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Nutrients and Microbial Evaluations of *Clarias gariepinus* Dried at Various Temperatures

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Abstract: *Nutrients and microbial evaluations of the African catfish, Clarias gariepinus dried at various temperatures were determined. Twenty freshly caught fish samples were obtained from the fish production unit, Federal College of Agriculture, Ishaigu, Ebonyi State. The Adult catfish were divided into four groups of five each: one groupwas used to determine the nutrient composition of the raw fish while the otherthree were dried using electric oven at temperatures of 100^0C, 150^0C, 200^0C, 250^0C. Mean Crude protein, Ether extract, Crude fibre, Ash and moisture content of raw fish were 17.18±3.63, 2.35±2.95, 0.12±0.12, 2.19±1.12 and 76.46±2.00 respectively. The Crude protein obtained at 100^0C, 150^0C, 200^0C and 250^0C was 53.67±3.86, 63.33±3.02, 57.98±2.46 and 59.85±1.85 respectively while the moisture content was 9.08±0.79, 8.71±0.77, 10.06±1.22 and 8.46±0.26 at 100^0C, 150^0C, 200^0C, 250^0C respectively. The differences in Crude protein was found to be significant ($p<0.05$) and highly significant ($p<0.001$) in ash for all the temperatures. Ether extract, Crude fibre and Moisture content showed no significant difference ($p>0.05$) for the temperatures used. There was a 100% occurrence of Bacillusspp, Staphylococcusspp and Yeast. Aspergillusspp had 75% occurrence while Pseudomonasspp and Penicillumspp had 50% occurrence for all temperatures. The least occurrence (25%) was recorded for Serratia spp. Mean bacterial load across the different temperatures was 14.47±3.81. Mean fungal load was 6.33±3.33. Changes in bacteria and fungi showed a significant difference ($p<0.01$) and ($p<0.05$) respectively. The results of the study showed that different drying temperatures significantly affect the microbial load of fish.*

Keywords:*African catfish, fish drying, nutrient composition, microbial load.*

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I. Introduction

Fish is a source of animal protein that has remained essential in the diet of man. When processed, dried or smoked, it becomes an important ingredient in diets across different parts of the World. (Chukwu, 2009) Fish has lower cholesterol content when compared with meat and therefore often recommended for consumption especially among the adult population. However, the gap between the demand and supply of fish is widening due to increase in population, poor post-harvest handling, and lack of unconventional fish species. The African Catfish, *Clarias gariepinus* is widely cultured in Nigeria and of great economic interest. It is generally considered to be one of the most important tropical Catfish species for agriculture. It has an almost Pan African distribution, ranging from the Nile to West Africa and from Algeria to South Africa (Osibonaet al., 2006).

Fish drying is an age long practice across the world. It is one of the methods of processing fish. Different processing and drying methods have different effects on nutritional composition of fish. Water removal from fish slows down or stops microbiological activity and can, be used as a method of preservation (Clucas, 1982). The processing and preservation of fresh fish is of utmost importance to prevent economic losses since fish is highly susceptible to deterioration shortly after harvest (Okanta and Ekelemu, 2005). As soon as fish dies, spoilage begins to set in. This spoilage is accompanied by various physical and chemical changes in the gills, eyes, and slime and skin tissues. Microbial activities in post-harvest fish brings about spoilage, resulting in serious economic losses (Eyo, 2001). Therefore, there is need to subject freshly harvested fish to processing techniques such as sun drying, smoking, salting, freezing and irradiation. The major constituents of fish are moisture, protein and fat with minerals occurring in trace amount (Holland et al.,1993). Generally, fish contains very little carbohydrate, while the moisture content is very high. In most fish species, the moisture content is between 60 to 80%, protein between 15 to 26% and 2 to 13% for fat, the fat content of fish varies with species, age, size and also season (Pearson and Cox, 1976). Sometimes, fish doesn't get dried at once due to a number of variables and when this happens, it gives room for microbial infection. This study, in addition to

evaluating the effect of different temperatures on the nutrient composition of dried *Clarias gariepinus* fish, also seeks to determine the kinds of microbes that affect fish that is not properly dried.

II. Materials and Methods

Processing of Harvested Fish

Twenty freshly caught adult African catfish, *Clarias gariepinus* each weighing about 1Kg were collected from the fish production unit of the Department of Fisheries Technology, Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. The samples were carried live in coolers to the laboratory of same department for preparation and processing.

The fish samples were killed, eviscerated and washed with clean water. The fleshy part of samples was cut into uniform size pieces each weighing about 100g for effective drying. The cut pieces were left on a sieve for about 30 minutes to allow removal of surface water before drying.

The Electric oven was pre-heated to the desired temperature of 250^0C using the temperature regulator. The samples were arranged in the drying tray, placed in the oven ready for drying. Weights of samples were taken at intervals of 30 minutes with an electronic scale (Capacity: 5000g x 177oz x 0.10z) until an average weight of 33g was reached. The procedure was repeated at temperature of 200^0C, 150^0C and 100^0C respectively.

Proximate Analysis

The proximate compositions were assayed to determine the percentage of crude protein, ether extract, crude fiber, Ash and moisture content present in the samples. Crude protein was determined using the Kjeldahl method (Chang, 2003). The total Nitrogen was determined and multiplied with factor 6.25 to obtain the protein content. The method of James (1995) was employed to determine Crude fibre. By difference, the weight of fibre was obtained and expressed as a percentage of the weight of the sample analyzed. It was given by the formula below:

$$\% \text{ Crude fibre} = 100 \frac{(W2-W3)}{\text{Wt of Sample}}$$ (Ilodibia et al., 2014)

Where W_2 = Weight of crucible + sample after boiling, washing and drying.

W_3= Weight of crucible + sample of ash

Ash was determined using the furnaces incineration gravimetric method described by James (1995) and AOAC (1984). Five grams (5.0g) of the processed sample was measured into a previously weighed porcelain crucible. The sample was burnt to ashes in a muffle furnace at 550^0C. When it had become completely ashed, it was cooled in a desiccator and weighed. The weight of ash obtained was calculated by difference and expressed as a percentage of the weight of sample analyzed as shown below:

$$\%\text{Ash} = \frac{100}{1} \text{x} \frac{(W2-W1)}{\text{Wt of Sample}}$$ (Ilodibia et al., 2014)

Where W_1 = Weight of empty crucible

W_2 = Weight of crucible + Ash

Determination of Moisture Content was done by the gravimetric method described by the AOAC (1990). The weight of moisture lost was calculated and expressed as a percentage of the weight of sample analyzed. It was given by the expression below:

$$\% \text{ Moisture content} = \left(\frac{100}{1}\right) \text{x} \left(\frac{W2-W3}{W2-W1}\right)$$ (Ilodibia et al., 2014)

Where W_1 = Weight of empty moisture can

W_2 = Weight of empty can + sample before drying

W_3 = Weight of can + Sample dried to constant weight

Ether Extract was determined by extracting fat with petroleum ether. The weight of extract, used to determine crude fat, was calculated as a percentage of the weight of sample analyzed.

$$\% \text{ Crude fat} = \frac{(W2-W1)}{\text{Wt of Sample}} \text{ x } \frac{100}{1}$$ (Ilodibia et al., 2014)

Where W_1= Weight of empty extraction flask

Where W_2 = Weight of flask + fat extract

Microbiological Analysis

The method of International Commission on Microbiological Specification of Foods was employed for the determination of microbial load. Bacteria culture was incubated at 37^0C for 24-48hours. Fungi culture plates were incubated at room temperature (28^0C-32^0C) for 2-5 days. The incubating plates were examined daily for growth. On establishment of growth, the number of colonies in each plate was counted and estimated accordingly.

The formula below was used(Hedges, 2002).

$$\text{TVC (cfu/g)} = \frac{1}{\text{VxNxD}}$$

Where N = No of colonies counted
V = Vol. of inocula
D = Dilution factor
Microbial Load was calculated from the following relationship:

$$\% \text{ Occurrence} = \frac{\text{Number positive}}{4} \text{ x } \frac{100}{1}$$

Statistical Analysis

Statistical package for the Social Sciences (SPSS) version 21 was used to analyze the data. Data obtained from the test was subjected to analysis of variance (ANOVA). Significant differences between the various treatments means was carried out using the Duncan multiple range test while the mean ± standard deviation of data obtained was determined using descriptive statistics.

III. Results

The proximate compositions of fresh and Oven-dried catfish are presented in Table 1. Each value is the mean ± standard deviation of triplicate determinations. The dried samples had mean crude protein content of 58.70%, ether extract 15.87%, crude fibre 0.46%, ash 13.41% and moisture content 9.02%. The bacteria found were *Bacillus spp,Staphylococcus spp*, *Pseudomonas spp* and *Serratiaspp* while the fungi identified were *Penicillumspp*, *Aspergillusspp*, and yeast (Table 2). The microbial loads at the different temperatures are shown in Table 3. Moisture content of dried fish was highest at 200^0C (10.06±1.22) and lowest at 250^0C (8.46±0.26). The moisture content at 150^0C (8.71±0.77) and 250^0C (8.46±0.26) falls within the recommended safe moisture content of dried fish (6-8%).The analysis indicated a fat content of 17.75±2.49, 17.14±2.86 and 16.02±2.52 at 100^0C, 200^0C and 250^0C respectively. Fat content of 12.57±2.78 at 150^0C indicates that the fat loss phenomenon was more intensive at 150^0C than at the other temperatures used. The ash content of fresh *Clarias gariepinus* was 2.19% which significantly increased ($p<0.001$) to mean value of 13.41% dried at different temperatures. It was lowest at 100^0C (10.42±0.45) and highest at 150^0C (15.55±0.63). Crude protein ranged from 0.17±0.29 at 250^0C to 0.79±0.13 at 200^0C. There was increase in crude fibre of fresh *Clarias gariepinus* from 0.12 to mean value of 0.46% in samples dried at the different temperatures. Ether extract, Crude fibre and moisture content showed no significant difference ($p>0.05$) for all temperatures used. *Bacillus spp, Staphylococcus spp* and yeast had the highest percentage occurrence of 100% while the least occurrence of 25% was recorded in *Serratiaspp*occurring in fish dried at 250^0C. *Aspergillusspp* occurred in samples dried at all temperatures except 250^0C with a percentage occurrence of 75%. *Pseudomonasspp* and *Penicillumspp* had a percentage occurrence of 50%.The occurrence of these microbes have also been reported by Abidemi- Irominiet al. (2011) on fresh samples of *Clarias gariepinus.*

Table 1: Proximate composition of Fresh and Oven-dried *Clarias gariepinus*.

	Fresh	250^0C	200^0C	150^0C	100^0C	Mean±SD	Sig.
Crude Protein	17.18±3.63	59.85±1.85	57.98±2.46	63.33±3.02	53.67±3.86	58.70±4.39	*
Ether Extract	2.35±2.95	16.02±2.52	17.14±2.86	12.57±2.78	17.75±2.49	15.87±3.09	ns
Crude Fibre	0.12±2.95	0.17±0.29	0.79±0.13	0.47±0.49	0.42±0.72	0.46±0.46	ns
Ash	2.19±1.12	14.35±0.57	13.33±0.13	15.57±0.63	10.42±0.45	13.41±2.02	**
Moisture Content	76.46±2.00	8.46±0.26	10.06±1.22	8.71±0.77	9.08±0.79	9.07±0.95	ns

* means significant ($p<0.05$); ** means significant ($P<0.001$); ns means not significant ($P>0.05$).

Table 2: Occurrence of microbes following incomplete drying at different temperatures.

Microbes	250^0C	200^0C	150^0C	100^0C	% Occurrence
Bacillus spp(B)	+ve	+ve	+ve	+ve	100
Staphyloccucusspp(B)	+ve	+ve	+ve	+ve	100
Pseudomonas spp(B)	+ve	+ve	-ve	-ve	50
Serratiaspp(B)	+ve	-ve	-ve	-ve	25
Penicillumspp(F)	-ve	+ve	-ve	+ve	50
Aspergillusspp(F)	-ve	+ve	+ve	+ve	75
Yeasts (F)	+ve	+ve	+ve	+ve	100

B-Bacteria; F-Fungi; +ve – microbes occurred at given temperature; -ve – microbes didnot occur at given temperature.

Table 3: Microbial load resulting from incomplete Oven-drying of *Clarias gariepinus* at various temperatures.

Microbes	250^0C	200^0C	150^0C	100^0C	Mean±SD
Bacteria ($x10^4$)	14.77±2.80	19.57±2.48	11.23±2.04	12.33±0.55	14.47±3.81
Fungi ($x10^2$)	3.33±1.53	5.57±4.45	6.33±1.52	10.10±1.06	6.33±3.33

IV. Discussion

Raw samples presented low protein and ash while the composition of moisture indicated a high content in the samples analyzed. This agrees with results of earlier researchers such as Effiong and Mohammed (2008)and Abdullahi (2001) where raw samples in their analyses showed low protein and ash content. The lower moisture content supports a longer shelf-life of the product as it hinders the growth of mould (Okparaku and Mgbenka, 2012). For prolonged shelf life, fish drying is encouraged at all temperatures (Clucas, 1982). Clucas (1982) reported that a fish well dried such that the moisture content reduced to below 15% will not be conducive for the growth of moulds and this will increase the shelf -life.

The significant increase in protein levels ($P < 0.05$) in dried catfish when compared with the raw fish is due to the fact that fresh fish samples have high moisture content. When dried, the moisture content is drastically reduced and the nutrients, especially protein is concentrated, hence the higher values (Olayemiet al., 2011). This is in agreement with the findings of (Puwasteinet al., 1999; Gokogluet al., 2004; Tao and Linchun, 2008). Composition of crude protein was highest in samples dried at 150^0C (63.33 ± 3.02) and lowest in those dried at 100^0C (53.67 ± 3.86). Bacterial load was highest in samples dried at 200^0C (19.57±2.48). This may be as a result of the high moisture content of samples dried at same temperature since the higher the moisture content, the more susceptible to infection. The least bacterial load was recorded in samples dried at 150^0C (11.2±2.04). This may be as a result of the least moisture content recorded in sampled dried at this temperature. The least bacterial load recorded for samples dried at 150^0C may be responsible for the high crude protein and ash content recorded at same temperature. Fungal load was highest in samples dried at 100^0C which may also be as a result of the high moisture content at same temperature. The least fungal load was recorded at 250^0C. This may also be attributed to the reduced moisture content at the same temperature.

V. Conclusion

Dried fish has always played a very important part in our diet being a precious commodity especially in areas without direct access to water. Therefore, method of processing is important to obtain a high quality product. This study presents the relationship between drying temperature and nutrient composition of dried fish. For a high ash and protein content, fish drying is encouraged at 150^0C. Fish dried at 100^0C could denature the fish protein. The shelf life of the product will increase at lower moisture content hence hindering the growth of mould. Fish becomes highly susceptible to microbial infection when not properly dried. Therefore, fish should be properly dried at whatever temperatures to avoid microbial infections and prolong the shelf life. This study provides information on basic carcass composition of the African catfish using electric oven drying for the drying process.

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