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Minerals and Heavy Metal Content of Roasted Cowhide Meat ("Kpomo") Sold in Some Abattoirs in Bayelsa and Rivers States

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ABSTRACT

This study investigated the mineral and heavy metal concentrations of roasted cowhide meat 'Kpomo' samples in some abattoirs in Bayelsa and Rivers State in Nigeria. Each abattoir employs unique procedure for the roasting of cowhides using characteristically different fuel sources for open fire singeing of the fur off the cowhide. Such open fire sources include fire made using firewood, plastics and expired automobile tyres. Roasted cowhide samples (500g) were randomly purchased from meat processors within the abattoirs. Samples were transported on ice-packed coolers to the laboratory for immediate analysis. The mineral contents were analyzed using the APHA method on an Atomic Absorption Spectrophotometer. Minerals assessed were calcium, potassium, sodium and magnesium while heavy metals analyzed were mercury, nickel, lead, copper, zinc, chromium, and cadmium. The Opolo firewood roasted cowhide samples recorded the highest minerals concentration with a total of 5245.4mg/kg value while the Tombia samples roasted with plastics totaled 4375.9mk/kg concentration of minerals and the Swale tyre roasted cowhide samples had least mineral contents value of 3470.2mg/kg. The result of this study further indicated that the firewood roasted cowhide sample from Opolo abattoir had the highest total heavy metals component of 80.063mg/kg, the Tombia plastics roasted cowhide sample recorded 34.894mg/kg, while Swale tyre roasted cowhide sample cumulated a 31.714mg/kg content and the least heavy metal contamination content (2.383mg/kg) was recorded in the control sample. The results showed that the different singeing methods adopted in respective abattoirs influenced the quantities of minerals and heavy metals present in the samples. The presence of toxic metals like lead, cadmium and chromium in edible cowhide could pose health risks to consumers thereby leading to metal poisoning especially if they bioaccumulate in the human system.

Keywords: Roasted cowhide, plastics, tyres, minerals, heavy metals, cadmium (Cd), lead (Pb), bioaccumulation

Introduction

The body require adequate minerals so as to carryout daily metabolic activities. Thus, food rich in nutrients both macro and micro nutrients especially those the body cannot synthesize is greatly recommended for consumption in the right proportion. According to Dabuo (2011), substance or substances derived from food that is needed for growth, body maintenance, tissue repairs including other functions that it is utilized for in the body is known as nutrient. These nutrients could be macronutrients (such as

Carbohydrates, proteins and fats) that make the bulk of our diets or micronutrients (such as vitamins and minerals) that make up the smaller, but equally essential part of our diets. Diseases associated with nutrient deficiency are well documented.

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The Food and Agricultural Organization (FAO) reported that unbalanced energy intake and deficiencies in vitamins and mineral nutrient is the cause of diseases affecting many people around the world (FAO, 2017).

Food deficiency is mostly attributed to developing nations and the impact could lead to diseases. Black *et al.* (2013) claimed that children and women from underdeveloped nations who are undernourished suffer serious health problems. Food could be consumed to satisfy hunger or taste but eating the right food which provides the body with essential nutrient is very important. For instance," *kwashiorkor*" which is a disease in children caused by protein deficiency may necessarily not mean that the children were not fed but because the meal is deficient of protein or the required protein needed by the body (Bwirhonde *et al*., 2018).

In some parts of Nigeria, processed cowhide known as *kanda* among the Ibos, *Fata* or *ganda* in Hausa and *ponmo* in Yoruba, is a very nice delicacy. The high rate of consumption of cowhide meat has been attributed to the low-class people in the society since it is thought to be cheaper than regular meat (Olukitibi *et al*., 2017). The continued demands for cowhide meat have increased the tendency to process large quantities to satisfy consumer demands and the adoption of different processing methods. The food and Agricultural Organization (FAO, 2003) has reported that burning of cowhide is a method adopted in some abattoirs to remove the fur of livestock.

One of the challenges that is of global importance that leads to toxicity and diseases in humans and animals is the contamination of food with heavy metal. Though these metals are natural components of the environment, high rate of industrialization has been responsible for their wider diffusion and dispersal in the environment (Rajaganapathy *et al*., 2011). Heavy metal pollution is a problem mostly associated with areas of intensive industry. According to Fairfax (2008), automobiles release zinc (Zn), copper (Cu), and lead (Pb), which account for at least 90% of the total metals in road runoff. Other ways for heavy metals to accumulate in the body include eating heavy metal contaminated fish, chicken, eggs, and other foods.

Obiri-Danso *et al.* (2008) claimed that the dearth of firewood has orchestrated the use of plastics, discarded automobile tires and used engine oil with firewood by local butchers and abattoir workers in the processing of cowhides. Since the fumes are absorbed during the singeing process, scrap tyres containing certain metals may have an influence on "kpomo" as well as the processor (Dabuo, 2011).

According to Jaishankar *et al*., 2014, heavy metal toxicity, depends upon the absorbed dose, the route of exposure and duration of exposure, i.e. acute or chronic, can lead to various disorders and can also result in excessive damage due to oxidative stress induced by free radical formation. Heavy metal toxicity can directly impact behaviour by impairing metal and neurological function, regulating neurotransmitter synthesis and use, and changing a variety of metabolic bodily processes. The aim of this study therefore was to determine the mineral composition and heavy metals associated with roasted cowhide from different abattoirs in Rivers and Bayelsa State, Nigeria.

Materials and Methods

Sampling Location

Samples for this study were collected from three abattoirs in Yenagoa Local Government Area of Bayelsa State and an abattoir in Obio Akpor Local Government Area of Rivers State. The abattoirs sampled in Yenagoa are: Tombia, Opolo and Swale abattoirs while Rumuokoro abattoir is in Obio akpor local government area of Rivers state.

Sample Preparation

Roasted cowhide samples were obtained from the aforementioned abattoirs. Meat handlers/processors in these abattoirs make use of different open fire sources for singeing the fur off the cowhide samples before sale to consumers. The roasting method employed in each abattoir is stated in Table 1 below: The abattoirs and their roasting fuel source are as follows;-

Tombia (Plastics), Opolo (Firewood), Swale (Automobile Tyre) abattoirs and Rumuokoro (Firewood); which were designated as Tombia (P), Opolo (FW), Swale (T), and Rumuokoro (FW) respectively. Cowhide samples scalded with hot water and the fur scraped out with a knife served as the Control.

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Sample Collection

Roasted cowhide samples of about 500 g sizes were purchased from meat processors within the designated abattoirs and placed into plastic containers. Samples were labeled appropriately and transported on ice-packed coolers to the laboratory for analysis.
Samples were homogenized by blending to smoothness in an alcohol sterilized Marlex blender and used for analyses.

Determination of Minerals Content

The mineral contents analyzed were calcium, potassium, sodium and magnesium. The mineral content of the samples was analyzed using the Standard methods for the examination of water and wastewater (APHA, 2012) with the aid of Atomic Absorption Spectrophotometer. The ash which was prepared from the sample was dissolved in 10% HCl and made up to the mark in 100ml standard flask with distilled water. This was later read in an atomic absorption spectrophotometer.

Determination of Heavy Metals Content
Seven heavy metals including Hg, Ni, Pb, Cu, Zn, Cr, and Cd were assessed in roasted cowhide samples. The Atomic Absorption Spectrophotometric method of APHA (2012) was used. Five grams of each sample (blended cowhide) were weighed each into a 250ml beaker and an empty beaker was stood in the analysis set up to represent the reagents/glass are blank.
One hundred millimeter (100ml) of distilled water was added, 1.0 ml of concentrated HNO_3 and 10ml of concentrated HCl were added respectively. The beaker was covered with ribbed watch glasses and heated at 95ºC on a hot plate. The beaker was removed from hot plate when the solution was remaining about 10-15ml. the content was allowed to cool to room temperature after which the solution was filtered and quantitatively transferred into a 50ml volumetric flask while diluting to volume with distilled water. A hallow cathode lamp for the desired metal was installed in the atomic absorption Spectrophotometer and the wavelength dial property set. The slit width was set for the element being measured. The instrument was turned on and allowed to warm up until energy source is stabilized. The current was readjusted as required after warm up and wavelength was optimized by adjusting the wavelength dial until optimum energy gain was obtained, the lamp was aligned accordingly. Ground state atoms are formed by desolation by the chemical flame and the particles absorb the light beam from the light source while the population of ground state atoms in the flame is directly proportional to the concentration of element of interest.

Results

Presented in Figures 1a and 1b are the results obtained from the assessment of mineral contents of roasted cowhide. Figure 1a shows that the concentration of Mg ranging from 136.64 – 39.97mg/kg as recorded in Opolo and Rumuokoro cowhide samples. Assessment for Na indicated concentration values ranging from 2,577.37 – 1973.82mg/kg as recorded in Tombia and Swale cowhide samples. The concentration value of K was highest in Tombia samples with value at 1564.75mg/kg and least in Rumuokoro sample with a value of 417.16mg/kg. Concentration values for Ca were between 258.25 – 52.13mg/kg which were obtained in samples from Opolo and Rumuokoro respectively. The decreasing order of these minerals in cowhide is in the order: Na > K > Ca > Mg. Furthermore, Figure 1b reveals the total mineral contents of cowhide roasted using distinct fuel sources. The Opolo firewood roasted cowhide samples recorded the highest minerals concentration with a total of 5245.4mg/kg value while the Tombia samples roasted with plastics totaled 4375.9mk/kg concentration of minerals and the Swale tyre roasted cowhide samples had least mineral contents value of 3470.2mg/kg.

The result obtained from the assessment of the seven (7) heavy metals (Hg, Ni, Pb, Cu, Zn, Cr, and Cd) in roasted cowhide samples is presented in Table 1.

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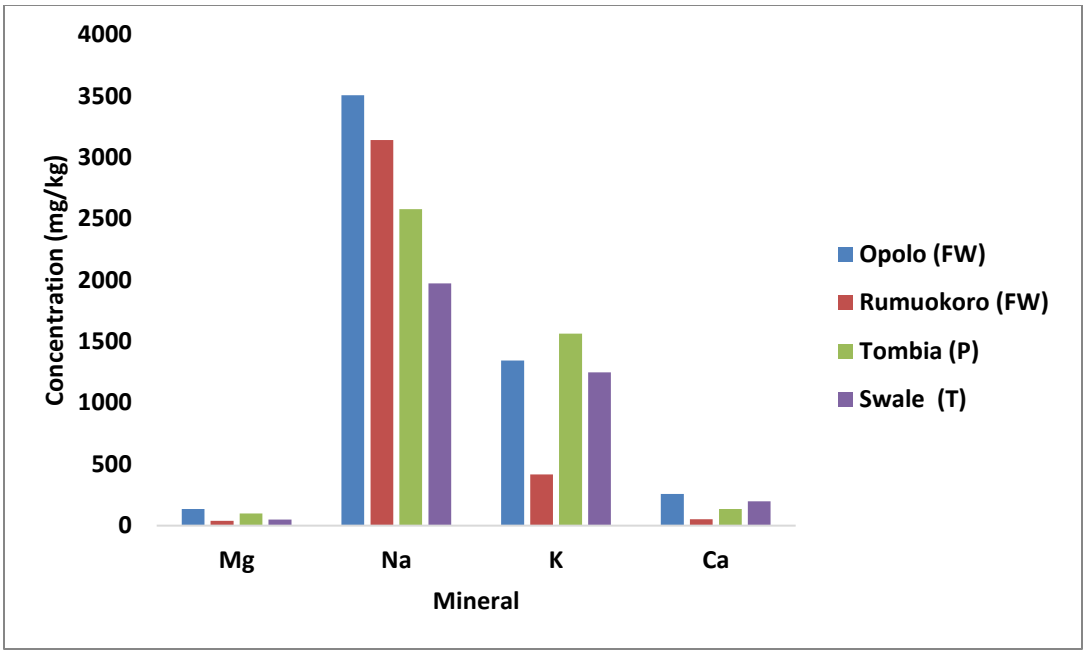
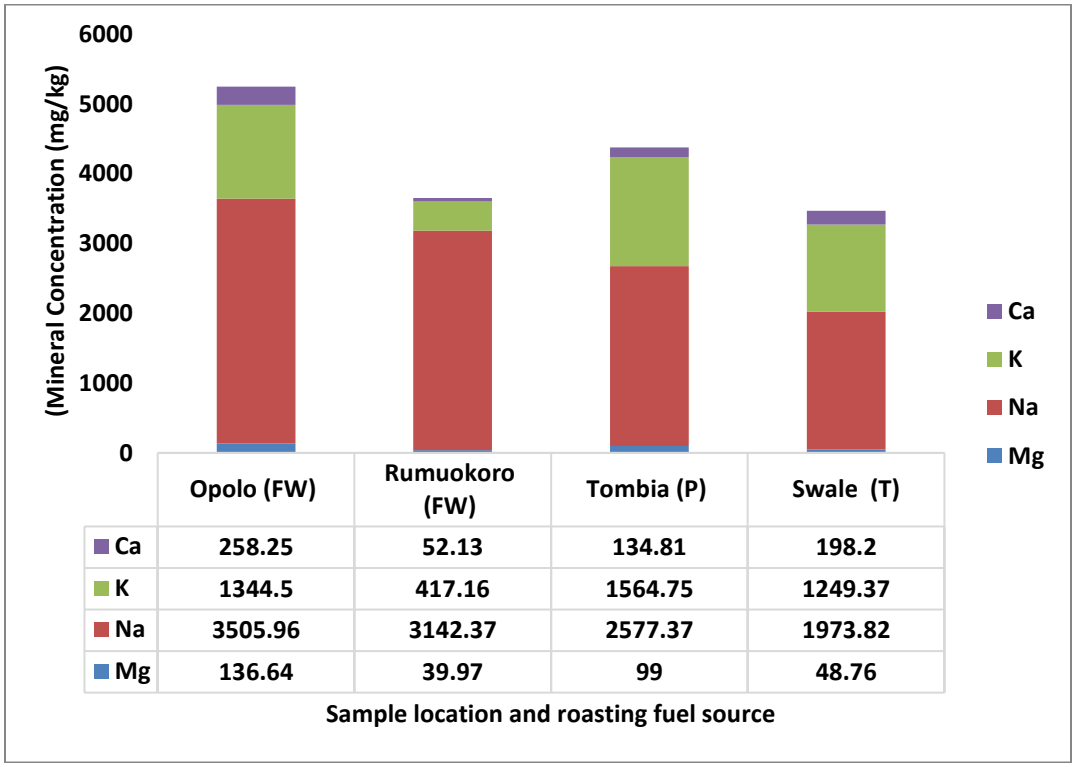


Figure 1a: Mineral contents of roasted cowhide with different roasting fuel source
Key: FW = Firewood roasted cowhide**,** P = Plastics roasted cowhide**,** T = Tyre roasted cowhide



	Opolo (FW)	Rumuokoro (FW)	Tombia (P)	Swale (T)
Ca	258.25	52.13	134.81	198.2
K	1344.5	417.16	1564.75	1249.37
Na	3505.96	3142.37	2577.37	1973.82
Mg	136.64	39.97	99	48.76

Figure 1b: Total mineral content of roasted cowhide with different roasting fuel source
Key: FW = Firewood roasted cowhide**,** P = Plastics roasted cowhide**,** T = Tyre roasted cowhide

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Table 1: Heavy Metal Content of Roasted Cowhide

Heavy metal	Abattoir location					Control
	Opolo (FW)	Rumuokoro (FW)	Tombia (P)	Swale (T)	Swale (FW)	
Pb	0.59	0.32	0.001	2.15	0.03	0.001
Cd	0.04	0.01	0.05	0.03	0.03	0
Cr	0.001	0.001	0.001	0.002	0.001	0.001
Ni	0.001	0.001	0.001	0.001	0.001	0.001
Hg	0.001	0.001	0.001	0.001	0.001	0
Zn	73.71	6.75	33.1	28.5	47.68	1.69
Cu	5.72	0.52	1.74	1.03	3.82	0.69
Total	80.063	7.603	34.894	31.714	51.563	2.383

Key: FW = Firewood roasted cowhide**,** P = Plastics roasted cowhide**,** T = Tyre roasted cowhide

The heavy metal with the highest mean concentration value was Zn. The highest concentration value of 73.71 mg/kg was obtained in firewood roasted cowhide from Opolo while the least value (1.69mg/kg) was recorded in the Control sample. The highest Pb concentration was recorded in tyre roasted cowhide sample from Swale abattoir with 2.15mg/kg concentration value and the least concentration was detected in firewood roasted cowhide prepared in Swale abattoir with a mean concentration value of 0.03mg/kg. The value of Cu detected in the cowhide sample was highest in cowhide from Opolo (5.72mg/kg) and lowest in Control sample (0.69mg/kg). Cd was undetected in cowhide samples from Rumuokoro (FW) and Control samples while it was detected in Tombia (P), Opolo (FW) and Swale samples at concentrations (0.05, 0.04 and 0.03) mg/kg respectively. Other heavy metals like Hg, Ni, and Cr were undetected in all the tested samples.

Summarily, the mean concentration of heavy metals in cowhide samples is in the order: Zn > Cu > Pb > Cd.
The above result further indicated that the firewood roasted cowhide sample from Opolo abattoir had the highest total heavy metals component of 80.063mg/kg, the Tombia plastics roasted cowhide sample recorded 34.894mg/kg, while Swale tyre roasted cowhide sample cumulated a 31.714mg/kg content and the least heavy metal contamination content (2.383mg/kg) was recorded in the control sample.

Discussion

The high demand for meat and meat products has influenced the methods of meat processing. The consumption of Kpomo has been widely accepted in our society despite the numerous controversies surrounding this delicacy. Kpomo is an essential ingredient in the preparation of many local foods, soups and stews (Obiri-Danso *et al*., 2008). This study has shown that cowhide though was insinuated by many to be void of nutritional value actually contain some important minerals required by the body though in trace amounts. The above submission is based on the inability of humans to produce the proteolytic enzyme - gelatinase, which allows living organisms to hydrolyse/digest gelatin (the protein present in cowhide) being not available in human physiology.

Thus making the essential amino acids in gelatin (almost all known essential amino acids are present in gelatin) unavailable to man (Joaquin *et al.*, 2009).

The minerals assessed in cowhide indicated that the concentrations of K and Na were the highest in all samples while the concentration of Mg was lowest. All the minerals examined had varied concentrations across each location. This variation could be attributed to the respective methods adopted during processing. As witnessed during sampling, most butchers roast the cowhide longer while others do not. There was no significant difference ($p>0.05$) in the minerals detected (Ca, Mg, Na and K) across cowhide samples.

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This study analysed seven (7) heavy metals in roasted cowhide processed for human consumption. The study confirmed the presence of zinc (Zn), lead (Pb), copper (Cu) and cadmium (Cd) in varying quantities, while mercury (Hg), nickel (Ni) and chromium (Cr) were undetected in all the cowhide samples analysed. Generally, the presence of heavy metals in cowhide could be due to environmental pollution of the abattoir, type of cowhide, singeing procedures and even handling, packaging and storage processes. The fur on the hide of slaughtered animals are usually got rid of by singeing with open flame fire which are usually ignited with fuel sources such as firewood, or firewood mixed with plastics, expired tyres or engine oils to enhance the flames.

The combustion of these fuel sources (especially tyres) may lead to the release and impartation of toxic organic substances such as dioxins, furans, volatile organic acids, polychlorinated biphenyls, benzenes and polycyclic aromatic hydrocarbons (PAHs) (ATSDR, 1995). Furthermore, heavy metals are also released during the combustion of tyres, plastics polystyrene polymers, tyres and woods fueled with engine oil (Okonkwo *et al*., 2014; Okiei *et al*., 2009; Ferrao *et al*., 2008).

Concentrations of Pb were above the USDA permissible limits in all the samples examined while the control sample had concentration below the USDA permissible limit. Consequently, the presence of this heavy metal could be connected to the impartation due to roasting as well as the open fire fuel source used. Furthermore, highest concentration of Pb was recorded in tyre roasted cowhide. This is because Pb and its alloys are used in the production of tyres (Mathew and Niklas, 2020).

The recorded Cd and Cu concentrations are below permissible limits. Mean concentration of Zn was above FAO/WHO permissible limit of 40mg/kg in firewood roasted samples obtained from Opolo and Swale abattoirs. Other stations had values within the permissible limit. These metals may have been imparted unto these foods materials through the smoke arising from the various organic fuel sources being used to roast them aside other environmental factors. The result of this study corroborates that of Kalu *et al*. (2015) who reported varying concentrations of Pb, Cu, Fe, Cd and Ni in roasted cowhide obtained from abattoirs in Nsukka, Nigeria. Furthermore, the study conducted by Okiei *et al*., 2009 on roasted cowhide indicated the presence of Zn, Cd, Cr, Pb and As in cowhide roasted with open flame fuelled by plastics.

However, Hg was obtained in addition to other metals in cowhide singed with burning tyres. Kalu *et al*., 2008 also analysed for heavy metals in cowhides roasted with tyres from three abattoirs in Port Harcourt and recorded traces amounts of mercury, arsenic, cadmium and lead in all the cow skins tested from the three abattoirs.

It has been reported that metals such as manganese cobalt, copper, chromium, iron, magnesium, molybdenum, and zinc are essential metals since they play important roles in biological systems, whereas cadmium and lead are non-essential metals which they are toxic to human system, even in trace amounts (Wang and Shi, 2001; WHO, 1996). The toxic and bio-accumulation properties of heavy metals therefore require close monitoring (Ali and Khan, 2018) and thus calls for caution in consuming them with food products. Lead (Pb) is known to interfere with a number of body processes and it is toxic to organs such as heart, kidney and bones, it also interferes with the development of the central nervous system and is therefore particularly toxic to children.

Chromium is an essential metal in the human body especially in enhancing insulin activity. Above recommended limits however, Cr and its compounds are well known toxins. Toxicity of Chromium is associated with allergic dermatitis in humans; arsenic is associated with skin damage, increased risk of cancer and problems with circulatory system while mercury is associated with kidney damage (Scragg, 2006). Cd also affects organs and it impairs mineral metabolism thus leading to mineral depletion. Based on the results obtained from this study, it is not advisable that pregnant women, nursing mothers and young children that are not up to six years to consume these roasted foods without caution because of the bio-accumulative property of these heavy metals.

In conclusion, this study has shown that cowhide though was insinuated by many to have no nutritional value actually contain some important minerals required by the body though in trace amounts. Furthermore, this study shows that the mineral and heavy metals contents of roasted cowhide assessed was influenced by the processing methods adopted, type of meat and other environmental factors.

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Consumption of cowhide along with other mineral rich foods could supply required minerals needed by the body. Nevertheless, the presence of some heavy metals in cowhide in limits above recommendations is a course for concern especially since bioaccumulation of these metals could have adverse effect on consumer's general wellbeing. However, processing of cowhide by scalding with hot water and using a knife to thrust out the animal fur was least contaminated and thus a recommended processing procedure for cowhide meat meant for human consumption.

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