

EFFECT OF HABITAT AND PROCESSING METHODS ON THE MICROBIAL AND PROXIMATE COMPOSITION OF AFRICA CATFISH *CLARIAS GARIEPINUS* IN ILORIN METROPOLIS

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ABSTRACT

Clarias gariepinus was sourced from 3 different aquatic habitats, namely; wild (Asa dam river), a concrete pond and an earthen pond in Ilorin metropolis, Kwara state, Nigeria. The fish samples were subjected to frying and smoking using standard methods of heat application. Microbial analysis was done on the gut and skin of the fresh samples. The fish samples (fresh, fried and smoked) were analyzed for protein, moisture, ash, lipid, fibre and carbohydrate content. The fresh fish samples showed higher protein and Moisture content (17.63 % - 19.52 % and 70.86% - 73.38%) respectively compared to smoked and fried catfish (15.48% - 17.62% and 16.33% - 17.22%) respectively. High protein and moderate Lipid content in Catfish fish proved the fact that Catfish fish belongs to the category of fish with high protein and moderate lipid content. The results of the analysis showed variation compared to the result of other similar researches. This could be as a result of some factors, which may include geographical location, sex, species, age, nutrient, migration and Season. The Processing method altered the composition of the Catfish as a result of heat application where denaturation of the fish composition is believed to have occurred. The Microbial analysis were within acceptable limits, the presence of Coliform Bacteria in the gut and skin of the wild fresh fish shows a fecal contamination of the aquatic environment. It can thus be concluded that fresh fish is more nutritious for human consumption.

Keywords: Catfish, Habitat, Processing, Proximate analysis, Microbiological Quality, Nutrient.

1. INTRODUCTION

Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other vital nutrients for the maintenance of a healthy body (Andrew, 2001). African catfish (*Clarias gariepinus*) of the family Clariidae, is generally considered to be one of the most important tropical catfish species for aquaculture. In Nigeria, it has also been noticed that fish is eaten fresh, preserved or processed (smoked, Fried) and form a much-cherished delicacy that cuts across socio-economic, age, religious and educational barriers (Adebayo-Tayo *et al.*,

2008). Fish is a major animal protein source, because it is palatable, cheap, highly accepted with little or no religious bias. It is also readily available from the artisanal fisheries, importation from distant waters and aquaculture (Eyo, 2001; Foran *et al.*, 2005). The microbial flora associated with freshly harvested fish is principally a function of the environment in which the fish are caught and not of the fish species; hence, the indigenous microbial populations of fish can vary significantly (Shewan, 1977). Since fish is not normally consumed raw, various processing methods are employed in preparing them for consumption and some of these processes include boiling, frying, roasting, smoking, which could have varying effects on their nutrient contents, texture and flavour (Eriksson, 1987). Measurement of some proximate profiles such as protein contents, carbohydrates, lipids, moisture contents and ash percentage is often necessary to ensure that they meet the requirements of food regulations and commercial specifications (Watermann, 2000). Fish is a very important source of animal protein in the diet of man. It is widely consumed in many parts of the world not only for both its high quality protein and low saturated fat content. It contains essential n-3 polyunsaturated fatty acids that are known to support good health, lower the risk of heart diseases in adults and are important for neuro-development in infants and young (Uauyet *et al.*, 2003; Marimuthu *et al.*, 2011). Fish is a rich source of lysine suitable for supplementing high carbohydrate diet, rich in thiamine, riboflavin, vitamin A and D, phosphorus, calcium and iron, high in polyunsaturated fatty acids important in lowering blood cholesterol level (Al-Jedah *et al.*, 1999). Fish dietary intake provides about 60% of the total animal protein consumed in West Africa (Saisithi, 1994).

The effect of different processing and preservation methods on nutritional compositions of different species of fish, such as *Citharinus citharus* (Effiong and Fakanle, 2009), *Oreochromis niloticus* (Abolagba and Melle, 2008; Egba *et al.*, 2010), Mullet, *Mugil cephalus* (Ghelichpour and Shabanpour, 2011) have been studied.

Fish spoilage can be delayed by many processes, including temperature, pH, and smoke, which eliminate, or reduce, microbial growth, enzyme activity, oxidation or insect infestation (Camire, 1990). Processing methods like heat application may denature protein; disrupt the food matrix thus resulting in lower essential amino acid bioavailability, reduced digestibility and protein quality (Mensa-Wilmot, 2001). Fish requires proper handling and preservation to increase its shelf life and retain its quality and nutritional attributes. Immediately a fish is caught, it loses its natural resistance to attack by microorganisms and also starts to

undergo both physical and chemical changes that in return bring changes in appearance, taste, smell and texture (Oladipo and Olukade, 2013). In Nigeria, fish cultivation has expanded to the use of concrete and earthen ponds and this has increased cultivation and consumption of fish. For reasons not established, consumers show more preference for fish from wild habitat. It is for this reason that this research work aimed at evaluating the proximate and microbial load of fish samples from different habitats. The effects of frying and smoking on the proximate composition of the fish samples were also assessed.

2. MATERIALS AND METHODS

Freshly harvested Catfish aged 5-6 months were obtained from three different sources; Asa river (wild), concrete pond (TI farms) and earthen pond (Asa Dam Farm) all in Ilorin metropolis in Kwara state, Nigeria. All were maintained in their respective water source prior to killing, evisceration and cleaning. All chemicals including agar used are laboratory grade and were obtained from the Department of Chemistry, University of Ilorin, Nigeria.

2.1. Fish processing

Fish samples were randomly taken and deep-fat fried in vegetable oil in a frying pan as previously reported with slight modifications (Oyeyinka *et al.*, 2017). The fish samples were slaughtered, gutted and cleaned. The cleaned fishes were then immersed in hot oil at 185°C for 10 min. Smoking of the cleaned fish samples was done as previously described (Chung *et al.*, 2011). Briefly, approximately 2 kg of charcoal were placed in the bottom of the grill and 100 mL of gasoline were poured onto charcoal to start a fire.

2.2. Proximate composition

The moisture, fat and ash content of the raw and cooked grains were determined according to the standard methods of the Association of Official Analytical Chemists International (AOAC) (2010). Protein content ($N \times 6.25$) was determined by Kjeldahl method while the total carbohydrate was estimated by difference.

2.3. Microbiological Analysis

10g of the skin and gut portion of the eviscerated fish samples were introduced separately into a 90ml of sterile distilled water. Serial dilutions of the solution were made to obtain a maximum dilution factor of 1:1000. Total heterotrophic plate counts for bacteria and fungi were done by pour plate method on nutrient agar (NA) and potato dextrose agar (PDA) respectively. Enumeration of the total coliform was done by methods described by (Fawole and Oso, 2007), the faecal coliform was determined by cultivation on Eosin Methylene Blue Agar using spread plate technique (Fawole and Oso, 2007). Selective isolation and enumeration of pathogenic bacteria such as *Salmonella* and *Vibrio parahaemolyticus* were done using Xylose Lysine Deoxycholate agar and Thiosulphate-citrate-bile salts-sucrose agar respectively. The number of colony forming units per ml (cfu/ml) was calculated by multiplying the number of colonies per dilution factor.

2.4. Data analysis

Data analysis was done using Analysis of variance (ANOVA) according to the statistical analysis system (Steel and Torie, 1987). Differences among sample means were tested for significance with Duncan's multiple range test (Duncan, 1955) at a level of 0.05.

3. RESULTS AND DISCUSSION

3.1. Effect of habitats on proximate composition of *Clarias gariepinus*

The proximate composition of fresh fish samples harvested from the wild, earthen and concrete ponds are presented in Table 1. With the exception of protein contents of the fish samples which was significantly ($p < 0.05$) different, the moisture, ash, fat, fibre and carbohydrate contents of the fish samples were not different. Fresh fish harvested from the wild had a protein content of 19.50% which was significantly higher than samples harvested from the earthen (17.63%) and concrete (18.26%) ponds. The reason for this difference remains unclear. However, it is possible that the fish harvested from the wild had varying sources of food which possibly may account for the higher protein content. The protein content of the fish samples in this study is within the range of values reported for *Clarias gariepinus* (Adewumi *et al.*, 2015). Ash (1.09-1.17%), fat (3.07-3.14%), fibre (0.52-0.61%) and carbohydrate (3.77-6.35%) contents of the fish samples were generally low (Table 1).

3.2. Effect of processing on proximate composition of *Clarias gariepinus*

Fish samples were processed by frying and smoking to enhance the shelf life of the fish samples. The proximate composition of the processed fish samples are shown in Table 1. In general, processing significantly affected the proximate composition of the

fish samples. In comparison with the fresh samples (Table 1), the protein content of the fresh fish samples reduced by approximately 8% and 14% after frying and smoking respectively (Table 1). Moisture contents of the samples similarly reduced after processing, but the reduction was very substantial. Fresh fish samples had higher moisture contents (approx. 72%) compared with fried (approx. 18%) or smoked samples (approx. 40%). The lower moisture contents of the processed fishes is expected because the heat applied during frying enhances loss of moisture into the frying medium as well as drip losses during smoking. Low moisture foods generally have higher shelf life compared to those with higher moisture content. Fat contents of the fried and smoked fishes increased significantly compared with the fresh samples. The increase in fat contents after frying may be explained by the absorption of oil during frying. According to previous research, both water and water vapour are removed from the surface and interior of the food and are replaced by hot oil (Oyeyinka et al., 2017). For the smoked samples, the increased fat contents may be due to the reduction in moisture which probably led to concentration of other nutrients such as carbohydrate and fat. Fibre content of the fish samples generally increased (twice) after processing, indicating that the processed fish samples will enhance digestibility. Previous workers had reported the effects of some processing methods on different fish types (Greenfield and Kosulwat, 1991).

Table 1: Proximate composition of fresh and processed *Clarias gariepinus* (%) harvested from different habitats

Parameters	Fresh			Fried			Smoked		
	Wild	Earthen	Concrete	Wild	Earthen	Concrete	Wild	Earthen	Concrete
Moisture	70.43 ^b	71.78 ^a	73.01 ^a	17.40 ^c	18.08 ^c	18.11 ^c	39.17 ^d	42.29 ^c	39.70 ^d
Protein	19.50 ^a	17.63 ^c	18.26 ^b	17.18 ^c	16.41 ^d	17.55 ^c	16.05 ^d	15.42 ^e	16.19 ^d
Ash	1.12 ^{bc}	1.09 ^c	1.17 ^{bc}	1.21 ^{bc}	1.20 ^{bc}	1.21 ^{bc}	1.42 ^a	1.33 ^{ab}	1.32 ^{ab}
Fat	3.14 ^a	3.07 ^c	3.14 ^c	4.15 ^a	4.14 ^a	4.06 ^a	3.97 ^{ab}	3.76 ^b	4.26 ^a
Fibre	0.57 ^c	0.52 ^c	0.61 ^c	1.07 ^d	1.12 ^d	1.19 ^{cd}	1.35 ^b	1.63 ^a	1.29 ^{bc}
Carbohydrate	5.21 ^{cd}	6.35 ^c	3.77 ^d	59.69 ^a	59.08 ^a	57.79 ^a	35.83 ^b	36.33 ^b	37.85 ^b

*Mean with the same superscripts along a row are not significantly different (P<0.05)
 *Wild, Earthen and Concrete indicate the habitats of the fish samples

3.3. Microbial count

This study revealed that the bacterial count of the skin of fresh fish samples ranged from 6.0×10^3 - 1.0×10^8 which is lower than that of the gut 1.5×10^7 - 3.0×10^7 cfu/g. The fungal count of the skin of fresh fish samples ranged from 5.0×10^2 - 1.0×10^4 cfu/g compared to the gut of the fresh samples 7.0×10^2 - 3.0×10^4 cfu/g. There was no salmonella occurrence on the fish samples from the three aquatic sources. There was a value range of *V. parahaemolyticus* as 7.0×10^3 - 1.0×10^8 cfu/g. The total coliform bacteria could in the gut and skin of the wild habitat is of great concern as pond water contaminated with these pathogenic bacteria could endanger consumers particularly if fish harvested from the wild are under-cooked. There was presence of coliform on the gut of the concrete pond habitat and none on the skin and this agree with the study of that the skin of fresh fish is normally sterile and had less mycoflora than the gut. The presence of pathogenic microorganisms especially *E. coli* and *Vibrio* can lead to the transmission of water borne diseases such as, Typhoid fever, Cholera, food poisoning and gastroenteritis (Piet, 2009) on consumption of improperly cooked fish cultivated in the wild and concrete pond. Statistically, t-test showed that there is a difference in the microbial load of fish sample from different sources owing to the Mycoflora in their respective environment and the gut of the fish had higher microbial load than the skin. The presence of Coliform Bacteria in the gut and skin of the wild fresh fish shows a fecal contamination of the aquatic environment. The total bacteria count and fungal load of the fishes were in the range of acceptable limit for human consumption, ICMSF (1986). Dam water supply to the earthen fish farm pond should be taken and examined in the laboratory periodically for its microbiological quality before stocking, this would give insight to the possible presence of certain types of microorganisms, hence provide enabling and hygienic environment for aquaculture purposes.

Table 2: Total viable counts of fresh *C. gariepinus* from different aquatic habitat

Sampling point	Pond type	Sample type	Feacal Coliform cfu/g	Total Coliform cfu/g	Salmonella cfu/g	Vibrio Parahaemolyticus cfu/g	Total Bacteria count cfu/g	Fungal count cfu/g
Asa dam river	Wild	Skin	2.0×10^2	5.0×10^2	0	7.0×10^3	2.0×10^5	2.0×10^4
Asa dam river	Wild	Gut	2.0×10^3	6.0×10^4	0	3.4×10^4	1.5×10^7	3.0×10^4
T.J farms	Concrete	Skin	0	1.0×10^6	0	3.0×10^5	6.0×10^3	5.0×10^2
T.J farms	Concrete	Gut	0	0	0	6.0×10^3	3.0×10^4	7.0×10^2
Dam fish farm	Earthen	Skin	0	0	0	1.0×10^8	1.0×10^8	1.0×10^4
Dam fish farm	Earthen	Gut	0	0	0	3.0×10^7	3.0×10^7	3.0×10^4

4. CONCLUSION

Moisture and protein were the major constituents of the fresh fishes. Fish habitat has significant effect on the protein content of the fish samples. Processing significantly reduced the protein content of the fish samples which had been considered in evaluating the nutritional value of the fishes studied. Proper cleaning and processing of the fish from the wild is advised to prevent illness due to the presence of Coliform Bacteria in the gut and skin of the wild fresh fish indicating fecal contamination of the aquatic environment. Therefore, this study advocates the need for the adoption of good processing practices and preserving of fish product, proper hygiene and storage of both processed and fresh fish, as well as controlled heat application process to prevent loss in quality nutrient. Fish should also be processed immediately after slaughter so as to arrest spoilage process and prevent post-harvest fish loss.

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