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Heavy Metals Concentration in Different Organs of Selected Domesticated Chickens in Bosso and Maikunkele Local Government, Minna, Nigeria

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ABSTRACT

This research work is aimed at determining the concentration of nickel, copper, lead and cadmium in different organs of selected domesticated chickens (local breeds and hybrid broilers). The metals were determined in three major organs (muscle, liver and gizzard) of the chickens using atomic absorption spectrophotometer (AAS). A total of sixteen (16) chickens (local breeds and hybrids) were collected for the purpose of the study. The contents of the metals were as follows: ND - 0.07 mg/kg ± 0.00 mg/kg, 0.01 mg/kg ± 0.00 mg/kg - 0.06 mg/kg ± 0.00 mg/kg, 0.25 mg/kg ± 0.01 mg/kg - 0.50 mg/kg ± 0.02 mg/kg and 1.24 mg/kg ± 0.07 mg/kg - 4.45 mg/kg for Cd, Cu, Ni and Pb respectively for the organs of chicken collected from Bosso. For the samples from Maikunlele, the concentrations of the metals were ND - 0.07 mg/kg ± 0.00 mg/kg, 0.01 mg/kg ± 0.00 mg/kg - 0.06 mg/kg ± 0.00 mg/kg, 0.30 mg/kg ± 0.01 mg/kg -0.54 mg/kg ± 0.03 mg/kg and 1.55 mg/kg ± 0.22 mg/kg - 4.16 mg/kg ± 0.13 mg/kg for Cd, Cu, Ni and Pb respectively. The concentration of Pb and Ni were higher than the maximum limit based on WHO standard. The concentration of the metals was generally higher in the broiler breed than the local. The liver and gizzard were also observed to accumulate more of the heavy metals when compared to the other organs. There is need to continually monitor the heavy metals in feeds and checkmate the activities around areas where poultry are kept for human safety.

KEYWORDS

Chicken; Gizzard; Heavy metal; Liver; Kidney; Organ

INTRODUCTION

More recently, the poultry farming has become one of the fastest growing and largest agro based industrial sector. This is due to the growing need for eggs and meat products from poultry. Across the globe, it is documented than above 50 billion of chickens are reared annually as food source most especially due to their high protein composition thus providing a vital dietary content for man [1]. Environmental contamination by heavy metals is an issue that has drawn much attention in recent times due to the toxicity of some of these metals. Some heavy metals play a vital role in the nutrient circulation pathways within animal organs. Anthropogenic activities and rapid industrialization are key causes of environmental contamination by heavy metals. Pollution from heavy metals presents a major problem

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worldwide, endangering animal, human health and environmental quality [2]. Heavy metals are metals with densities above 5 g/cm^3 and are mostly found in the periodic table groups III - V. Such metals contaminate the atmosphere from a variety of sources, including effluents from industries, lead in petrol and metal ions leaching into water bodies from soil as well as acid rain [3]. There are some heavy metals that are of more concern due to their high toxicity which include mercury, arsenic, lead and cadmium. Most heavy metals accumulate with varying half-lives in one or more body organs. Feed contamination of heavy metals poses major problem in the food chain because these metals have deleterious effect on humans and animals and are capable of biomagnifying and bioaccumulating in tissues and organs [4]. Demirezen et al. [5] reported that heavy metals tend to accumulate more in vital body organs such as kidney, liver and brain. Ingestion of heavy metals in food stuff contributed to a substantial proportion of overall pollution of humans. Heavy metals are directly or indirectly consumed by humans through the food chain and partially stored in the human body. The tendency of heavy metals to bioaccumulate in the tissue of birds has become of immense concern more recently because of the lethal impact of their accumulation, which may lead to higher mortality rates, lower fertility levels, and endanger human health and the entire environment [3]. Heavy metals are easily enriched by contaminated food, water and feed additives in the animal's body and it may ultimately proceed into the body of humans through the food chain hence threatening human health. Heavy metal assessment in the tissue of animals most especially chickens become paramount since they are the most commonly available and consumed in most areas [5].

There is pertinent need to continually assess the contents of heavy metals for the purpose of health safety concern. The present study therefore aims at determining the content of nickel, copper, cadmium and lead in the liver, muscle and gizzard of selected domesticated chickens in Bosso and Maikunkele local government, Minna, Nigeria.

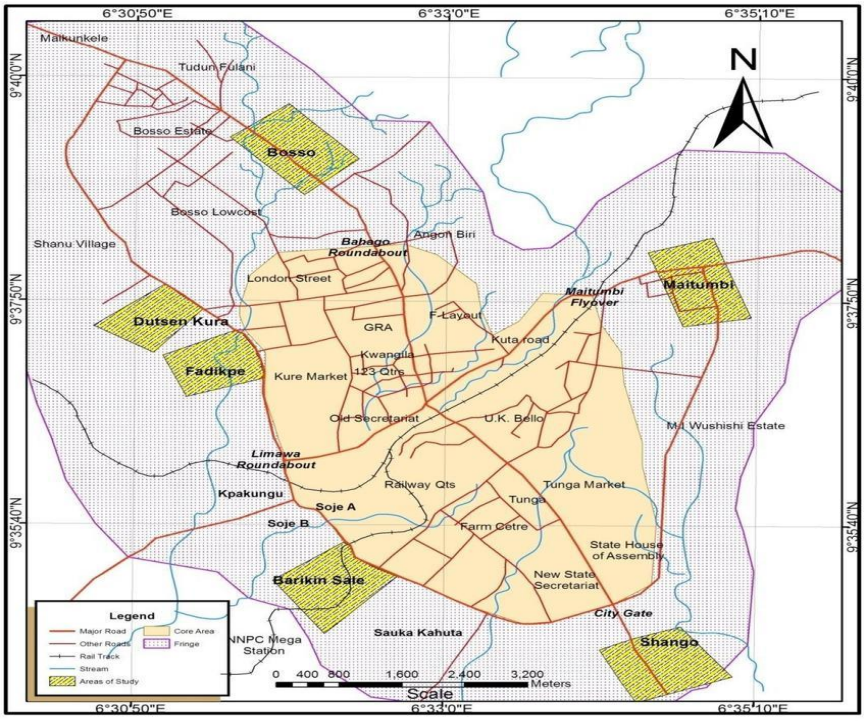

Figure 1: Map of Niger State showing the study area. Source: Lawal (2011).

MATERIALS AND METHOD

Sampling

Sixteen (16) live chickens' sample (broilers and locals) were obtained from farms and around the neighborhood of Angwa Masa area of Bosso and Maikunkele area, all in Minna Niger State, Nigeria. Four were taken from each area. They were then subjected to the pretreatment stage.

Sample Pretreatment

The birds were slaughtered and washing was done using de-ionize water for the removal of blood and dirt [6]. The liver, gizzard and pectoral muscle were extracted from each bird. These samples were placed in polythene bags and labeled and were conveyed to the laboratory for further analysis. The metals in tissue content were determined in line with the method described by Deng *et al.,* [7]. Drying of the samples was done in oven at 105°C for 24 hours and it was grinded into fine form using ceramic mortar and pestle.

Sample Digestion

Into a 250 cm^3 flask was weighed 2 g of each oven-dried sample. 18 cm^3 of HNO_3 (concentrated) was carefully added and left for 10 minutes before addition of 6 cm^3 concentrated Perchloric acid ($HClO_4$). The mixture was swirled gently and digested at moderate heat. The mixture was digested until a transparent solution was obtained which indicate a complete digestion and the flask was left to cool. The product was filtered into a 100 cm^3 volumetric flask and was filled to the mark using distilled water [8]. It was then stored in 100 cm^3 polyethylene bottle for further analysis. The digested samples were analyzed for heavy metals (Cd, Cu, Pd, and Ni) using Atomic Absorption Spectrophotometer (AAS).

All standard procedures and quality control measures were adhered to for the purpose of precision and accuracy in analyses. Glassware was sterilized by storing them in diluted nitric acid (10 percent) during the night and rinsed with de-ionized water and then dried in the oven.

Statistical Analysis

The results obtained were subjected to statistical analysis using One way Analysis of Variance (ANOVA) to check for statistical differences. This was done using SPSS version 20. The final results were presented as mean standard ± deviation for triplicate determinations.

RESULTS AND DISCUSSION

Metals	Local			Broiler			WHO Standard (2017)
	Liver	Muscle	Gizzard	Liver	Muscle	Gizzard	
Cd	ND	0.02 ± 0.00^a	0.01 ± 0.00^a	0.06 ± 0.00^a	ND	0.07 ± 0.00^a	0.50
Cu	0.03 ± 0.00^b	0.04 ± 0.00^c	0.01 ± 0.00^a	0.06 ± 0.00^c	0.04 ± 0.00^b	0.01 ± 0.00^a	5.00
Ni	0.50 ± 0.02^b	0.38 ± 0.00^a	0.34 ± 0.00^a	0.38 ± 0.00^b	0.34 ± 0.00^b	0.25 ± 0.01^a	0.20
Pb	1.79 ± 0.22^a	4.23 ± 0.09^c	2.42 ± 0.68^b	4.45 ± 0.29^c	3.55 ± 0.10^b	1.24 ± 0.07^a	0.50

Table 1: Heavy metal concentrations (mg/kg) in different organs of selected chickens from Bosso.

Results are expressed as mean ± standard deviation for triplicate determinations; values with the same superscript along the same row are not significantly different at ($p \leq 0.05$), while those with different superscripts are significantly different at ($p \leq 0.05$).

Table 1 presents the heavy metals concentration in different organs of selected chicken from Bosso. From the result, it can be deduced that the gizzard of broiler had higher concentration of cadmium (0.07 mg/kg) than the local (ND), this was followed by the liver of the broiler with 0.06 mg/kg for Cd. Cd was not detected in the muscles of the broiler and the liver of the local breed. The content of Cu ranges from 0.01 mg/kg - 0.06 mg/kg. The highest amount was in the liver of broiler. The least content of Cu was recorded in the gizzards of both breed of chicken. The concentrations of Cu

were all lower when compared to maximum limit of 5.0 mg/kg from WHO [9]. The concentration of Ni ranged from 0.25 mg/kg - 0.50 mg/kg which were generally lower when compared to the permissible limit of 0.20 mg/kg from WHO. The highest amount of Ni was observed in the liver of the local breed. The two breeds had similar amount of Nickel in their organs with the livers accumulating more Nickel than the other organs. The concentrations of Pb from this study (1.24 mg/kg - 4.45mg/kg) where all higher than the maximum limit allowed (0.50 mg/kg) based on WHO, [9].

The concentration of lead is relatively high in the organs of the two chickens, but it is higher in the organs of the broiler than the local with the broiler accumulating the highest value of (4.65 mg/kg) in the liver. The result of this study is lower than the one reported by Bendeddouche et al. [10] for lead (7.76 mg/kg) and cadmium (1.39 mg/kg) in chickens. This observed trend in the content of heavy metal in the various organs may be related to the differences in human activities around the areas where these chickens were collected. The heavy metals are readily passed across the food chain [11]. A major source of heavy metals contamination in chicken has been reported to be from the different feeds in which the animals feed on [12].

Metals	Local			Broiler			WHO Standard (2017)
	Liver	Muscle	Gizzard	Liver	Muscle	Gizzard	
Cd	ND	0.07 ± 0.00^{b}	0.01 ± 0.00^{a}	0.05 ± 000^{a}	0.04 ± 0.00^{b}	0.05 ± 0.00^{a}	0.50
Cu	0.03 ± 0.00^{c}	0.02 ± 0.01^{ab}	0.01 ± 0.00^{a}	0.01 ± 0.00^{b}	0.06 ± 0.00^{a}	0.05 ± 0.00^{b}	5.00
Ni	0.44 ± 0.00^{b}	0.36 ± 0.01^{ab}	0.30 ± 0.01^{a}	0.48 ± 0.01^{b}	0.48 ± 0.01^{b}	0.54 ± 0.03^{a}	0.20
Pb	1.55 ± 0.22^{a}	2.06 ± 0.05^{b}	3.35 ± 0.17^{c}	2.12 ± 0.41^{a}	4.16 ± 0.13^{b}	4.13 ± 0.00^{b}	0.50

Table 2: Heavy metal concentrations (mg/kg) in different organs of selected chickens from Maikunkele.

Results are expressed as mean ± standard deviation for triplicate determinations; values with the same superscript along the same row of selected chicken organs are not significantly different at ($p \leq 0.05$), while those with different superscripts are significantly different at ($p \leq 0.05$). Table 2 shows the heavy metal concentrations in different organs of selected chickens from Maikunkele, it can be observed from the table that the concentration of cadmium is higher in the muscle of local (0.07 mg/kg) than that of broiler (0.04 mg/kg). Cd was not detected in the liver of both breed of chicken. The contents of Cd were all lower than the maximum limit (0.5 mg/kg). Cadmium has been documented as one of the most toxic heavy metals and has no known function in the biological system but rather is highly toxic even at the trace concentration. The difference in the contents in the organs investigated could be related to the activities around the areas where the chickens were reared and also the feeds. It has been reported that the composition of farm animals is greatly affected by the nature of the feed [13]. Cu was detected in all the samples with a concentration ranging from 0.01 mg/kg - 0.06 mg/kg. The muscle and gizzard of broiler showed the highest values of 0.06 mg/kg and 0.05 mg/kg respectively.

The content of Ni varied from 0.30 mg/kg - 0.54 mg/kg. The organs of broiler accumulated more Nickel concentrations than the local with the gizzard of the broiler having the highest value of Nickel (0.54 mg/kg). The contents of Pb in all the analyzed organs were higher than the maximum limit (0.50 mg/kg). The concentration of lead is also higher in the organs of the broiler than that of the local with broiler having the highest lead concentration in the muscle (4.16 mg/kg). The least content of Pb (1.55 mg/kg.) was found in the liver of the local breed.

For the two chicken breeds analyzed, the heavy metals accumulations were much in the internal organs of the broilers. This could be attributed to the type of feed used for growing them in order to enhance their growth rate. These

metals could get into the feeds during the processing of the feeds. Heavy metals in broiler feeds especially Mn, Ni, Cu, Zn, Pb are added into their feeds during processing and could be 10 times more than the needed quantity. The content of heavy metals in the feed of broiler is of concern since these metals are bio toxic and capable of biomagnifying across the food chain [14].

Among the metals investigated, Ni and Pb had the highest contents when compared to others within the gizzards and liver. This is in line with the findings of [5] that heavy metals tend to accumulate in organs involved in metabolism such as liver and also tend to bioaccumulate more within such organs. Okoye et al. [15] in their work documented that the liver is the major site of metabolism where different processes occur. The excretory role is played by the kidney, while the gizzard aids in the disintegration of particles. The muscle has no known metabolic role and this could also be accountable for the low content of heavy metals in the muscles of the birds investigated.

The result from ANOVA showed that the accumulation of the heavy metals in the internal organ differ significantly at ($P \leq 0.05$). From the results it can also be deduced that the metals investigated accumulated to different extent in the organs which is due to the different roles played by these organs. The accumulation of the metals in the organs investigated where in the order: muscle <gizzard <liver. The higher concentration of Pb, Ni and Cu in the organs analyzed may be attributed to the activities around the environment of the chicken, the nature of the feed or even the water used for rearing them.

CONCLUSION

The present study has confirmed the presence of nickel, cadmium and copper in the internal organs of the two breeds of chicken investigated. It was also observed that the contents of these metals were generally higher in the gizzard and liver than the muscles. The contents of the metals in the organs were generally attributed to the feed and environment of rearing. There is need to continually monitor the content of heavy metal in the feeds of domestic birds.

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CONFLICT OF INTEREST

The authors and planners have disclosed no potential conflicts of interest, financial or otherwise.

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