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Research Article

PHYTOCHEMICALS, MINERALS AND HEAVY METAL CONTENTS OF SMOKED CATFISH SAMPLES SOLD IN SOME ABATTOIRS IN BAYELSA AND RIVERS STATE

[1, *]Ariyo, Adenike Bosede and [2]Obire, Omokaro

[1, *]Department of Microbiology, Federal University, Otuoke, Bayelsa State, Nigeria
[2]Department of Microbiology, Rivers State University, Port Harcourt, Nigeria

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Abstract

This study investigated the phytochemicals, minerals, and heavy metal content of smoked catfish. Smoked catfish were randomly purchased from people carrying out fish smoking activities within the selected abattoirs. Calcium, potassium, sodium, and magnesium were the minerals analysed, while heavy metals like Hg, Ni, Pb, Cu, Zn, Cr, and Cd were assayed in catfish using the A.P.H.A. analytical methods. The phytochemicals were screened using the A.O.A.C. method. The mean ranges of catfish phytochemicals are as follows: phenols: 0.260.15-0.850.26, tannins: 0.00290.005 to 0.00430.00, oxalate: 0.00110.001 to 0.00130.006, and saponins: 0.200.0.000 to 0.580.0.015. Catfishes had an average mineral range of (Ca: 566.67-995.83, Mg: 374.66-446.09, Na: 1961.13-5642.4, and K: 4,794.70-9,421.63) mg/kg. The results of the heavy metal content are: Zn (20.39-28.75 mg/kg), Pb (0.23-0.54 mg/kg), Cu (0.82-1.72 mg/kg), Cd (0.72-0.08 mg/kg), and Cr (0.8-6.0 mg/kg). Heavy metals like Hg and Ni were undetected in all samples. Numerous factors, including the physico-chemical parameters of the water from which the catfish were harvested; the composition of aquaculture feeds; environmental factors; and the varying smoking procedures employed in the handling of the fish, may have altered the amounts of phytochemicals, minerals, and heavy metals recorded in the samples, resulting in the wide range of results obtained in this study. Nevertheless, the presence of heavy metals in processed foods raises concerns about public health issues if they accumulate in the body over time.

Keywords: Smoked catfish, Phytochemicals, Minerals, Heavy metals, Accumulate.

INTRODUCTION

The term "abattoir" refers to a slaughterhouse and comes from the French word "abattre," which means "to strike down" [1]. An abattoir is a facility that has been recognized and registered by the regulatory body for hygienic slaughtering and inspections of animals, as well as the processing, preservation, and storage of meat products for human use [2]. It is a structure where animals, such as cattle and goats, are slaughtered, dressed, and distributed for human consumption and other industrial purposes [1]. Williams and Dimbu [3] claim that an abattoir or slaughter house is a specialized environment where meat processing is usually carried out. While the abattoir is mainly known as a site for meat processing, other activities which are not reported also take place in the abattoir site and such activity include processing of fishes especially in abattoirs close to the river. Fish farming has become a vibrant and dynamic commercial sector in Nigeria and it presents investment and employment opportunities. In Nigeria, the catfish (*Clariasgariepinus*) is mainly a freshwater fish and because of its distinct taste, flavor, and texture, it has been well accepted in most regions of the country. It's readily available and widely cultivated in both natural and artificial ponds [4]. Nigeria's current fish production stands at 0.8million metric tons with a shortfall of 1.9 million metrics tons of fish, as local demand for the protein is 2.7 million tons annually [5]. However, due to their high moisture content and significant nutritional value, fish are more vulnerable to reckless microbial attack or spoilage. Consequently, the necessity for preservation strategies to supply the teeming population with fish that are still very nutrient-rich.

Corresponding Author:** ***Ariyo, Adenike Bosede
Department of Microbiology, Federal University, Otuoke, Bayelsa State, Nigeria

If no processing or preservatives are used to extend the fish's shelf life, it tends to degrade quite quickly once it is dead [6]. This is because immediately the fish dies a number of physiological and microbial deterioration sets in. Consequently, the primary goal of fish roasting or smoking is for preserve it by extending its shelf life and preventing microbiological deterioration. [7] reported different types of fish preservation methods; drying, smoking, freezing, chilling and brining. But the most prominent fish preservation in Niger Delta is smoke drying. This could be attributed to the fact that most of the fish communities have no access to electricity to refrigerate their products. Smoke is very complex compound consisting of over 400 components Combustion of both lignin and hemicellulose yields polycyclic aromatic hydrocarbons (PAH) at high generation temperatures, especially in the absence of oxygen [8]. The continued demands for fish as have increased the tendency to process large quantities to satisfy consumer demands and the adoption of different processing and preservation methods. According to Obiri-Danso [9], the lack of firewood has compelled local butchers to roast cowhide and smoke other meat products with plastics, old tyres, and used engine oil in addition to firewood. This practice has been applied in fish roasting were many uneducated fish farmers use these materials in smoking the fishes so as to enhance the shelf-life. The usage of these substances may have a negative impact on the nutritional value of the processed fish, and ultimately put consumers at health risk. Phytochemicals are non-nutritive compounds, and they often have a pharmacological effect [10] (Leitzmann, 2016). Although, plants produce these chemicals to protect themselves, but recent research shows that theycan also protect humans against well-known diseases [11] (Breslin, 2017). Based primarily on the concentration that can be consumed and/or subsequently absorbed into the body, phytochemicals are evaluated in foods

for their nutritionally helpful and/or detrimental qualities. Information on the phytochemicals and mineral contents of smoked catfish produced and sold in abattoirs is lacking. This current study evaluated the phytochemicals minerals and heavy metal contents of smoked catfish prepared and marketed in some selected abattoirs.

MATERIALS AND METHODS

Sampling Location: Four abattoirs in Yenagoa Local Government Area of Bayelsa State and one in ObioAkpor Local Government Area of Rivers State provided samples for this investigation.The abattoir locations are shown in Table 1 along with their map coordinates.

Table 1. Sample Locations and Coordinates

Location	Northing (N)	Easting (E)
Igbogene	5^0 2' 17.8188"	6^0 24'14.958"
Tombia	4^0 57' 17.8092"	6^0 20'53.2428"
Opolo	4^0 56'52.764"	6^0 20'3.984"
Swale	4^0 53'42.9576"	6^0 16'39.7164"
Rumuokoro	4^0 52' 11.64"	7^0 01' 026"
Azikoro (Control)	$4^0$57' 13.77"	6^0 21' 19.5048"

Sample Collection: The smoked catfish (Clariasgariepinus), which weighs about 500g, was collected at random for this study and acquired from people roasting fish in the abattoirs. Coolers filled with ice packs were used to transport samples to the lab for examination.

Sample preparation: Samples were blended to smoothness in an alcohol sterilized Marlex blender, packaged into sterile medium sized plastic bowl containers for analyses.

Determination of Mineral Content

Calcium, potassium, sodium, and magnesium were the minerals analysed. Atomic absorption spectrometer was used to determine the samples' mineral content (Oshodi, 1992). The cash generated from the sample was dissolved in 10% HCl and adjusted to the proper consistency in a 100ml standard flask using distilled water. An atomic absorption spectrophotometer was used to read this afterwards.

Determination of Phytochemicals

The A.O.A.C. [12] technique was used for the quantitative screening for phytochemicals Extraction for phytochemicals was carried out using ethanol-chloroform as described by Harborne [13]. In this approach, twenty (20g) grams of air-dried, blended sample was weighed into a beaker, adding 300 ml of ethanol-chloroform (2:1) combination, thoroughly mixing it, and allowing it to extract for 24 hours at lab temperature. The mixture was filtered and the filtrate evaporated and concentrated by boiling on a water bath. The concentrate obtained was used for the screening. Qualitative analysis was carried out using the methods described by Harborne [13] and Kokate [14]. According to Mariita*et al*. [15], the concentration of each compound was calculated. The smoked catfish was evaluated for its presence of alkaloids, phenols, tannins, and saponins.

Determination of Heavy Metals

The presence of seven heavy metals including Hg, Ni, Pb, Cu, Zn, Cr, and Cd was examined in smoked catfish samples. The Atomic Absorption Spectrophotometric method of A.P.H.A [16] was used for the assessment. Five grams of oven dried (to constant weight at 105^0C) and blended catfish sample(s) was weighed each into a 250ml beaker and an empty beaker was stood in the analysis set up to represent the reagents/glass are blank. 100ml of distilled water was added, 1.0ml of concentrated HNO_3 and 10ml of concentrated HCl were added respectively. The beaker was covered with ribbed watch glasses and heated at 95^0C on a hot plate. The beaker was removed from hot plate when the solution was concentrated to about 10-15ml. The resultant concentrate was allowed to cool to room temperature, filtered, and then transferred quantitatively into a 50 ml volumetric flask while being diluted to volume with distilled water. The wavelength dial property of the atomic absorption spectrophotometer was set, and a hollow cathode lamp for the chosen metal was installed. For the element being measured, the slit width was predetermined. After being turned on, the instrument was allowed to warm up until the energy supply was stable. After the lamp warmed up, the current was readjusted as necessary. The wavelength was then tuned by changing the wavelength dial until the maximum energy gain was attained, and the bulb was positioned appropriately. The number of ground state atoms in the flame is directly proportional to the concentration of the element of interest. Ground state atoms are generated by desolationby the chemical flame, and the particles absorb the light beam from the light source.

RESULTS

The results for the phytochemical assay of catfish samples are presented in Table 2. The obtained results indicated varying concentrations of the analyzed phytochemicals were obtained in the sampled stations. The phenol content was highest in catfish samples from Igbogene while those from Swale abattoir recorded higher phenol values than Opolo samples. The phenol contents of the Tombia and Rumuokoro had the least values of 0.26 ± 0.15 and 0.27 ± 0.11 respectively. More so, the highest Saponins values were recorded in catfishes obtained from Igbogene followed by those obtained from Opolo abattoir while the least Saponin value was recorded from catfishes obtained from Tombia abattoir. Statistical evaluation indicated significant difference ($P \leq 0.05$) in Tannin values obtained from the various stations while there was no significant difference between values of oxalates obtained from all stations despite the disparity in the obtained values across the stations.

The result can be summarized as:

Phenols: IG > SW > OP > OK > TO
Tannins: TO > IG > SW > OP > OK
Oxalates: TO > OK > OP > IG > SW
Saponins: IG > OP > OK > SW >TO

From the aforementioned finding, the concentrations of phenols and saponins are highest in Igbogene catfish samples whereas they are lowest in Tombia samples. On the other hand, Tombia samples had the highest concentrations of tannins and oxalates, and lowest in Rumuokoro and Swale samples, respectively.

Figure 1 shows the values of the mineral content of smoked catfish. Potassium (K) concentration values are least in Tombia samples with a value of 4,794.70mg/kg and highest in Swale samples with a value of 9,421.63mg/kg.

Table 2: Mean phytochemicals composition of smoked catfish

Abattoir	Phenols %	Tannins %	Oxalates %	Saponins %
Igbogene (IG)	0.85 ± 0.26	0.0040 ± 0.006	0.0012 ± 0.001	0.58 ± 0.015
Opolo (OP)	0.43 ± 0.15	0.0032 ± 0.006	0.0012 ± 0.000	0.32 ± 0.008
Rumuokoro (OK)	0.27 ± 0.11	0.0029 ± 0.005	0.0013 ± 0.006	0.29 ± 0.025
Tombia (TO)	0.26 ± 0.15	0.0043 ± 0.000	0.0014 ± 0.001	0.20 ± 0.000
Swale (SW)	0.70 ± 0.10	0.0037 ± 0.007	0.0011 ± 0.001	0.28 ± 0.200

The concentrations of sodium (Na) ranged from 1961.13 to 5,642.4 mg/kg. The concentration of Calcium (Ca) was from 566.67to 995.83mg/kg as recorded in Rumuokoro and Swale sample respectively. The values of magnesium (Mg) ranged from 374.66 to 446.09 mg/kg. The decreasing order of these minerals in catfish is K>Na>Ca>Mg. There was no significant difference (p>0.05) in the minerals detected (Mg, Na, K and Ca) in all samples across the abattoir locations.

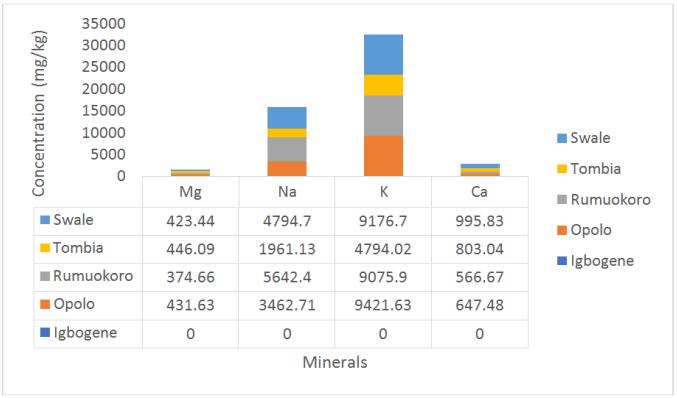

Fig. 1. Concentration of minerals in smoked catfish samples

The quantities of heavy metals present in smoked catfish are shown in Figure 2-6. All catfish samples from all of the abattoir locations had their levels of Ni and Hg evaluated, but undetected. Zn had the highest concentrations (of all the heavy metals evaluated), ranging from 20.39 to 28.75 mg/kg as obtained in fish samples from Rumuokoro and Swale respectively. Pb concentrations ranged from 0.23 mg/kg in Igbogene samples to 0.54 mg/kg in Rumuokoro samples, with the latter having the highest value. The concentrations of Cu detected in the smoked catfish at the Swale and Rumuokoro abattoirs were the highest and lowest, at 1.72 and 0.82 mg/kg, respectively. Catfish samples from Igbogene had the highest concentration of Cd (0.72 mg/kg), whereas those from Tombia had the lowest concentration (0.08 mg/kg). Cr was found in Rumuokoro fish at the highest level of 6.0 mg/kg and in the Igbogene sample at the lowest level of 0.8 mg/kg (least value). The result of heavy metals assessment in smoked catfish indicated the mean concentration of heavy metal is in the decreasing order: Zn > Cr > Cu > Cd > Pb.

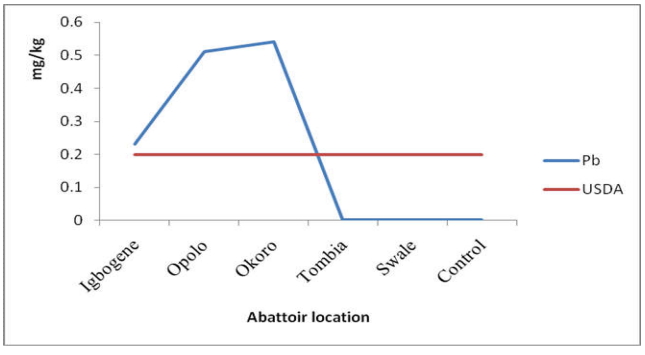

Fig. 2: Concentration of Pb in smokedcatfish compared with USDA Limit

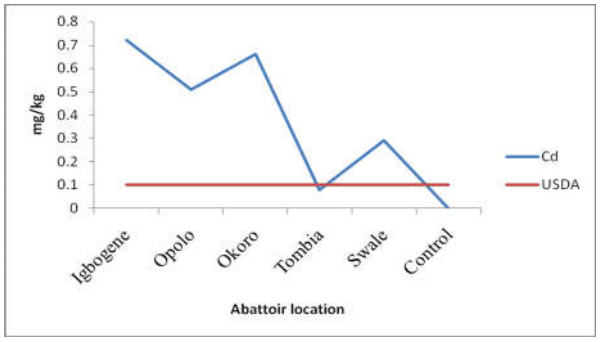

Fig. 3. Concentration of Cd in smokedcatfish compared with USDA Limit

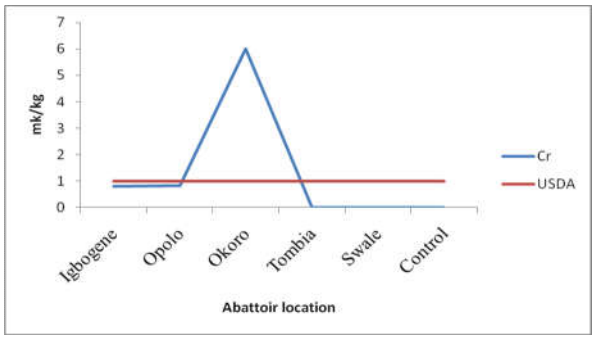

Fig. 4. Concentration of Cr in smoked catfish compared with USDA Limit

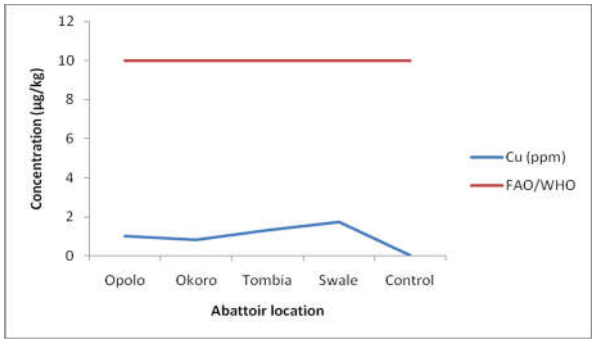

Fig. 5. Concentration of Cu in smoked catfish Compared with FAO/WHO Limit

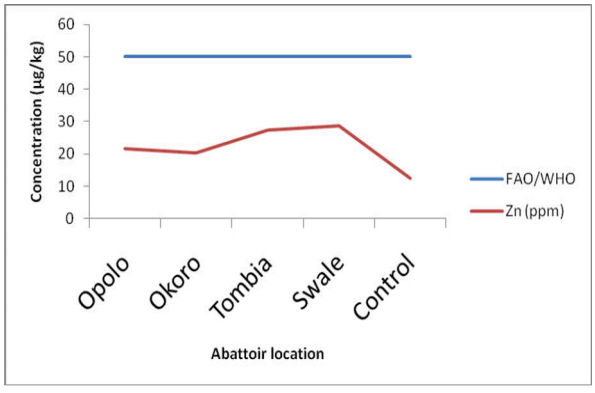

Fig. 6. Concentration of Zn in smokedcatfishcompared with FAO/ Limit

DISCUSSION

Fruits, vegetables, cereals, and other plant foods contain phytochemicals, which are bioactive nutritional plant compounds that may have health advantages above and beyond those of simple nutrition by lowering the risk of serious chronic diseases [17]. Due to growing public awareness of the significance of ecologically friendly products with nutritional benefits, cultured aquatic foods that are devoid of synthetic ingredients have recently been preferred. This understanding has brought attention to the need to replace synthetic products and antibiotics used in aquaculture feed production with phytochemicals, which are bioactive substances derived from plants (Francesca *et al.,* 2021) [18]. Consequently, phytochemicals found in fish and other animal products may have been imparted from the feed component or during the course of flaming wood to smoke the fishes. Phytochemicals protect us against many diets related diseases. Herbs that have tannins as their component are astringent in nature and are used for the treatment of intestinal disorders such as diarrhoea and dysentery [19]. It has been reported that flavonoids and phenolics are free radical scavengers that prevent oxidative cell damage, and have strong anticancer activities [20]. In recent years, researches on antioxidant activities of medicinal plants have remarkably augmented by virtue of increased interest in their potential high antioxidant capacity and positive health benefits [21]. The study by Hina *et al.,* [22], obtained saponin levels as high as 8.8% and alkaloid level of 21% from medicinal plants. Alkaloids have detoxifying and antihypertensive properties.

Assessment of minerals in catfish in this report showed that K and Na had the highest concentrations values in all samples across all locations while the concentration of Mg was lowest in all the samples also. The coastal communities of the Niger Delta region is endowed with brackish and saline waters. This may inform the saline nature of the fishes harvested from these water bodies. Study conducted by Onyia *et al.,* [23] on the proximate and mineral composition of some fishes in upper river Benue also showed that K and Na had the highest concentration values. He further attributed this to the dominance of the element in the water body where the fish lives. The concentration of Ca was highest in smoked catfish obtained from Swale abattoir and lowest in smoked catfish obtained at Rumuokoro abattoir. This could be attributed to the fact that most of the catfish available at Swale are the wild type (i.e. fishes harvested from natural environment or rivers) while most of the fish available in Rumuokoro are those raised in artificial ponds. The Na level is also highest in the Rumuokoro catfish because the handlers sometimes season the fish with little salt (to increase the shelf life) before roasting. The concentrations of K in Tombia samples were relatively lower than others. The fact that handlers in this abattoir roast their fishes longer which is responsible for the lowest moisture and highest crude fibre content of fishes in this abattoir may be may be a factor affecting the K content. However, Eyo [24] reported that mineral content of fish makes them unavoidable in the diet because these minerals contribute greatly to good health. Generally, the presence of heavy metals in fish could be due to environmental pollution of the prevailing water body where the fish was raised, type of fish species, age of fish, biological and physical processes in aquatic environment, and even handling, packaging and storage processes. Although Zn (which is an essential heavy metal in the human body) had highest concentration values in all samples yet the concentrations obtained in this report were below the FAO/WHO permissible limit. This result corroborates with the study conducted by Itoro *et al.,* [25] who also recorded Zn in highest concentrations when the team examined heavy metals in smoked fishes in Akwa Ibom markets. Furthermore, Daniel *et al*. [26] assessed heavy metals in smoked fishes in Benin City and the result he obtained show Zn to be next to Fe in concentration values. Furthermore, concentration of Cu was below the FAO/WHO permissible limit in all the catfish samples assessed. Study conducted by Saadettin *et al*. [27] reported that the most abundant micro element present in fish were Zn and Fe followed by Cu while the other elements present in low levels. The concentrations of Cd were higher than the USDA permissible limit of 0.1mg/kg in catfish samples collected from Igbogene, Opolo, Rumuokoroas well as Swale while the concentration in samples from Tombia were slightly below the permissible limit. Cr levels was significantly above the USDA permissible levels of 1.0mg/kg in samples collected from Rumuokoro abattoir and lower than the permissible limit in samples from other abattoir stations. It was observed that most of these stations process catfish that are harvested from the wild (which is largely brackish water).

Pb was detected above the USDA permissible limits of 0.2mg/kg in the three stations (Igbogene, Opolo and Rumuokoro). This observation is in accordance with the report by Adekunle and Akinyemi [28] who reported Pb more than thirty folds above the stipulated safety standard for lead level in smoked fish exposed to vehicular traffic density of the near-by highway to each market. Long-term Pb exposure can create issues in adults, such as an increased risk of high blood pressure and renal damage. Young children are more exposed to the harmful effects of lead, which can have long-term consequences, particularly in terms of brain and nervous system development. Only one of the five study sites showed Cd values that were somewhat lower than the USDA's permitted levels. Cd is most hazardous to bodily organs including kidneys and bones, particularly the proximal tubular cells, which are the primary location of accumulation [29]. However, Ogundiran *et al.* [30] found trace amounts of heavy metals (Fe > Cd > Pb > Zn > Ni > Cu) in some commercial marine fish obtained from two markets in south western Nigeria(while Fe and Cu recorded the highest and lowest concentrations respectively).

Fish muscle has been known to have the ability to bioaccumulate metals [31, 32, 33, 34]. Heavy metals' toxicity and bioaccumulation qualities make them unsuitable for consumption with smoked foods. Pb is known to disrupt a variety of biological functions and is harmful to organs such as the heart, kidneys, and bones. It also affects the development of the central nervous system, making it particularly dangerous to children. Chromium is an important metal in the human body because it helps to improve insulin function. Cr and its derivatives, however, are well-known poisons when consumed in excess of recommended limits. In humans, chromium toxicity is linked to allergic dermatitis; arsenic is linked to skin damage, an increased risk of cancer, and circulatory difficulties; and mercury is linked to kidney damage [35] Cd also has an effect on organs and interferes with mineral metabolism, resulting in mineral deficiency. Because of the bio-accumulative tendency of these heavy metals, it is not recommended for pregnant women, nursing mothers, and small children under the age of six to consume these smoked meals without caution.

Conclusion

This study revealed that smoked catfish are a rich of important phytonutrients and minerals. The findings in this study also showed that the phytochemical and mineral contents of the catfish varied across stations, which could be affected by the physico-chemical status of the water from which the fish was raised, composition of aquaculture feeds, environmental factors involved and the varying smoking procedures employed in the different abattoirs. Although the availability of phytochemicals and micro-nutrients in smoked catfish is beneficial to humans, the simultaneous presence of heavy metals in catfish at levels above recommended limits raises concerns for public health, particularly because excessive accumulation of these metals could harm consumers.

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