Proximate analysis and Minerals Evaluation of Fresh and Smoked Catfish (*Clarias Gariepinus*)

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Abstract
The nutritional value of fish can be defined in terms of its proximate contents (% Carbohydrate, % Protein, % Fat, % Ash content, % fibre content and % moisture content) and nutrient values (Ca, Cd, Cr, Fe, Hg, Mg, Pb and Zn). The aim of this study was to evaluate the nutritional contents such as proximate composition and mineral elements of both fresh and smoked catfish (Clarias Gariepinus) in order to ascertain it nutritional value and understand the effect of smoking on the nutritional properties of the fish. Proximate analysis was carried out using AOAC (2007) method while the mineral elements were evaluated using Atomic Absorption Spectrophotometer. Fresh catfish (% carbohydrate, 48.23 ± 0.85; % protein, 21.06 ± 0.08; % fat, 27.01 ± 0.40; % ash content, 3.48 ± 0.32; % fibre content, 0.97 ± 0.07; % moisture, 10.03 ± 0.53; Ca, 11.03 ± 0.31; Cd, 0.035 ± 0.00; Cr, 0.71 ± 0.01; Fe, 35.02 ± 0.023; Hg, 0.17 ± 0.04; Mg, 12.20 ± 0.02; Pb, 0.58 ± 0.03; Zn, 1.03 ± 0.05). Smoked catfish (% carbohydrate, 51.03 ± 0.04; % protein, 18.88 ± 0.25; % fat, 25.08 ± 0.28; % ash content, 4.09 ± 0.31; % fibre content, 0.71 ± 0.01; % moisture, 8.09 ± 0.32; Ca, 67.25 ± 12.67; Cd, 0.031 ± 0.01; Cr, 0.73 ± 0.03; Fe, 26.01 ± 0.01; Hg, 0.09 ± 0.05; Mg, 7.22 ± 0.12; Pb, 0.67 ± 0.02; Zn, 0.87 ± 0.01). For the proximate values, there are significant differences between the fresh catfish samples and the smoked catfish samples with less value for the smoked catfish samples except %carbohydrate and %ash content. The results show significant differences between fresh catfish and smoked catfish samples with higher values for the fresh catfish samples except calcium and lead. The fresh catfish samples have higher nutrient values than the smoked catfish samples.
Keywords: *Clarias Gariepinus, proximate, analysis, nutrients, fresh catfish, smoked catfish.*

INTRODUCTION

Fish belongs to phylum chordate and class Pisces. They are classified based on according the types of skeleton they have either as cartilaginous or Bony fishes (Salihu-Lasisi *et al*., 2013). They include salmon, sardines, tilapia, cod, and herring with herring and salmon canned and exported from Europe and America to all countries of the world. Catfish (*Clarias genepinus*) is a fresh water fish with a variety of body shapes, with no scale. Some are cylindrical, with a flattened ventrum for benthic feeding, and some use the skin for cutaneous breathing (Salihu-Lasisi *et al*., 2013). Fish is the cheapest source of protein in human diets. It is one of the few sources of animal proteins available to many Nigerians with an estimated annual per capita of 13.3 kg in 2013 (FAO, 2017). Fish contains four basic ingredients in varying proportions: protein, fat, water, and minerals. Flesh from healthy fish contains 60–84% water, 15–24%

protein, and 0.1–22% fat, mineral usually constitutes 1–2%. Fish flesh is easily digestible because is very nutritious, palatable and with a tender flesh. (Erepamowei and Timi, 2019; Namaga *et al*., 2020). Fish protein can hence be used to complement the amino acid pattern and improve the overall protein quality of a mixed diet (Namaga *et al*., 2020; Erepamowei and Timi, 2019). Fish meat contains significantly low lipids and higher water than beef or chicken and is favored over other white or red meats. The nutritional value of fish meat comprises moisture, lipids, vitamins, dry matter, protein, and minerals plus the caloric value of the fish. Mineral components, such as potassium, magnesium, calcium, iodine, phosphorus are important for human nutrition (Solomon and Oluchi, 2018; Erepamowei and Timi, 2019).

Fresh fish are the most perishable products if not adequately preserved since they can easily be attacked by microbes (Salihu-Lasisi *et al*., 2013). Preserving of foods make them safer for consumption and also increase their shelf lives. A number of processing techniques are employed for the preservation of meat and fish and these include salting, canning, chilling, freezing, drying and smoking (Usman *et al*., 2024; Confred and Henry, 2017). Moreover the health implication of consuming spoilt fish cannot be quantified. Smoking enhances flavor and increases utilization of fish. Nonetheless, deterioration and spoilage still occur in smoked fish during storage (Oyedokun, 2020). Smoking is the most popular method used for fish drying. Smoking as a food processing technique is a temporary, but an effective method of preserving food products. It helps to improve texture and also as flavor enhancer (Usman *et al*., 2024). Smoke drying of fresh fish is of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses (Oyedokun, 2020). Muscle is the main part of fish used for human consumption and when fish is suggested as a means for improving health; fatty acid and amino acid composition should be considered (Erepamowei and Timi, 2019). Excessive fatty acid consumption results in overweight. As a results, fish lipids and proteins have been recognized as beneficial for human health (Namaga *et al*., 2020). Preservation of food by smoking often affects some of these essential nutreints of meat and fish by either denaturing them depending on the smoking temperate and nature of woods type used (Confred and Henry, 2017; Usman *et al*., 2024; Asiedu *et al*., 2018; Ajibare *et al*., 2023; Ayofemi and Adeyeye, 2018; Confred and Henry, 2017). In Nigeria, fish smoking which is one of the oldest techniques of fish preservation usually leaves the processor with two end products; fresh smoked fish and smoked-dried fish which has a longer shelf-life than fresh smoked fish. Fish smoking combines the effects of drying, salting and heating (Ajibare *et al*., 2023).

The African catfish, *Clarias gariepinus* is one of the most widely consumed freshwater fish in Nigeria due to its large availability. Nutritional composition of cultivated fish is majorly dependent on the type of food administered. Other factors may include water quality, feeding habit, cultured medium and period. C*larias gariepinus* is generally considered as one of the most important tropical catfish species for aquaculture. It has an almost Pan-African distribution, ranging from the Nile to West Africa and from Algeria to Southern Africa (Olayemi *et al*., 2011; Ajibare *et al*., 2023; Solomon and Oluchi, 2018). They also occur in Asia Minor, Israel, Syria and South of Turkey. *C. gariepinus* is characterized with naked skin and with fairly long dorsal and anal fins. They have string pectoral fins with spines that are serrated on the outer side. It possesses nasal and maxillary barbells and smallish eyes (Salihu-Lasisi *et al*., 2013; Solomon and Oluchi, 2018).

African catfish (*C. gariepinus*) is one of the most important species that are cultured both in and outside its natural environments. It is highly favored by fish farmers due to its rapid growth,

robust resistance to diseases, and adaptability to a broad range of environmental conditions, including extreme temperatures and low oxygen levels (Olayemi *et al*., 2011; Solomon and Oluchi, 2018; Ajibare *et al*., 2023). The aim of this research work is to assess the proximate and essential mineral contents of these food products Fresh catfish (*Clarias Gariepinus*) and smoked catfish (*Clarias Gariepinus*) and comparing the experimental result obtained with the recommended limits so as to ensure consumer safety and healthy living since the minerals when present at lower or greater concentrations, pose hazard to human health.

MATERIALS AND METHODS

Sample collection

The African catfish (*Clarias Gariepinus*) used in this study were obtained from Argungu river landing site kebbi state, Nigeria. Fish samples comprising juvenile and adults were obtained. The collected fishes were packaged in separate labeled polythene bags containing ice chips at an average temperature of 4 ^{o}C and immediately conveyed to the Chemistry Laboratory, Waziri Umaru Federal Polytechnic Birnin Kebbi for analysis.

Preparation of fresh and smoked samples

The fresh catfish were washed with tap water and then with distilled water to remove adhering substances and then drained. The catfish was dismembered with a knife and the guts was removed. The fresh fish samples were oven-dried at a temperature of 105 ^{o}C, pulverized into powder and stored in a capped plastic container for further analysis. Furthermore, the smoked samples were deboned, pulverized and stored for further analysis.

Proximate Composition of Fresh and Smoke Fish *(Clarias Gariepinus)*

Proximate analysis (moisture, ash, Fat, crude fibre, crude protein and carbohydrate) of the smoked and fresh Catfish samples were carried out according to the AOAC (2007) method.

Digestion of samples for essential mineral analysis

The digestion of samples (Fresh fish and smoked fish) were carried out using a mixture of concentrated HNO_3 and $HClO_4$ in the ratio of 2:1. 10 cm^3 of the mixture were added into a digestion flask containing 2.0 g of the pulverized fresh fish sample. It was then digested in a fume hood until a clear solution/digest was obtained and the samples were allowed to cooled and filtered using Whatman No1 filter paper into a 100 cm^3.

Determination of Mineral Composition Fresh and Smoke Fish (*Clarias Gariepinus*)

Minerals elements were determined according to the standard method of AOAC, 2005 using an Atomic Absorption Spectrophotometer (Varian Spectr AA. 20 plus).

RESULTS AND DISCUSSION

Table 1: Proximate composition of Fresh and Smoked fish (*Clarias Gariepinus*)

Composition	Fresh Fish Concentration (Mean ± SD)	Smoked Fish Concentration (Mean ± SD)	P Value*
Carbohydrate (%)	48.23 ± 0.85^{a}	51.03 ± 0.04^{b}	0.013
Protein (%)	21.06 ± 0.08 ^{a}	18.88 ± 0.25 ^{a}	0.051
Fat (%)	27.01 ± 0.40 ^{a}	25.08 ± 0.28 ^{a}	0.162
Ash content (%)	3.48 ± 0.32 ^{a}	4.09 ± 0.31 ^{b}	0.004
Fiber content (%)	0.97 ± 0.07 ^{a}	0.71 ± 0.01 ^{b}	0.007
Moisture (%)	10.03 ± 0.53 ^{a}	8.09 ± 0.32 ^{b}	0.003

Key: Results are presented in triplicate as mean ± SD. P value □□0.05 is statistically considered significant, * = Independent T test, Values in the same row having similar superscripts are considered significant while value in the same row having difference superscripts are statistically different.

The table 1 above presented the results of proximate composition of fresh and smoked *Clarias Gariepinus* fish, were evaluated. Proximate composition refers to the analysis of the major nutritional components of a substance. The obtained results compares various parameters, such as carbohydrate, protein, fat, ash content, fiber content, and moisture, between fresh and smoked fish samples. The mean carbohydrate concentration in fresh fish is 48.23 ± 0.85%, while in smoked fish, it increases significantly to 51.03 ± 0.04%, and there is a statistical significant differences, indicating that smoking the fish leads to an increase in carbohydrate content. Fresh fish contains a mean protein concentration of 21.06 ± 0.08%, which is slightly higher than the protein content in smoked fish 18.88 ± 0.25%. However, the difference is not statistically significant (P value = 0.051). The fat content in fresh fish is 27.01 ± 0.40%, while in smoked fish, it is slightly lower at 25.08 ± 0.28%. The difference in fat content is not statistically significant (P value = 0.162).

The ash content in fresh catfish is 3.48 ± 0.32%, while in smoked catfish, it significantly increases to 4.09 ± 0.31%. The P value of 0.004 indicates that this difference is statistically significant, suggesting that smoking the fish leads to a higher ash content. Fresh fish has a mean fiber concentration of 0.97 ± 0.07%, whereas smoked fish has a lower fiber content of 0.71 ± 0.01%. The difference in fiber content is statistically significant (P value = 0.007). Fresh fish has a higher moisture content with a mean of 10.03 ± 0.53%, while smoked fish has significantly lower moisture content, measuring 8.09 ± 0.32%. The difference is statistically significant (P value = 0.003).

Table 2: Concentrations of Mineral Elements of Fresh and Smoked Fish (*Claria Gariepinus*)

Mineral elements (mg/L)	Fresh Fish Concentration (Mean ± SD)	Smoked Fish Concentration (Mean ± SD)	P Value*
Calcium	11.03 ± 0.31^{a}	67.25 ± 12.67^{b}	0.002
Cadmium	0.035 ± 0.00^{a}	0.031 ± 0.01^{a}	0.116
Chromium	0.71 ± 0.01^{a}	0.73 ± 0.03^{a}	0.586
Iron	35.02 ± 0.023^{a}	26.01 ± 0.01^{b}	0.001
Mercury	0.17 ± 0.04^{a}	0.09 ± 0.05^{a}	0.284
Magnesium	12.20 ± 0.02^{a}	7.22 ± 0.12^{b}	0.001
Lead	0.58 ± 0.03^{a}	0.67 ± 0.02^{a}	0.845
Zinc	1.03 ± 0.05^{a}	0.87 ± 0.01^{b}	0.001

Key: Results are presented in triplicate as mean ± SD P value □□0.05 is statistically considered significant, * = Independent T test, Values in the same row having similar superscripts are considered significant while value in the same row having difference superscripts are statistically different.

The table 2 above presents the mineral elements composition of fresh and smoked cat fish, such as calcium, cadmium, chromium, iron, mercury, magnesium, lead, and zinc in mg/L. The mean concentration of calcium in fresh fish is 11.03 ± 0.31 mg/kg while that of smoked fish as 67.25

± 12.67 mg/kg, which is significantly higher (p = 0.002). Both fresh and smoked fish have very similar cadmium concentrations, with means of 0.035 ± 0.00 mg/kg and 0.031 ± 0.01 mg/kg, respectively. Suggested no significant difference in cadmium concentration between fresh and smoked fish. Chromium concentrations in both fresh and smoked fish are very close, with means of 0.71 ± 0.01 mg/kg and 0.73 ± 0.03 mg/kg, respectively. Indicated no significant difference (p=0.586) in chromium concentration between the two fishes. The mean concentration of iron is significantly higher in fresh fish 35.02 ± 0.023 mg/kg compared to smoked fish 26.01 ± 0.01. The p-value of 0.001 indicates a statistically significant difference in iron concentration between fresh and smoked fish. Fresh fish has a mean mercury concentration of 0.17 ± 0.04 mg/kg which is relatively higher compare to smoked fish 0.09 ± 0.05 mg/kg. Hence there is significant difference in mercury concentration. The mean concentration of magnesium is significantly higher in fresh fish 12.20 ± 0.02 mg/kg compared to smoked fish 7.22 ± 0.12 mg/kg and statistical difference in magnesium concentration observed. Both fresh and smoked fish have similar lead concentrations, with means of 0.58 ± 0.03 mg/kg and 0.67 ± 0.02 mg/kg, respectively. The mean concentration of zinc is significantly higher in fresh fish 1.03 ± 0.05 mg/kg compared to smoked fish 0.87 ± 0.01. Smoking fish can lead to changes in the mineral content of the fish. Specifically, smoking can increase the concentration of calcium and magnesium, while decreasing the levels of iron and zinc (Usman *et al*., 2024). The current results are in agreement with previous studies that have reported changes in the mineral content of smoked fish. It is important to note that smoking can also lead to the loss of important nutrients and antioxidants in fish meat (Usman *et al*., 2024).

Proximate composition of Fresh and Smoked catfish (*Clarias Gariepinus*)

From the results obtained, smoking the fish leads to an increase in carbohydrate content. This is in agreement with the study on Comparative Nutritional Evaluation of Fresh and Smoked Catfish (*Clarias Gariepinus*) and the effect of different smoking processes on the nutritional and polycyclic aromatic hydrocarbons composition of smoked *Clarias Gariepinus* and *Cyprinus carpio* respectively, it was found that there is a significant increase ($p < 0.05$) in the carbohydrate content of smoked fish (Usman *et al*., 2024; Cristelle *et al*.; 2019). The current finding on *Clarias Gariepinus* fish is in agreement with some previous research that suggests smoking fish can lead to an increase in carbohydrate content. The nutritional contents of catfish is determined by its protein content, which includes all the essential amino acids, making it one of the most high-quality sources of protein (Usman *et al*., 2024; Shadyeva *et al.,* 2019). Smoking can lead to protein denaturation and loss.

According to Abbati *et al*. (2021) a research conducted in Dadin Kowa Dam, Gombe, determined the protein content of fresh and smoked *Clarias Gariepinus* and Oreochromis niloticus. The research work found that the protein content in fresh and smoked samples of *Clarias Gariepinus* and *Oreochromis niloticus* ranged from 21.67% to 28.75% and 25.43% to 26.10%, respectively. These researched recommend that smoking fish can affect its nutritional composition, including its protein content. However, the extent of this effect may depend on factors such as the type of fish, the smoking method, and the season.

Earlier research has shown that the smoking process can reduce the fat content of fish, but it can also increase the fat content in some cases. This study found no statistically significant difference in fat content between fresh and smoked fish.

Based on the research findings in this current study, it can be concluded that the fat content of smoked fish is not always the same as that of fresh fish. While some studies have found a

decrease in fat content after smoking, others have found an increase or no significant difference. This study is in agreement with previous research that has also found an increase in ash content in smoked fish. For example, a study on processed tilapia found significant changes in the ash content from 11.12% (fresh) to 14.72% (traditionally smoked) (Kiczorowska *et al*.; 2019). According to Usman *et al*. (2024) reported that the mean ash content of raw fish was 2.49 ± 0.31 %. However, it is important to note that these studies did not specifically investigate the effect of smoking on ash content. This study on smoking fish highlights the importance of considering different cooking methods when analyzing the nutritional composition of fish. It also suggests that smoking fish may be a good way to increase the mineral content of fish (Usman *et al*., 2024).

Fiber is an important nutrient that plays a vital role in sustaining a healthy digestive system. It is recommended that adults consume between 25-30 grams of fiber per day (Usman *et al*., 2024). While smoked fish may have a lower fiber content than fresh fish, it is still a good source of other important nutrients such as protein, omega-3 fatty acids, and minerals like calcium, magnesium, and zinc (Kiczorowska *et al*., 2019). This finding is in agreement with some previous researches that reported a reduction in fiber content in fish after smoking. This finding is not in agreement with a previous study that reported no significant difference in fiber content between fresh and smoked samples of *Clarias Gariepinus* and Oreochromis niloticus fish species (Abbati *et al.;* 2021). Another finding on selected fresh and smoked fish also reported no significant difference in fiber content between fresh and smoked samples (Paul *et al.;* 2022). Similarly, the fiber content of fish can differ depending on the species and the processing method used. The recent finding suggested that smoked fish has a lower fiber content than fresh fish is significant and should be taken into consideration when planning a balanced diet.

The current work has originate that fresh fish (*Clarias gariepinus*) has a higher moisture content with a mean of 10.03 ± 0.53%, while smoked fish has significantly lower moisture content 8.09 ± 0.32% indicating decrease in moisture content of fresh fish after smoking. The difference is statistically significant (P value = 0.003). This finding is in agreement with previous research that has also reported a decrease in fresh fish moisture after smoking. Smoke-drying reduced the moisture content of all the samples significantly. The values obtained for freshly smoked fish ranged from 9.02 ± 0.53 % to 5.79 ± 0.69 % (Usman *et al*., 2024). The lower moisture content recorded in smoked-dried fishes when compared to the smoked fishes is due to the drying step which follows smoking (Usman *et al*., 2024).

Concentrations of Mineral Elements of Fresh and Smoked Fish (*Claria Gariepinus*)

The present research work reported a significant difference in calcium concentration between fresh and smoked fish of the same species, *Clarias Gariepinus.* This results is in agreement with previous studies that have studied the effects of smoking on the nutrient and mineral content of fish .A comparative study showed that smoke-dried fish contained more minerals than oven-dried fish (Usman *et al*., 2024). These research work suggest that smoking can have a significant impact on the nutrient and mineral content of fish. This results suggests that smoked fish has a much higher concentration of calcium than fresh fish. A study that evaluated the amino acid, vitamin, and mineral profile of smoked fish as affected by smoking methods and fish types found that high-temperature smoking modifies protein, lowers the essential amino acids, and may result in the loss of major nutrients (Usman *et al*., 2024). Cadmium is a poisonous heavy metal that can accumulate in the body over time and cause health problems, including kidney damage and cancer. Therefore, it is crucial to monitor the levels of cadmium and other heavy metals in fish and other food sources to ensure that they are safe for human

consumption. This recent study provides valuable information on the cadmium concentrations in *Clarias Gariepinus* fish. . A study found higher concentrations of heavy metals in smoked fish samples than in fresh samples (Usman *et al*., 2024).

A study in Nigeria investigated the concentrations of five heavy metals, including cadmium, in the muscle of three types of fish. The results showed that the concentrations of cadmium in the fish samples were below the maximum limits, indicating that they were safe for consumption (Ikeogu *et al*.; 2021). A study in Ghana investigated the concentrations of cadmium and lead in the tissues of fresh and smoked *Clupea harengus* (herring fish) and Gadus. The results showed that the concentrations of cadmium and lead were higher in smoked fish than in fresh fish (Oyeleke *et al*., 2021). Findings from these studies suggest that heavy metal concentrations in fish can vary depending on the type of fish, the location where it was caught, and whether it is fresh or smoked. However, the recent study on *Clarias Gariepinus* fish suggests that there may not be a significant difference in cadmium concentration between fresh and smoked fish.

The findings of the present study on chromium concentrations in *Clarias Gariepinus* are consistent with previous studies that have found no significant difference in chromium concentration between fresh and smoked fish. In contrast, a study on the polycyclic aromatic hydrocarbon and elemental profile of smoked fish found that the chromium levels in both raw and smoked fish were found to differ (Usman *et al*., 2024). Another study on heavy metal concentrations in freshwater fish found that the chromium concentration in smoked fish was higher than in fresh fish (Usman *et al*., 2024). Another study on heavy metal content in freshwater fish found that the chromium concentration was below the maximum limits in almost all fish samples (Usman *et al*., 2024).

The present results showed that the mean concentration of iron is higher in fresh fish 35.02 ± 0.023 mg/kg compared to smoke fish 26.01 ± 0.01 mg/kg, showing a significant difference in iron concentration between fresh and smoked fish. A study published in 2015 investigated the effects of smoking and freezing on the nutritive value of African mud catfish. The study found that iron content was highest in the fresh fish samples and lowest in the smoked fish samples (Usman *et al*., 2024). The current results was in agreement with this study.

In comparison with previous research, the results is in agreement with the low mercury concentrations observed in *Clarias Gariepinus* fish stipulated by Usman *et al*. (2024). The low mercury concentrations observed in *Clarias Gariepinus* fish in this study may be due to the fish's feeding habits, as they are known to feed on a variety of food sources, including insects, crustaceans, and small fish (Usman *et al*., 2024).

Additionally, the study's findings may be influenced by the location and environmental conditions in which the fish were caught, as previous studies have found variations in mercury concentrations in *Clarias Gariepinus* from different locations (Kassegne *et al*., 2018). The results obtained suggest that *Clarias Gariepinus* has relatively low mercury concentrations, and there is no significant difference in mercury concentration between fresh and smoked fish. It is possible that differences in sampling locations and methods, such as the size and age of the fish, the type of food they consume, and the level of pollution in the water, can affect the mercury concentration in fish (Usman *et al*., 2024). Although the current finding shows no significant difference in mercury concentration between fresh and smoked *Clarias Gariepinus*, it is important to note that even low levels of mercury can have harmful effects on human health, especially for pregnant women, infants, and young children. Therefore, it is recommended to limit the consumption of fish that are known to contain high levels of mercury, and to follow local guidelines for safe fish consumption (Usman *et al*., 2024).

The current research shows that the mean concentration of magnesium is significantly higher in fresh *Clarias Gariepinus* 12.20 ± 0.02 % compared to smoked types 7.22 ± 0.12 %, showing a statistically significant difference in magnesium concentration. While there are no previous studies that openly compare magnesium concentrations in fresh and smoked *Clarias Gariepinus*, there are several studies that have examined the effects of various substances on the fish, including heavy metals and pesticides (Usman *et al*., 2024). Similarly, another recent work evaluated the effects of sub-lethal concentrations of cadmium and lead on some tissues of the African catfish (*Clarias gariepinus*) and shows that exposure to these substances caused biochemical changes in the fish (Usman *et al*., 2024).

This recent work that both fresh and smoked *Clarias Gariepinus* fish have a very similar lead concentrations and is not in agreement with some previous finding that shows high lead concentrations in the fish. A research work in Poland showed that smoked fish contained much more lead than fresh fish (Usman *et al*., 2024). However, the current work did not evaluate the effects of lead exposure on the fish's biochemical parameters, as some previous research did.

Additionally, the recent study did not compare lead concentrations in *Clarias Gariepinus* to other fish species, as some previous studies did. The current finding found that the mean concentration of zinc is significantly higher in fresh *Clarias Gariepinus* 1.03 ± 0.05 % compared to smoked fish 0.87 ± 0.01 %. A research work designed to examined the levels of cadmium, lead, and zinc in *Clarias Gariepinus* fish sold at selected markets in Kano State, Nigeria (Oyeniyi *et al*.; 2019), found that the levels of zinc in the fish were within the range of reported zinc content, which is in agreement with the current research work that fresh *Clarias Gariepinus* fish have higher levels of zinc than smoked fish. The concentration of zinc in fish can be influenced by a variety of factors, including their diet and water chemistry (Usman *et al*., 2024). While seafood consumption can have positive impacts on health, it is important to be aware of the potential for toxic levels of zinc and other metals in fish and other aquatic animals. While smoking can increase the concentration of some basic nutrients, it can also reduce the fat and mineral content of fish, as well as alter the amino acid, vitamin, and mineral profile. Therefore, it is important to consider the effects of smoking when evaluating the nutritional value of fish.

CONCLUSION

Smoking cat fish (*Clarias Gariepinus)* significantly alters its proximate composition and mineral element concentrations. Findings from this study reveal that smoking of cat fish (*Clarias Gariepinus)* results in significant changes in its nutritional content. Particularly, smoking leads to increased ash, carbohydrate, and decreased moisture and fiber content. However, protein and fat content show minor differences. The variations in the concentrations of mineral elements in fresh and smoked fish observed that calcium, Chromium and Lead concentrations differ significantly between the two, while cadmium, Iron, mercury, and Zinc concentrations show no significant differences. These findings may have revealed the nutritional values for dietary choices and potential health implications of consuming both fresh and smoked fish.

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