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EFFECT OF DEBONING AND DRYING METHODS ON THE CHEMICAL CHARACTERISTICS OF CATFISH (*CLARIAS GARIEPINUS*)

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Abstract: Effects of deboning and drying methods on chemical characteristics of catfish were investigated. Twenty catfish (450±50g each) were randomly separated into four equal portions and processed into oven dried whole (ODW); oven dried deboned (ODD) at 70°C and smoked dried whole (SW) with fresh whole fish (FW) as the control. Samples were analyzed for proximate and mineral composition, and biochemical changes. There was a significant difference ($p<0.05$) in moisture content (9.73–67%). Crude protein content was highest (46.92%) in ODD and lowest (15.79%) in FW. There was a wide variation in crude fat content (3.47–35.94%); ash contents (1.32–6.64%) were significantly low in comparison with other nutrients. Calcium and iron were the most abundant mineral elements and were significantly highest (67.6 and 36.21 mg/100g respectively) in ODD. The mineral constituents meet the WHO recommended dietary allowance showing the samples as good sources for the determined minerals. However, biochemical changes observed in ODD suggests the need for additional preservative treatment(s). Notwithstanding, ODD fish could serve as alternative nutritious fish diet to solve the problem of Pnigophobial. Results of the study will influence the choice of an adequate method for processing catfish of good nutrient retention and minimal biochemical changes.
Keywords: Catfish, drying, deboning, proximate and mineral compositions, biochemical changes

1. INTRODUCTION

Fishes as seafood are a rich source of animal protein and other food nutrients needed for proper growth and development, it is commonly consumed as an alternative to meat due to the higher cost of the later (Omolara and Omotayo, 2009). Particular, in addition to other nutrients, catfish contains appreciable content of mineral elements especially calcium (Ca) which is necessary for proper development of bones and teeth (Mogobe *et al.*, 2015). Consequently, due to the nutritional importance of catfish, it could be recommended to be included in various diets for all categories of people but there have been restrictions to this. One of the major factors to the restrictions is the extremely perishable nature of fish at tropical temperatures which rendered the fish inedible within twelve hours of harvest, thus, spoilage begins as soon as the fish dies (FAO, 2012). Additionally, fish is a low acid food and very susceptible to the growth of food poisoning bacteria. These facts necessitate that fish should be processed immediately after harvest to prevent the growth of spoilage bacteria (FAO, 2012).

Considering the quick perishable nature of fish, various methods of processing and preservation have been adopted, some date back to antiquity while some of the other methods are fairly recent. Ásbjörn *et al.* (2007) reported that processing of fish, especially by drying does not impair the nutritional content of the fish. In their work, they measured amino acids in dried fish and made a comparison with that of eggs; the authors concluded that the protein in dried fish was of higher quality than those in eggs. Therefore, the importance of fish processing and preservation by drying which is one of the most simple and inexpensive methods of preservation cannot be overemphasised.

Notwithstanding, despite the vast established documentation about the high nutrient retention in dried fish, the phobia of being choked by the fishbone (referred to as 'Pnigophobia') place some constrains in its consumption. Thereby, a fairly large percentage of the world populace especially the children who should have benefited immensely from high nutrients content of fish rather avoids eating fishes in their diet to avoid the bone choking incident which could eventually breed other health complications. Thus, this study aimed to investigate the effect of deboning and different drying methods on the physicochemical properties of catfish.

2. MATERIALS AND METHODS

— Materials and preparation of the sample

African catfish (*Clarias gariepinus*) of an average weight of 450 ± 50 g each were obtained from a local fish market in Ile-Ife, Osun State, Southwestern, Nigeria. Twenty fishes were gutted, thoroughly washed with tap water and were randomly separated into four parts of five pieces each. One part was for smoking whole using a local type smoking kiln, two parts for oven drying using an air draught electric oven and the last part, the fresh whole fish (FW) serves as the control.

— Fish processing procedure

The samples were immersed in a brine solution of 90 g of salt/1000 ml of water for 30 minutes and allowed to drain on iron wire gauze (Otolowo and Olapade, 2018). The drained fish portions were placed in the smoking kiln (60–70°C) and electric oven (at 70°C) accordingly for the smoked whole (SW) and oven dried whole (ODW) portions. The deboned portion had the head region severed and discarded; after cleaning, the fish was manually filleted using a clean knife before drying in the electric oven (ODD). The smoking was completed after five days while oven drying for ODW was for three days and that for ODD was achieved after two days. The samples were cooled at room temperature and the muscle part ground with the aid of laboratory mortar and pestle, then packaged in polyethylene bags prior analyses.

— Proximate and mineral composition analyses

The proximate composition (moisture, crude fat, crude protein, ash and carbohydrate contents) and mineral elements analyses were done according to the method of AOAC (2005).

— Biochemical analysis

The determinations of biochemical components of the ground muscle part of the fish samples namely; peroxide value (PV), acid value (AV) and free fatty acid (FFA) were done using the method described by Pearson (1976).

— Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) of SPSS version 22.

3. RESULTS AND DISCUSSION

— Proximate composition of fresh and dried catfish

The proximate composition of the fresh and processed catfish is represented in Figure 1. There is a significant ($p < 0.05$) difference in all the parameters and a positive impact of processing in lowering the moisture content. The moisture content reduces from 67.64% in the fresh whole to 9.73% in oven-dried deboned showing that deboning increased the surface area for the removal of the largest volume of water from the fish muscle and the consequent concentration of nutrients. Low moisture content is good for extended shelf life because the chance of spoilage by microbial activities especially during storage will be reduced. This is similar to the report of previous researchers (Effiong and Mohammed, 2008; Chukwu and Shaba, 2009; Kumolu-Johnson *et al.,* 2010; Ayeloja *et al.*, 2013).

The protein content takes the reverse trend of that of moisture content; it increased from 15.79 % in the fresh whole sample to the highest value (46.92%) in oven-dried deboned implying that there was no loss of protein during drying but rather got concentrated which concurred with the reports of Tao and Linchun (2008) and Akinwumi *et al.* (2011) on fish drying. The ash content increased from 1.32% in the fresh whole fish to the highest value (6.64%) in oven-dried whole. The variation in ash content could be attributed to the brining operation and the positive impacts of drying that make for its concentration (Jittinandana *et al.*, 2002). This implies that the oven-dried whole sample possesses the potential of being a good source of mineral elements for nutritional importance.

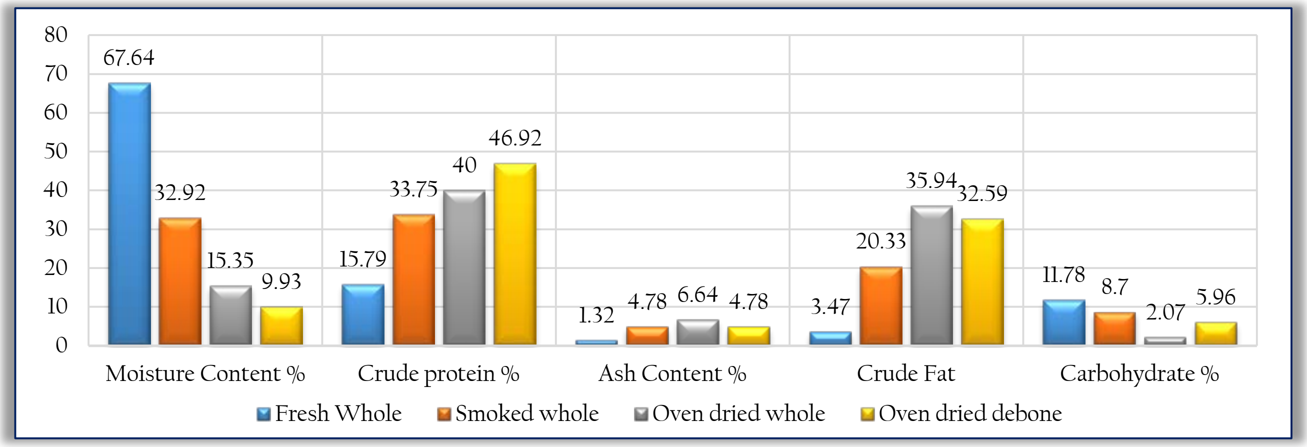

Figure 1: Proximate Composition (%) of the Fresh and Processed Catfish Samples

There was significant variation in the fat contents of the catfish samples with the least value (3.47%) in the fresh whole fish and highest (36.30%) in oven- dried debone. This is in agreement with the report of Adeyeye *et al.* (2016b) that significant variations exist in the proximate composition of dried catfish. Fishes are generally known to contain a significant amount of oil mostly with unsaturated fatty acids which are responsible for the rancid nature of oxidised fish oil. Thus, fat content could affect the stability of the food material due to lipid oxidation. However, the culinary importance of fat in food lies majorly in the fact that it improves the mouth feel of and impacts certain desirable characteristic flavour to food. The values obtained for fat content in the present work agreed with the values reported by Abdulkadir *et al.* (2010) for other species of catfish. The carbohydrate content of the fish samples (ranged 2.07 to 11.78%) were generally low with oven dried whole having the lowest while the fresh whole had the highest value. Generally, fishes are not good sources of carbohydrate.

— Mineral composition of the catfish samples

Although the oven-dried whole (ODW) catfish exhibited good retention of nutrients (Figure 1), it was excluded in the mineral composition and biochemical analyses for the fact that the most widely and commonly consumed form of catfish in larger geographical locations in Nigeria are the fresh whole (FW) and smoked dried whole (SW), and that of oven-dried deboned (ODD) is necessary to check the effect of deboning and drying methods.

Results of mineral composition for the control (FW), SW and ODD samples are presented in Table 1. Mineral elements are an important component of diet because of their physiological and metabolic function in the body. Consequently, calcium (Ca) is the most abundant element that occurred in the catfish samples which similar to the report of Otolowo and Olapade (2018); the values range from the lowest (42.31 mg/100 g) in the FW to the highest value; 67.62 mg/100 g in ODD. The high Ca content in ODD might probably be as a result of some 'dust' of the bone component in the fish fillets during deboning since the operation was manually done with the use of a sharp knife. Calcium is an important mineral required for bone and teeth formation, and neurological function of the body. The recommended daily intake for Ca by World Health Organisation (WHO) for children and adult is 800 mg showing that catfish samples in this study could provide the WHO requirement for Ca. The FW sample had the lowest (2.18 mg/ 100 g) magnesium (Mg) content while the SW exhibited the highest (5.19 mg/ 100 g). Magnesium plays an essential role in calcium metabolism in bones and is involved in the prevention of circulatory diseases; also, Mg helps in regulating blood pressure and insulin releases (Onyiriuka *et al.*, 1997; Umar *et al.*, 2005). The recommended dietary allowance (RDA) for magnesium in adult averaged 350 mg/day, while in children is 130 mg/day (Lenntech, n.d.) indicates SW and ODD relatively fits a good source for Mg.

Table 1: Mineral Composition of Catfish Samples (mg/100 g)

Samples	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Iron (Fe)	Cadmium (Cd)
FW	42.31	2.18	3.72	18.69	0.00
ODD	67.6	4.29	3.13	36.21	0.00
SW	52.6	5.19	1.00	31.81	0.02

Values are means of triplicate determinations.

Key: FW = Fresh whole catfish; ODD = Oven dried deboned; SW = Smoked dried whole

The iron (Fe) contents of the fish samples ranged from 18.69 to 36.21 mg/100 g with the least and highest values in FW and ODD, respectively. Iron is important in the formation of the protein haemoglobin, which carries oxygen throughout the body in red blood cells, and myoglobin, which transports oxygen in the muscles (Onwordi *et al.*, 2009). The recommended dietary allowance for Fe in children is 9 mg/day, female adult; 15 mg/day, and male adult; 13 mg/day (WHO, 2010). This study shows that catfish samples are rich sources of Fe. Potassium (K) is essential in the regulation of heartbeat, neurotransmission and water balance of the body. Catfish samples had potassium content of between 1.00 and 3.72 mg/ 100 g. The WHO recommended daily intake for potassium is 2000 mg for adult and 1600 mg for children. This indicates that the K content of catfish in the present study may not meet up with the WHO standard; similar to the report of Otolowo and Olapade (2018). However, cadmium (Cd), the heavy metal determined was not detected in the samples except a negligible amount in SW indicating the safety of the samples for human consumption.

Although smoking could provide a relative nutritional stability in fish, reports about cancerous effect due to the high content of polycyclic-aromatic-hydrocarbons (PAHs) of the deposited smoke (Adeyeye *et al.,* 2016a) and other health implications are serious drawbacks to its widespread use.

— Biochemical changes in catfish

The mean values for biochemical changes observed in catfish samples are presented in Table 2. Only the fresh fish had the peroxide (PV) and avid (AV) values within the standard limits similar to the results of previous researchers (Seifzadeh *et al.,* 2012). The dried samples had higher PV, AV, and FFA values above the standard maximum permissible levels. This contradicts the previous reports that oven dried could prevent lipid oxidation in catfish (Bragadóttir *et al.*, 1998; Chukwu and Shaba, 2009). The contradiction could emanate from lower temperature and longer drying time involved in the present study and the variations in the source of catfish. However, ODD had the highest values (8.91 meq O_2/kg PV and 3.87% FFA) while the highest mean value of 7.17 mg KOH/g AV was observed for the SW. A suggested limit of PV for quality and acceptability of oils (and oils in fish) for human consumption is 8 meq O_2/kg (Boran *et al.*, 2006); 3.76% AV and 1.38% FFA (Pearson, 1976).

Table 2: Biochemical Changes in Catfish Samples

Sample	PV (meq O_2/kg)	AV (mg KOH/g)	FFA (%)
Fresh whole fish (FW)	6.32	5.87	3.05
Oven dried deboned (ODD)	8.91	6.84	3.87
Smoked whole fish (SW)	8.04	7.17	3.45

Values are means of duplicate determinations

Key: PV = Peroxide value; AV = Acid value; FFA = Free fatty acid

Consequently, the biochemical changes observed in the present study shows that the processed fish samples may not encourage shelf stability which implies that a higher drying temperature or additional preservative treatment(s) may be required to strengthen the stability.

4. CONCLUSION

The drying methods significantly lowered the moisture content which in turn resulted in the concentration of nutrients; low moisture content is advantageous for a prolonged shelf life in the dried catfish. The results of the present study show that there is a possible application of electric oven drying as an efficient drying process for catfish, though its continued use in poor-resource communities in the developing countries is limited. However, this study suggests oven dried deboned fish with more nutrients retention as an alternative fish diet to solve the problem of malnutrition and Pnigophobia, especially among children. Consequently, the study will influence the choice of an adequate method for processing catfish of good nutrient retention and minimal biochemical changes. Nevertheless, the observed biochemical changes suggest that a higher drying temperature or an additional preservative treatment may be required to strengthen the shelf stability of the products, hence further research in this regard is necessary.

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