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Level of Selected Heavy Metals in Liver and Muscles of Cow Meat Sold in Yenagoa Metropolis, Bayelsa State, Nigeria

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Abstract

This study evaluated the level of some selected heavy metals in liver and muscle of cow meat sold in Yenagoa, Bayelsa state, Nigeria. Replicate samples of liver and muscles were purchased from Etegwe Junction market in Yenagoa metropolis, Bayelsa state, Nigeria. The samples were dry-ashed, digested and analyzed using flame atomic adsorption spectrophotometer. Results showed mean manganese, copper, chromium, zinc and iron were 2.62 ± 0.23 mg/kg, 140.15 ± 18.15 mg/kg, <0.001 mg/kg, 53.42 ± 2.29 mg/kg and 654.65 ± 22.54 mg/kg respectively (liver) and 0.87 ± 0.10 mg/kg, 1.27 ± 0.40 mg/kg, <0.001 mg/kg, 38.07 ± 1.55 mg/kg and 43.82 ± 0.47 mg/kg respectively (muscle). Statistically, there was significant variations ($P<0.05$) among the heavy metals concentration in liver and muscle. Copper, iron and zinc concentration were above recommended level for beef as specified by World Health Organization. The implications of possible source of heavy metals in meat are from the food sources, (vegetation and drinking water) was discussed.

Keywords: Contaminants; Cow meat; Heavy metals; Yenagoa metropolis

Introduction

Like water, food is one of the essential resources needed for survival, and it also play vital role in the human body [1-7]. Food resources are the main source of protein, carbohydrate, vitamins, and minerals utilized by the human body for effective functioning the organs/systems and growth [3]. These food resources are mainly from vegetation/plants (cereals, legumes, oil crops, fruits, etc) and animals (some species of mammals, reptiles, aves, amphibians, fisheries etc).

Among the food resources, meat is an excellent source of high quality protein, and minerals [3]. Meat is derived from the flesh of animals, and it can easily contaminated [3,8]. Meats are processed into several forms after slaughtering, smoking, frying and boiling. This is the three main forms through which meat is consumed.

In a developing country like Nigeria, meat products are obtained from the wild "bushmeat" [9] and from domesticated animals. Some of the commonly consumed bush meat include bush pig, rabbit, guineafowl, antelope, squirrel, etc. while the domestic animals include sheep, cattle/cow, goat, poultry products such as chickens, turkey, ducks, etc [3,8]. Cow meat is one of the most widely consumed in Nigeria. Most cow/ cattle are moved from place to place in search of food (herbs) and water in Nigeria.

Several part of cow is consumed including rumen/intestine, kidney, liver, muscles, soft bone etc. Cow is a typical herbivorous animal (vegetation feeders). Most vegetation has the tendency to bio-accumulate toxicant such as heavy metals from their environment. The bioaccumulation tendency of plants varies type of plant and heavy metals, soil properties etc. For instance, Ogwok et al. [10] reported varying concentration of heavy metals in different part (liver, kidney, rumen and intestine) of cow from Kampla city, Uganda. Ihedioha et al. [11], Ihedioha and Okoye [12] also reported different concentration in different part (muscle, kidney, liver, intestines and tripes) of cow from an urban Nigerian population. Among the different part of cow, muscles/flesh is the largest. The liver is also another vital organ of the cow that play essential role. According to Swaileh et al. [13], Ubwa et al. [14], the liver is one of the major organs used for assessing heavy metal

contamination in animals probably due to their role in detoxification of toxins such as heavy metals.

Cattles in Nigeria moves around consuming vegetation. Plants has the tendency to bio-accumulate toxic substances such as heavy metals from the environment they were grown. When other living organisms such as cattle and humans consume plants that have high heavy metals, it may accumulate and over long period of time it could have recipient effects. Furthermore, when cows consumes the plants and humans further go ahead to consumes the cow it may have a health effect on human over a long period of time probably due to the residues found in the animals.

Basically, heavy metals are metalloid whose density is about 5 times denser that of water [2,15-17]. Heavy metals occur naturally in the environment and can also be released into the ecosystem from human activities in the ecosystem [18]. Heavy metals are classified into essential (copper, chromium, nickel, iron, zinc, manganese etc) and non-essential (cadmium, mercury, arsenic, lead, etc) [15,18]. Non-essential heavy metals are highly toxic even at trace concentration in biodiversity (plants and animals) [18]. Therefore this study aimed at assessing the level of heavy metals in muscle and liver of cow meat sold in Yenagoa metropolis, Nigeria.

Materials and Methods

Study area

Bayelsa state is one of the Niger Delta states. The region is characterized by sedimentary basin. Fishing is a major occupation of the resident of the area. Yenagoa metropolis is in Yenagoa Local

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Government area of Bayelsa state and it's also the state capital. The region is characterized by high water table/level and multiple flooding events [18]. According to Kigigha et al. [18], Yenagoa is a fast developing city with few industries and several business activities. Slaughterhouses are located in Swali, Etegwe junction and Igbogene. The activities of slaughter house are mostly carried out close to surface water resources [19]. The climate of the area is similar to other areas of the Niger Delta that have been comprehensively documented [19-30]. Furthermore, the area is characterized relative humidity and atmospheric temperature of 50-95% and 29 ± 5°C all year round [31-34].

Sample collection

Replicate samples of muscle and liver of cow meat were obtained from Etegwe Junction market and packaged in sterile Ziploc bag and transported to the laboratory where analysis was carried out.

Sample preparation and Heavy metal analysis

The samples were oven dried at 105°C to constant minimum moisture content for 6 hours and blended into powered [29]. Then it was dry-ashed in a muffle furnace at 450°C until sample was completely ashed [29,35,36]. The ashed samples were allowed to cool in a desiccator. The cooled ashed sample was digested using mixture nitric and hydrochloric acid which formed solution. Reagent blank containing acid mixtures were also prepared. The heating continued until dense fumes appeared. The heated mixture was allowed to cool and all acid solutions were made up to 20 ml using distilled water [35]. Samples and reagent blanks were aspirated into Flame Atomic Absorption Spectrophotometer (Model: GBC Avanta PM A6600) and the corresponding analyte concentrations were analyzed at varying wave length of: 213.9 nm, 324.70 nm, 248.3 nm, 279.5 nm and 357.90 nm for zinc, copper, iron, manganese and chromium respectively.

Statistical Analysis

SPSS version 20 was used for the statistical analysis. Data was presented as mean ± standard error. Significant difference between the heavy metal concentration in muscle and liver was determined using student t-test at $P < 0.05$.

Results and Discussions

Table 1 present the concentration of some selected heavy metals in liver and muscle of cow meat sold in Yenagoa metropolis, Bayelsa state, Nigeria. The concentration of chromium were <0.001 mg/kg in both liver and muscle of the cow meat. The concentration of chromium reported in this study is lower than the findings of other previous reports. For instance, Belete et al. [37] reported chromium in cow milk from Borena zone Ethiopia in the range of 0.845-0.895 mg/kg. Ihedioha et al. [11] reported mean of chromium in muscle and liver of cow sold in abattoir in Enugu and Nsukka as 1.24 µg/g and 4.28 µg/g respectively. This suggest that additional source of chromium can be introduced into diets of individuals that consumes cow meat in the study area.

Parameters	Liver	Muscles	t-value	p-value
Iron (mg/kg)	654.65 ± 22.54	43.82 ± 0.47	27.1	0.001
Zinc (mg/kg)	53.42 ± 2.29	38.07 ± 1.55	5.541	0.031
Copper (mg/kg)	140.15 ± 18.15	1.27 ± 0.40	7.65	0.017
Manganese (mg/kg)	2.62 ± 0.23	0.87 ± 0.10	7.165	0.019
Chromium (mg/kg)	<0.001 ± 0.00	<0.001 ± 0.00	NA	NA
NA: Not Applicable				

Table 1: Level of heavy metals in muscle and liver of cow meat sold in Yenagoa metropolis, Bayelsa state, Nigeria.

The concentration of zinc in the liver and muscle ranged from 51.12-55.71 (mean=53.42 mg/kg) and 36.52- 39.62 (mean=38.07 mg/kg) respectively. There was significance variation ($P < 0.05$) in the level of heavy metal among both part of the cow meat. The level of zinc in this study is within 50 mg/kg in muscle and above in liver as specified by Codex Alimentarium Commission in edible offal's [11,38]. Zinc concentration in this study is lower than the mean values of 121.27 µg/g and 132.33 µg/g in cow meat from Abattoir in Nsukka and Enugu, respectively, Nigeria as reported by Ihedioha et al. [11]. But higher than the value of 5.003-6.218 mg/kg in in cow milk from Borena Zone, Ethiopia as reported by Belete et al. [37]. Typically, zinc is essential heavy metals that are required by the body at certain concentration. Zinc is ingested into the body through food, water and dietary supplements. According to Belete et al. [37], the recommended dietary allowance (RDA) of zinc is 11 mg/day and 8 mg/day for men and women, respectively. The authors further reported that 10-15 times higher dose compared to the RDA when ingested could cause health related issues such as nausea, stomach cramps and vomiting.

The level of copper in the liver and muscle ranged from 122-158.30 (mean=140.15 mg/kg) and 0.87-1.67 (mean=1.27 mg/kg) respectively. There was significance variation ($P < 0.05$) in the level of heavy metal among both part of the cow meat. The copper concentration in the liver was higher than the 40 mg/kg recommended by WHO in food [10]. According to Iwegbue [39], Ogwok et al. [10], 100 mg/kg is the lethal dose of copper in the body. Furthermore, the authors also reported that copper level in the range of 100-300 mg/kg do not pose health risk. The concentration of copper in this study is higher compared to previous works. For instance, Belete et al. [11] reported copper concentration in cow milk from Borena Zone, Ethiopia in the range of 0.087-0.115 mg/kg. Ogwok et al. [10] reported copper concentration in some organs/tissues (liver, kidney, rumen and intestine) of cow in Kampla city, Uganda in the range of <0.002-0.58 µg/g. Like other essential heavy metals, copper is vital in the human body due to their role in physiology, growth and post natal development [11]. Typically, low concentration of copper in the muscle suggests copper deficiency in the cow. According to Puls [40], Korsruf et al. [41], Ogwok et al. [10] suggested that when copper concentration in muscle of animal is <10 mg/kg it indicates copper deficiency.

The level of iron in the liver and muscle ranged from 632.11-677.15 (mean=654.65 mg/kg) and 43.35-44.28 (mean=43.82 mg/kg) respectively. There was significance variation ($P < 0.05$) in the level of heavy metal among both part of the cow meat. The level of iron in liver cow was above the concentration of 45-300 mg/kg in beef liver [10,40] and limits of 30-150 mg/kg recommended in food [10,42]. The concentration of iron in this study is higher compared to previous works. For instance, Ogwok et al. [10] reported iron concentration in some tissue/organs (liver, kidney, rumen and intestine) of cow from Kampla city, Uganda in the range of 38.65-41.00 µg/g. Typically, high concentration of iron in food could be detrimental to the body over a prolong period of time.

The high iron concentration in the various part of the cow under study could have stemmed from intake of heavy metal from vegetation and drinking water. Furthermore, high concentration of iron has been reported in some vegetables sold in Yenagoa metropolis by Izah and Aigberua [29]. Furthermore, Izah et al. [15] have reported that high iron in the environment from the Niger Delta could be due to the geology of the area.

Manganese concentration in the liver and muscle ranged from 2.39-2.84 (mean=2.62 mg/kg) and 0.77-0.96 (mean=0.87 mg/kg)

respectively. There was significance variation (P<0.05) in the level of heavy metal among both part of the cow meat. The concentration of manganese in this study is higher than the concentration reported in milk of cow from Borena zone, Ethiopia by Belete et al. [37]. Typically, manganese is one of the essential heavy metals. High concentration in the body could induce disease conditions including birth defects, infertility in male, bone under development. The authors further reported that manganese toxicity resulting from chronic inhalation is characterized by neurodegenerative disorder [15]. The high concentration of manganese may have stemmed from environmental contamination were the food resources of the cow were frequently obtained.

Among the four detected heavy metals the concentration of heavy metals was significantly lower in muscle compared to the liver. This could be due to the role of liver in detoxification. According to Abou-Arab [43], Ubwa et al. [14], the highest level of heavy metals in liver is associated to their ability to remove toxins fully from the body.

Conclusion

Cow meat is one of the most consumed red meat. It's a major source of animal protein. The rearing, slaughtering and sales is a major source of livelihood to several families in Nigeria especially the Hausa/Fulani tribe. This study investigated the health risk assessment of heavy metal in muscle and liver of cow meat sold in Yenagoa, Bayelsa state, Nigeria. Results of the study found that heavy metals such as copper, iron and zinc were above recommended level specified by World Health Organization for red meat. Based on the findings of this study, caution should be exercise during the consumption of the liver and muscle of cow meat.

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