Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol .11, 2013

Effect of Processing Methods on Nutritive Value of Catfish (*Clarias gariepinus)*

[1]Ayeloja, A. A.; [2]George, F.O.A.; [2]Akinyemi, A. A.; [1]Jimoh, W. A.; [3]Dauda, T. O. and [4]Akinosho, G. A.

[1]Fisheries Technology Department, Federal College of Animal Health and Production Technology Moor Plantation, PMB 5029 Ibadan
[2]Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta (UNAAB) PO Box 2240 Abeokuta
[3]Department of Statistics Institute of Agric Research and Training Moor Plantation, PMB 5029 Ibadan
[4]Department of Computer Science, Federal College of Animal Health and Production Technology Moor Plantation, PMB 5029 Ibadan
* E-mail of the corresponding Author: ayeloja2@gmail.com, aye_ayo@yahoo.com +2348032111426

Abstract

This study was carried out to determine the effect of processing methods on catfish (*Clarias gariepinus).* A total of fifty four catfish (*Clarias gariepinus)* were used for the experiment. The average weight of the fish used was 500g. The experimental design was Complete Randomized Design (CRD) with the treatments been the processing methods (smoking, frying and boiling) all replicated thrice. The adopted indices of fish quality assessment of the samples collected were organoleptic assessment, proximate composition and microbial analysis. There was significant difference ($P < 0.001$) among the group respondent over a period of 5 days with the chi-square statistics test ($\chi^2 = 51.436^{xxx}$) for boiled fish, ($\chi^2 = 54.464^{xxx}$) for fried fish and ($\chi^2 = 77.348^{xxx}$) for smoked fish samples. The result suggested that protein quality will be better retained from smoked fish samples than fried fish samples left at ambient over days as there was no significant difference ($p < 0.05$) in the crude protein of the smoked fish samples between day 1 and the day 5 of the experiment while significant difference ($p < 0.05$) existed between day 1 and day 5 in fried fish samples. The microorganisms found on the fish samples included *Bacillus spp, Staphylococcus spp and Pseudomonas spp.*
Keywords: smoking, frying, boiling and catfish

Introduction

The global consumption of fish and derived fish products has greatly increased during recent decades, due to a number of distinct factors (Wim *et al.*, 2007). Foremost among these factors is the growing knowledge that fish constitute an important and healthy part of the human diet, mainly owing to the presence of ω-3 polyunsaturated fatty acids (PUFA), which play an essential role in human health (Ruxton *et al.*, 2004), also to the presence of vitamins, minerals and proteins with a high biological value. Consequently, it is a well-known fact that fish represent a high-quality nutritional source (Sidhu, 2003). Fish demand is also increasing as a result of the increasing world population, higher living standards and the good overall image of fish among consumers (Cahu *et al.*, 2004). Fishes are rich source of protein commonly consumed as an alternative source of protein due to the higher cost of meat and other sources of animal protein (Omolara and Omotayo, 2009). Harris (1997) also reported that fish has lower cholesterol content when compared with meat and thus often recommended for consumption especially among the adult population. 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). Previous workers had reported the effects of some processing methods on different fish types (Greenfield and Kosulwat, 1991), it was reported that the type of food and cooking procedures influence the fat content and other nutrients. The fat content of raw fishes can also influence fat exchanges and interactions between the culinary fat and that of the fish during processing (Sanchez-Muniz, 1992). There seems to be a scarcity of information on the effect of processing methods on the nutritive value of Nigeria fish species thus this study investigates the effect of processing methods on the nutritive value of *Clarias gariepinus.*

Materials and Methods

Materials and Preparation of Sample

Clarias gariepinus and *Oreochromis niloticus* were bought by 8am at Eleyele fish landing site Ibadan Oyo State Nigeria. These fishes were chosen because they were the fish just landed by the artisanal fishermen on the day of this experiment; they are usually available, cheap and affordable by Nigerian. They were transported within one hour in a cooler made from Polyethylene terephthalate (plastic) and packed with iced block, they were taken to the fish processing laboratory of Federal College of Animal Health and Production Technology Moor Plantation Ibadan Oyo State Nigeria. They were gutted, thoroughly washed using clean tap water, cut into about 50g-pieces and washed again with tap water. The head region was discarded. The fish samples were then separated into four parts. One part was boiled in water; the second part was deep-fried with vegetable oil in a frying pan while the third part was smoked using a local mud type smoking kiln with heat and smoke from *Anogeissus leiocarpa* (locally known as Ayin). *A. leiocarpa* was used because it is a hardwood believed to generate heat smoke with greater preservative potential than smoke from soft wood (Eyo, 2001).

Fish Processing Procedure

The boiling was done using clean tap water and the water was kept boiling for about 30 minutes until the pieces were well cooked and tender. The deep – frying was done in vegetable oil in a frying pan on hot flame with occasional turning in order to achieve even frying. Frying was achieved within 18 minutes and the temperature was about 240ºC. Fish smoking was done using a local mud type smoking kiln and it was completed within 5hours. The fish samples were immersed in 8% brine prior to processing.

Analytical Procedures

Three replicates of each treatment were randomly selected for proximate and microbial analysis while the rest were used for sensory evaluation using hedonic scale modified from Eyo (2001) and Tobor (1994) and a ranking scale which test specific attributes of the fish products.

Proximate Analysis

The determination of the crude protein, moisture, ash and fat contents of the raw and smoked fish were carried out in triplicates in accordance with AOAC (1995).

Microbiological Analysis

Culture Media Preparation and Sterilization:

Nutrient Agar (NA) and Sabourand Dextrose Agar (SDA) were used. In preparing the media, 28 g of NA was dispersed in 1 litre of ionized water. But 250ml each was needed; so 7g of NA and 15.5g of SDA were used. The weighed media were mixed with the water in a conical flask, autoclaved for 15mins at 121°c and left to cool. The top of the conical flask was wrapped with foil to prevent contamination (Pelczar, 1977). The area (bench) where the work was done was properly cleaned with disinfectant soap and water, wire loop was flamed before and after use.

Preparation of Sample for Serial Dilution:

A ten-fold serial dilution was made. For each fish sample, four (4) test tubes were used for the serial dilution. The test tubes were filled with 9ml of deionized water. For the fresh fish, swab stick was used to swab the body (external part), then the fish was cut open and the accessory breathing organs ,gills and intestine (internal parts) were used for the experiment. For the smoked fish, the skin was used. 1g of these samples were transferred into the assigned test-tube (making it 10ml) and thoroughly mixed. Further sequential dilutions were made by taking 1ml of 10ml mixture to other test-tubes.

Culturing, Incubating, Colony Count:

After the serial dilution,1ml of each sample, taken from the 3rd and 4th test-tubes were transferred to a petri-dish that has been appropriately labeled with marker. The pour plate method was used for culture (Fankhauser, 2005). The petri-dish was shaken in an anti clockwise direction to enable the agar that was poured into it set and spread out evenly. The plates of bacterial count were kept in the incubator at 37°c for 24hours. All the Petri-dishes were incubated upside down (Pelczar, 1977), after 24 hours, the bacterial count was done. Colonies appeared as clusters and each plate was counted and recorded.

Sensory Evaluation

Sensory evaluation was carried out by a 50 men-trained panel from Federal College of Animal Health and Production Technology (FCAH&PT) Moor Plantation Ibadan using a 5-point hedonic scale modified from Eyo

(2001) and Tobor (1994). The following grades were allotted depending on the condition of the fish. 8≥10 = very good, 6≥8 = good, 4≥6 = fair, 2≥4 = bad and ≤2 = worst. The fish odour, flavour and texture were examined while ranking test which is a form of discriminating test aim to evaluate specific attributes of the processed fish was conducted. The characteristics of products tested for include: taste, texture, flavour and colour acceptance. Each taster ranked the processed fish product in 1st, 2nd and 3rd order respectively.

Statistical Analysis

Analysis of variance (ANOVA) was carried out using F-test to determine the treatments level of significance. Treatments were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1955) at 95% confidence value ($P < 0.05$).

Results and Discussion

General characteristics of the processed fish samples (table 1) showed that there was significant difference ($P < 0.001$) among the group respondent (average, dislike very much, dislike, like, like very much) over a period of five days with the chi-square statistics test ($\chi^2 = 51.436^{xxx}$) for boiled fish, ($\chi^2 = 54.464^{xxx}$, $P < 0.001$) for fried fish and ($\chi^2 = 77.348^{xxx}$, $P < 0.001$) for smoked fish samples. The result shows significance difference ($P<0.01$) among the response of the respondent when the taste quality (table 2) of the processed fish was considered for a period of five days with Chi-square value ($\chi^2 = 43.637^{xxx}$) for boiled fish, ($\chi^2 = 37.727^{xxx}$) for fried fish and ($\chi^2 = 44.863^{xxx}$) for smoked fish samples. Similarly, there was significant difference ($P<0.01$) in the response of the respondent when the texture (table 3) of the processed fish were considered with Chi-square value ($\chi^2 = 39.416^{xxx}$) for boiled fish samples, ($\chi^2 = 33.497^{xxx}$) for fried fish and ($\chi^2 = 51.072^{xxx}$) for smoked fish. The respondent established that there was significant difference in the flavour (table 4) of the processed fish product during the period of the experiment with chi-square value ($\chi^2 = 35.159^{xxx}$) for boiled fish, ($\chi^2 = 32.775^{xxx}$) for fried fish and ($\chi^2 = 50.826^{xxx}$) for smoked fish. Significant difference ($P<0.01$) also existed in the way the respondent accepted the colour (table 5) of the processed fish samples with Chi-square value ($\chi^2 = 34.020^{xxx}$) for boiled fish, ($\chi^2 = 48.065^{xxx}$) for fried fish and ($\chi^2 = 38.509^{xxx}$) for smoked fish. The result of the proximate composition of fried and smoked (table 6) catfish (boiled fish samples got spoilt and thus could not be analyzed) shows that processing methods have effect on the proximate composition of processed catfish (Clarias gariepinus) which is similar to the report of Ogbonnaya and Ibrahim (2009) that methods of drying have effects on the proximate compositions of catfish. The result (table 6) shows that there was no significant difference ($p>0.05$) in the moisture content of the fried fish samples between the first two days; however there existed significant difference ($p < 0.05$) between the moisture content of the fried fish samples between the first two days and other days. The moisture content of the smoked fish samples only show significant difference ($P < 0.05$) between day 1 and day 3. Ogbonnaya (2009) reported similar report on the moisture content of dried *Oreochromis niloticus* using different drying methods, this results indicated that drying methods have effects on the nutritional properties of tilapia fish. Similarly, the result obtained in this study shows that there was no significant difference ($p < 0.05$) in the crude protein of the smoked fish samples between the first and the last day of the experiment (table 6) while significant reduction existed between the fifth day and other days in fried fish sample thereby suggesting that better protein quality will be retained from smoked fish samples than fried fish samples when left at ambient over days. Significant difference ($p < 0.05$) existed in the crude lipid of the smoked fish samples consistently between day 3, 4 and 5 which was not the case in fried fish thus suggesting that smoked fish may get rancid earlier than fried fish if left at ambient. Ash content of the fried fish samples shows no significant difference ($P > 0.05$) over the period of the experiment while significant difference ($P < 0.05$) existed in the ash content of the smoked fish samples between the first and the fifth day of experiment, similar result was reported by Oluwaniyi and Dosumu (2009). The microbial count in the sampled boiled, fried and smoked fish samples on daily basis over a period of five days is presented on table 8 which are similar with microorganism found on Bonga fish (*Ethmalosa fimbriata*) by Abolagba and Igbinevbo (2011). Some of the microorganisms found on the fish samples include *Bacillus spp* which produces two types of toxin that causes illness (Gilbert, 1992). The toxin causing the *vomiting* type of disease is heat stable. The toxin causing the *diarrhoeal* type of disease is destroyed by heat. *Bacillus spp* also produces spores that can survive the pasteurization process. *Staphylococcus spp* and *Pseudomonas spp* were also found (table 8) on the processed fish samples. The more *Staphylococcus aureus* bacteria present, the more toxin is produced. Symptoms of *Staphylococcus aureus* eating contaminated food include severe vomiting, with diarrhoea, abdominal pain and

cramps, sometimes followed by collapse (Gilbert, 1992). The microorganisms found on fish samples indicated that HACCP (Hazard Analysis Critical Control Point) should be strictly adhered to in the line of production.

Conclusions

The result obtained in this study shows that there is there no significant difference ($p>0.05$) in the crude protein of the smoked fish samples between the first and the last day of the experiment while significant reduction ($p<0.05$) existed between the fifth day and other days in fried fish sample thereby suggesting that better protein quality will be retained from smoked fish samples than fried fish samples left at ambient over days. Significant difference ($p < 0.05$) existed in the crude lipid of the smoked fish samples consistently between day 3, 4 and 5 which was not the case in fried fish thus suggesting that smoked fish may get rancid earlier than fried fish if left at ambient. Thus it is recommended that HACCP should be strictly adhered to in the line of production. Fish should also be processed immediately after slaughter so as to arrest spoilage process and prevent post harvest fish loss.

REFERENCES

Abolagba, O. J. and Igbinevbo, E. E. (2010). Microbial load of fresh and smoked fish marketed in Benin metropolis, Nigeria. Research Journal of Fisheries and Hydrobiology, 5(2): 99-104.
AOAC (1995). Official Methods of Analysis (16th Ed). Association of Official Analytical Chemist, Arlington, V. A. 1298pp.
Cahu, C.; Salen, P.; De Lorgeril, M. (2004). Farmed and wild fish in the prevention of cardiovascular diseases: assessing possible differences in lipid nutritional values. Nutr Metab Cardiovas. 14:34–41.
Eriksson, C. E. (1987) Oxidation of lipids in food systems. In: *Autoxidation of unsaturated lipids*. HWS Chan (Ed). Academic press, London. pp 207-231.
Eyo, A. A. (2001). Fish processing technology in the tropics. National institute for freshwater fisheries (NIFER), New Bussa Nigeria. 405pp.
Fankhauser, D. (2005). Pour plate technique for Bacterial Count. Accessed 29/10/09.
Greenfield, H. and Kosulwat, S. (1991) Nutrient composition of Australian fresh retail sausages and the effects of cooking on fat content. *J. Sci. Food Agric.* 57: 65 – 75.
Harris, W. S. (1997) n-3 fatty acids and serum lipoproteins: human studies. *American Journal of Clinical Nutrition* 65:1645S-1654S.
Ogbonnaya, C. (2009). Influences of Drying Methods on Nutritional Properties of Tilapia Fish (*Oreochromis nilotieus*). World Journal of Agricultural Sciences 5 (2): 256-258.
Ogbonnaya, C. and Ibrahim, M. S. (2009). Effects of drying methods on proximate compositions of catfish (*Clarias gariepinus*). World Journal of Agricultural Sciences 5 (1): 114-116.
Omolara O. O. and Omotayo O. D. (2009). Preliminary Studies on the effect of processing methods on the quality of three commonly consumed marine fishes in Nigeria. BIOKEMISTRI. 21(1): 1-7.
Omolara, O. O. and Omotayo, O. D. (2009). Preliminary Studies on the effect of processing methods on the quality of three commonly consumed marine fishes in Nigeria. BIOKEMISTRI 21(1): 1-7.
Pelczar, M.J., R.D. Reid and E.C.S Chan, 1977. Microbiology: 4th edition Tata McGraw Hill publishing Company Ltd. New Delhi., pp: 69-128.
Ruxton, C. H.; Reed, S. C.; Simpson, M. J.; Millington, K. J. (2004). The health benefits of omega-3 polyunsaturated fatty acids: a review of the evidence. J Hum Nutr Diet. 17:449–459.
Sanchez-Muniz, F. J., Viejo, J. M. and Medina, R. (1992) Deep frying of sardines in different culinary fats; Changes in the fatty acids composition of sardines and frying fats. *J. Agric. Food Chem.* 40: 2252 – 2256.
Sidhu, K. S. (2003). Health benefits and potential risks related to consumption of fish or fish oil. Regul Toxicol Pharmacol. 38:336–344.
Tobor, T. G. (1994). Fish production and Processing on Nigeria. NIOMR Tech. Paper No.22.
Wim V.; Isabelle, S.; Karen, B.; Stefaan, D. and John, V. (2007). Consumer perception versus scientific evidence of farmed and wild fish: exploratory insights from Belgium. Aquacult Int. 15:121–136

Table 1- General characteristics of processed fish

S/N	Samples	Day	Disk	Dvm	Like	Lum	Neither	X2=test.
1	**Boiled fish**	**1**	**5**	**6**	**3**	**1**	**5**	51.436***
		2	**3**	**8**	**6**	**0**	**3**	
		3	**4**	**6**	**5**	**0**	**4**	
		4	**9**	**5**	**1**	**0**	**5**	
		5	**11**	**0**	**1**	**7**	**1**	
2	**Fried fish**	**1**	**2**	**5**	**7**	**2**	**3**	54.464***
		2	**5**	**2**	**4**	**6**	**3**	
		3	**10**	**0**	**0**	**2**	**7**	
		4	**5**	**2**	**1**	**1**	**11**	
		5	**1**	**0**	**0**	**6**	**12**	
3	**Smoked fish**	**1**	**8**	**4**	**1**	**3**	**4**	77.348***
		2	**6**	**2**	**2**	**1**	**9**	
		3	**3**	**8**	**1**	**1**	**6**	
		4	**6**	**9**	**2**	**1**	**2**	
		5	**0**	**0**	**5**	**15**	**0**	

Disk – dislike

Dvm – dislike very much

Lum – like very much

Neither – neither like nor dislike

TABLE 2: FOR TASTE QUALITY

S/N	Samples	Day	Dislike	Dvm	Like	Lvm	Neither	X2=Test
1	**Boiled**	**1**	**10**	**2**	**3**	**0**	**5**	43.637***
	fish	**2**	**5**	**5**	**5**	**3**	**2**	
		3	**10**	**0**	**2**	**2**	**5**	
		4	**16**	**1**	**0**	**0**	**3**	
		5	**18**	**0**	**0**	**1**	**0**	
2	**Fried fish**	**1**	**3**	**5**	**4**	**3**	**5**	37.727***
		2	**3**	**5**	**1**	**3**	**8**	
		3	**2**	**8**	**0**	**2**	**7**	
		4	**2**	**5**	**0**	**0**	**13**	
		5	**0**	**1**	**0**	**1**	**16**	
3	**Smoked**	**1**	**3**	**9**	**1**	**2**	**5**	44.863***
	fish	**2**	**5**	**3**	**8**	**0**	**4**	
		3	**3**	**9**	**5**	**1**	**1**	
		4	**3**	**14**	**0**	**0**	**3**	
		5	**0**	**17**	**0**	**1**	**1**	

Dvm – dislike very much

Lvm – like very much

TABLE 3: TEXTURE QUALITY

S/N	Sample	Day	Dislike	Dvm	Like	Lvm	Neither	X2=Test
1	**Boiled**	**1**	**7**	**2**	**5**	**0**	**6**	39.416***
	fish	**2**	**8**	**1**	**5**	**2**	**4**	
		3	**10**	**4**	**2**	**0**	**3**	
		4	**16**	**1**	**0**	**0**	**3**	
		5	**15**	**5**	**0**	**0**	**0**	
2	**Fried fish**	**1**	**6**	**1**	**2**	**3**	**8**	33.497***
		2	**1**	**6**	**2**	**3**	**8**	
		3	**0**	**6**	**1**	**1**	**11**	
		4	**2**	**2**	**0**	**0**	**16**	
		5	**4**	**2**	**0**	**0**	**13**	
3	**Smoked**	**1**	**2**	**10**	**4**	**2**	**2**	**51.072***
	fish	**2**	**4**	**5**	**6**	**2**	**3**	
		3	**8**	**4**	**2**	**5**	**0**	
		4	**2**	**17**	**0**	**0**	**1**	
		5	**2**	**13**	**0**	**0**	**5**	

TABLE 4: FLAVOUR QUALITY

S/N	Sample	Day	Dislike	Dvm	Like	Lvm	Neither	X2=Test
1	**Boiled**	**1**	**10**	**0**	**4**	**2**	**4**	35.159***
	fish	**2**	**4**	**5**	**4**	**3**	**4**	
		3	**5**	**4**	**3**	**1**	**6**	
		4	**16**	**1**	**0**	**0**	**2**	
		5	**14**	**2**	**1**	**0**	**3**	
2	**Fried fish**	**1**	**2**	**4**	**2**	**5**	**7**	32.775***
		2	**5**	**6**	**3**	**2**	**4**	
		3	**4**	**6**	**1**	**1**	**7**	
		4	**0**	**4**	**0**	**0**	**15**	
		5	**3**	**5**	**0**	**0**	**11**	
3	**Smoked**	**1**	**3**	**10**	**3**	**0**	**4**	50.826***
	fish	**2**	**4**	**2**	**7**	**0**	**7**	
		3	**8**	**6**	**0**	**2**	**3**	
		4	**3**	**14**	**0**	**0**	**2**	
		5	**2**	**14**	**0**	**0**	**4**	

Dvm – dislike very much

Lum – like very much

Neither – neither like nor dislike

TABLE 5: COLOUR ACCEPTANCE QUALITY

S/N	Samples	Day	Dislike	Dvm	Like	Lvm	Neither	X2=Test
1	**Boiled**	**1**	**9**	**4**	**3**	**2**	**2**	34.020***
	fish	**2**	**5**	**4**	**5**	**1**	**5**	
		3	**5**	**5**	**4**	**1**	**4**	
		4	**15**	**2**	**0**	**0**	**3**	
		5	**17**	**2**	**0**	**0**	**1**	
2	**Fried fish**	**1**	**1**	**1**	**4**	**4**	**10**	48.065***
		2	**4**	**6**	**4**	**4**	**2**	
		3	**7**	**5**	**0**	**3**	**4**	
		4	**2**	**3**	**0**	**0**	**15**	
		5	**2**	**4**	**0**	**0**	**13**	
3	**Smoked**	**1**	**3**	**8**	**3**	**2**	**4**	38.509***
	fish	**2**	**6**	**3**	**5**	**1**	**5**	
		3	**4**	**6**	**2**	**0**	**7**	
		4	**2**	**16**	**0**	**0**	**2**	
		5	**1**	**14**	**0**	**0**	**5**	

TABLE 6: PROXIMATE COMPOSITION OF FRIED AND SMOKED *Clarias gariepinus*

FRIED *Clarias gariepinus*					SMOKED *Clarias gariepinus*			
Sample	**% Moisture content**	**%Crude protein**	**%Crude lipid**	**%Ash**	**% moisture content**	**% Crude protein**	**% Crude lipid**	**% Ash**
Day 1	8.84 ± 0.24^{a}	60.64 ± 0.12^{a}	9.23 ± 0.04^{ab}	5.92 ± 0.04^{a}	9.09 ± 0.24^{bc}	61.69 ± 0.76^{ab}	6.31 ± 0.34^{bc}	5.37 ± 0.06^{c}
Day 2	8.87 ± 0.18^{a}	60.88 ± 0.13^{a}	9.07 ± 0.04^{b}	6.33 ± 0.08^{a}	9.17 ± 0.08^{c}	62.22 ± 0.56^{ab}	6.21 ± 0.03^{c}	5.59 ± 0.13^{bc}
Day 3	10.18 ± 0.23^{b}	60.59 ± 0.15^{a}	8.94 ± 0.08^{b}	6.30 ± 0.46^{a}	8.18 ± 0.09^{a}	61.55 ± 0.54^{b}	6.17 ± 0.04^{c}	5.97 ± 0.12^{ab}
Day 4	11.01 ± 0.46^{c}	60.86 ± 0.22^{a}	9.27 ± 0.12^{ab}	6.08 ± 0.50^{a}	8.67 ± 0.11^{abc}	62.07 ± 0.05^{ab}	6.97 ± 0.13^{b}	5.58 ± 0.43^{bc}
Day 5	9.88 ± 0.50^{b}	60.18 ± 0.07^{b}	9.48 ± 0.14^{a}	6.17 ± 0.90^{a}	8.55 ± 0.58^{ab}	62.75 ± 0.11^{a}	6.55 ± 0.13^{a}	6.05 ± 0.19^{a}

Column with difference superscript are significantly different ($P<0.05$) from each other.

TABLE: 7: Microbial count of processed *Clarias gariepinus*

DAYS	BOILED (Cfu/g)	FRIED (Cfu/g)	SMOKED (Cfu/g)
1	3.6×10^2	2.4×10^2	2.6×10^2
2	4.2×10^4	4.0×10^2	3.8×10^2
3	7.7×10^7	1.2×10^3	1.3×10^3
4	TMC	1.4×10^3	1.8×10^3
5	TMC	2.5×10^3	3.5×10^3

TABLE 8: MICROORGANISMS ISOLATED FROM PROCESSED *Clarias gariepinus*

S/N	BOILED	FRIED	SMOKED
DAY 1	*Staphylococcus spp*	*Staphylococcus spp*	*Bacillus spp*
DAY 2	*Staphylococcus spp*	*Staphylococcus spp and pseudomonas spp*	*Bacillus spp and Pseudomonas spp*
DAY 3	*Staphylococcus spp and pseudomonas spp*	*Bacillus spp and staphylococcus spp*	*Bacillus spp*
DAY 4	*Staphylococcus spp and pseudomonas spp*	*Staphylococcus spp and pseudomonas spp*	*Staphylococcus spp and pseudomonas spp*
DAY 5	*Staphylococcus spp*	*pseudomonas spp*	*Bacillus spp*

TABLE 9: BIOCHEMICAL TEST

S/N	gram reaction	oxidase test	catalase test	motility test	Glucose test	fructose	sucrose	lactose	gelatin	indole	shape	smell	DCA	probable bacteria isolate	colour
1	+	-	+	+	A/G	A/G	A	+	±	+	R		brown	*Staphylococcus aureus*	purple
2	-	-	+	+	A/G	A/G	-	+	+	-	R	-	light brown	*Pseudomonas spp*	pink
3	+	-	+	+	A/G	A	+	±	-	+	R	-	purple	*Bacillus spp*	purple

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage: http://www.iiste.org

CALL FOR PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** http://www.iiste.org/Journals/

The IISTE editorial team promises to the review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar