Determination of Some Heavy Metals in Free Range *Gallus Gallusdomesticus* in Mubi North Local Government Area of Adamawa State, Nigeria

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***Abstract*: - Heavy metals are persistent in the environment and are subject to bioaccumulation in food chains. However, exposure does not result only from the presence of a harmful agent in the environment. The present study was undertaken to investigate the concentrations of heavy metals (Zn, Cr, Pb, and Cu) in some organs and tissue such as blood, bones muscle and liver of local chicken sold in Mubi. Heavy metals were determined by standard methods of atomic absorption spectroscopy (AAS). One way analysis of variance (ANOVA) was used to analyze the data followed by Duncan multiple range test (DMRT) for means separation. The concentration of the above heavy metals in the studies samples were found to be significant, they are generally above the tolerance limit set by WHO, CODEX and FAO. Therefore consumption of free range local breed of chickens in Mubi has the danger of ingestion of heavy metals.**

Key words: **Determination, Heavy Metals, Free range, *Gallus gallusdomesticus*, Mubi**

I. INTRODUCTION

Heavy metals are natural components of earth's crust which cannot be degraded or destroyed (Reis *et al.*, 2010). Living organism especially mammals and humans, require varying amounts of heavy metals such as Iron (Fe), Cobalt (Co), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn), but exceeding permissible levels can be dangerous to the organisms. Some heavy metals such as Cu, Sc, Zn are essential to maintain metabolism in human body and can also lead to poisoning at higher concentration (El-Sayed, 2008). Ingestion of metals such as Lead (Pb), Cadmium (Cd) , Mercury (Hg), Arsenic (As), Barium (Ba) and Chromium (Cr) may pose great risk to human health as they accumulate in living thing any time they are taken up and stored faster than they are broken down, that is metabolized or excreted (El-Sayed, 2008).

Heavy metal pollution in the environment arises from many sources but the common are purification of metals like smelting of copper and electroplating in chromium and cadmium as well as industrial waste. Precipitation of heavy metals compounds in soils and mud they can localize or lay dormant, unlike organic pollutants, they do not decay and thus pose a different kind of challenge for remediation (Samar *et al.*, 2013).

Heavy metals uptake and accumulation can be active (energy-dependent), passive (energy-independent) or both. For instance, heavy metals poisoning could occur from drinking contaminated water (lead pipes) higher air concentration emission sources and intake via the food chain (Arif*et al.*, 2015). The presence of heavy metal in the atmosphere, soil and water can cause serious problems to all organisms even in traces and bioaccumulation in the food chain can be highly dangerous to human health (Arif*et al.*, 2015).

Local breed chickens are widely distributed in the rural area of tropical and sub-tropical countries, where they are kept by the majority of the rural indigenes. Local chickens in Africa are general hardly adaptive to rural environment survives on little or no inputs and adjust to fluctuations in feed availability. Local chickens constitute 80% of the 120 million poultry type raised in the rural areas in Nigeria (Rim, 2010). They are self-reliant and hardly birds with the capacity to with stand hash weather condition and adaptation to adverse environment, they are known to possess qualities such as the ability to hatch on their own, brood and scavenge for major parts of their food and possessed appreciated immunity from endemic diseases (Horst, 2012).

Pollution of the natural environment by heavy metals is a worldwide problem that influences the functional and structural integrity of aquatic and terrestrial ecosystem (Samar *et al.*, 2013). Heavy metals have high toxicity, long persistence, bioaccumulation and biomagnifications in the food chain, may constitute serious threats against wild animals, particularly those occupying high tropic levels (Zhuang*et al.*, 2009). However, information about the possible contamination of free range of local breed chicken which is highly consumed by human in Mubi North Local Government Area of Adamawa State is not known. The chicken are not restricted they are exposed to various area of possible accumulation of waste water and feeds from various sources hence the purpose of this research. This research work was carried out mainly to determine the level of heavy metals (cadmium, zinc, lead, copper, and chromium) in bone, muscles, liver and blood of free range local breed of chickens in Mubi North Local Government Area of Adamawa State, Nigeria.This study will give knowledge to understand the status of the heavy metals concentration level (Zinc, Lead,

Copper, Cadmium, and Chromium) and subsequence transfer of these heavy metals in food chain and to serve as baseline of the heavy metals accumulation of organism in the study area.

II. MATERIALS AND METHODS

The Study Area

The study was carried out in Mubi North Local Government Area of Adamawa State, Nigeria. Mubi is located on the latitude 10^{o} 12'North and longitude 13^{o} 10' East of the equator(Adebayo *et al*., 2012).

Sample Collection

A total of (20) twenty samples of local breed chickens (*Gallus gallusdomesticus*)Ten (10) male and Ten (10) femalewere collected in Mubi North Local Government Area of Adamawa State. The sample was transported to the Animal Nutrition Laboratory, Department of Animal Production, Adamawa State University, Mubi for dissection and digestion.

Determination of Heavy Metals

Different organs/tissue part of *Gallus gallusdomesticus* that is bone, liver and muscle was isolated after dissection.The organssamples were homogenized each, separately and 10g of fresh homogenized samples was weighed into porcelain dishes and evaporates to dryness in an oven at 105°C. The ground *samples* of *Gallus gallusdomesticus*, were transferred to a porcelain basin and put into a muffle furnace and the temperature was increased gradually until 550^{o}C was reached.The tissue (blood) was dropped on a Whatman No.1 filter paper, and air dried then kept for digestion and determination of the heavy metals. The samples were digested with tri-acid mixture (HNO_3: HCO_4: H_2SO_4) in the ratio of 10:4:1, respectively at a rate of 5ml per 5.0g of sample and were placed on a hot plate at 100^{o}C temperature. Digestion was allowed to continue until the liquor became clear. All the digested liquor was filtered through Whatman 541 filter paper and diluted with 25mls of distilled water as in Akan *et al*., (2012) Determination of the heavy metals was done directly on each final solution using a Buck Scientific 200A Model, Atomic Absorption Spectrophotometer (AAS). The heavy metals (Cd, Cr, Cu Pb and Zn) concentration was quantify from the calibration curve of the standard.Values obtained were expressed in milligram per gram (mg/g) (AOAC, 2000; AOAC, 2010; APHA, 2017).

Data Analysis

Data obtained were analyzed by one way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) for means separation.Using a statistical software package (SPSS for Windows 21.0). The results were presented as mean±standard error and $P > 0.05$ was regarded as not statistically different

III. RESULTS

Table 1 shows the mean concentrations of Cr, Cu, Pb and Zn in the blood and different or gans of *G.gallusdomesticus*. All the studied metals were presrent in the blood and organs of *G.gallusdomesticus.* The highest mean concentration of Cr (4.06±0.20mg/g) was found in the liver of *G.gallusdomesticus*, followed by the bone (3.09±0.80mg/g) and muscles (2.71±0.20mg/g). The least mean concentration was found in the blood with a value of 2.2±0.45mg/g and thereis significant difference ($p< 0.05$) in the mean concentration of Cr in the blood and organs of male *G.gallusdomesticusin* in the study area. For Cu the result shows that liver had the highest mean concentration (20.81±0.20mg/g), followed by the bone (20.79±0.60mg/g) and muscles (20.63±0.30mg/g) and the least mean concentration was also found in the blood (20.56±0.00mg/g). The differences were also significant ($p< 0.05$).The liver of the *Gallus gallusdomesticus* contained the highest mean concentration of Pb (2.09±0.00mg/g), followed by the bone (2.06±0.62mg/g), muscles (2.04±0.63mg/g) and the blood (2.02±0.00mg/g). Therewas no significant difference ($p> 0.05$). Also Table1 shows that bone had the highest mean concentration of Zn (13.42±0.42mg/g) followed by the liver (11.27±0.60mg/g) and muscles (11.20±0.80g/g), while the blood showed the least value of 10.33±0.50mg/g and these differences were significant ($p< 0.05$).

Table 1: Mean concentration of Heavy metals in blood, borne, muscle and liver of male local breed of chickens (*Gallus gallusdomesticus*)

S/No	Organs/tissue	Cr(mg/g)	Cu(mg/g)	Pb(mg/g)	Zn(mg/g)
1	Blood	$2.20±0.45^{a}$	$20.56±0.00^{a}$	$2.02±0.00^{a}$	$10.33±0.50^{a}$
2	Bones	$3.09±0.80^{b}$	$20.79±0.60^{a}$	$2.06±0.62^{a}$	$13.42±0.42^{c}$
3	Muscles	2.71±0.20a	$20.63±0.30^{a}$	$2.04±0.63^{a}$	$11.20±0.80^{a}$
4	Liver	$4.06±0.20^{c}$	$20.81±0.20^{a}$	$2.09±0.00^{a}$	$11.27±0.60^{a}$

Mean in the same column having the same superscripts are not significantly different ($p>0.05$)

Table 2: shows the mean concentrations of all the studied heavy metals in blood, bone, liver and muscles of *Gallus gallusdomesticus* samples. Cr had the highest mean concentration (3.67±0.80mg/g) in the liver, followed by bone and muscles (3.09±0.20mg/g). The least mean concentration was found in the blood with (2.29±0.61mg/g) and the differences of the mean concentrations were not significant at ($P >0.05$). Copper had the highest mean concentration of 20.79±0.60mg/g in the liver of *Gallus gallusdomesticus*, followed by bone with mean concentration of 20.65±0.50mg/g

and muscles with20.60±0.69mg/g. The least mean concentration of Cu was found in the *Gallus gallusdomesticus* blood with a value of 20.49±0.25mg/g and the differences were significant (p< 0.05).

Pb concentration was highest in the bone of *G.gallusdomesticus*2.65±0.20 mg/g, followed by liverwith mean concentration of 2.34±0.60mg/g and muscle with2.11±0.80mg/g. The least mean concentration of 1.97±0.25mg/g was found in the blood; and the differences were significant (p< 0.05). Zn was highest in the bones (11.85±0.00mg/g) followed by liver, with11.45±0.80mg/g and muscles with11.33±0.50mg/g. The least mean concentration of 11.05±0.20mg/g was found in the blood; and the differences were significant(p< 0.05).

Table 2: Mean concentration of Heavy metals in blood, borne, muscle and liver of female local breed of chickens (*Gallus gallusdomesticus*)

S/No	Organs/tissue	Cr(mg/g)	Cu(mg/g)	Pb(mg/g)	Zn(mg/g)
1	Blood	2.29±0.61[a]	20.49±0.25[a]	1.97±0.25[a]	11.05±0.50[a]
2	Bones	3.09±0.80[b]	20.65±0.50[a]	2.65±0.20[a]	11.85±0.20[b]
3	Muscles	3.09±0.20[b]	20.60±0.60[a]	2.11±0.60[a]	11.33±0.80[a]
4	Liver	3.67±0.80[b]	20.79±0.69[a]	2.34±0.80[c]	11.45±0.00[a]

Mean in the same column having the same superscripts are not significantly different (p>0.05)

Fig.1 shows that Cr was observed in all the organs/tissues of *G.gallusdomesticus* studied. The trend of chromium in the organs/tissue of local breed of chickens (*G.gallusdomesticus*) was liver>bone>muscles>blood.

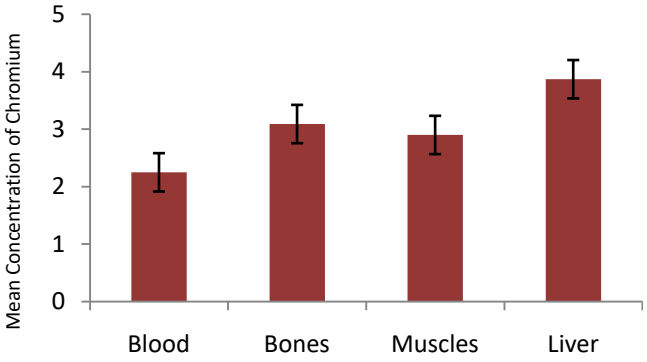

Fig. 1: Mean Concentrations of Cr in Organs/Tissue of local breed of chickens (*G.gallusdomesticus*)

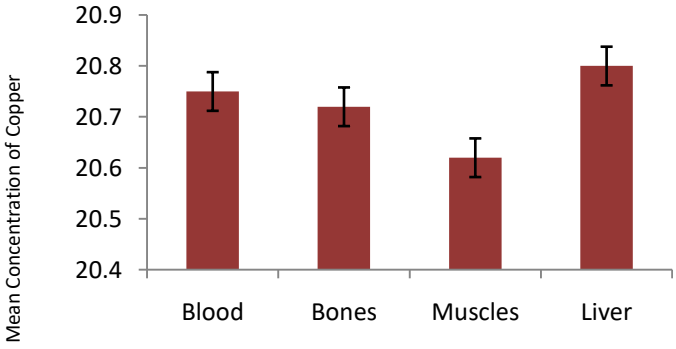

Fig. 2: Mean Concentrations of Cu in Organs/Tissue of local breed of chickens (*G.gallusdomesticus*)

From Fig.3, the highest mean concentration of Pb was 2.355±0.009 mg/g, which was found in the bone, followed by liver with 2.215±0.005mg/g andmuscles with 2.075±0.004mg/g. The least mean concentration of Pb 1.995±0.004mg/g, was detected in the blood.

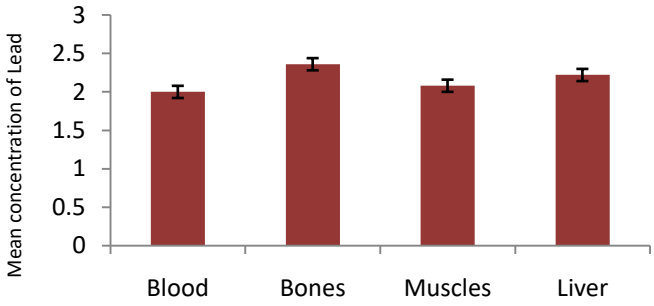

Fig. 3: Mean Concentrations of Pb in Organs/Tissue of local breed of chickens (*G.gallusdomesticus*)

Fig.4. shows the mean concentrations of Zn in blood, bone, liver and muscles of local breed of chickens (*G.gallusdomesticus*) samples. Zn had the highest mean concentration (12.635±0.000mg/g) in the bones, followed by liver (11.361±0.002mg/g) and muscles (11.265±0.003mg/g). The least mean concentration was found in the blood with (10.690±0.000mg/g) and the differences of the mean concentrations were not significant at (P >0.05).

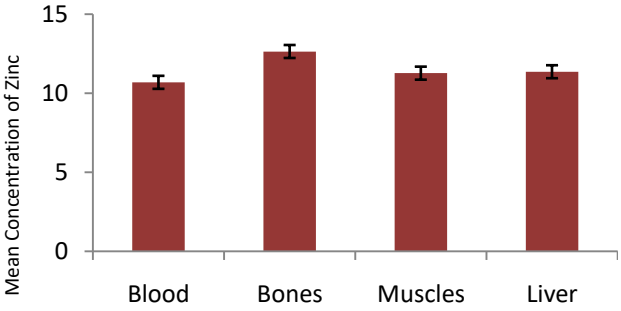

Fig. 4: Mean Concentration of Zn in Organs/Tissue of local breed of chickens (*G.gallusdomesticus*)

IV. DISCUSSION

The result of this research work revealed the mean concentrations of all the studied heavy metals in blood, bone, liver and muscles of local breed of chickens (*G.gallusdomesticus*) samples. The concentration of chromium in blood and organs of *G.gallusdomesticus* was significantly different between various organs and blood. Liver and muscle of *G.gallusdomesticus* recorded higher Cr concentration than blood and bones. The highest Cr concentration was found in liver of both male and female *G.gallusdomesticus.* This may be attributed to pesticides, fungicide as well as fertilizer application in farm land nearby houses. The concentration levels of Cr in the study were higher than 0.65µg/g (liver) and 0.27µg/g (kidney) as in local chicken reported by (Akan *et al.,* 2010). There is discrepancy in the result of this study with Iwebue *et al.*, (2008) reported chromium concentration in chicken meat, gizzard and turkey to range between 0.01 and 3.43µg/g-^{1}.This may be due tobioavailable metal concentration in the biotic components of their habitats as stated by Peakall and Burger, (2003) and Marchovecchio, (2014). The mean concentration Cr in this present study is above the permissible limit of 0.10mg/g by FAO/WHO (2000). This may also be because of presence of these heavy metals in the Mubi ecosystem due to the anthropogenic activities improper dumping of refuse.

Chromium is an essential element assigning the body to utilize sugar, protein and fat at the same time it is carcinogenic. It acts as a co-factor in insulin hormone responses controlling carbohydrate metabolism in human. However, increased concentration of this metal can affect mineral and enzymes stains of animal and human being.ATSDR, (2004) pointed out that excessive amount of chromium may cause adverse health effects. The chromium concentration in all the organs of study samples is strikingly high and indicating chromium can be transported by surface run-off to surface water in its soluble form.

Cu is an essential part of several enzymes and it is necessary for the synthesis of haemoglobin. Cu toxicity in animals is taken up directly from the water via drinking or feeding on organisms that are loaded with such metals, and accumulation of Cu in various organs and tissues depends upon the way of exposure such as through diet or their elevated level in the surrounding environment (Alam*et al*. 2002).The liver had the highest mean concentration of Cu, followed by bone, then muscles. The blood of *G. gallusdomesticus* had the least mean concentration of Cu in both sexes. This is in line with other previous studies which showed similar body part specific distributions such as high concentrations of Cu in the liver, and low concentrations in the brain (Kim *et al*. 1998; Nam *et al*. 2005).

The liver and bones of both male and female *G. gallusdomesticus* recorded higher lead concentration level and lowest level was observed in the blood. The high mean concentration of Pb in liver and bones shows that, the toxic metal accumulates mostly in the liver where they are detoxified. This result confirm with the findings of Akan *et al.,* (2010) who observed 0.22mg lead concentration in liver of chicken in rural area of Maiduguri, Nigeria. Mariam *et al.*, (2004) reported higher levels of lead concentration in liver and kidney of poultry (3.15mg/g). Also a research carried out by spierremburg *et al*. (1988) recorded high mean concentration of Pb in liver and kidney of cattle within a 20km radius of zinc refineries, compared to cattle in unpolluted controls areas. This result revealed the Pb accumulated mostly in liver which agrees with reports of other studies (Miranda *et al*. 2005, Buba *et al.* 2018). High levels of Pb in poultry products possibly arise mainly from contamination of feed and water sources (Oforka *et al.*, 2012). The major source of lead pollution is automobile exhaust gases which arise from anti-knocking agent added in gasoline resulting in soil contamination and plants (Mariam *et al.*, 2004). Other sources are untreated waste effluents of industry, which find their way to irrigation channels and hence pollute the fodder through soil. Lead is a metabolic poison and neurotoxin the birds to essential enzymes and several other cellular components and inactivates then cunning harm. Toxic effects of lead are seem on haemopoietic, nervous gastrointestinal and renal system (Baykov *et al.*, 1996; Akan *etal.*, 2010).

This research work also revealed the concentration of zinc ranged more in bones and liver of local breed of chicken (*G. gallusdomesticus)*. Highest value was observed in bones, followed by liver then muscles while lowest concentration was found in blood (Bones > Liver > Muscles >.Blood) The concentration of zinc in this present study of organs and tissue samples, were within the permissible limit which range from 15mg/g by World Health Organisation/ Environmental Protection Agency (WHO/EPA) and 30mg/g by Nigerian Federal Environmental Protection Agency(FEPA).Zinc is an intestinal irritant present in ecosystem, the first sign of zinc poisoning is usually intestinal distress which includes vomiting, stomach cramps, diarrhea and nausea.

In conclusion, the results obtained in this study shows that the concentrations of chromium, copper, lead and zinc in the blood and organs of the study local breed of chicken (*G. gallusdomesticus*) were above the permissible limit with the exception of zinc which is within the permissible limit. From the outcome of this study, the following recommendations could be made: Consumption of free range local breed of chicken (*G. gallusdomesticus*) sold in Mubi Main market should be minimized to avoid bioaccumulation and biomagnification of these heavy metals in human. Regular monitoring of heavy metals in the animals of Mubi North Adamawa State, Nigeria should be carried out to ascertain the level of toxicants.

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S/NO.	Organ/Tissue	Cr	Cu	Pb	Zn
1	Blood	2.25±0.61	20.75±0.34	2.00±0.25	10.69±0.50
2	Bones	3.09 ±0.08	20.72±0.06	2.36±0.20	12.64±0.06
3	Muscles	2.90±0.20	20.62±0.06	2.08± 0.08	11.27±0.08
4	Liver	3.87±0. 04	20.80±0.24	2.22±0.03	11.36±0.03