

Determination of Heavy Metals and Anti – Nutrients in Cow Meat Sold in Minna, Major Markets

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Meat is a major source of protein for the urban – population, but it could be susceptible to contamination by heavy metals, heavy metals and anti - nutrients pose a serious threat to human well being due to thier toxicity and chelating activity, this call for the need to determine thier level in meat which is one of our daily food.

Objectives: This study is designed to determine the concentrations of heavy metals (Lead, Chromium, Cupper, Cadmium, and Zinc) and anti-nutrients (Phytate, Oxalate and cyanogenic glycoside) in cow meat sold in different locations in Minna, Niger State.

Method: A total of 12 beef samples were bought from beef outlet in 4 major markets in Minna namely Bosso Market, Kure Market, Mobil Market, and Tunga Market. The level of the heavy metals were assayed using Atomic Absorbance Spectrophotometry (AAS) while that of anti – nutrients were determined using standard analytical methods.

Results: Show that the concentration of Lead is highest across all locations while that of Zinc is the lowest across all locations. The order of the level of heavy metal concentration across the locations are Pb > Cd = Cu >Cr > Zn. Lead (Pb) concentrations across the four markets are 6.340±1.3562µg/g, 6.766±0.3684µg/g, 6.057±1.2097µg/g, 3.716±0.247µg/g respectively, while that

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of zinc are $0.310 \pm 0.0061 \mu\text{g/g}$, $0.304 \pm 0.0023 \mu\text{g/g}$, $0.298 \pm 0.0227 \mu\text{g/g}$, $0.299 \pm 0.0180 \mu\text{g/g}$ respectively.

Conclusion: Results from this study indicate that heavy metal toxicity could result from the consumption of cow meat from these study areas.

Keywords: Cow meat; heavy metals; phytate; oxalate; cyanide; Minna.

1. INTRODUCTION

Food safety is a major public concern worldwide, and food poisoning has been associated with consumption of food stuffs contaminated by pesticides, heavy metals and/or toxins [1].

Food poisoning is an illness due to eating or drinking water contaminated with bacteria, parasite or chemicals.

Heavy metals has been broadly utilized as a group name for metals and metalloids that have been associated with contamination and potential toxicity or eco-toxicity. [2,3] stated that heavy metals in general are not biodegradable, have long biological half-life and have the potential for accumulation in the different body organs leading to unwanted side effects.

Beef is the kitchen or menu name for meat from dairy cattle, especially skeletal muscle. People have been eating this meat since ancient times [4]. It is classified as red meat (a term use for the meat of warm blooded animals, which contain higher measure of iron than chicken or fish). Normally eaten as meals, ribs, or steaks, beef is also ground or minced. Patties of ground meat are regularly utilized in hamburgers. Processed beef products include corned beef, meat jerky, and sausage. Beef is rich in protein, fat [5], different vitamins and minerals, particularly iron and zinc [6], and is therefore prescribed as a feature of a balanced diet.

Aside from beef and meat products forming an imperative piece of the human eating routine and as well as important source of an extensive variety of nutrient, they may likewise contain certain toxic substances [7]. Heavy metals in cattle tissues can be caused by an assortment of sources including animal drugs, pesticides, feeds and other agricultural or industrial chemicals substances [7]. Occurrences of heavy metal pollution in beef products during processing have additionally been accounted for [5,8]. In different cases, contaminated animal feeds and rearing of animals near polluted environment were reported responsible for heavy metals in meat [7].

Heavy metals in their standard state have a particular gravity (density) of more than around 5 g/cm^3 [9]. Living organisms require different amounts of heavy metals. Iron, cobalt, copper, manganese, molybdenum, and zinc are require by humans. All metals are dangerous at higher concentration. Excess level can be harming to living organisms. Other heavy metals can be, for example, mercury, plutonium, and lead are harmful metals that have no known vital or beneficial roles on organisms, and their accumulation after some time in the bodies of the animal can cause serious illness.

The hazard associated with the exposure to heavy metals present in food item have arouse widespread concern in human health. Heavy metals interfere with a number of body functions and primarily affecting the central nervous, hematopoietic, hepatic and renal system producing serious disorder [10].

Anti-nutrients are natural or synthetic compounds that interfere with the absorption of nutrients [4]. Anti-nutrients are substances that are damaging to health, they include metals such as phytate, oxalate, cyanide, saponin, lipase inhibitor protease inhibitor etc. These compounds chelate metals such as iron and zinc and reduce the absorption of these nutrients.

This study is aim at evaluate cow meat sold in Minna for presence of some heavy metals and anti-nutrients.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of 12 beef samples was bought from beef outlet in 4 major markets in Minna (3 from each market), these markets were Bosso Market, Kure Market, Mobil Market, and Tunga Market. All samples was then properly labeled and stored in clean polythene bags according to their place of collection and brought to the laboratory for preparation and treatment.

2.2 Sample Preparation And Treatment

The collected samples was rinsed with distilled water to remove any contaminants particles. The samples was then cut to small pieces using clean knife. Samples was then dried in an oven (Gallenkamp) at 100°C. After drying, the samples was grained into a fine powder using a pestle and mortar and stored in sample bottle until used for digestion.

2.3 Digestion

Acid mixture (10 mL, 70% high purity HNO₃ and 65% HClO₄, 4:1 v/v) was be added to the beaker containing 0.5 g dry sample according to AOAC [11]. The mixture was then digested using Kjal Digestion Block (Gerhardt Kjeldatherm) at 285°C till the transparent solution is achieved. After cooling, the digested samples will be filtered using Whatman no. 42 filter paper and the filtrate will be diluted to 50 mL with deionized water.

The concentrations of Lead (Pb), Chromium (Cr), Cupper (Cu), Cadmium (Cd), and Zinc (Zn) was determined by an Atomic Absorbance Spectrophotometer (AAS).

The concentration of antinutrients were determined using standard analytical procedures.

2.4 Statistcal Analysis

Data generated from the study were presented as mean + SD of 3 determinants. Statistcal analysis was done by one way analysis of Variance (ANOVA) using the SPSS version 21.0. The mean differrene at P<0.05 were considered statistically significant.

3. RESULTS AND DISCUSION

The concentrations of heavy metals (Lead, Chromium, Cadmium Zinc and Copper) are given in Fig. 1. The result shows that there is no significant difference in lead concentration between meat sample from Mobil, Kure and Bosso market but these values significantly differ from the value obtained for meat from Tunga market. For Chromium, cadmium, zinc and copper, there is no significant difference in their concentrations across all location sampled at P ≤ 0.05.

The concentrations of phytate and oxalate are given in Fig. 2. The result indicate that, there is

no significant difference in phytate concentration across locations sampled. For Oxalate concentration, there is no significant difference between meat sample from Tunga, and Bosso market but these values differ significantly from values for Mobil as well as Kure market at P ≤ 0.05.

The concentration of Cyanide is given in Table 1. The result shows that there is no significant difference in cyanide concentration between meat samples from Tunga, Mobil and Kure market but these values significantly differ from values obtained from Bosso market at P ≤ 0.05.

Heavy metal were detected in all samples across the four location where the samples were collected while that of anti – nutrients were very low.

The concentration of Lead is highest across all location while that of Zinc is the lowest across all location. The order of the level of heavy metal concentration across the locations is **Pb > Cd = Cu > Cr > Zn**.

Lead was present in the range of 3.761 – 6.766 µg/g. The Turkish acceptable limit and EU limit for Pb (µg/g⁻¹) is 0.40, [12,13], permissible value by Malaysian Food Regulation [14] is 2.00, by Hong Kong Environmental Protection Department [15] it is 6.00, by USEPA [16] it is 0.491, by FSANZ [17] is 0.200, by EUROPA [18] it is 0.100. The obtained result of lead concentration exceeds the permissible level of all the above regulations, except samples from Tunga Market (3.761µg/g) which falls below the limit set by HKEPD, [15] of 6.00.

Cadmium was found in the range of 1.467 – 1.480µg/g, this obtained value exceeds the permissible level (0.1). The Turkish Food Code [13], European Union [12] limit of 0.05 mgkg⁻¹, United States Environmental Protection Agency [16] 0.491µg/g, Food Standards Australia New Zealand [17]; 0.200 µg/g, EUROPA [18]; 0.100. However, the obtained result in this study falls below the limit set by Hong Kong Environmental Protection Department [15]; 2.00µg/g and United States Food and Drug Administration [19]; 3.70µg/g. For zinc (µg g⁻¹) the permissible limit by Canadian Food Standard is 100, by Hungarian Standard 80, by Australian Standard 10 Turkish Standards [13] it is 50 mg kg⁻¹. Zinc concentration in this study (0.299 – 0.310µg/g) falls below the above stated regulations.

For Cu ($\mu\text{g g}^{-1}$) Canadian Food Standard is 100, Hungarian standard 60, the range of international standard 10-100, Turkish acceptable limit 20, the permissible limits set by the Malaysian Food Regulation [14] 30, USEPA [17] Limit 120. Cu concentrations in all meat samples (1.47 – 1.476 $\mu\text{g/g}$) analyzed were below the corresponding authorized limits.

Chromium concentration was found in the range of 1.463 – 1.467 $\mu\text{g/g}$, this obtained value exceed the permissible limit set by FSANZ [18]; 0.200 and 0.100 by EUROPA [19].

The low value of the anti – nutrients determined point to the fact that anti-nutrients do not bio-accumulate like the heavy metals therefore does not store in the animal tissue.

There are various sources of emission of trace metals into the Nigerian environment. Indiscriminate dumping of metal containing wastes including electronics and disposal of lead based products such as lead-acid and torchlight batteries is very common in the country. An example could be seen in the recent lead

poisoning that occurred in five villages (Dareta, Yargalmal, Tungar Daji, Sunke and Abare) in Anka L.G.A of Zamfara State where 160 villagers with children topping the number that died and hundreds more hospitalized due the lead released into the environment from the illegal mining of gold ore in the area. The miners crush the excavated rocks containing lead ores and sieve the crushed rock to extract the precious gold. The remains are discarded into the environment and thus contaminating the soil and water bodies. The soil in these villages was reported to have lead levels 23 times the limit in U.S standards [20] and barefooted children streaked with dust sat on the contaminated ground, running their hands through the silt and sucking their fingers. Also livestock drink from the contaminated water bodies.

Open refuse burning can also enrich the environment with some of these metals. Other sources of these metals especially lead, cadmium and nickel could be from vehicular emission. Many countries have banned the use of leaded petrol, but Nigeria has not yet made any categorical statement on the issue.

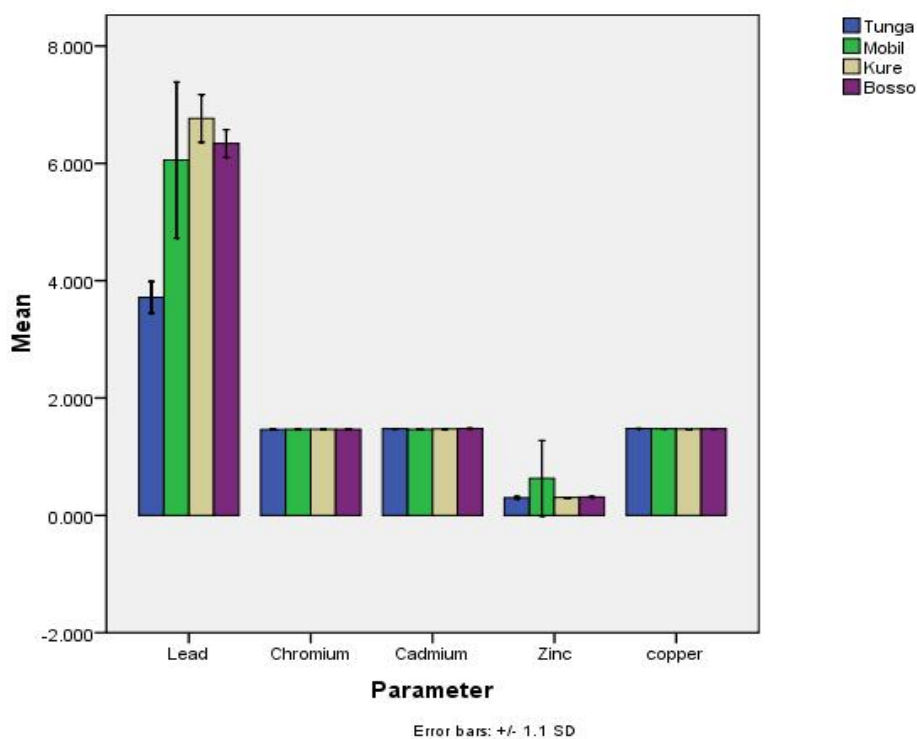


Fig. 1. Heavy metal concentration across location of Tunga, Mobil, Kure and Bosso
 Values are in mean \pm SD of triplicate readings. Values with the same superscript are not significantly different at $P \leq 0.05$

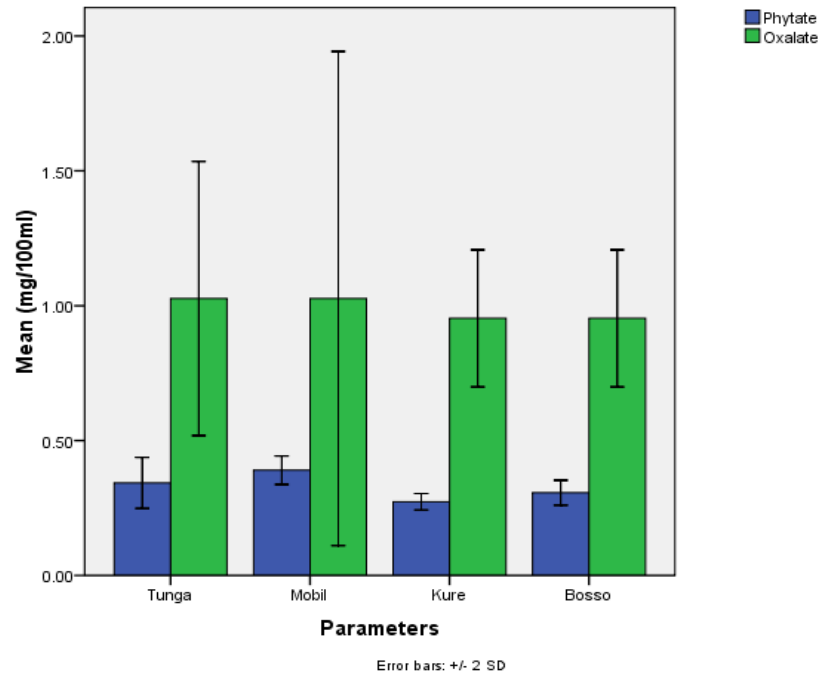


Fig. 2. Mean concentration of phytate and oxalate across locations
 Values are in mean \pm SD of triplicate readings. Values with the same superscript are not significantly different at $P \leq 0.05$

Table 1. Cyanide concentration in cow meat sold in different location in Minna, Niger State

Sample	Mean \pm SD Cyanide Concentration (mg/L)
Tunga	0.0093 \pm 0.0011 ^b
Mobil	0.0080 \pm 0.00150 ^{ab}
Kure	0.0092 \pm 0.00098 ^b
Bosso	0.0064 \pm 0.00158 ^a

Values are expressed in mean \pm SD of triplicate readings. Values with the same superscript are not significantly different at $P \leq 0.05$

4.CONCLUSION

It can be concluded from the results obtained in this study that lead, chromium and cadmium are present in meat from all locations and are above the permissible limit set by World Health Organization, Food Agricultural Organization and Experts Committee Commission. Therefore heavy metal toxicity could result from consumption of cow meat from the study areas.

The high levels of lead, chromium and cadmium in cow meat in Minna call for continuous monitoring of our environment to ensure protection from further pollution and there is need for the Federal Government to bring about a control method of feeding cattle for example creation of game reserves where livestock can graze without exposure to contaminants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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