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Assessment of heavy metals in chicken feeds available in Sokoto, Nigeria

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Abstract

In the present work six metals (Cu, Pb, Zn, Cd, Mn and Ni) were analyzed for, using atomic absorption spectrophotometry in three main feed brands commonly used in Sokoto (2 commercial feed and 1 locally compounded chicken feed). Initially, the samples were digested with concentrated nitric acid and perchloric acid at about 370^0C to 450^0C heat in a digestion block. The concentration in µg/ml of the six metals analyzed for in the feed samples ranged between 0.04 and 1.21 for Cu, 0.01 and 0.55 for Pb, 1.43 and 11.65 for Zn, 0.10 and 0.12 Cd, 0.94 and 3.12 for Mn and 0.004 and 0.25 for Ni. In most of the analyzed samples, the concentration of Cu, Zn, Mn and Ni was found to be lower than the nutritional requirement of broiler chicken at a level which could be harmful for the poultry. Also the study showed the presence of heavy metals (Pb and Cd) in all the feed samples analyzed, but none exceeded permissible levels as set by European Union and National Research Council.

Keywords: Atomic absorption spectrophotometry, Chicken feeds, Contamination, Heavy metals, Sokoto, Toxicity

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Introduction

Poultry farming is one of the most important aspects of agriculture with commercial layers and broilers contributing tremendously in meeting the upward protein demand of the increasing population through eggs and meats. Supplementation of some essential metals such as copper (Cu), zinc (Zn) and manganese (Mn) in chickens' diets is of great importance. Copper prevents anaemia, while Zn and Mn act as catalysts in many enzymatic and hormonal reactions that are related with growth, immunity and skeletal integrity (McDowell, 1992). Supplementation of Cu, Zn and Mn at 8, 40 and 60 ppm (µg/ml) respectively was recommended in broiler diets by NRC (1994) majorly in term of growth. However, Cu deficiency in birds can lead to rupture of the aorta. Diets deficient in Zn cause retarded growth, shortening and thickening of leg bones and enlargement of the hock joint, poor feathering, anorexia and mortality. Chicks hatched from Zn-deficient hens are weak, while a deficiency of Mn in the diet of chickens is one of the causes of perosis. Nickel is a transition metal with an atomic structure very similar to that of cobalt. Although it is not normally added to chicken diets, but nickel has been detected in liver, kidney and muscle of broilers (Coleman *et al.,* 1992). Evidence of nickel deficiencies in chicks has been reported (NAS, 1980) and dietary nickel levels of 0.1 – 0.3 parts/10^6 or µg/ml dry weight are considered adequate in poultry diets (Puls, 1988).

Heavy metals are ubiquitous and are being released continuously from man-made sources into the aquatic and terrestrial ecosystems, threatening the health of man and animals (Aschner, 2002; Abulude *et al.,* 2006a, Abulude *et al.* 2006b). They are potentially dangerous due to their toxicity, bioaccumulation and biomagnification abilities when found within living tissue (Aycicek *et al.,* 2008), and are stored more quickly than they are excreted. The increase in urbanization, industrialization and agricultural activities have been shown to release heavy metals into the environment (Falandysz *et al.,* 2005). In early 2010, there was an incidence of heavy metal poisoning in Zamfara State, Nigeria due to indiscriminate mining by the locals (WWPPR, 2010).

In Port-Harcourt and other southern parts of Nigeria, heavy metal contaminations of chicken meat, eggs and other products have been reported (Okoye *et al.,* 2011; Oforka *et al.,* 2012). Okoye *et al.* (2011) speculated that heavy metals in chicken products could be due to contamination of chicken feeds, the raw materials of which are of various origins. However, little works are available on heavy metal contamination of poultry feed to confirm this speculation and there is no report of such from the study area. In view of the foregoing, coupled with the fact that Sokoto State is a neighbour to Zamfara State where heavy metal poisoning was recently reported, this study was undertaken in order to determine the levels of these metals in commercial and locally made chicken feeds available in Sokoto, Nigeria.

Materials and Methods

Sampling

Five brands (chick, grower and layer mash, broiler starter and broiler finisher) of two commercial feeds (X and Y) and a locally compounded feed Z, were purchased from different locations within Sokoto metropolis, Nigeria.

Sample Preparation

Each brand of the same feed sample obtained from different locations, mixed, homogenized thoroughly, and 1g each of chick mash, growers mash, layers mash, broiler starter and broiler finisher was weighed using Mettler weighing balance. Each sample was then transferred into a 50ml Kjeldahl digestion flask, 10ml of concentrated nitric acid were added and then 2ml of perchloric acid were also added. The content was swirled gently and digested at about 370^0C heat first in a digestion block. Increasing the heat slowly to about 450^0C for 15min, after the appearance of white fumes, the digested samples were allowed to cool. The samples were dissolved using 10ml of distilled water and then filtered using Whatman filter papers. The filtrates were poured individually into 50ml prewashed sample bottles, the samples were ready for Atomic Absorption Spectrophotometry (AAS) analysis.

Determination of heavy metals

The digested samples were analyzed for the presence of heavy metals vizs; copper (Cu), cadmium (Cd), zinc (Zn), lead (Pb), manganese (Mn) and nickel (Ni) at a required wavelength using SensAA GBCAvanta Version 2.20 Atomic Absorption Spectrophotometer. Sample preparation and heavy metal determination were carried out in the Central Laboratory of the Usmanu Danfodiyo University, Sokoto, Nigeria.

Data analysis and presentation

Data were analyzed using descriptive statistics and they were presented in the form of histogram.

Results

As shown in the Fig. 1, the mean concentration of Cu ranged between 0.04µg/ml and 1.21µg/ml. Also mean concentration of Cu was highest in broiler finisher, while the chick mash had the lowest concentration. Feed Y had the highest mean concentration of Cu (0.67µg/ml) and lowest in Z (0.13µg/ml). However, considering the requirement of Cu for broiler chicken (NRC, 1994), all the feed samples were found to contain Cu at concentration below nutritional requirement.

Fig. 2 showed that mean concentration of Pb ranges from 0.01µg/ml to 0.55µg/ml. It was highest in broilers finisher (0.29µg/ml) and lowest in growers mash (0.14µg/ml). However the Z feed had the highest mean concentration of Pb (0.37µg/ml) and lowest in Y.

The mean concentration of zinc was between 1.43µg/ml and 11.65µg/ml (Fig. 3). The mean Zn concentration was highest in broiler finisher (6.57µg/ml) while layers mash had the lowest of 2.33µg/ml. However, feed Z had the highest mean concentration (8.29µg/ml), followed by Y and lowest concentration was found in X. Considering the requirement of broiler chicken for Zn (NRC, 1994), all the feed samples were deficient of Zn.

The mean concentration of Cd as shown in Fig. 4, was found to be highest in growers and layers mash (0.12µg/ml).

From this study, Mn concentration had range of 0.94µg/ml to 3.12µg/ml (Figure 5). Mn concentration was highest in layers mash and least in growers mash. Also, average concentration of Mn was found to be highest in Y, followed by X and lowest in Z Local feed. Considering the dietary requirement of broiler chicken for Mn (NRC, 1994), all the feed samples were deficient of Mn.

As shown in Figure 6, the mean concentration of Ni was highest in chick mash (0.19µg/ml), while the

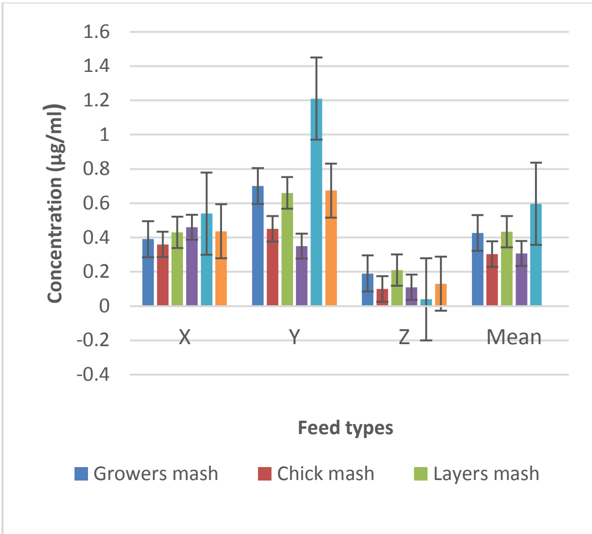

Figure 1. Mean copper concentration in all samples

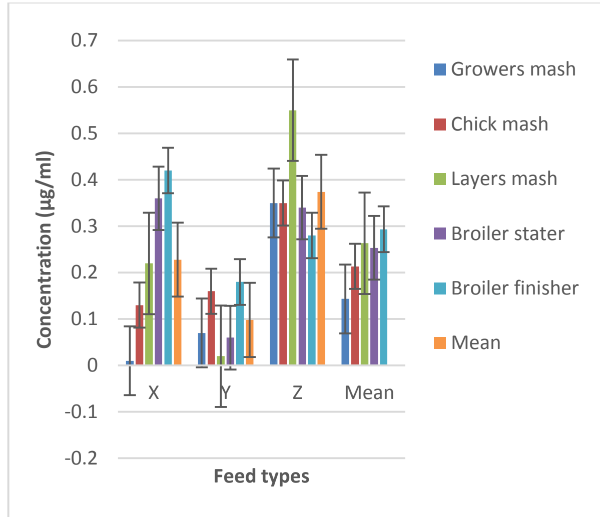

Figure 2: Mean lead concentration in all samples

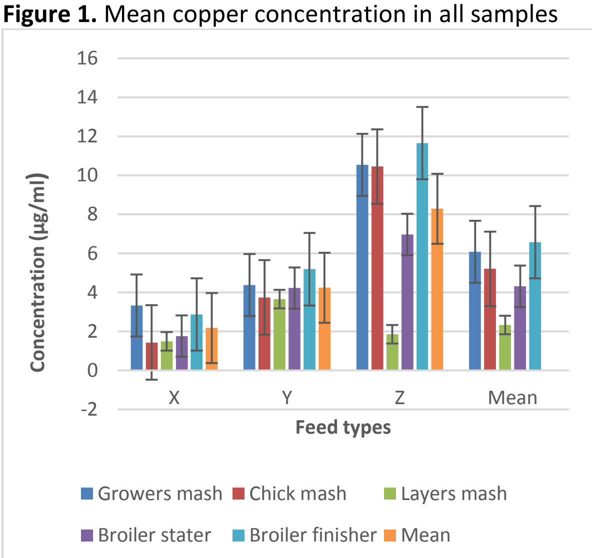

Figure 3: Mean zinc concentration in all samples

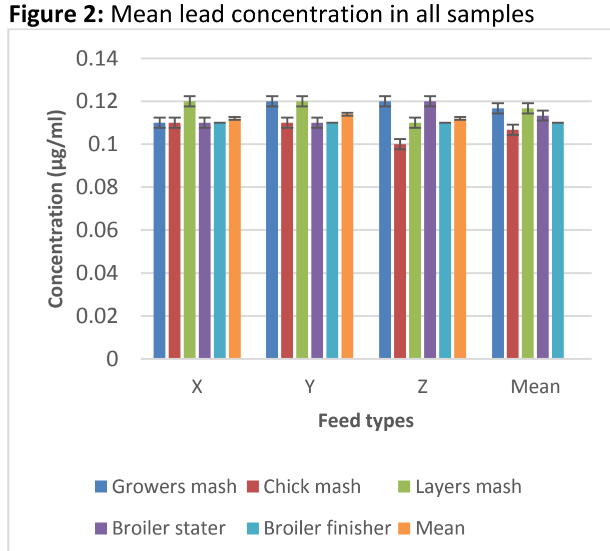

Figure 4: Mean cadmium concentration in all samples

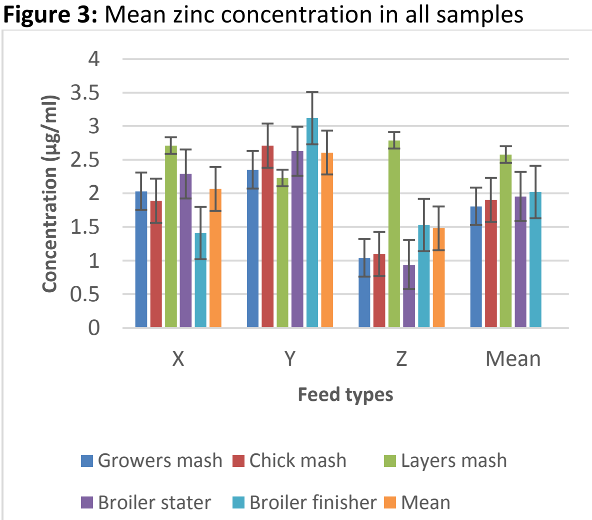

Figure 5: Mean manganese concentration in all samples

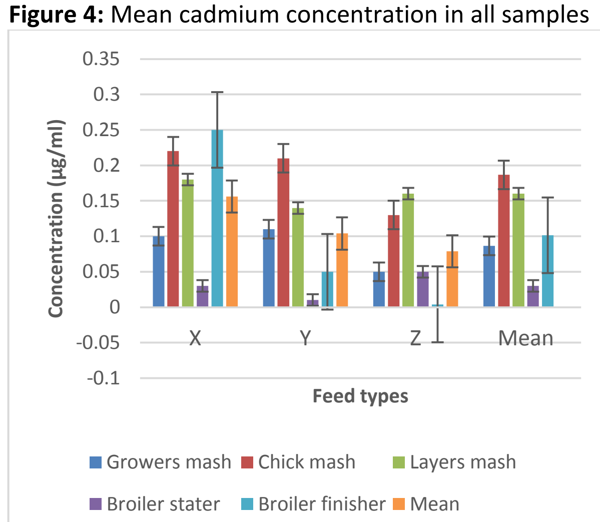

Figure 6: Mean nickel concentration in all samples

broiler starter had the lowest concentration (0.03µg/ml). Feed X had the highest mean concentration (0.16µg/ml) and lowest concentration of Ni was found in Z, which is the only feed type with Ni below the normal requirement for broiler (Puls, 1988).

Discussion

The results obtained from this study showed that the concentration of copper, an essential micro-nutrient was far below the required range in all brands of feed. The values gotten were also lower than 6.52 – 16.94µg/ml obtained by Okoye *et al.* (2011). The zinc content of three most used chicken feeds in Sokoto were found to be very low in concentration. However, the values obtained in this study were higher than what was obtained by Islam *et al*. (2007), who got 0.02 – 422.30µg/ml for zinc, and it was also comparably lower than 54.3 – 482.2µg/ml obtained by Mahesar *et al.* (2010). Manganese is also an essential trace mineral required for many biological processes (Costa, 2000), and all the feeds sampled contained manganese at a concentration lower than the recommended (NRC, 1994). The values gotten from this study were also lower than 26.91 – 76.74µg/ml obtained by Okoye *et al.* (2011). Nickel has been implicated as an essential trace metal in experimental animals (Costa, 2000). The Ni contents of all the feeds sampled were found to be within required range (NRC, 1994), except for Z which was below normal ranges. The value gotten was also lower than 2.25 and 4.87µg/ml reported by Okoye *et al.* (2011) and 37.57µg/ml by Islam *et al.* (2007). This could be as a result of un-harmonised nutritional requirements of chicken which differs from one area to another and errors during processing and mixing of ingredients to the feed. Also, inadequacies of some of these essential metals as shown in this study, when compared with the recommended values of NRC (1994), also revealed inadequate supplementation of these metals in the feed.

Lead and cadmium are non-essential elements that are of direct health concern to both poultry and humans (Costa, 2000). These metals are more of contaminants than nutrients, therefore should be our main concern in discussing heavy metals in poultry. The concentration of Pb obtained from this evaluation was found to be lower than 0.60 – 20.65µg/ml reported by Islam *et al.* (2007). This could be as a result of difference in environment and environmental activities. The Cd content of all the feeds was found to be within the ranges of 0.038 – 0.463µg/ml as reported by Okoye *et al.* (2011). The mean levels of Pb and Cd in all analyzed feed samples were much lower than the NRC (2005) limits of 10 ppm for both Pb and Cd, and European Commission (2003) limits of 5 ppm for Pb and 0.5 ppm for Cd. The presence of these metals could be attributed to the ubiquitousness.

In conclusion, the study revealed the presence of Pb and Cd in chicken feeds at non toxic levels. To maintain the safety of food chain and to further minimize the heavy metals contamination therefore, it is mandatory for the nation's chicken feed producers to always observe and maintain these standards for heavy metals in chicken feeds,, then any activity allowing heavy metals to gain access into food chain beyond those limits can automatically be regarded as unsafe and will be proscribed for alleviation strategies. On the other hand, zinc, copper and manganese appeared in all the feed samples at a level below what is required by chickens. Therefore, efforts should be made to increase supplementation of these micro-elements in chicken feeds.

Further studies should be done to cover more locations/states in northwestern part of the country. Also, other poultry feeds available in the region should be screened for heavy metal contamination. Feed companies should periodically carry out heavy metal assessment of their feed products so as to keep them at a safe level.

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