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Contents of Toxic Minerals in Poultry Droppings Obtained from Some Poultry Farms in Makurdi Metropolis North-Central, Nigeria

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Abstract

This study was conducted to analyze some toxic mineral elements (heavy metals) levels in four different poultry farm droppings obtained in Makurdi metropolis, North-central Nigeria. The samples were analyzed using Atomic Absorption Spectrophotometer (AAS-240FS). The contents of Mn, Pb, Zn, Ni, Cu, Fe, Cr and Cd ranged between: 6.095 – 3.458 µg/kg, 0.074 – 0.002 µg/kg, 2.388 – 1.794 µg/kg, 0.095 – 0.052 µg/kg, 0.499 – 0.222 µg/kg, 1.803 – 1.1470 µg/kg, 0.120 – 0.043 µg/kg and 0.017 – 0.008 µg/kg respectively. The highest metal concentration in the poultry dropping was Mn (6.095±0.0005 µg/kg) and the least was Pb (0.002±0.0005 µg/kg). The mean levels of heavy metals in the sample increased in the order: Mn (4.5193±0.0001 µg/kg) >Zn (2.0463 µg/kg)>Fe (1.560 µg/kg)> Cu (0.3153 µg/kg)> Cr (0.091 µg/kg)> Ni (0.078 µg/kg) > Pb (0.046 µg/kg) > Cd (0.011 µg/kg). Analysis of the variations of the poultry droppings' metals levels between farms showed significant differences ($P < 0.05$) in Pb, Mn and Zn while Cd variation was statistically not significant. Even though, the feeds used by the farmers were mostly of the same make, differences in the feeding time, quantity consumed and how often may greatly influence the bird's metabolic processes which will also affect the quality of the droppings. The concentrations of the heavy metals were however; lower than the maximum permissible limits of the heavy metals contents of ruminants feed. Therefore, present levels of the heavy metals content of the poultry dropping does not pose any risk for use as ruminant feeds. However, periodic monitoring is advisable to monitor bio-accumulation following prolong ingestion.

Keywords: Heavy Metals, Poultry Droppings, Feeding Practice, Ruminant Feeds

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Introduction

Worldwide, poultry industry is growing rapidly and contributes towards addressing key national development goals such as job creations and improving the standard of living of people Agblevor *et al.*, 2010. Research work has shown that poultry wastes are higher in nutritional value than other animal wastes and are especially rich in crude protein and minerals. Due to the high fiber and non-protein nitrogen contents of the wastes, ruminants are best suited for utilization of the wastes Fontenot, 1998. It was also submitted that poultry litter is the primary animal waste used extensively in animal feeding in the USA, where it is used for feeding beef cows, stocker cattle and finishing cattle. Traditionally, animal wastes have been applied to farmland as organic fertilizer. The fertilizing value of poultry waste is excellent because of its high nutrient content especially for Nitrogen, phosphorus and potassium. However, animal excreta, including bedding and associated materials, has been identified as more valuable as a feed nutrient than as a fertilizer Arndt *et al*., 1979. The economic value of excreta as feed components in balanced diets for several classes of ruminants may be 3 to 10 times greater than their value as plant nutrients Smith and Wheeler, 1979.

Feeding poultry wastes to ruminants may also present concern from the animals' welfare point of view and health implication. Several pathogenic organisms have been isolated from poultry litter; notably bacteria such as *Clostridium sp., Corynebacterium sp., Salmonella sp., Actinobacillus sp., Mycobacterium sp., Bacillus sp., Staphylococcus sp., and Streptococcus sp.,* Alexander *et al*.,1968;Hall,1985. *Clostridium botulinum* can cause mass breaks of bovine botulism such as the cases that occurred in Israel and Australia in 1990, Jones, 1981. One major problem associated with large scale poultry production in Makurdi metropolis is the quantity of wastes produced which required appropriate treatment or disposal to minimized environmental and human risks. Poultry wastes appear in two different forms: litter and manure. Poultry litter is a mixture of bedding material and excreta which is collected from sheds where birds have been kept on deep litter. Poultry manure is a pure excreta (dropping) which is collected from birds which are kept in cages. Generally, livestock wastes have been identified to contain a considerable amount of heavy metals Agblevor, *et al*., 2010. In most instances, the large amounts of wastes produced annually are dispersed intensively over relatively small areas of land, resulting in accumulations that pose potential environmental risks to the surface and groundwater. Poultry wastes were identified as a major concern in the control of water, soi1 and air pollution. This concern was reported to possess potential for substantially restricting manure use in the future, if no precaution is taken to reduce heavy metals content Irshad et al., 2013.

There are several potential dietary sources of toxic elements for poultry such that if adequate quality control programs are not taken at the feed mill, there could be likelihood of significant contamination which will have impact on the droppings quality. Many diets formulated from natural feedstuffs are deficient in one or more of the essential minerals which must be provided in supplemental forms, Henry and Miles, 2001. Generally the elements are not supplied as purified reagent grade chemicals. Some may be ores which have had little processing or purification while others may be by-products of some industrial process. The amount of contaminating elements will depend on the native material from which the mineral supplement is obtained and the type of processing which it undergoes. Certain elements present may be beneficial while others may be potentially toxic to poultry, Henry and Miles, 2001 and they may produce potentially toxic excreta. Thus, considering the value chain of poultry wastes and the applications of the droppings in ruminants feed and as organic manure in vegetable farms within Makurdi metropolis, It becomes imperative to determine the content of heavy metals in the poultry droppings from different farms within the metropolis and compare the results with recommended health guideline values with the view to ascertaining their suitability for the present uses.

Materials and Methods

Samples of poultry droppings were collected from four different locations in Makurdi metropolis namely; Wurukum, High level, Wadata and North-bank and labeled as sample A, B, C and D respectively. The samples were placed in dry, clean polyethene bags and taken to the laboratory for pretreatment and preparation for analysis. 20 g each, of the poultry droppings from each farm were air-dried in the open laboratory for two days. Thereafter, each sample was ground to powder and sieved using a 0.25-mm mesh sieve. The powdered sample was then stored for digestion and subsequent analysis.

Each pretreated sample was digested using aqua regia (a mixture of concentrated HCl and HNO_3 in a ratio of 3:1). 1.0 g of pretreated sample was digested in 20 mL of aqua regia and 80 mL of de-ionized water on a hot plate for 3 hours at a temperature of 110^{o}C. After evapouration to almost dryness, the sample was filtered through a Whatman filter paper no 40 into a 100 ml volumetric flask and diluted with de-ionized water to the marked level. The extracts were then analyzed for the levels of manganese, zinc, iron, copper, chromium, nickel, lead and cadmium using Atomic Absorption Spectrophotometer (AAS) model number 240FS.

Results and Discussion

A total of eight heavy metals (manganese, Zinc, iron, copper, chromium, nickel, lead and cadmium) were determined in each of the four different samples of poultry droppings. The results of the analyses are as shown in Table 1 and depicted on a bar chart in Figs.1 to 4. The results of the concentrations of the heavy metals varied between farms. Analysis of the variations of the poultry droppings' metals levels between farms showed significant differences ($P < 0.05$) in Pb, Mn and Zn while Cd variation was statistically not significant. The variations may be attributed to the type of feeds given to birds, quantity consumed during each feeding point, feeding frequency and their sources of drinking water. Furthermore, the type of drug given to the birds in an effort to keep them healthy is an important factor. Interactions with the poultry farmers showed that the feeding sequence differed from farm to farm. Even though, the feeds used by the farmers were mostly of the same make, differences in the feeding time, quantity consumed and how often may greatly influence the birds' metabolic processes which will also affect the quality of the droppings. The Concentrations of Mn (μg/kg) were generally higher in the four different samples than the other metals. The mean levels of heavy metals in the sample increased in the order: Mn (4.5193 μg/kg) > Zn (2.0463 μg/kg) > Fe (1.560 μg/kg) > Cu (0.3153 μg/kg) > Cr (0.091 μg/kg) > Ni (0.078 μg/kg) > Pb (0.046 μg/kg) > Cd (0.011 μg/kg). Generally, the concentrations of the heavy metals recorded in this study were lower than the maximum permissible limits of the heavy metals contents of complete ruminant feeds (Table 3). This suggests that the content of the heavy metals in the feed may be low and the poultry farm environment is free from contamination through anthropogenic sources.

Heavy metal contents of animal manures are largely a reflection of their content in the feeds consumed, the efficiency of feed conversion by the animals and their low absorption in the alimentary tract. A number of authors have measured Mn, Pb, Zn, Ni, Cu, Fe, Cr and Cd concentrations in poultry dropping/litter. The following Zn concentrations have been reported: 349-511mg/kg (Menzi and Kessler, 1998), non-detectable to 660kg/mg (this studies 2.0463 μg/kg). Whilst Zn is needed by poultry for growth, feather and skeletal development, and production; the amount required is only 50mg/kg, ARC, 1975. The reported Cu concentrations of poultry feeds ranged from nd-232mg/kg, 35-44mg/kg Johnson *et al.*,1985 and (this study 0.3153 μg/kg). Copper concentrations of poultry manure were ascribed to copper sulphate supplements added to the diet. Currently, most poultry producers feed their broilers on excess of copper sulfate. Although this excess, results in faster weight gains, the gains are not due to a change in diet per se, but rather due to the change in litter composition Johnson *et al.*, 1985. There are two possible explanations for this phenomenon: (1) the high copper levels in the litter reduced populations of pathogenic microorganisms or (2) non-biologically mediated reactions, such as ammonia volatilization, are affected. It should be noted that not all broilers respond positively to this excess of copper in the diet Moore *et al.,* 1996.

The heavy metal contents of poultry wastes have previously been shown to be related to additions in the diet. For example, it has been observed that Cu levels in broiler litter were linearly related to Cu added to the diet and were concentrated 3.25 times, Kunkle *et al.*, 1981. Concentrations of other heavy metals measured in this study are comparable to those found in Swiss poultry wastes as reported in similar studies, Sims and Wolf, 1994; Fleming and Mordenti, 1991.Higher mean concentrations of Ni, Pb, Cd, and Cr in poultry droppings (Table 2) have been reported in England and Wales layer manure, than the levels of the same metals recorded in this study. This was attributed to the high content of these metals in the poultry feeds in those areas.

Conclusion and Recommendations

The results of this study revealed varying concentrations of lead, manganese, zinc, nickel, iron, copper, chromium and cadmium in the poultry droppings collected from four farms in Makurdi. The Concentrations of Mn were generally higher in the four different samples than the other metals while Pb (or Cd, please confirm) recorded the least. Analysis of the variations of the poultry droppings' metals levels between farms showed significant differences ($P < 0.05$) with Pb, Mn and Zn while Cd variations was statistically not significant. The variations may be attributed to the type of feeds given to birds, quantity consumed during each feeding point, feeding frequency and their sources of drinking water. Furthermore, the type of drug given to the birds in an effort to keep them healthy is an important factor. The concentrations of the heavy metals were however; lower than the maximum permissible limits of the heavy metals contents of complete ruminant feeds. Therefore, the present levels of the heavy metals in the poultry droppings do not pose any risk for use as ruminant feeds. However, periodic monitoring is advisable to monitor bio-accumulation following prolong ingestion.

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Tables

Table 1: Concentrations (*μg/kg*) of some heavy metals in poultry droppings collected from four locations in Makurdi Metropolis.

Sample heavy metal	A	B	C	D
Pb	$0.002^{a} \pm 0.0005$	$0.043^{b} \pm 0.0005$	$0.074^{c} \pm 0.0002$	$0.063^{d} \pm 0.0004$
Mn	$6.095^{a} \pm 0.0005$	$4.378^{b} \pm 0.0001$	$4.146^{c} \pm 0.0028$	$3.458^{d} \pm 0.0009$
Zn	$2.388^{a} \pm 0.0001$	$1.952^{b} \pm 0.0006$	$2.051^{c} \pm 0.0003$	$1.794^{d} \pm 0.0017$
Ni	$0.052^{a} \pm 0.0210$	$0.095^{b} \pm 0.0220$	$0.081^{c} \pm 0.0190$	$0.083^{c} \pm 0.0170$
Cu	$0.222^{a} \pm 0.0003$	$0.260^{b} \pm 0.0002$	$0.499^{c} \pm 0.0001$	$0.280^{d} \pm 0.0003$
Fe	$1.797^{a} \pm 0.0004$	$1.803^{a} \pm 0.0004$	$1.147^{b} \pm 0.0003$	$1.491^{c} \pm 0.0003$
Cr	$0.097^{a} \pm 0.0008$	$0.043^{b} \pm 0.0004$	$0.102^{a} \pm 0.0002$	$0.120^{a} \pm 0.0008$
Cd	$0.009^{a} \pm 0.0003$	$0.009^{a} \pm 0.0002$	$0.008^{a} \pm 0.0002$	$0.017^{a} \pm 0.0002$

A = Wurukum, B = High Level, C = Wadata, D = North-Bank
Within rows, data with different alphabets are statistically significant ($P < 0.05$)

Table 2: Comparison of some mean of heavy metals in the poultry droppings with another study

Zn	**Cu**	**Ni**	**Pb**	**Cd**	**Cr**	**Ref.**
459	64.8	7.1	8.37	1.06	4.57	[a]
2.05	0.32	0.08	0.05	0.01	0.09	[b]

Source: [a] Nicholson *et al*, [11]1999 [b] this study

Table 3: Maximum permissible limits (mg/kg) of some of the heavy metals in ruminant feeds

Heavy metal	Cattle	Sheep	pig	Horse
Fe	900	450	2700	900
Mn	900	900	369	900
Cu	90	22.5	225	720
Zn	450	675	900	450

Source: General Requirements for Farm **Feeds ...** - Afma
www.afma.co.za/...%20farm%20**feeds**%20and%20remedies%20; Accessed: 11/3/2014

Figures

Figure 1: Concentrations of the heavy metals in poultry droppings from Wurukum

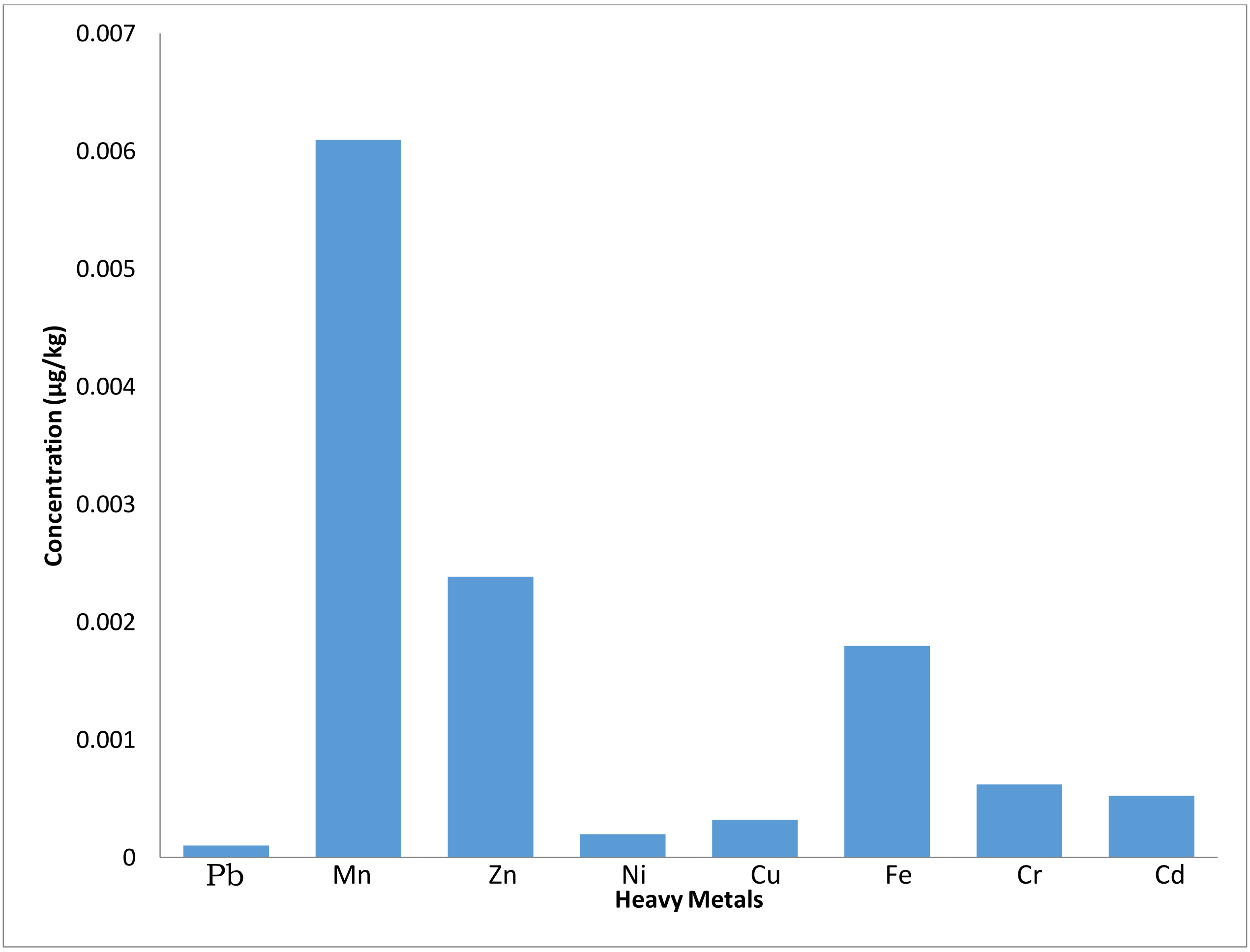

Figure 2: Concentration of the heavy metals in poultry droppings from High Level

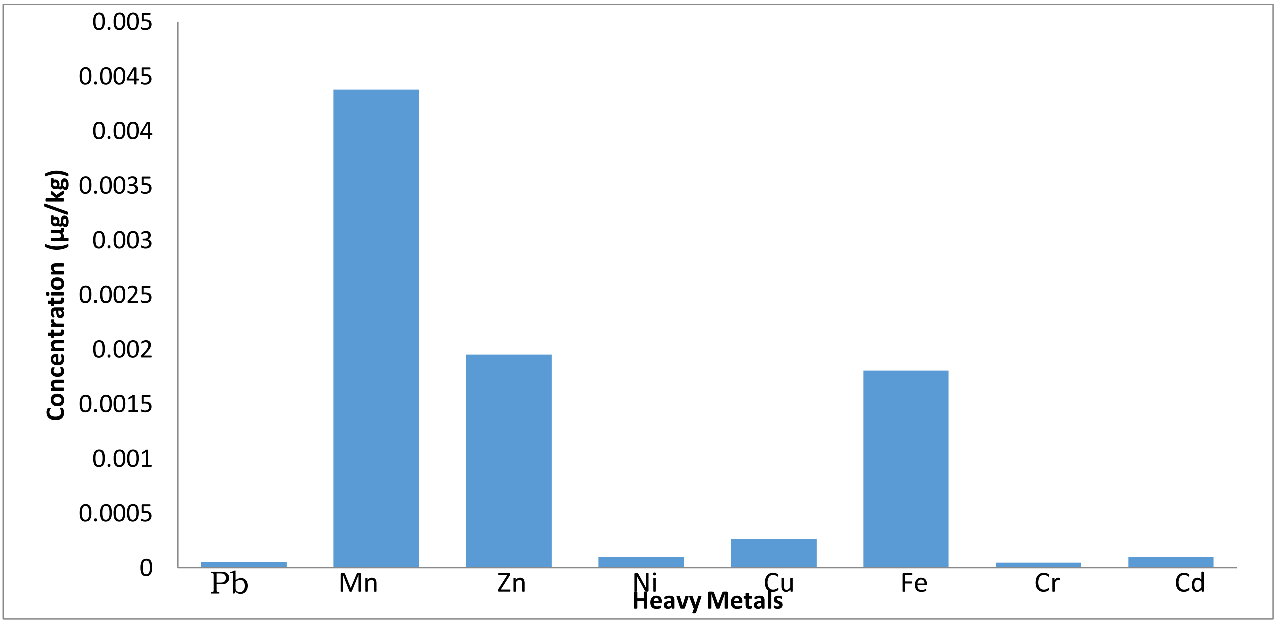

Figure 3: Concentrations of the heavy metals in poultry droppings from Wadata

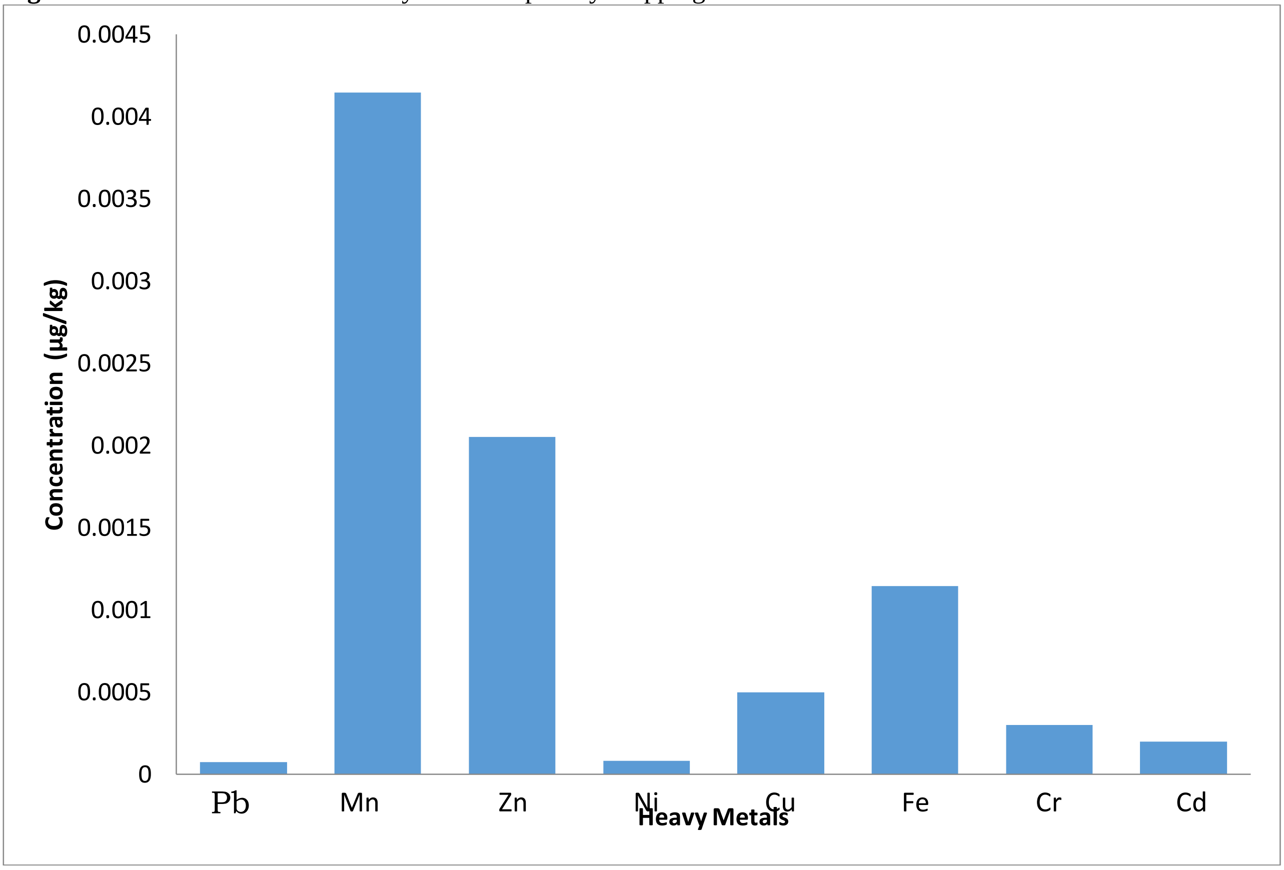

Figure 4: Concentrations of heavy metals in poultry droppings from North Bank