Original Research Article

Effects Of Bleeding And Gutting Procedures On The Nutritional Value Of Smoke- Dried *Clarias Gariepinus* Under Storage At Room Temperature

ABSRACT

This experiment was aimed at determining the effect of bleeding and gutting procedures on the nutritional value of smoked catfish (*Clarias gariepinus*) under storage at room temperature.

Fresh samples were collected and various treatments were applied on them. The fish samples collected were divided into four parts (samples A, B, C, D). Sample A (neither bled nor gutted), sample B (bled but not gutted, sample C (gutted but not bled), and sample D (bled and gutted). The nutritional compositions of the fresh and smoke - dried fish under ambient storage were analyzed.

The results obtained in this study indicated that the nutritional value of fresh fish samples was;, moisture content which ranged from 52.00 ± 2.000% (sample D) to 55.00 ± 1.000% (sample A); crude protein: 22.95 ± 1.420% (sample A) to 26.070 ± 1.28% (sample D); crude fat: 7.467 ± 0.75% (sample C) to 11.123 ± 1.120% (sample D) and crude fibre: 0.22 ± 0.020% (sample B) to 0.683 ± 0.142% (sample C). Immediately after smoking, the nutritional value was; moisture content which ranged from 10.53 ± 0.252% (sample C) to 13.900 ± 0.1% (Sample A); crude protein: 54.80 ± 0.265% (sample A) to 58.47 ± 0.459% (sample D); crude fat: 14.00 ± 0.100% (sample D) to 16.33 ± 0.306% (sample B) and crude fibre: 1.460 ± 0.633% (sample D) to 1.74 ± 0.060% (sample A). After two months of storage, the nutritional value was; moisture content which ranged from 13.06 ± 0.053% (sample D) to 15.37 ± 0.551% (sample A); crude protein: 52.40 ± 1.510% (sample A) to 56.08 ± 0.576% (sample D); crude fat: 13.90 ± 0.100% (sample D) to 16.00 ± 0.200% (sample B) and crude fibre: 1.33 ± 0.130% (sample C) to 1.727 ± 0.025% (sample D). The result showed that bleeding and gutting procedures were efficient methods in fish processing in terms of the retention of the crude protein value, moderate fat content and reduction in moisture content. The result also revealed that gutting was more efficient method in enhancing the nutritional value of fish.

Keywords: Nutritional value, Smoke- drying, *Clarias gariepinus,* Bleeding and Gutting.

INTRODUCTION

Fish is one of the most important sources of animal protein and has been widely accepted as a good protein source and other elements for the maintenance of healthy body (Ravichandran *et al*., 2012). It is cheap and highly acceptable with little or no religious bias, which gives it an advantage over pork or beef (Eyo, 2011; Ligia, 2002). According to Adekoya and Miller (2004), globally, fish and fish products constitute more than 60% of the total protein intake in adults, especially in the rural areas. Fish has the potential to be considered as a balanced food and can therefore be expected to provide relief from malnutrition (Ogundiran *et al*., 2014). It also has a high economic value for many countries because it represents the largest share among agribusiness products on the global market (Silva *et al*., 2008).

The quality of fish is influenced by a number of factors which include: temperature, handling practices and initial microbial load. In farmed fish, particularly catfish, other factors which can influence quality include the fish feed used, bleeding and stress. Bleeding operation soon after capture or harvest contributes substantially to consumer acceptance based on colour appearance of fresh fish (Ahimbisibwe *et al*., 2010). The nutritive values of fish might be affected by processing or cooking methods (Weber *et al*., 2008; Ersoy and Ozeren, 2009).

Smoking is the process through which volatile substance from combustion of wood penetrates fish or meat flesh. The phenomenon is based on incomplete combustion followed by thermal disintegration or pyrolysis of high molecular mass which becomes volatile at the smoking temperature while the wood used for smoke generation are composed of cellulose, hemicelluloses and lignin; the compounds reputed to be of most importance in smoke flavouring are produced from the pyrolysis of lignin fraction. Heat generated as a result of smoking dehydrate, inhibits bacteria growth, retard enzymatic actions, add aroma, taste and colour in processed fish. Smoking is affordable and most widely used method for fish preservation in Nigeria, Ghana and other West African countries (Nyarko, 2011).

Fish smoking is a traditional method of processing globally; it accounts for about 3% of the world's catch and also increases the shelf-life (Olowoniyan *et al*., 1998). The flesh of smoked fish is delicate, succulent, delicious and can be readily consumed without further processing (Eyo, 2001). Smoking involves the application of heat to remove water and inhibit bacterial and enzymatic action on fish. In addition, Co-operative Extension Service (2012) observed that smoking fish for a short time offers the best quality product for canned fish in Nigeria.

This study is therefore aimed at determining the effects of bleeding and gutting procedures on the nutritional value of smoke- dried *Clarias gariepinus* under storage at room temperature.

MATERIALS AND METHOD

Collection of Samples

Sixteen freshly harvested catfish (*Clarias gariepinus*) were obtained from fish farm of the Department of Fisheries, Faculty of Agriculture, University of Benin, Benin city, Edo State, Nigeria. Same size and weight of fish were carefully selected with each weighing 0.9kg and body length of 50cm. The fishes were shared into four parts, with each part containing four fish and were labeled A to D.

Sampling Procedure

Sample A was neither bled nor gutted, sample B was bled but not gutted, sample C was gutted but not bled, and sample D was bled and gutted samples. The methods of applying treatments are shown in Table 1.

Table 1: Treatments application plan

Batch No.	Number of fish per batch	Types of sample	Type of treatment applied
A	4	Neither bled nor gutted	They were hit on the head and then washed thoroughly.
B	4	Bled but not gutted	They were beheaded and turned upside down for blood to drip out and then washed thoroughly to remove slime and blood.

C	4	Gutted but not bled	They were hit on the head, left for some minutes for fish blood to coagulate, then eviscerated through the mouth and opening of the operculum to avoid bleeding and washed thoroughly to remove slime.
D	4	Bled and gutted	They were beheaded and turned upside down to drip blood out, eviscerated with the fish belly cut open, and then washed thoroughly.

Fish-Smoking Process

The fish were smoke-dried for 24 hours using Magbon- Alade smoking kiln to constant weight, with a temperature of 80^0C. Moisture loss was determined after smoke-drying.

Determination of Nutritional Value

Percentage moisture, protein, crude fibre, fat, ash and Nitrogen Free Extract (NFE) contents according to AOAC (2000) were determined on the fish when fresh and immediately after smoke-drying. They were all wrapped in brown papers and stored in a cool and dry place. After which, it was also determined after two months of ambient storage.

STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was employed to ascertain differences between the results from the experiment. All data analyses were done in triplicate using Duncan's Multiple Range Test ($p < 0.05$) to study the difference between means.

RESULTS

Table 2 shows the nutritional value of fresh samples (A, B, C & D) applied with various treatments. The result indicated that the percentage moisture content was highest in sample A (55.00 ± 1%) and lowest in sample D (52.00 ± 2.000%).
Crude protein was highest in sample D (26.07 ± 1.280%) and lowest in sample A (22.95 ± 1.420%). The percentage ash content of the four samples were significantly different from each other with samples A (10.27 ± 0.250%) and B (8.53 ± 0.420%) having the highest and lowest values respectively. The percentage crude fat (ether extract) level was highest in sample D (11.133 ± 1.120%), and the least value was obtained in sample C (7.467 ± 0.750%).
The highest percentage crude fibre content was recorded in sample C (0.683 ± 0.142%), while the least was observed in sample B (0.220 ± 0.020%).
The percentage NFE value was highest in sample C (1.70 ± 0.020%) and lowest in sample B (0.697 ± 10.020%).

Table 2: Mean Nutritional values of fresh *Clarias gariepinus* applied with various treatments

Nutritional	Sample A	Sample B	Sample C	Sample D	SED

values	(Neither bled nor gutted)	(Bled but not gutted)	(Gutted but not bled)	(Gutted and bled)	
Moisture	55.00±1.000^{a}	54.33±1.160^{ab}	54.33±0.580^{ab}	52.00±2.000^{b}	1.16
Crude protein	22.95±1.420^{b}	25.79±0.440^{a}	26.02±0.950^{a}	26.07±1.280^{a}	0.99
Ash	10.27±0.250^{a}	8.53±0.420^{c}	9.80±0.600^{ab}	8.87±0.760 ^{bc}	0.45
Crude fat	10.067±0.660^{a}	10.433±0.910^{a}	7.467±0.750^{b}	11.133±1.120^{a}	0.79
Crude fibre	0.563±0.070^{a}	0.220±0.020^{b}	0.683±0.142^{a}	0.677±0.180^{a}	0.11
NFE	1.157±0.020^{c}	0.697±0.020^{d}	1.70±0.020^{a}	1.597±0.020^{b}	0.02

Means of the same superscript are not significantly different from each other ($p > 0.05$) across each row in the table.
SED – Standard Error of Differences of mean.

The mean nutritional values of *Clarias gariepinus* immediately after smoking are shown in Table 3. The result indicated that the percentage moisture content was highest in sample A (13.90 ± 0.91%), lowest in sample D (11.06 ± 0.053%) and there was significant difference between the four samples collected.
The highest percentage crude protein was recorded in sample D (58.47 ± 0.459%) and lowest in sample A (54.80 ± 0.265%).
The percentage ash content was highest in sample D (14.10 ± 0.656%) but lowest in sample A (13.20 ± 0.265%). There was no significant difference between the four samples collected.
The highest percentage crude fat was recorded in sample B (16.33 ± 0.306%) and lowest in sample D (14.00 ± 0.1%). There was significant difference ($P < 0.05$) between samples B (16.33 ± 0.306) and D (14.00 ± 0.1), which were significantly different from samples A (15.37 ± 0.513%) and C (15.67 ± 0.153%).
The percentage crude fibre level was highest in sample D (14.60 ± 0.633%), lowest in sample A (1.74 ± 0.06%) and there was no significant difference between the four samples.
The percentage NFE content was highest in sample A (0.987 ± 0.309%) and lowest in sample B (0.76 ± 0.046%). There was no significant difference between samples C (0.627 ± 0.194) and D (0.63 ± 0.11) but were significantly different from samples A (0.987 ± 0.309) and B (0.76 ± 0.46).

Table 3: Mean Nutritional values of *Clarias gariepinus* immediately after smoke-drying

Nutritional values	Sample A (Neither bled nor gutted)	Sample B (Bled but not gutted)	Sample C (Gutted but not bled)	Sample D (Bled and Gutted)	SED
Moisture	13.90±0.100^{a}	11.47±0.610^{b}	10.53±0.252^{c}	11.06±0.053^{bc}	0.25
Crude protein	54.80±0.265^{d}	56.22±0345^{c}	57.83±0.176^{b}	58.47±0.459^{a}	0.26
Ash	13.20±0.265^{a}	13.68±0.861^{a}	13.80±0.346^{a}	14.10±0.656 ^{a}	0.41
Crude fat	15.37±0.513^{b}	16.33±0.306^{a}	15.67±0.153^{b}	14.00±0.100^{c}	0.23
Crude fiber	1.74±0.060^{a}	1.543±0.150^{a}	1.527±0.064^{a}	1.460±0.633^{a}	0.28

NFE	0.987 ± 0.309^{a}	0.76 ± 0.046^{ab}	0.627 ± 0.194^{b}	0.63 ± 0.110^{b}	0.13

Means of the same superscript are not significantly different from each other ($p > 0.05$) across each row in the table.
SED – Standard Error of Differences of mean

Table 4 shows the nutritional values of *Clarias gariepinus* after two months of storage at room temperature.
The result indicated that the percentage moisture content was highest in sample A (15.37 ± 0.551%) and lowest in sample D (13.06 ± 0.053%). There was no significant difference between samples A and B (14.80 ± 0.436), but both were significantly different from samples C (13.80 ± 0.346) and D (13.06 ± 0.053).
The crude protein was highest in sample D (56.08 ± 0.576%) and lowest in sample A (52.40 ± 1.510%). There was significant difference between all the samples collected.
The percentage ash content was highest in sample D (14.00 ± 0.3%) and lowest in sample A (13.10 ± 0.265%), but there was no significant difference between the four samples.
The highest percentage crude fat was recorded in sample B (16.00 ± 0.2%) and lowest in sample D (13.90.00 ± 0.1%). All the samples collected were significantly different from each other for the percentage crude fat content.
The highest percentage crude fibre was in sample D (1.727 ± 10.025%) and the lowest in sample C (1.33 ± 0.13%). Samples A (1.64 ± 0.262%) and B (1.40 ± 10.4%) were not significantly different from samples C (1.33 ± 0.13) and D (1.727 ± 0.025).
The percentage NFE content was seen to be highest in sample A (0.90 ± 0.1%) and lowest in both samples C (0.530 ± 0.03%) and D (0.530 ± 0.01%). The values in samples C (0.530 ± 0.03%) and D (0.530 ± 0.01%) were similar and there was no significant difference between them and sample B (0.563 ± 0.071%), three of them were significantly different from sample A (0.90 ± 0.1).

Table 4: Mean proximate values of smoke-dried *Clarias gariepinus* after two months of ambient storage.

Nutritional values	Sample A (Neither bled nor gutted)	Sample B (Bled but not gutted)	Sample C (Gutted but not bled)	Sample D (Bled and Gutted)	SED
Moisture	15.37 ± 0.551^{a}	14.80 ± 0.436^{a}	13.80 ± 0.346^{c}	13.06 ± 0.053^{c}	0.30
Crude protein	52.40 ± 1.510^{c}	53.20 ± 0.917^{bc}	55.00 ± 100^{ab}	56.08 ± 0.576^{a}	0.97
Ash	13.10 ± 0.265^{a}	13.50 ± 0.500^{a}	13.60 ± 0.721^{a}	14.00 ± 0.300^{a}	0.43
Cude fat	15.10 ± 0.755^{b}	16.00 ± 0.200^{a}	15.37 ± 0.07^{ab}	13.90 ± 0.100^{c}	0.31
Crude fibre	1.64 ± 0.262^{ab}	1.40 ± 0.400^{ab}	1.33 ± 0.130^{b}	1.727 ± 0.025^{a}	0.14
NFE	0.90 ± 0.100^{a}	0.563 ± 0.071^{b}	0.530 ± 0.030^{b}	0.530 ± 0.010^{b}	0.05

Means of the same superscript are not significantly different from each other across each row in the table.
SED – Standard Error of Differences of mean

DISCUSSION

Proteins, lipids and moisture contents were the major constituents, which were considered in evaluating the nutritional value of the fishes studied.

The highest moisture content found in the fresh unbled and ungutted *Clarias gariepinus* may be due to the presence of visceral and blood in the fish, while the lowest moisture content recorded in sample D may be due to the bleeding and gutting of the fish prior to smoking. Goulas and Kontominos, (2005) reported that the moisture content of smoked mackerel was 58.1% and 59%. Koldzejska *et al*. (2002) also reported that the moisture content of smoked mackerel was 56.7%. Here, the results of moisture content (13.090 ± 0.1%, 11.47 ± 0.61%, 10.53 ± 0.252%, 11.06 ± 0.053) were less than this value. This might be due to the various treatments applied prior to smoking, such as gutting and bleeding. The crude protein is lowest in sample A due to high amount of moisture, while crude protein is recorded highest at sample D, which may be due to lowest amount of moisture, leading to higher crude protein value. Similar results were obtained by Daramola, *et al*. (2007) and Kumolu-Johnson *et al*. (2010) who worked on *Clarias gariepinus* and Egbal *et al*. (2010) who worked on *Oreochromis niloticus* and *Clarias lazera*. The ash content was recorded highest at sample A, while the ether extract was recorded highest at sample D and crude fibre highest at sample C, followed by sample D. The NFE is given by difference; that is, the percentage of moisture protein, fat and ash subtracted from 100. NFE was low because fish is highly proteinous.

The results of the nutritional composition of the fish samples immediately after smoking indicated the percentage moisture decreased from the value of fresh *Clarias gariepinus* to the smoke-dried ones. This is due to application of heat. The initial heating process, which was very high (80^0C) led to quick evaporation of moisture from the fish. The heating process resulted in a gradual reduction in moisture content of the fish. The crude protein in the mean proximate composition was found to increase due to an increase in dry matter content per unit weight following sample dehydration (Steffens, 2006). Similar findings were reported by Unlusayin and Gulyavuz, (2001) in European eel, pike perch and rainbow trout. Industrial specifications for "smoked finished products" generally is recommended with water content in the fish flesh of less than 65% Cardinal *et al*. (2001). This is also in line with the report of Daramola *et al*. (2007) in smoke-dried fish of different species. Smoking decreases the water activity in fish tissue. Percentage crude fat (lipids) increased on smoking. This may be attributed to the liquefaction of fat the fish sample due to heat. The increase in ash and crude fibre can be attributed to an increase in the dry matter content per unit weight following sample dehydration and during the smoking process (da Silva, 2002). These results agreed with the work of Omojowo *et al*. (2008); Omojowo *et al*. (2009) and da Silva *et al*. (2008). An increase in the value of ash from the fresh fish sample to the dry fish sample could be as a result of thermal effect on the elements contained in the fish sample. Fapohunda and Ogunkoya (2006) reported that smoke drying methods increased the protein, ash and fat contents of *Clarias gariepinus*. Salan *et al.* (2006) observed decrease of moisture, carbohydrate, potassium and vitamin C contents and increase of protein, ash, crude fiber, and phosphorus and iron contents in smoked *Clarias gariepinus*. The authors further noted that the increase in ash content in the smoked fish was due to the loss of humidity and that the significant reduction in the moisture content when the fish was smoked was a result of the loss in moisture during hot smoking. Also, in the corresponding smoked products, the percentage of total protein, lipid and ash contents increased due to water loss during smoking. The result of the nutritional composition showed that the higher moisture content, the lower the value of other nutritional components, while the lower the moisture content, the higher the values of other nutritional components. Earlier reports by Daramola *et al*. (2007 are in agreement with findings in this study.

The nutritional value of smoke-dried *Clarias gariepinus* after two months of ambient storage is as shown in Table 4. It was deduced that the smoke-dried *Clarias gariepinus* absorbed moisture during the two months of ambient storage. This implies microbial multiplication, which was encouraged by higher moisture content. The crude protein was found to decrease. This is because spoilage has set in. The reduction in crude protein during the storage period may be due to gradual degradation of the initial crude protein to more volatile products, such as Total volatile Bases (TVB). Similar results were obtained by Daramola *et al.* (2007), who stated that low protein value recorded in two months stored sample may also be due to denaturation of fish protein associated with the leaching out of some extractable soluble protein fraction (Daramola *et al*., 2007). The crude protein was found highest at sample D, followed by sample C and lowest at sample A. This may be due to the high amount of moisture in sample D, which resulted to the highest crude protein value in sample D. Smoke-dried fish samples showed a reduction in crude fat during storage period. This may be due to the heating effect of drying (Pace *et al*., 1989) and oxidation of poly-unsaturated fatty acid (PUFA) to products such as peroxide, aldehydes, ketones and the free fatty acids (Daramola *et al*., 2007). The highly susceptibility of fish to oxidative rancidity resulted from the high degree of unsaturation in the form of multiple double bonds in fatty acids (Obemeata *et al*., 2011). The ash content was found to decrease from pre-storage to post-storage ash content. This is due to absorbance of moisture and loss of protein. Similar results were obtained by Effiong and Mohammed (2008), Mumba and Jose (2005) and Abdullahi (2001). The crude fibre was also found to decrease. From the result shown in table 4, there was slight decrease in the post-storage NFE of all the samples collected. This is also in line with the analysis carried out by Effiong and Mohammed (2008); Mumba and Jose (2005) and Abdullahi (2001).

CONCLUSION

There was significant influence of bleeding and gutting procedures on the nutritional value of catfish, *Clarias gariepinus*. The bled and gutted sample had the highest crude protein, moderate fat content and the lowest moisture content. Bleeding and gutting procedures carried out in fish processing are efficient because of its relatively high value of protein content in the fish's flesh. Some fish species quality and shelf life can be increased much more if they are bled and the viscera removed, as gutting and bleeding practices remove the fish intestine, limiting access of most spoilage bacteria.

The result also revealed that the two treatments applied were efficient but gutting was more efficient method in fish processing in terms of the retention of the percentage crude, protein value, moderate fat content, reduction in moisture content. The knowledge obtained in this study could improve the preservation strategies of dried fish and thus prolong the shelf life of fish species.

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