gariepinus* were collected between April and June, 2015 from Nsidung beach, Calabar River, Nigeria. Fish samples were washed severally with dechlorinated tap water, then with distilled water before subjecting them to different preservation methods including frying, smoking, boiling and freezing. The fried, smoked, boiled, frozen and fresh samples were subjected to proximate analysis for moisture, ash, protein, fat, fibre and carbohydrate content following standard methods. Results showed that the highest moisture content was observed in the boiled sample (91.40%), while the lowest moisture content was observed in the fried fish sample (13.96%). The highest ash content was observed in the smoked fish (8.85%), while the lowest ash content was observed in the fried fish (5.64%). The highest protein content was observed in the fresh fish (39.32%), while the lowest was observed in the fried fish (11.30%). The highest fat content was observed in the fried fish (18.39%), while the lowest was observed in the smoked fish (5.18%). The highest fibre content was observed in fried fish (0.69%), while the lowest was observed in smoked fish (0.19). The highest carbohydrate content was observed in the smoked fish (48.80%), while the fresh fish had the least (39.47%). There were significant difference in nutrients contents for the fresh, frozen, boiled, smoked and fried fish samples at $P < 0.05$. It was therefore concluded that frying was the best means of preservation, but nutritionally reduced the moisture, ash and protein below the FAO acceptable limit. Frying increased the fat and fibre content above the acceptable limit.

Keywords: Preservation methods; frying; smoking; boiling; freezing; nutritional quality; *Clarias gariepinus*, Calabar River.

1. INTRODUCTION

In developing countries, fish is one of the potential sources of animal protein and essential nutrients for

the maintenance of a healthy body [1]. Compared to other sources of protein, fish are well known to be excellent sources of protein which can be seen from its amino acid composition and protein digestibility

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[2]. Fish has lower cholesterol content when compared with meat [3] and thus often recommended for consumption especially among the adult population. Fish and shell fish contain about 19% protein which is similar in amino acid composition of muscle meats. The content varies from 1 to 20% depending upon the species and the season of the year. This gives a substantially lower fat content than beef [4]. According to [5], fish is rich in n-3 polyunsaturated fatty acids (n-3 PUFAs) such as docosahexaenoic acid (DHA; C22:6n-3) and eicosapentaenoic acid (EPA; C20:5n-3). These fatty acids have been reported to be beneficial in controlling of diseases such as cancer [6], coronary heart disease [7], inflammatory disease [8]. According to [9], they also enhance mental health by supporting the development and function of the brain.

In Nigeria, acceptability and consumption of fish protein is increasing due to its degree of affordability [10]. The major constituents of fish are moisture, protein and fat with minerals occurring in trace amount [11]. The knowledge of fish composition is essential for its maximum utilization. The nutritional composition of fish varies greatly from one species and individual to another, depending on age, feed intake, sex and sexual changes connected with spawning, environment and season [12]. Spoilage is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory and nutritional characteristics [13]. The processing and preservation of fresh fish is of utmost importance since fish is highly susceptible to deterioration immediately after harvest and also to prevent economic losses [14]. According to [15], processing methods decreases the protein content due to changes in physical and chemical nature of the fish, thereby resulting in protein denaturation. Fish species with low levels of fat are suitable for processing. Fat content of a processed fish increases with a corresponding decrease in water content. Heating, undoubtedly causes oxidation of lipid in fish [16]. [17] reported a reduction in ash content in all the treatment methods. Different processing methods are known to influence the nutritional qualities of fish. Boiling gave fish its best nutritive value, frying ensured a longer preservation. According to [18], smoked fish has high protein and fat content, compared to fresh fish.

In Nigeria, the African catfish *Clarias gariepinus* is one of the popular fresh water fish species [19]. According to [20], *C. gariepinus* belonging to the family Clariidae is mostly cultivated in Nigeria due to its ability to tolerate a varying range of environmental conditions, high stocking densities under culture conditions, fast growth rate, disease resistance, acceptability of artificial feed, high fecundity, good

taste and meat quality, ease of artificial breeding and high market value. Since *C. gariepinus* is highly consumed by inhabitants of the Calabar River, it is important to establish its best preservation method. Therefore, the objective of this study was to determine the effect of different preservation methods on the nutritional quality and shelf life of *C. gariepinus* from the Calabar River Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is located at Nsiding Beach in Calabar River, between Latitude: N 4° 57' 326''; Longitude: E 8° 18' 557'' at 26 feet altitude [21]. The climate of the area is characterized by a long wet season from April to October and a dry season occurring between November and March [22]. The annual total rainfall is about 2000mm. There is always a short period of drought in the wet season around August/September which is called August drought. There is usually a cold, dry and dusty period between December and January referred to as the harmattan season [23]. Air temperature generally ranges from 22°C in wet season to 35°C in the dry season with relative humidity, generally above 60% at all seasons and up to 90% during the wet season [24]. Cross River has a mangrove dominated vegetation consisting of mangroves like *Rhizophora racemosa*, *Avicennia africana* and *Nypa fruticans*. The vegetation also contains palm trees (*Elias guineensis*) as well as African oak species [25]. Fig. 1 shows the map of the study area indicating the sampling locations.

2.2 Collection of Fish Samples

A total of forty five (45) samples of *C. gariepinus* were collected from fishermen on landing in Nsiding beach, Calabar River between February to April, 2015 (15 samples per month). Once the samples were collected, they were preserved in ice block, in order to maintain its good condition before the preservation procedure commences. The samples were then taken to the Biochemistry laboratory, University of Calabar, where the moisture, crude protein, fat, ash and carbohydrate content were analyzed in the smoked, fried, frozen and boiled fish samples.

2.3 Processing and Preservation of Fish Samples

2.3.1 Freezing

Fresh samples of *C. gariepinus* were collected and washed with tap water severally before rinsing with distilled water, then cut into slices. The slices were

stored in a plastic container in a refrigerator. The fishes were frozen at a temperature of -18°C for 30 days.

2.3.2 Boiling and frying

The fish was boiled for 45 minutes at 120°C, and then analyzed. The washed fish were then fried using 470 ml of vegetable oil and were heated to a temperature of 170°C and until the fish turned brown. To achieve uniform frying, the samples were occasionally turned by means of wooden spatula.

2.3.3 Smoking

A modified drum kiln of about 90 cm length and 58 cm diameter were used for the smoke-drying process. The drum was cut open midway. The base was used as the combustion chamber with a firebox of 22 × 22 cm². An internally Built damper made of perforated metal plate were installed above the fire box. The smoking chamber was separated into 3 compartments using wire mesh 10 cm above the damper. Fire wood were set up in the combustion chamber and then lighted. The temperature of the smoke generated was monitored in the smoking chamber. The fish samples were then placed on the mesh. The burning wood was adjusted continuously to maintain the required temperature in the chamber during the smoking period.

2.4 Chemical Analysis

In the laboratory, the moisture, crude protein, fat, ash, and carbohydrate content of the different preserved fish were measured.

For the samples of smoked, boiled, fried and the fresh fish, the moisture content, crude protein, carbohydrate content, fat content, and ash content were analyzed using the method of analyses by Association of Official Analytical Chemists [26].

2.5 Moisture Content

The samples were weighed first (Initial weight), and then dried in electric oven at 105°C for 24–30 hours to obtain a constant weight. The moisture content was calculated as follows:

$$\text{Moisture\%} = \frac{\text{initial weight} - \text{dry weight}}{\text{Initial weight}} \times 100$$

2.6 Crude Protein Content

The kjeldahl method for estimation of nitrogen was applied. Nitrogen content was then converted to protein percentage by multiplying 6.25 as follows:

$$\text{Protein \%} = \frac{((V_a - V_b) \times N \times 14 \times 100 \times 6.25)}{1000 \times W_t}$$

Where:

- V_a = volume of HCL used in titration.
- V_b = volume of sodium hydroxide of known normality used in back titration.
- 0.014 = conversion factor of ammonium sulfate to nitrogen.
- 6.25 = conversion factor of nitrogen to protein.
- W_t = weight of tissues sample

2.7 Fat Determination

Fat content (ether extract) of each sample were determined according to Soxhlet method, using 2 grams of fish samples. The extraction continued for 5 Hours at 100°C. Fat percentage was calculated as follows:

$$\text{Fat \%} = \frac{\text{extracted fat weight} \times 100}{\text{Initial weight}}$$

2.8 Ash Determination

Ash was determined by heating 1g at 550 C in a muffle furnace until a constant weight was obtained. Ash content percentage was calculated by the following formula:

$$\text{Ash \%} = \frac{\text{Ash weight} \times 100}{\text{Sample weight}}$$

2.9 Carbohydrate Content

Carbohydrate was obtained from the standard equation 100% - (% protein + % fat + % Ash + % moisture) and the energy content was obtained by multiplying the protein, carbohydrate, and fat content by the factors 4, 4, and 9, respectively.

2.10 Statistical Analysis

Results obtained for the proximate indices of *C. gariepinus* processed using different preservation methods were subjected to One Way Analysis of Variance (ANOVA) for significant difference using PASW windows software program for statistical analysis (version 18.0). Effects with a probability of (P < 0.05) was be considered significant and LSD was used for mean separation.

3. RESULTS

The mean moisture, ash, protein, fat, fibre and carbohydrate content in fresh, frozen, boiled, smoked and fried *Clarias gariepinus* are shown in Table 1 and Fig. 2. Mean moisture content was significantly highest (P < 0.05) in boiled samples (91.40 ± 0.10%),

followed by frozen sample ($79.46 \pm 0.01\%$), followed by smoked samples ($16.80 \pm 0.10\%$) and least in dried samples ($13.96 \pm 0.01\%$).

Mean ash content was significantly highest ($P < 0.05$) in smoked samples ($8.85 \pm 0.02\%$), followed by $8.76 \pm 0.02\%$ (frozen), followed by $7.46 \pm 0.02\%$ (boiled) and least in fried samples ($5.64 \pm 0.10\%$) respectively.

The ash content was significantly highest ($P < 0.05$) in 8.85% (smoked), followed by 8.76% (frozen), followed by 8.85% (boiled) followed by 7.46% (frozen) and least in fried samples (5.64%).

Mean protein content was significantly highest ($P < 0.05$) in frozen samples ($32.50 \pm 0.10\%$), followed by $28.95 \pm 0.01\%$ (smoked), followed by $27.6 \pm 0.01\%$ (boiled) and least in fried samples ($11.30 \pm 0.10\%$) respectively.

Mean fat was significantly highest ($P < 0.05$) in fried samples ($18.39 \pm 0.01\%$), followed by $8.54 \pm 0.02\%$ (boiled), followed by 7.83 ± 0.01 (frozen) and least in smoked samples ($5.13 \pm 0.01\%$).

Mean fibre content was significantly highest ($P < 0.05$) in fried samples ($0.69 \pm 0.01\%$), followed by $0.26 \pm 0.01\%$ (boiled), followed by $0.25 \pm 0.01\%$ (frozen) and least in smoked samples ($0.19 \pm 0.02\%$).

Mean carbohydrate content was significantly highest ($P < 0.05$) in smoked samples ($48.80 \pm 0.02\%$), followed by $48.03 \pm 0.02\%$ (boiled), followed by $42.50 \pm 0.02\%$ (frozen) and least in fried samples ($40.13 \pm 0.02\%$).

All the proximate indices of *Clarias gariepinus* evaluated in this study were within the FAO acceptable range (15-75%), except for the protein content of fried sample and moisture content of boiled samples values were below the FAO [27] acceptable range for fish.

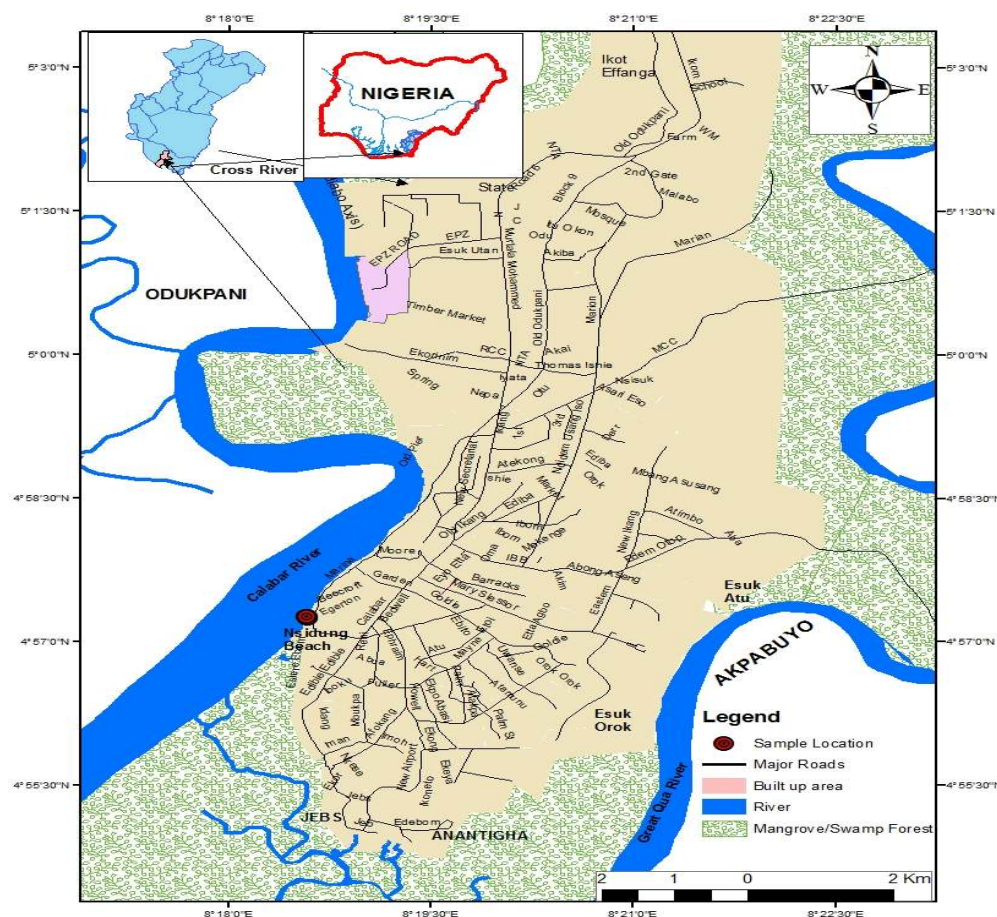


Fig. 1. Map of Calabar River showing the sampling station at Nsidung Beach

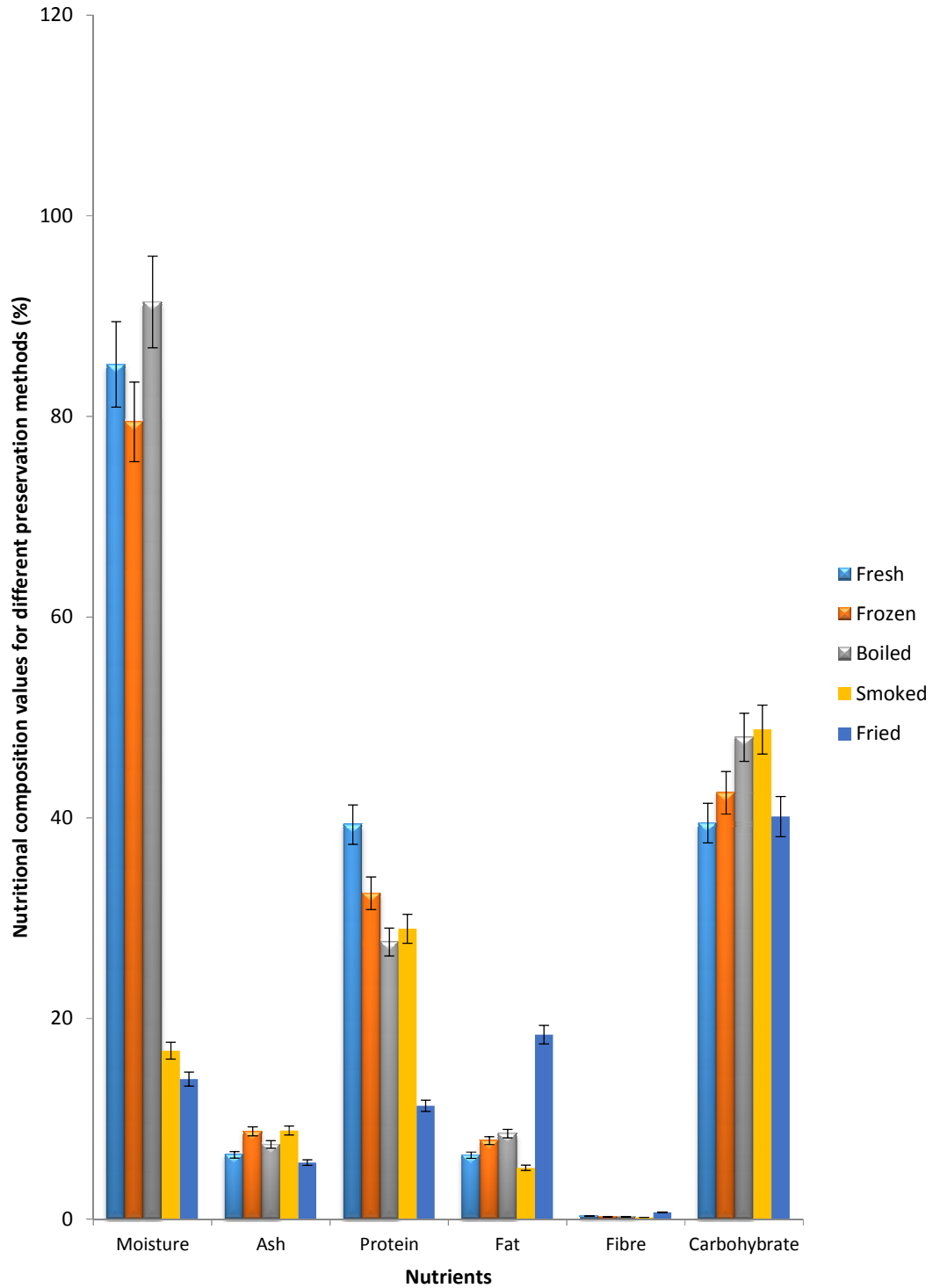


Fig. 2. Variations in mean proximate nutrients content for Fresh, frozen, boiled, smoked and fried samples of *Clarias gariepinus*

Table 1. Mean proximate composition of *Clarias gariepinus* subjected to different preservation methods

Proximate nutrients	Frozen (%)	Boiled (%)	Smoked (%)	Fried (%)	FAO, 2010 accepted standard
Moisture	79.46±0.01 ^a	91.40±0.10 ^b	16.80±0.10 ^c	13.96±0.01 ^d	78 – 90%
Ash	8.76±0.02 ^a	7.46±0.02 ^b	8.85±0.02 ^c	5.64±0.10 ^a	-
Protein	32.50±0.10 ^a	27.63±0.01 ^b	28.95±0.01 ^c	11.30±0.10 ^d	15 -75%
Fat	7.83±0.01 ^a	8.54±0.02 ^b	5.13±0.01 ^c	18.39±0.01 ^d	-
Fibre	0.25±0.01 ^a	0.26±0.01 ^a	0.19±0.02 ^a	0.69±0.01 ^d	-
Carbohydrate	42.50±0.02 ^a	48.03±0.02 ^a	48.80±0.02 ^a	40.13±0.02 ^d	2–5%

*means with the same superscript are not significantly different ($P>0.05$)

4. DISCUSSION

The effect of different preservation methods on the proximate composition of *C. gariepinus* was observed in this study, and this corroborates with the report of [28], who reported that different processing methods altered the percentages of moisture, ash, protein, fat, carbohydrate and energy. The mean moisture content of boiled sample in this study is higher than that reported by [29-31] respectively. This might be as a result of the fact that different fish species were used in the different reported study. [32] reported that boiled fish had the highest moisture content, and this is similar to this study, because the boiled fish also the highest moisture content. The boiled fish had the highest moisture content because water was absorbed into the fish in the process of boiling. Moisture contents were reduced in frozen, smoked and fried fish samples, but the most reduced moisture content was observed in fried fish sample. The ash content increased in the fish samples from different preservation methods except in the fried fish sample, and this is contradicting to the earlier report of [17], who reported a reduction in ash across all preservation method. [29] reported that dried fish has more ash content than boiled *C. gariepinus*, and a similar result was observed in the present study. The protein content decreased in the frozen, boiled, smoked when compared to the fried sample. This could be as a result of the changes in physical and chemical components of the preserved fishes, thereby leading to the denaturing of the protein molecules [15]. Protein content of frozen, boiled and smoked samples was within the FAO acceptable range, except for fried samples which were below FAO acceptable limit. This could be because difference nutritional components of fish undergo different changes at elevated temperatures. [29,31] reported lower protein content compared that observed in this study. Again, this variation could be as a result of the use of different fish species. The different preservation methods reduced the protein contents in the present study. This is contradicting to the reports of [29]

and [18] who reported a higher protein in smoked fish. Protein content reduced in all the preservation methods, but the reduction was most obvious in the fried fish sample. This observation corroborates with the report of [17], who also observed a reduced protein in fried fish samples. The fat content of the present study is by far higher than that reported by [31]. These differences in observation could be because different fish species were used. The smoked fish had the least fat content in the present study. This is contradicting to report of [18], who reported a higher fat content in smoked fish than the boiled fish sample. Again this variation could be due to the fat that different fish samples were used. The fibre content of the fish samples decreased in the frozen, boiled, smoked, and fried samples of *C. gariepinus* in the present study. The smoked fish had the most reduced fibre content, and this could be because the fire might have destroyed the fibre content during the smoking process. There were also variations in the Carbohydrate content between the frozen, boiled, smoked and fried samples. Also, frying increased the fat and fibre content above the acceptable limit. Nutritionally, freezing is recommend as the best means of preservation, because most of the proximate nutrients contents were within the FAO [27] acceptable range except for carbohydrate.

5. CONCLUSION

The study showed that different preservation methods affected the nutritional contents of *C. gariepinus*. Frying reduced the moisture, ash and protein contents drastically, but remarkably increased fat and fibre content. It was also observed that smoking increased the carbohydrate content the most, but reduced the fat and fibre contents.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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