ASSESSMENT OF SOME HEAVY METALS LEVEL IN ANIMAL ORGAN SAMPLES FROM NIGER DELTA, NIGERIA

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Abstract- The aim of the study was to assess some heavy metal (Zinc, Arsenic, Mercury, Copper and Vanadium) in 14 different animal organs in Niger Delta in Nigeria. The metal concentration Vanadium (V), Cadmium (Cd), Arsenic (As), Zinc (Zn), Mercury (Hg) and copper (Cu) were obtained in 84 meat and poultry samples using a Solar Thermo Elemental Flame Absorption Spectrometer (S4 710). The highest mean metal concentration of zinc was found in cow meat muscle while the lowest mean metal concentration of zinc was found in broiler chicken gizzard with mean concentration ranging from 20.917±13.68ppm in all animal organs. The highest mean concentration of Vanadium was found in Native goat muscles while the lowest mean concentration was found in fresh fish B with mean concentration ranging from 0.0225±0.04ppm. The highest mean concentration of copper was found in cow meat liver while the lowest mean concentration was found in broiler chicken gizzard with mean concentration ranging from 9.087±3.748ppm. The highest mean concentration of arsenic was found in Native Chicken muscle while the lowest mean concentration was found in dried fish B with mean concentration ranging from 0.05±0.17ppm. The result of the metal concentration showed that the cow and native goat organs tends to accumulates more heavy metals than any poultry and fishes organs. The result from ANOVA showed that there was significant difference in the concentration of zinc in the various animal's organs but there was no significant difference in the concentration of the other heavy metal.

1. INTRODUCTION

Food is required by all living organisms for life sustenance [1]. The occurrence of heavy metals in food has been reported in several studies [2]. Increase in urbanization and industrialization in developing countries has resulted to the release of environmental pollutants into the food chain resulting in the heavy burden of pollutants like heavy metals in food consumed [3]. Heavy metals and hydrocarbons contamination of the total environment (air, soil, water and biota) in the Nigeria's Niger Delta region has become a paramount interest and several studies have revealed levels and impacts considered toxic and dangerous [4]. By definition, heavy metals are metallic elements that have relatively high density compared to water [5].

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Heavy metals are major environmental contaminants that play no biological role in the human body [6]. Exposure to heavy metals results from natural and anthropogenic activities [6]. These pollutants are naturally occurring and can exhibit significant environmental persistence [7]. Environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water [8]. While essential heavy metals can play biochemical and physiological roles in the body, other toxic heavy metals called priority metals (lead, cadmium, mercury and arsenic) play no biological function at all [9]. Heavy metal exposure can result to toxicities such as neurotoxicity, cardiovascular effect, nephrotoxity malignancies etc. (Rehman, Fatima, Waheed, & Akash, 2018).

In this study, the human health risk associated with some heavy metals in different food groups consumed in the Niger Delta, Nigeria is determined.

2. MATERIALS AND METHODS

2.1. Study Area

The study areas used for this study were located in the Niger Delta region of Nigeria. The Niger Delta is the delta of the

Niger River sitting directly on the Gulf of Guinea on the Atlantic Ocean. The Niger Delta region is located in the South-South geopolitical zone of Nigeria (See Fig. 1) that is made up of nine oil producing states namely Rivers, Delta, Edo, Ondo, Akwa Ibom, Abia, Imo, Ondo and Cross River. Animal organs samples were taken from three of the Niger Delta state namely Bayelsa, Akwa Ibom and Rivers states. The study area lies within the geographical coordinate of longitude 4º15'N - 6º30'N and latitude 5º32'E - 8º22'E of the lower Niger River in Nigeria. Fig. 1 shows location map of the study area.

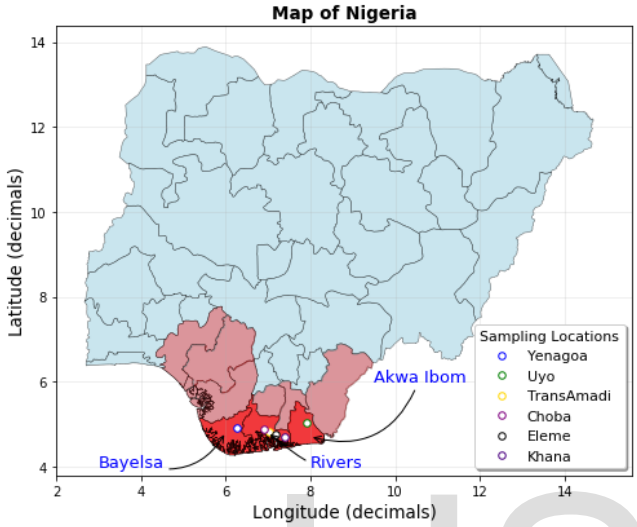

Fig 1: Map showing the sampling locations used for the study

2.2 Sample Collection and Preparation

Food samples namely cow meat liver and muscle, fresh fish samples, dried fish samples, native goat liver and muscle, goat meat from pepper soup, chicken suya, beef suya, fried meat, kilishi, native and broiler chicken muscle and gizzard were utilized in the present study. The cow and goat meat samples were collected directly from the Abattoirs, Two types of fresh fish samples (one from natural rivers and another from the pond) were also collected in the course of the study. Soil samples were collected with a metastenic stainless steel hand trowel. The hand trowel prior to collection was cleaned properly to prevent cross contamination. This was collected randomly at distance of 5m alongside their corresponding soil samples. All samples were preserved at -40c in an ice pack and transported to the laboratory for analysis.

2.3 Heavy Metal Determination

Heavy metals (V, Zn, As, Cu and Hg) in the samples were analyzed by a two-step process; dry-ashing and acid digestion. Fresh samples (meat and fish tissues) were oven-dried at 70°C for 24 hours while other samples were air dried for 24hours. Dried samples were ground using a pestle and mortar and sieved through Muslin cloth. Five grams of each sample was digested in 9 mL of 65% concentrated HNO3 and 3 mL perchloric acid. The solution was transferred to a hot plate of 110°C for about 5 hours. Afterwards, the samples were introduced into an oven under a temperature that was gradually increased in 100°C every 60 minutes until the wished final temperature of 450°C was reached 18 hours later; white ashes were obtained. Following this, samples were left to cool. The white ashes were then dissolved with 1.5% HNO3 (5 mL) and a final volume of 25 mL was made by adding deionized water. The resulting solution was filtered using a Whatman filter paper (number 42) fitted into a Bucher funnel into a beaker before it was transferred into a tightly sealed plastic container. The presence of heavy metals (V, Zn, As, Cu and Hg) was determined using a Solar Thermo Elemental Flame Absorption Spectrometer (S4 710).

2.4. Quality Control

The instrument was recalibrated after every ten runs. The analytical procedure was checked using spike recovery method (SRM). A known standard of the metals was introduced into already analyzed samples and reanalyzed. The results of the recovery studies for Cd, Cr, As, Pb, Ni, and Sn, were more than 95%. The relative standard deviation between replicate analyses was less than 4%. The limit of detection (LOD) for V, Zn, As, Cu and Hg was 0.001 ppm with blank values reading as 0.00 ppm for all the metals in deionized water with electrical conductivity value of lower than 5 µS/cm. The limits of quantification LOQ for V, Zn, As, Cu were 0.004 and for Hg, was 0.006 ppm.

2.5 Data Analysis

Descriptive Statistic was carried out to determine the mean concentration and the standard deviation for level of concentration in the various animal organs. One-way analysis of variance (ANOVA) was used to determine whether the concentrations of the metals varied significantly, with values less than 0.05 ($p<0.05$) considered to be statistically significant. The statistical calculations were performed with XLSTAT software, 2016 version.

3. RESULTS AND DISCUSSION

3.1 Zinc Concentration

The metal concentration of zinc in animal protein found in the Niger Delta region of Nigeria ranged from 4.251 to 45.267 ppm, with a mean concentration of 20.917ppm and standard deviation of 13.68ppm. The mean metal concentration of zinc in cow meat muscle was 45.27±21.50ppm, the mean metal concentration of zinc in cow meat liver was 40.77±17.63ppm, the mean metal concentration of zinc in broiler chicken gizzard was 10.67±3.90ppm and the mean metal concentration of zinc in native chicken gizzard was 12.35±4.47ppm. The highest mean metal concentration of zinc was found in cow meat muscle while the lowest mean metal concentration of zinc was found in broiler chicken gizzard. The World Health Organisation recommended a provisional maximum tolerable daily intake of lead to be 0.3-1mg/kg bw/d and an average zinc intake in adult to be 14 – 20mg/kg. All the concentration of zinc found in the animal organs where below 50mg/kg Codex permissible limit standard. High concentration of zinc in the human body can cause various health issues like gastrointestinal irritation (nausea, cramps, and diarrhoea), anaemia and reduction in activities of several important enzymes in various tissues.

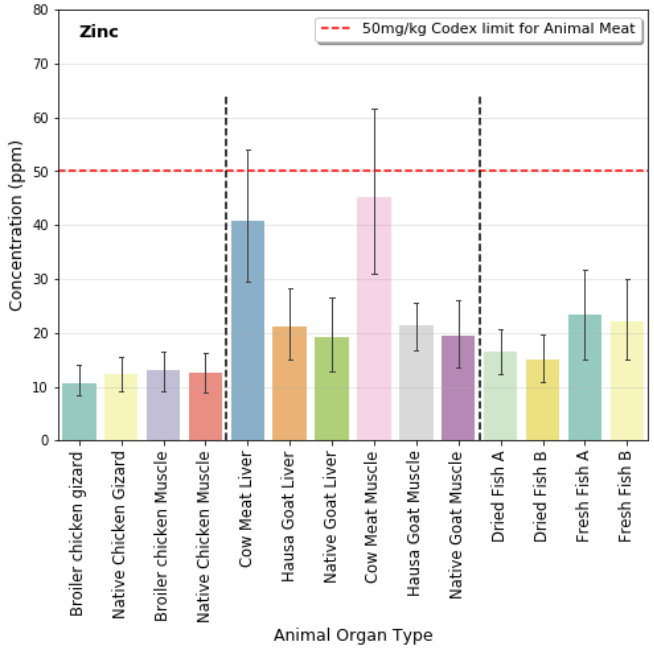

Fig 2: Barplot of heavy metal concentration of Zinc in animal organs in Niger Delta region of Nigeria

3.2 Vanadium Concentration

The metal concentration of Vanadium in the various animal organ used for the study ranged from 0.0001 to 0.227ppm, with a mean metal concentration of 0.0225ppm and a standard deviation of 0.04ppm. The mean metal concentration of Vanadium in Native goat liver was 0.0459±0.089ppm, the mean metal concentration of native goat muscle was 0.0463±0.084ppm, the mean metal concentration of fresh fish B was 0.002±0.003ppm while the mean metal concentration of broiler chicken gizzard was 0.0183 ±0.0372ppm. The highest mean concentration of Vanadium was found in Native goat muscles while the lowest mean concentration was found in fresh fish B as shown in Fig. 3

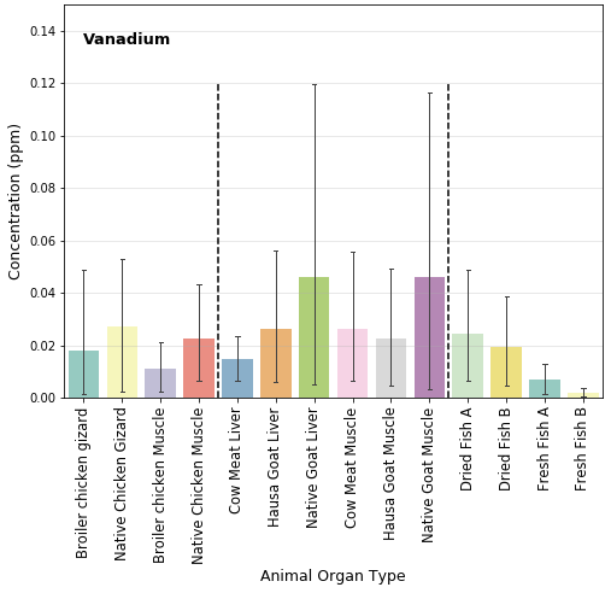

Fig 3: Barplot of heavy metal concentration of Vanadium in animal organs in Niger Delta region of Nigeria.

3.3 Copper Concentration

The metal concentration of copper in the various animal organ used for the study ranged from 1.24 to 20.88ppm, with a mean metal concentration of 9.087ppm and a standard deviation of 3.748ppm. The mean metal concentration of copper in cow meat liver was 12.475±6.921ppm, the mean metal concentration of cow meat muscle was 12.065±6.009ppm, and the mean metal concentration of broiler chicken gizzard was 6.270±2.432ppm while the mean metal concentration of broiler chicken muscle was 6.413±3.033ppm. The highest mean concentration of copper was found in cow meat liver while the lowest mean concentration was found in broiler chicken gizzard as shown in Fig 4. Chronic exposure to copper can lead to nausea, abdominal discomfort (diarrhea), emesis, haemoglobinuria and/or haematuria, jaundice, oliguria/anuria, hypotension, coma and death. The fatal oral human dose is about 200 mg/kg [11].

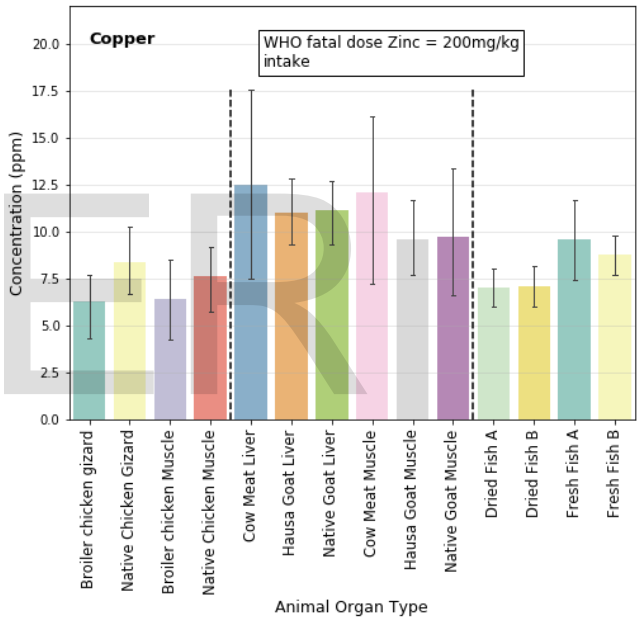

Fig 4: Barplot of heavy metal concentration of Copper in animal organs in Niger Delta region of Nigeria.

3.4 Arsenic Concentration

The metal concentration of arsenic in the various animal organ used for the study ranged from 0.0002 to 1.24ppm, with a mean metal concentration of 0.05ppm and a standard deviation of 0.17ppm. The mean metal concentration of arsenic in Native chicken Muscle was 0.223±0.499ppm, the mean metal concentration of arsenic in broiler chicken gizzard was 0.138± 0.296ppm, the mean metal concentration of arsenic in dried fish B was 0.005±0.006ppm. The highest mean concentration of arsenic was found in Native Chicken muscle while the lowest mean concentration was found in dried fish B as shown in Fig. 5. It was observed from Fig. 5 that arsenic concentration were high in chicken organs than in any other animal part, this was due to the fact that poultry feed are mainly fish feed which contain high concentration

of arsenic [11]. Excessive intake of arsenic above the recommended limit can result to arsenic induced skin cancer. Due to the high level of concentration of arsenic in chicken organs in the Niger Delta region of Nigeria, consumption of livestock would be a safer option to reduce the risk of arsenic skin induce cancer.

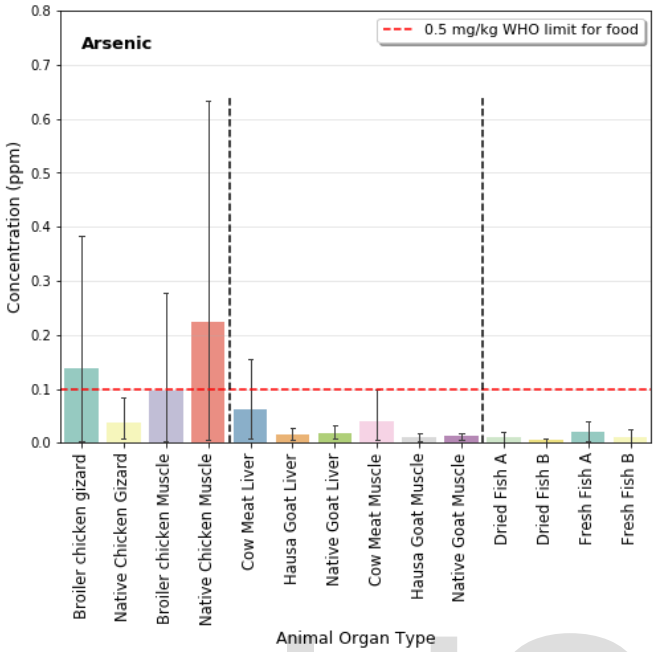

Fig 4: Barplot of heavy metal concentration of Arsenic in animal organs in Niger Delta region of Nigeria.

3.5 Mercury Concentration

The metal concentration of mercury in the various animal organ used for the study ranged from 0.0172 to 0.0001ppm, with a mean metal concentration of 0.0032ppm and a standard deviation of 0.0035ppm. The mean metal concentration of mercury in cow meat liver was 0.0064±0.004ppm, the mean metal concentration of mercury in native goat liver was 0.0047± 0.0066ppm, the mean concentration of mercury in fresh fish A was 0.00152±0.002ppm while the mean concentration of mercury in dried fish B was 0.0009±0.001ppm. The highest mean concentration of mercury was found in cow meat liver while the lowest mean concentration was found in dried fish B as shown in Fig. 5. The recommended maximum intake limit of mercury should be 0.51mg/kg in food [11]

3.6. Analysis of Variance

A one way analysis of variance was perform to see if there is any significant difference between the concentration of heavy metals in the various animals organs. From Table 1, it was observed that there was significant difference at level of significant of 0.05 in the mean metal concentration of Zinc in the various animal organs. The mean concentration of Zinc in cow meat muscle was significantly higher than the mean metal concentration of native chicken muscle, it was also observed that the mean concentration of lead in cow meat muscle was also higher than the mean concentration in chicken gizzard (broiler and native), this indicate that the sources and the rate both animal accumulate lead were very much different. The mean concentration of zinc in cow meat liver was significantly difference from the mean concentration of lead in broiler chicken gizzard. There was no significant different at level of significant of 0.05 in the mean metal concentration for the remaining heavy metals.

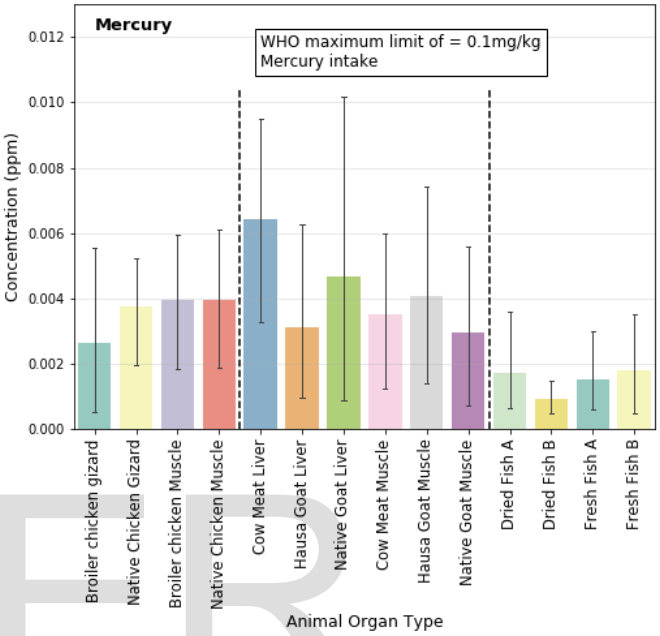

Fig 5: Barplot of heavy metal concentration of Mercury in animal organs in Niger Delta region of Nigeria.

Table 1: Summary table for the mean, standard deviation and significant difference between the heavy meatal for different animal organ part for Niger Delta Nigeria

Animal Organ Part	V	Zn	As	Cu	Hg
Cow meat liver	$0.015^{a} \pm 0.012$	$40.765^{bc} \pm 17.626$	$0.062^{a} \pm 0.114$	$12.475^{a} \pm 6.921$	$0.006^{a} \pm 0.004$
Native goat liver	$0.046^{a} \pm 0.089$	$19.156^{abc} \pm 9.772$	$0.019^{a} \pm 0.017$	$11.173^{a} \pm 2.369$	$0.005^{a} \pm 0.007$
Hausa goat liver	$0.027^{a} \pm 0.037$	$21.272^{abc} \pm 9.223$	$0.015^{a} \pm 0.015$	$10.994^{a} \pm 2.390$	$0.003^{a} \pm 0.004$
Cow meat muscle	$0.027^{a} \pm 0.036$	$45.267^{c} \pm 21.502$	$0.041^{a} \pm 0.070$	$12.065^{a} \pm 6.009$	$0.004^{a} \pm 0.003$
Native goat muscle	$0.046^{a} \pm 0.084$	$12.557^{abc} \pm 5.243$	$0.012^{a} \pm 0.009$	$9.700^{a} \pm 4.691$	$0.003^{a} \pm 0.003$
Hausa goat muscle	$0.023^{a} \pm 0.032$	$21.344^{abc} \pm 6.353$	$0.010^{a} \pm 0.010$	$9.604^{a} \pm 2.529$	$0.004^{a} \pm 0.004$
Native Chicken muscle	$0.023^{a} \pm 0.025$	$12.557^{ab} \pm 5.243$	$0.223^{a} \pm 0.499$	$7.654^{a} \pm 2.493$	$0.004^{a} \pm 0.003$
Broiler Chicken muscle	$0.011^{a} \pm 0.014$	$12.986^{abc} \pm 5.207$	$0.097^{a} \pm 0.218$	$6.413^{a} \pm 3.033$	$0.004^{a} \pm 0.003$
Fresh fish A	$0.007^{a} \pm 0.008$	$23.388^{abc} \pm 11.712$	$0.019^{a} \pm 0.026$	$9.606^{a} \pm 3.054$	$0.002^{a} \pm 0.002$
Fresh fish B	$0.002^{a} \pm 0.003$	$22.151^{abc} \pm 10.164$	$0.010^{a} \pm 0.018$	$8.777^{a} \pm 1.409$	$0.002^{a} \pm 0.002$
Dried fish A	$0.024^{a} \pm 0.030$	$16.578^{abc} \pm 5.776$	$0.010^{a} \pm 0.014$	$7.034^{a} \pm 1.417$	$0.002^{a} \pm 0.002$
Dried fish B	$0.020^{a} \pm 0.024$	$15.005^{abc} \pm 5.834$	$0.005^{a} \pm 0.006$	$7.109^{a} \pm 1.483$	$0.001^{a} \pm 0.001$
Native Chicken Gizzard	$0.027^{a} \pm 0.038$	$12.355^{ab} \pm 4.469$	$0.038^{a} \pm 0.053$	$8.353^{a} \pm 2.540$	$0.004^{a} \pm 0.002$
Broiler Chicken Gizzard	$0.018^{a} \pm 0.037$	$10.672^{a} \pm 3.903$	$0.138^{a} \pm 0.296$	$6.270^{a} \pm 2.432$	$0.003^{a} \pm 0.004$

4. CONCLUSION

From the study of assessment of some heavy metal in Niger Delta of Nigeria, the following Conclusion can be drawn.

1.) The zinc concentration level was particularly high in Cattle and goat organs parts and low in poultry meat sources.

2.) The concentration of mercury in the animal organs was relative high in cattle, goat and chicken organs but relatively low in fishes.

3.) The concentration of arsenic was relatively high in poultry meat source than in any other animal organs.

4.) The difference recorded in the level of zinc concentration in animal organs was significant but the difference was not significant in other heavy metals.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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