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CHEMICAL COMPOSITION OF SOME CONVENTIONAL FISHES OBTAINED IN ASEJIRE DAM, EGBEDA LOCAL GOVERNMENT AREA OF OYO STATE, NIGERIA

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ABSTRACT*: Freshly caught freshwater fish samples of three conventional fishes Clarias gariepinus (Burchell, 1822), Chrysichthys nigrodigitatus (Lacepede, 1803) and Parachanna obscura (Gunther, 1861) were purchased from Asejire Dam in Egbeda Local Government Area of Oyo State Nigeria in April 2017. Fishes were degutted, washed and processed using steam-cooking, oven-drying, kiln-drying and raw as control. Samples were divided into four equal portions of 500g each and transported in ice to the Central Research Laboratory, Federal University of Technology, Akure for Proximate analysis. Free Fatty Acid was also determined according to the methods of AOAC, 2005. Crude fat estimation was done using the Folch Method. Minerals were obtained by Dry–ashing the fish samples at 550^{o}C and determined using Atomic Absorption Spectrophotometer (Perkin–Elmer Model 403, Norwalk CT). Potassium was determined by flame photometer (Corning, UK Model 405), [AOAC, 1980] and Phosphorus by the vanadomolybdate calorimetric method. Descriptive statistics (mean and standard deviation) were conducted while statistical significance ($P < 0.05$) was determined by Analysis of Variance (ANOVA) with SPSS version 10. Ducan multiple range test was used to determine significant differences between the means. The results showed that the moisture contents were highest (72.43%) in raw C. gariepinus and lowest (7.23%) in kiln-smoked C. gariepinus. Ash content was highest (9.26%) in kiln-smoked C. gariepinus and lowest (0.89%) in steamed-cooked C. gariepinus. Kiln-smoked C. gariepinus had the highest fat content (29.72%) and raw C. gariepinus recorded the lowest (0.86%) fat. The crude fiber was present in P. obscura and conspicuously absent in other species. Crude protein content ranged from 73.40% in kiln-smoked P. obscura to 17.31% in raw C. nigrodigitatus. Carbohydrate was highest (12.82%) in steamed-cooked C. gariepinus and lowest (0.45%) kiln-smoked C. nigrodigitatus. Free Fatty Acid was highest (1.90%) in steamed-cooked P. obscura but lowest (0.92%) in kiln-smoked C. gariepinus and steamed-cooked C. nigrodigitatus respectively. fiber content was absent in all the species except P. obscura that has low fiber content. the above reveals that moisture, ash, crude protein, fat, fiber, Carbohydrate, and Free Fatty Acid were not significantly ($p>0.05$) affected by the treatment. Minerals contents of all the species subjected to different processing methods were within tolerable levels needed for optimal growth and development. Cadmium was not detected in all the fishes irrespective of the processing method. The above reveals that Cu, Fe, Zn, Mg, Ca, and K were not significantly ($p<0.05$) affected by the processing methods. The Mean value of treatment in C. gariepinus is similar to C. nigrodigitatus but significantly ($p<0.05$) lesser than P. obscura. Based on the findings of this study, Kiln-smoking is the best processing method and P. obscura has the highest protein content. Its culture could be initiated through research efforts to boosts its availability at an affordable price. The finding of this research will be useful to the consumers in*

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choosing fish based on their nutritional values rather than taste, appearance, norms and other physical features.

KEYWORDS*: Proximate composition, Minerals, conventional fishes, Asejire, processing methods.*

INTRODUCTION

Fish is one of the most important foods valued for its nutritional qualities. Fish protein is a good source of high-quality protein containing essential amino acids in the amount and proportion required for good nutrition. It also provides a good source of vitamins and minerals. The importance of fish in the diets of infants, young children and pregnant women cannot be over-emphasized. The crude protein content of fish can be of immense nutritional value to pregnant women for proper development of the foetus and prevention of abortion (Rahimeh *et al* 2017). It also enhances proper mental and development of immunity against diseases among growing children (NAFDAC, 2003). In low-income countries, staple foods such as rice, wheat, maize, and cassava make up the bulk of the food consumed by the people. However, some essential nutrients (essential amino acids and micronutrients) are not found in these staples. These important nutrients can be supplied by fish because they contain very light connective tissue (Eyo, 2001).

Fish is a key ingredient on the global menu, a vital factor in the global environmental balance, and an important basis for livelihood worldwide (UNICEF, 2006). Fish has no cultural or religious restrictions which makes it more advantageous than pork, beef and mutton (NIFFR, 1999) Fish is an indispensable source of micronutrients, such as iron, iodine, zinc, vitamin A and B (Haruna, 2003; World Fish Centre, 2005).

Present knowledge of the chemical proximate composition of fish species from Nigerian waters is scanty. The measurement of some nitrogen-free extract and crude fiber is often necessary to ensure that they meet the dietary requirements and conventional specification (Onyia *et al*., 2010). Some authors had worked on the comparative proximate composition of wild and cultured *Clarias gariepinus* (Edward 2006; Olapade *et al*. (2011), *Clarias anguillaris* (Onyia and Danwesh, 2008).

However, fish is highly perishable because it provides a favorable medium for the growth of microorganisms after death (Aliya *et al.*, 2012). An estimate of 40% post harvest losses of total fish landings has been reported in Nigeria (Akande, 1996). Fish spoilage in Nigeria is influenced to a large extent by high ambient temperatures, considerable distances of landing ports to points of utilization and poor as well as inadequate infrastructure for postharvest processing and landing. Thus, it is imperative to process and preserve some of the fish caught in the period of abundance, so as to ensure an all year round supply.

This will invariably reduce post-harvest losses, increase the shelf-life of fish, and guarantee a sustainable supply of fish during off season with a concomitant increase in the profit of the fishermen (Eyo, 1997). Proper preservation starts the moment fish is harvested until it reaches the consumer's table (Oluborode *et al.*, 2010).

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Fish is an extremely perishable commodity, spoiling soon after death, due to enzymatic and microbial actions. Some factors responsible for this include the prevailing high temperatures in Nigeria and the facilities for processing; storing and distributing the fish caught are frequently inadequate or non–existence in most cases. There is therefore enormous waste through spoilage of both fresh and dried fish.

Fish is smoked until cooked in order to obtain a product with extended Shelf–life since alternative preservation methods such as refrigeration are absent in remote fishing villages where most fish processing takes place. The determination of some proximate parameters such as moisture, ash, lipid and protein contents are necessary so as to ascertain that they meet the requirements of food regulations and conventional specifications (Aremu and Ekunode 2008, Eyo 1997, Oyarekua and Ketiku 2012).This study aims at comparing the nutritional characteristics of three of the most cherished conventional fishes from Asejire Lake (*Clarias gariepinus, Chrysichthys nigrodigitatus and Parachanna obscura* using different processing methods such as kiln-drying, oven-drying, steam-cooking and raw (as control) with a view to exploring their nutritional value thereby providing preliminary information towards effective utilization of these fishes in various food applications in Africa, especially Nigeria.

Preliminary studies through the use of questionnaires revealed these fishes as most sought by restaurant, hotels and local eateries, which calls for their increase in production. Research by Okaeme (2006), revealed that these fishes apart from their aquaculture potentials have rapid growth, high premium taste, and all-season availability which had led to low population of *Parachanna obscura.*Fish makes up about 60% of world protein supply and developing countries derive more than 30% of their annual protein from these freshwater conventional fishes (FAO 1994). Teutscher (1990) reported that fish provides between 30% and 80% of the total animal protein intake of the coastal people of West Africa. In Nigeria, fish constitute 40% of animal protein intake. Fish demand is 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; Oshozekhai and Ngueku, 2014). Fish and fish products are highly nutritious with a protein content of 15 to 20% and are particularly efficient in supplementing the cereal and tuber diets widely consumed in Africa (Fagbenro *et al.*, 2005). Kreuzer and Heen (1962); Waterman (1976); Olomu (1981); Ojutiku *et al*. (2009) also highlighted that fish is rich in protein with amino acid composition very well suited to human dietary requirements comparing favorably with egg, milk, and meat in the nutritional value of its protein. Fish also contains absorbable dietary minerals. In Nigeria, fish is eaten fresh and smoked and form a much-cherished delicacy that cut across socio-economic, age, religions and educational barriers (Adebayo *et al*., 2008) and it is a rich source of protein commonly consumed due to the higher cost of meat and other sources of animal protein.
Although West Africans especially Nigerians are suffering from food insecurity and nutritional problems going by the Food Sustainability Index (UNICEF, 2018). Also, foods are usually badly processed leading to substantial loss of nutrients which could be part of the reasons for low intakes of nutrients by Nigerians as revealed by several nutritional assessment studies (Eze *et al*, (2017); Omobuwa *et al*., (2014); Otegbayo *et al* (2017); National Bureau of Statistics (2016)., and Senbanjo *et al*., (2016).

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Developing proper processing and preservation techniques of fish and fish products could contribute to proper resource utilization and higher intake of nutrients.
Even though other processing and preservation techniques are well studied, smoking, oven drying, and cooking play major roles in processing and preservation techniques in Nigeria.In the urban areas, the need for traditional flavor, taste and color of fish in ready to eat form increase in day to day market. Processing contributes to the consumption of fish which in turn leads to an increase in production capacity and productivity. It also increases farm income and creates employment opportunity.Capture freshwater fishes have faced a post-harvest loss due to lack of personal hygiene and shelf elongating process technology. So the need for easily available modified technology to reduce losses especially in this valuable fish species before it reaches the market is very vital. In addition, developing appropriate process technology creates market opportunity (business) for the fish products. Based on the fact above, The proximate composition values obtained from the processing method chosen will be useful in helping consumers choose a processing method based on their nutritional need apart from taste and will also provide an update to food composition database as little efforts were placed on post-harvest technology to cater for unprecedented glut in fisheries industry in Nigeria.

This study is quite auspicious so that proper post-harvest management plans or strategies to sustain this valuable fish in the lake will be established also; there are no records on the study of *Clarias gariepinus, Chrysichthys nigrodigitatus and Parachanna obscura* simultaneously, hence the relevance of this study.

METHODOLOGY

Study Area

Fish samples were conducted at Asejire water dam in Egbeda Local Government Area of Osun state, Nigeria. Asejire dam is man-made, constructed on river Osun in 1972. It lies on latitude 7^{o} 23' North and longitude 4^{o} 05' West. (Fig. 1). The catchment area of the dam is 7,800km^2 and the impounded area is 2,342 hectares. River Osun is one of the series of West African rivers which do not drain into Niger systems but discharge into coastal Lagoons and creeks bordering the Atlantic Ocean. The dam has a normal pool elevation (water level) of 150m and maximum flood elevation of 152.4m. The lake has appropriate gross storage of 7,403 million liters. (Osun State Water Corporation).

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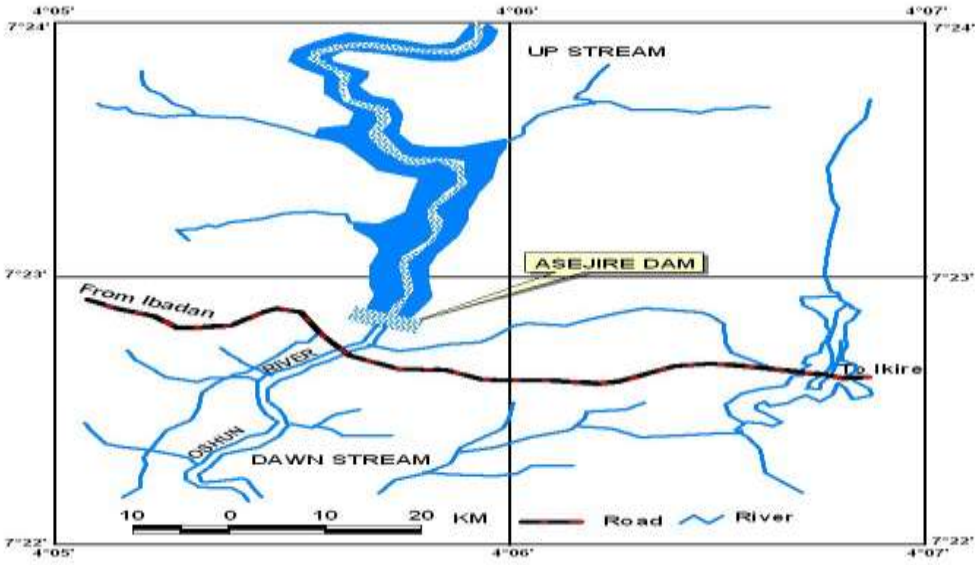

Fig. 1: Map Showing Asejire Water Dam
Source; Field survey, 2017.

Sample collection and treatment

Twelve (12) each of Fresh sample of three conventional fishes namely: *Clarias gariepinus, Chrysichthys nigrodigitatus and Parachanna obscura* were purchased from a fisherman in Asejire Dam in April 2017. They were weighed, with standard length measured, degutted, washed with running water to remove dirt and to prevent cross-contamination.

The samples were transported in ice to the Central Research Laboratory (CRT) of Federal University of Technology, Akure for analysis. The samples were divided into four equal portions of about 500g each and labeled appropriately.

Processing procedures

This involves the raw form (control), Steam-cooking in a pressure cooker for 15 minutes without water or salt, Oven-drying in an electric oven at about 105^{o}C for 4 hours, and Kiln-smoking using coal as a source of heat. The dried samples were blended separately into fine powder and labeled accordingly. All samples were blended using a Kenwood food blender.

The raw and processed powdered portions were placed in a labeled plastic container and the processed fish was stored inside the deep freezer in the laboratory at about –10^{0}C prior to analysis as adopted from Buikema *et al.* (1982).

Proximate Analyses

Moisture, Crude Protein (N × 6.25), Lipid, Crude Fibre, Ash, Carbohydrate (NFE by difference) and Free Fatty Acid (FFA) were determined in accordance with Association of Official Analytical Chemists International methods (AOAC, 1990). All chemicals were of Analar grade (chemicals of high purity standard with known contaminants for use in chemical analyses).

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Mineral Analysis
The minerals were analyzed from solutions obtained by first dry–ashing the fish samples at 550^{o}C and dissolving the ash in distilled deionized water in flasks. All the metals were determined by using atomic absorption spectrophotometer (Perkin–Elmer Model 403, Norwalk CT). Potassium (K) was determined by using a flame photometer (Corning, UK Model 405), while NaCl and KCl were used to prepare the standards [AOAC, 1980]. Phosphorus (P) was determined by vanadomolybdate colorimetric method [James, 1996]. Mineral elements analyzed include **Macro elements:** Potassium (K), Calcium (C), Manganese (Mn) and Magnesium (Mg) **Micro elements:** Zinc (Zn), Copper (Cu), Cadmium (Cd) and Iron (Fe).

Statistical Analyses
The descriptive statistics (mean and standard deviation) were conducted while the statistical significance of differences ($P < 0.05$) was determined by analysis of variance (ANOVA) with SPSS version 10.0 (Duncan, 1955) was performed to determine significant differences between the paired samples.

RESULTS AND DISCUSSION

Results
The **moisture** contents in these findings fell within an acceptable standard average of about 70%. However, there were ranges with the highest (72.43%) in raw *C. gariepinus* and lowest (7.23%) in kiln-smoked *C. gariepinus. **Ash** content was highest (9.26%) in* kiln-smoked *C. gariepinus* and lowest (0.89%) in steamed-cooked *C. gariepinus***. Fat** in Kiln-smoked *C. gariepinus* is highest (29.72%) and raw *C. gariepinus* recorded the lowest *(0.86%)* fat. **Crude fiber** is present in *P. obscura* and conspicuously absent in all the other species under study. **Crude protein** content ranged from 73.40% in kiln-smoked *P. obscura* to 17.31% in raw *C. nigrodigitatus.* **Carbohydrate** was highest (12.82%) in steamed-cooked *C. gariepinus and lowest (0.45%)* kiln-smoked *Chrysichthys nigrodigitatus* **Free Fatty Acid** was highest (1.90%) in steamed-cooked *P. obscura* but lowest (0.92%) in kiln-smoked *C. gariepinus* and steamed-cooked *Chrysichthys nigrodigitatus* respectively.

The **mineral** results showed that the concentration of Calcium was highest in kiln smoked *P. obscura* (1866.83 mg/l) followed by oven dried. *C. gariepinus* (1843.17 mg/l), *lowest* in steam-cooked *C. gariepinus* (80.4 mg/l). Minerals contents of all the species subjected to different processing methods are within tolerable levels needed for optimal growth and development.
Cadmium was not detected in all the fishes irrespective of the processing methods.
The charts below show the Percentage Proximate composition and Free Fatty Acid contents of the samples under four processing methods are presented in figures 2- 4

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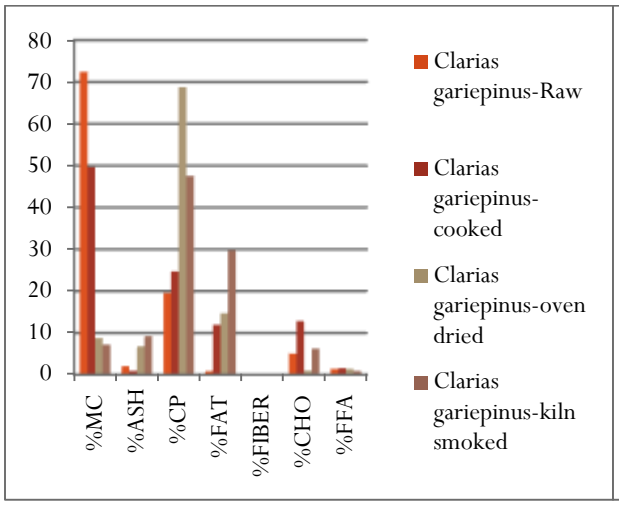

Fig. 2

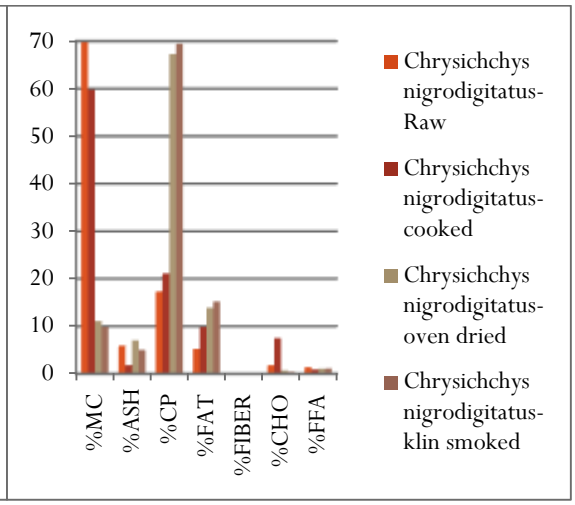

Fig. 3

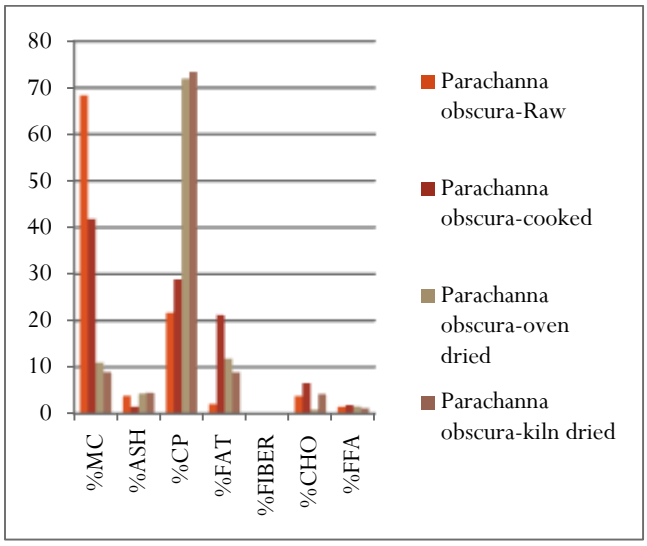

Fig. 4

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Table 1: Mean proximate and free fatty acid composition of samples

Tx	*C. gariepinus*	*C. nigrodigitatus*	*P. obscura*	SEM
MC	34.52±32.00	37.60±31.62	32.52±28.23	8.03
Ash	4.74±3.93	4.95±2.26	3.55±1.38	0.73
CP	40.16±23.25	43.80±25.11	48.97±31.03	16.01
Fat	14.30±8.10	11.04±4.49	6.00±5.18	1.82
CF	0.00±0.00	0.00±0.00	0.07±0.10	0.01
CHO	6.27±10.12	2.60±3.25	3.87±12.92	3.76
FFA	1.32±0.28	1.13±0.21	1.53±0.29	0.08

a-b: mean within rows having different superscript are significantly different (p<0.05)

The above reveals that Moisture, Ash, Crude protein, Fat, Fiber, CHO and FFA were not significantly (p>0.05) affected by the treatment.

SEM= Standard Error of Mean

Table 2: Result of Mineral composition of samples under four processing methods (ppm)

Tx	Cd	Cu	Fe	Mn	Zn	Mg	Ca	K
1A	ND	3.80	31.49	1.42	24.17	96.19	1079.40	2343.45
1B	ND	1.98	11.10	ND	7.41	98.41	80.40	1950.50
1C	ND	35.89	223.04	4.99	46.84	103.08	1843.17	21405.78
1D	ND	2.27	18.82	0.65	23.62	67.90	345.23	4514.25
2A	ND	3.77	11.50	2.83	17.91	95.65	823.76	1858.49
2B	ND	4.98	42.00	0.50	29.33	102.88	205.67	4447.76
2C	ND	31.34	235.53	10.95	32.82	104.37	1637.01	3452.74
2D	ND	6.21	64.87	5.32	88.63	92.09	510.78	6179.08
3A	ND	4.99	54.10	10.48	30.42	105.68	770.16	6457.09
3B	ND	39.34	71.92	3.98	45.80	106.96	1533.57	4950.20
3C	ND	10.38	44.56	16.20	25.31	88.76	1045.80	5789.04
3D	ND	12.49	61.15	25.97	69.91	106.78	1866.83	5464.54

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Table 3: Mean Mineral composition of samples (ppm)

Tx	*C. gariepinus*	*C. nigrodigitatus*	*P. obscura*	SEM
Cu	10.9816.62	11.5713.21	16.80	4.02
Fe	71.11	88.47	57.93	21.94
Mn	1.76[a]	4.90[ab]	14.15[b]	2.25
Zn	25.51	42.17	42.86	6.61
Mg	91.40	98.75	102.04	3.18
Ca	837.05	794.30	1304.10	182.25
K	7553.50	3984.51	5665.21	1497.96
Cd	nd	nd	nd	-

-b: Means within rows having different superscripts are significantly different (P<0.05)

The above reveals that Cu, Fe, Zn, Mg, Ca, and K were not significantly ($p<0.05$) affected by the treatment (processing methods).
The Mn. value of treatment in Clarias is similar to Chrysichthys but significantly ($p<0.05$) lesser than Parachanna
*nd – not detected

DISCUSSION

The proximate composition of nutrients in all fish samples showed variation among the individual species.

Moisture contents in all the raw of the three species were within the acceptable level (60-80 %), which could be due to the stable water levels because the dam has a normal pool elevation (water level) of 150m and maximum flood elevation of 152.4m. The dam has appropriate gross storage of 7,403 million liters in the location where the fish were collected (Osun State Water Corporation, Adewumi, *et al. 2014).* The percentage of water is also a good indicator of its relative content of energy, protein, and lipid (Olagunju, *et al. 2012).* This perennial water availability ensures the well being of the fish species in the water body of the dam and thus their sustainability. Moisture content *in* all the species agreed with the observation of Udo (2012), Olagunju, *et al. (2012), and* Mazumder, *et al*. (2008) in several freshwater fish species.

There were variations in the **Protein** content of the three species examined in this study, with *Parachanna obscura* recording the highest value. The high protein content of *Parachanna obscura may be* attributed to the fact that they are carnivorous and known to feed on mollusks, shrimps, crabs, and fish. Abdullahi (2001) reported that the protein content in fish varies with species due to certain factors such as the season of the year, effect of spawning and migration, food availability

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and so on. Fish of various species do not provide the same nutrient profile to their consumers (Soriguer *et al., 1997; Takama et al., 1999).* According to Daniel and Anthony (2013), it was reported that the protein content of *P. obscura* compares favorably with other members of the family Channidae.

These differences in the nutritional compositions of different species may be attributed to food composition, food and feeding habit, feeding rate, habitats, sex, age, size, genetic traits and season/migration (Abdullahi, 2001). However, despite the variations, the range of protein in fishes in this study indicates that these species of fishes are good sources of protein to consumers.

According to Ackman [1989], fish can be grouped into four categories according to their fat content: lean fish (< 2 %), low fat (2 to 4 %), medium fat (4 to 8%), and high fat (> 8%).From the results obtained, the mean **Lipid** contents *C. gariepinus and P. obscura* indicates that they are low in fat in raw form, while *C. gariepinus* and *Chrysichthys nigrodigitatus* can be classified as a high fat fish in raw and steamed cooked forms as compared to the other two. On the other hand, *C. gariepinus* and *C. nigrodigitatus* have high lipid content as compared to *P. obscura.* This indicates that both fishes are better sources of lipid in the body when consumed. Udo (2012) equally reported high values of fat for *Heterobranchus longifilis, Clarias gariepinus and Chrysichthys nigrodigitatus* of the Cross River, Nigeria. However, this result is at variance with 2.13% protein contents for *C. nigriodigitatus* obtained from Yenegoa as reported byKeremah and Amakiri (2013).The differences in these values could be due to age variation, season and maturity. Species difference may also contribute to the significant differences in the total lipid (Piggot and Tucker, 1990).

Ash is a measure of the mineral content of every food item. (Adewumi *et al., 2014).*The range of ash in this study suggests that these species of fishes are good sources of minerals such as Calcium, Potassium, Zinc, Iron, and Magnesium.

Fiber content is completely absent in all the species studied except *Parachanna obscura* that shows significantly low fiber content. This is in agreement with the findings of Daniel and Anthony (2013)

Carbohydrates are sources of instant energy used in the body's development and growth (Olagunju *et al., 2012).* Fish generally have very low levels of carbohydrates because glycogen does not often contribute much to the reserves in the fish body tissue (USDA 2010; Jayasree *et al.,* 1994; Das and Sahu 2001). High Carbohydrate content of raw and steam cooked *C. gariepinus* in this study was above known Recommended Daily Allowance (R.D.A.) value due to increase in age and liver size of the fish (Shahidi 1993), their ability to convert glycogen to glucose under duress, Increase in glucose transportation in low oxygen water due to anaerobic Adenosine Tri-Phosphate (ATP) or lactate production and cool temperature after night feeding which reduces their ability to utilize or burn the excess glucose in their body.

The **Free Fatty Acids** in the fish under different processing shows that the fat contents is in unsaturated forms and are safe as compared to saturated fatty acids in other foods. An unsaturated fat contains good cholesterol which has a protective effect on the cardiovascular system. In

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addition, unsaturated fats reduce the risk of inflammatory heart diseases and some types of cancer. (University of Maryland, 2015) hence these categories of fishes under study are suitable for consumption where health is considered.

Minerals contents of all the species subjected to different processing methods are within tolerable levels needed for optimal growth and development. Cadmium was not detected in all the fishes irrespective of the processing methods. The values were within the WHO /FAO (1974) recommended levels of daily intake of minerals.

These freshwater fishes are good sources of iron and copper. The concentration of these minerals in these freshwater fishes compares favorably with the values obtained for calcium and magnesium for some freshwater fishes. Freshwater fishes are rich sources of minerals especially iron and copper; iron is important for the formation of hemoglobin and copper play a crucial role in iron absorption. This research has shown that all the freshwater fishes are rich sources of minerals for man and other animals.

CONCLUSION AND RECOMMENDATION

Conclusion

Based on the findings of this study, Kiln-smoking and Oven-drying were the most suitable methods of processing although steam-cooking is also nutritionally suitable at least for our local consumption and especially in developing countries where all the required sophisticated storage equipment is not available. It can thus be concluded that kiln-smoking is the best when preservation of the fish is the priority and when nutrient conservation is the focus followed by oven-drying.
Kiln-drying improved the protein quality by prevention of lipid oxidation as compared with other conventional drying such as the use of drum, clay kilns, and sun-drying.

The highest protein was found in *P. obscura* and the lowest fat contents were found in the steamed-cooked fishes. *C. gariepinus and C. nigrodigitatus* are *also* good sources of protein and other nutrients.

The information obtained from these findings will be useful to the consumers in choosing fish based on their nutritional values rather than taste, appearance, norms and other physical features.

Recommendations

- Fish processing should be adopted under strict hygienic conditions and proper storage devices should be put in place.
- Environmental sanitation, education, and orientation should be organized for fish processors and workers to improve the quality of smoked fish for the benefit of public health and to enhance food safety in the country.
- Since fish and fish products are perishable without any preservative and processing measures, it is imperative and essential to process and preserve fish in order to assure health safety of the product and reduce moisture to the bearest minimum as much as possible.
- There are evidences of losses at every stage from harvest to consumption, these losses have a direct impact on the nutrition of millions of people, and therefore fishes should be processed as soon as it is harvested.

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- *P. obscura* is most preferred in terms of its nutritional characteristics, its culture which has not been established as compared to other conventional fishes in Nigeria should be considered.

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