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PROXIMATE, ELEMENTAL AND ENERGY VALUES OF *Clarias gariepinus* SUBJECTED TO TWO DRYING METHODS

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ABSTRACT

Proximate, mineral and energy compositions of the African catfish (*Clarias geriepinus)* collected from Great Kwa River were determined using the methods of the Association of Analytical Chemists (AOAC,2005). Moisture contents were 87.40±0.1%, 18.16±0.1% and 15.58±0.01% for the control (fresh), smoked and oven-dried samples respectively, while ash contents were 4.70±0.1%, 6.50±0.1% and 9.10±0.1% for the control, smoked and oven-dried samples respectively. There was a significant difference ($p<0.05$) among the crude protein and ash contents. Fat contents showed marginal difference between the control and oven-dried samples which recorded 25.70±0.1% and 25.30±0.1% for the control and oven-dried respectively while the smoked sample recorded the highest value of 37.96±0.02%. Values of crude fibre were quite low with 0.39±0.1%, 0.32±0.02% and 0.26±0.01% obtained for the control, smoked and oven-dried samples respectively. Mineral nutrients (Potassium, Sodium, Calcium, Magnesium, Iron and Zinc) as well as energy values were recorded in adequate quantities and none of the preservative methods appeared to have negative effects on both the proximate and elemental composition of the preserved fish samples.

Key words: Nutrients, energy values, *Clarias gariepinus*, smoking, oven-drying.

1. INTRODUCTION

The African catfish *Clarias gariepinus* is a fresh water fish which is a very important source of animal protein in human diets as well as other essential nutrients needed for the maintenance of a healthy body (Fawole *et al.,* 2007). The fish has an almost Pan African distribution, ranging from the Nile to West Africa and from Algeria to South Africa (Osibona *et al.* 2006). It is generally considered to be one of the most important tropical catfish species for culture. In Nigeria, the fish has enjoyed wide acceptability in most parts of the country because of its unique taste, flavor and good texture. Besides, when eaten, the fish is soft and more easily digestible when compared with other meats such as beef, chicken, pork and bush meat. *Clarias gariepinus* contains some bio-active compounds with therapeutic properties that are beneficial to human health (Nnaji *et al.,* 2010; Lordan *et al.,* (2011). Like other fishes, *Clarias gariepinus* are highly perishable and can record considerable losses in quality once out of water, if not properly processed. The number of malnourished people world-wide has been estimated at 963 million (FAO,2008) and this calls for urgent attention if the trend is to be reversed, by ensuring that useful protein sources like fishes, are not wasted. In order to reduce post-harvest losses, a number of processing techniques are in operation in many parts of the world including Nigeria. These include chilling, freezing, salting, canning, drying, and smoking. Perhaps, the easiest and cheapest ways of fish preservation are smoking and oven-drying, which have been known to preserve fish quality for an extended time as well as offering several advantages such as minimum deterioration in product colour, flavor and texture (Obuz and Dikeman 2003 and Ekpenyong and Ibok, 2013). These methods involve heat application to remove water which result in bacterial and enzymatic action inhibition in fish and in turn preserve the nutrient quality of the fish which are known to play important roles in human diets. For example sodium and potassium are required for the maintenance of osmotic balance as well as the pH of the body fluid, regulation of muscle and nerve irritability, control of glucose absorption as well as enhancement of normal retention of protein during growth (Adeyeye and Adamu, 2005). The present study is aimed at assessing the quality of the proximate and mineral composition as well as the energy values as contributed by fat, protein and carbohydrate in *Clarias gariepinus* subjected to two preservative methods namely, smoking and oven-drying.

2. MATERIALS AND METHODS

2.1 Description of study area

The Great Kwa River is one of the major tributaries of the Cross River estuary. It takes its rise from the Oban Hills in Nigeria, flows southwards and discharges into the Cross River estuary around latitude 4°45'N and longtitude 8°20'E. The lower reaches of the river drains the eastern side of Calabar Municipality, Cross River State, Nigeria. The River runs through the eastern side of Calabar at the South eastern boarder of the University of Calabar. The climate of the study area is characterized by a long wet season from April to October and a dry season lasting from November to March. The mean annual rainfall is about 200m. A short period of drought, the "August break", occurs in the wet season around August/September while the harmattan season usually occurs between December and January each year. Temperatures generally range from 25°C in the wet season to 35°C in the dry season. The Great Kwa River is one of the several tributary rivers that inundate the Cross River estuary.

2.2 Collection of samples

Twenty mature samples of *Clarias gariepinus* were purchased from the artisanal fisherman at the landing site of the Great Kwa River fisheries and taken in an ice chest to the Research Laboratory, Biochemistry Department, University of Calabar, for preparation and the relevant analysis. In the laboratory, the samples were carefully washed with clean water, to remove any adhering contaminants.

2.3 Preparation of samples for analysis

Two samples each were selected for smoke-drying, and oven drying while another two were analysed fresh, to serve as control. A batch of the fresh fish was dried in an electric oven (Genlab model N532cF) at 110°C for 50 minutes according to Akinwumi *et al.,* 2001) while the third batch was smoke dried using a local smoking kiln near the University of Calabar, for about five hours. A portion of each fresh part was taken out for moisture determination while the remaining portions were dried in an electric oven between 55°C and 60°C, to constant weight and allowed to cool. The individual portions were ground separately, into fine powdery form using a kitchen blender, kept in labeled air-tight sample bottles and stored in the refrigerator at 20°C according to Ekpenyong *et al.,* 2013), ready for the analysis.

2.4 Proximate analysis

The levels of protein, fat, moisture and ash were determined using the fresh, the smoke-dried and the oven-dried samples according to the methods of Association of Official Analytical Chemists (AOAC.,2005).

2.4.1 Moisture content

For moisture content, 2g of each sample was dried to a constant weight at 87°C-98°C with the aid of an electric oven (Astell Heason, England) for 24 hours. Moisture content was taken as the weight loss at the end of the drying period.

2.4.2 Protein content

Protein was determined using the micro-kjeldahl method which estimates the amount of nitrogen in the sample and subsequently multiplied by a factor of 6.25 according to AOAC (2005).

2.4.3 Fat content

Fat content was obtained by intermittent extraction with petroleum ether (B.Pt 40-60°C) using soxhlet apparatus (corning, England), while ash content was determined from the residue left after incineration of a weighed portion of the sample at 550°C using a muffle furnace.

2.4.4 Crude fibre content

Crude fibre was estimated by boiling the sample with 1.25% (w/v) sulphuric acid and then with 1.25% (w/v) sodium hydroxide and the residue incinerated at 550°C; the loss in weight represented the crude fibre content of the sample (AOAC, 2005).

2.5 Determination of energy value

The caloric value, expressed as kcal/g of each sample was calculated using the Atwater factors for protein, fat, and carbohydrate (Atwater and Bryant, 1900). Accordingly, the amount of protein obtained by chemical analysis was multiplied by 4, fat multiplied by 9, and digestible carbohydrate multiplied by 4 according to AOAC (2005). Energy value, was calculated as the sum of the three values.

2.6 Determination of mineral elements

Mineral elements were determined using the solution obtained by dry-ashing the samples of 550°C and dissolving in distilled water with a few drops of concentrated hydrochloric acid in a volumetric flask. Sodium (Na) and Potassium (K) were measured with a corning U.K. Model 405 flame photometer while Iron (Fe), Magnessium (Mg) and Calcium (Ca) were obtained spectrophotometrically (AOAC, 2005).

2.7 Statistical analysis

All results were subjected to one way analysis of variance (ANOVA) using the SPSS 2009 (Version 17.0).

3. RESULTS

3.1 Proximate composition

Moisture content was highest (87.40±0.1%) in the control samples not subjected to any form of drying while those of the smoked and oven-dried samples were 18.16±0.1% and 15.58±0.01%, respectively. Ash content on the other hand, ranged from the least value of 4.70±0.1% for the control sample, to the highest value (9.10±0.1%) for the oven-dried sample while the smoked sample recorded an ash content of 6.50±0.1%. Similarly, protein content was highest (37.44±0.2%) for the control sample, followed by 12.35±0.01% and 9.50±0.01% for the smoked and oven-dried samples respectively. The highest fat content (37.96±0.02%) was recorded for the smoked samples followed by the control with 25.7±0.1% while the oven-dried sample recorded a value of 25.30±0.1%. Fibre contents were generally very low as compared with other proximate values, with 0.39±0.1%, 0.23±0.02 and 0.2±0.1% recorded for the control, smoked and oven-dried samples respectively (Figure 1) The least carbohydrate value (31.53±0.02%) was recorded for the control sample, 43.08±0.02% for the smoked sample, while the highest value (44.76±0.02%) was obtained for the oven-dried samples.

3.2 Energy value

The total energy value (kcal/g) was highest in the smoked samples which recorded 517.16 kcal/g for the oven-dried sample with a value of 365.96 kcal/g. The Percentage of total energy due to protein value was highest (146.76 kcal/g) in the control sample, followed by oven-dried sample (85.36kcal/g) while that of the smoked sample was the least (49.4 kcal/g). The percentage of energy due to fat values showed increasing trend of smoked>control> oven-dried. On the other hand, the percentage of total energy due to carbohydrates was highest (179.4 kcal/g) for the oven-dried samples while the control and the smoked samples each recorded 126.12kcal/g (Table 1)

3.3 Mineral Composition

Highest potassium content (28.50 g/100g) was recorded for the smoked sample, followed by the control with 23.90 g/100g) while the least value (14.40 g/100g) was obtained for the oven-dried sample. Sodium content was highest (176.94 g/100g) in the control while those of the oven-dried and smoked samples were 146.60 g/100g and 150.43 g/100g respectively. Similarly, calcium content was highest (163.40 g/100g) for the smoked sample, followed by 128.10g/100g for the control while oven-dried sample recorded a value of 78.09 g/100g. Recorded magnesium values were least (14.46 g/100g) for the oven-dried sample, followed by 18.07 g/100g for the control sample, while the highest value (22.50 g/100g) was obtained for the smoked sample. Iron content on the other hand, ranged from 12.63 g/100g for the oven-dried sample to the highest value (16.44 g/100g) for the smoked sample, while the control sample recorded 13.72 g/100g. Zinc content was generally low in the various treatments, with 4.98 g/100g, 2.54 g/100g and 5.46 g/100g recorded for the control, oven-dried and smoked samples respectively.

4. DISCUSSION

Results of the present study recorded highest moisture content (87.40±0.1%) in the fresh samples which were not subjected to any form of drying. This was not surprising since this set of samples was not subjected to any form of dehydration. Besides, it a known fact that bodies of organisms are made up of significant percentage of water. The results in Figure1 indicate that there were 79.22% and 82.17% moisture reduction in the oven dried and smoked samples respectively, compared to the fresh sample control). Olayemi et al., 2011) observed that about three quarters of the body weight of catfish consists of water and that an urgent step should be taken for its protection against destructive micro-organisms which thrive best in the presence of water. In this study, a greater proportion of water was rapidly removed from the samples exposed to smoke-drying and oven-drying. This observation agrees with Akinneye *et al.,* 2010) who reported that oven-drying generally achieved the required moisture content earlier and more uniformly than sun-drying. Similarly, Ahmed *et al.,* 2011) recorded moisture contents of between 11.5±0.71% and 14.06±2.1g/100g in selected sun-dried tropical finfish and noted that the flesh of the dried fish tended to moisturize the ambient air humidity while the protective coating formed in oven-dried fish would reduce rehydration. These observations could also be applicable to the present study. Ash content recorded for the oven-dried sample (9.10±.0.1%) was significantly higher ($P<0.05$) than in the smoked sample with a value of 6.50±0.1% as compared to the control (4.7±0.1%). The ash contents were higher in dried samples as a result of water loss related to these treatments. Ahmed *et al.,* 2011) recorded ash content of 4.60±0.76 for dried *Arius parkii* while Ogbonnaya (2009) recorded 15.46±0.06% for *Oreochromis. niloticus* According to Owaga *et al.,* 2009) the ash content of fish is an important indicator of mineral contents in fish. The highest protein content found in the control sample (37.44±0.01%) is not in agreement with results reported by Ninawe and Rathnakumar (2008) which had the highest content in the dried fish. According to them, increase of protein in the dried fish may be due to the dehydration of water molecule present between the protein molecules thereby causing aggregation of protein which results in the increase in protein content of dried fish. Also, Ogbonnaya and Shaba (2009) reported that protein nitrogen was not lost during drying, resulting in increased protein content with reduced moisture content in the fish samples. Fat contents were relatively low in control (25.70%) while (25.30%) was recorded for oven-dried samples with smoked sample recording the highest value (37.90%), may be as a result of evaporation of moisture contents as earlier observed by Ogbonnaya and Shaba (2009). The fibre contents were very low, with 0.39%, 0.32%, and 0.26% recorded for the control, smoked and oven-dried samples respectively. This is opposed to be findings of Akinneye *et al.,* (2010) which detected no fibre at all in the three fish species (*Heterotis niloticus*, *Sardinella* spp and Bonga spp.) subjected to oven and sun-drying despite the relatively low concentrations, the recorded values can still perform significant nutritional role in reducing constipation and speeding up the excretion of wastes and toxins from the human body (Bland, 1966). The highest amount of carbohydrate (54.13±0.02%) was found in the oven-dried sample while 43.08±0.02% and 31.53±0.02% were recorded in the smoke dried and control samples respectively. These results are not in agreement with the previous work reported by Arora and McFariane (2005) which recorded the highest carbohydrate content in fresh fish species while the lowest was recorded for the dried fish samples. The main function of carbohydrates is to provide energy to the body for the performance of muscular contractions and other numerous physiological functions. According to Holden (2003), low-carbohydrate diets have been reported to lower blood pressure by causing weight loss and improving the insulin sensitivity in diabetics. None of the elements was adversely affected by the method of preservation. Both sodium (Na) and Calcium (Ca) were quite high, indicating that none of the treatments had an adverse effect on the nutrient status of the fish. The same observations were made for Potasium (K), Magnesiun (Mg), Iron (Fe) and Zinc (Zn). Each of the investigated elements has specific functions to play in the human body. For instance, Potasium (K) helps to control intracellular cations, glucose absorption as well as retention of protein during growth (Adeyeye and Adamu, 2005). Even though the concentration of Zinc (Zn) as relatively low, the values were good enough to enhance proper functioning of the human body while Potasium (K) which is an essential nutrient plays an important role in electrolyte balance of the body. As shown in Table 1, energy values of the various nutrients were generally high and are regarded as adequate for proper functioning of the human body.

5. CONCLUSION

Drying methods are known to affect nutrient quality in different ways. Appreciable reduction in water quantity was recorded in both oven-dried and smoked samples of *C.gariepinus* which resulted in increased protein concentration. Ash content was higher in oven-dried samples than the fresh and smoked samples. Also energy values were not adversely affected by drying methods as seen by the high PEP,PEF & PEC values.

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Table 1. Energy value (k cal/g) as contributed by protein, fat and carbohydrate

Parameter	Control	Smoked	Oven-dried
Total energy	507.18	517.16	365.96
PEP%	149.76	49.4	85.36
PEF%	213.30	341.64	101.2
PEC%	126.12	126.12	179.4

PEP= Percentage of total energy due to protein
PEF= Percentage of total energy due to fat
PEC= Percentage of total energy due to carbohydrate

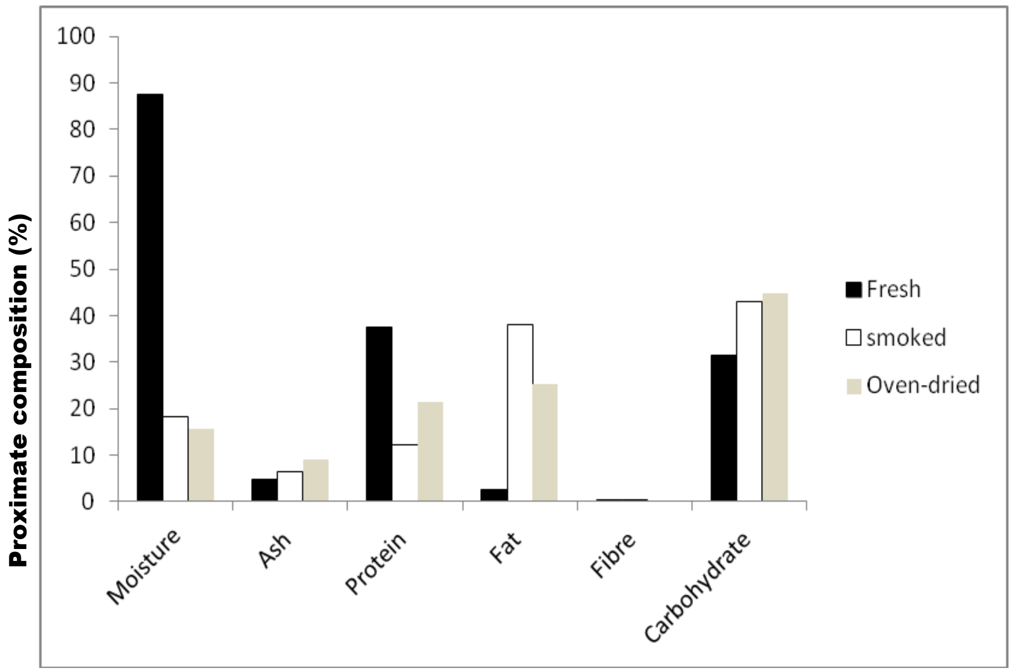

Figure 1: Proximate composition (%) of *Clarias gariepinus* subjected to the different methods of preservation.

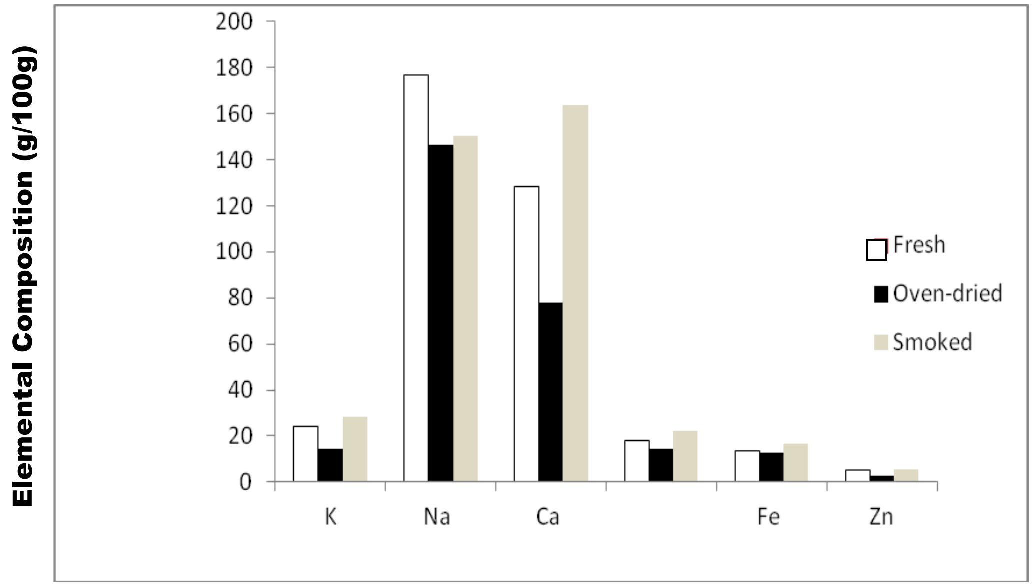

Figure 2: Elemental composition of *Clarias gariepinus* subjected to different methods of preservation

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