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Assessment of the Heavy Metal Levels in Feeds and Litters of Chickens Rose with in Awka Metropolis and Its Environs

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Abstract: *40 chicken (layer and broiler) litters and 20 feed samples of the four brands used by farmers within Awka metropolis and its environs were collected from different farms and analyzed for heavy metal residues using atomic absorption spectroscopy.The samples were digested with a mixture of perchloric and nitric acid. The range of the mean heavy metal concentration in the feeds in mg/g were Pb; (0.120 – 0.293), As; (0.068 – 0.167), Cd; (0.281 – 0.379), Cr; (0.042 – 0.121), Hg; (0.300 – 0.486), Ni; (0.0379 – 0.172) and Cu; (0.069 – 0.205). The order of the metal concentration increase in the feeds were, Hg > Cd > Pb > Cu > Cr > As > Ni. Vanadium was not detected in the entire feeds and litter samples. The range of the mean heavy metal concentration in the chicken litters in mg/g were Pb; (0.014 – 0.017), As; (0.031 – 0.044), Cd; (0.015 – 0.019), Cr; (0.106 – 0.143), Hg; (0.035 – 0.043), Ni; (0.094 – 0.276) and Cu; (0.130 – 0.355). Anova analysis showed significance of the metals in the feeds at p < 0.05. The metals were within permissible levels in the feeds except mercury on few occasions.*

I. Introduction

Certain mineral elements such as iron, manganese, copper and zinc are essential dietary nutrients for poultry feed additions and animal medicines, which were used to facilitate weight increase and disease prevention for poultry under intensive farming will easily cause environmental problem due to medicine residue and metal uptake by these birds (Zhang, 1995). The impacts of pollution on animals results in serious economic losses. The environmental pollutants are spread through the different channels, many of which finally enter into food chain of livestock and man (Kaplan et al., 2010).

Heavy metal pollution has become a serious health concern in recent years because of industrial and agricultural development. Heavy metal toxicity is one of the major current environment health problems and is potentially dangerous because of bioaccumulation through the food chain and this can cause hazardous effects on livestock and human health. (Musa et al., 2013).

The toxic heavy metals of great concern are Cd, Pb and Hg which are usually associated with harmful effects in man and animals (Okoye et al., 2010). Many heavy metals accumulate in one or more body organs with differing half lives.

(Demirezen et al., 2006) noted that primary routes of heavy metals to chickens are through feeds, water and processing. The toxic metals present in feeds pose serious health hazards to primary and secondary consumers due to bio magnification (Cang et al., 2004). Because these metals are not easily digested, they cause serious effects not only to the tissues but also the bone and other parts of the body (Musa et al., 2013).

The utilization of poultry manure as an organic fertilizer, is essential for improving soil productivity and crop production, however, several problems arise as a result of application of manure which include salt toxicity of manure to plants and accumulation of heavy metals in the soil and plants may pose a health risk to humans or animals making use of the products of these plants (Kingery et al., 1994). Chicken are one of the main source of proteins for the South East population especially in Awka metropolis and its environs were there are variety of poultry farms and abundant market. There is insufficient data as to the heavy metal levels of feeds consumed and poultry litters used by the people as manure within in the studied environs, hence this research. The heavy metals determined in the feeds and litters of the chickens were lead, arsenic, cadmium, chromium, mercury, nickel, vanadium and copper.

II. Materials And Methods

Sample Collection

The starter (vital), grower (vital), finisher (vital) and layer (gold metal) feeds were purchased while the litters of the broiler and layer chickens were collected from different farms within Awka metropolis and its environs.

Sample Preparation: 2g of each sample was weighed into a 100ml polythene bottle 10ml of the digestion mixture (3:2 65% HNO_3 and 70% $HClO_4$) were added. The bottles were tightly closed and the contents were gently swirled and allowed to stand overnight. The samples were heated for 3hours in a water bath adjusted to 70^oC with occasional swirling at 3mins interval to ensure complete digestion of the samples. Finally, the digest was allowed to cool and then transferred into a 20ml standard flask. The solutions were transferred into an acid leached poly-ethlene bottles and kept at room temperature until analysis with AAS.

Spectroscopic Analysis: The sample solutions were subsequently analyzed for heavy metal contents as wet weight basis using flame atomic absorption spectrometer. Measurements were made using the hollow cathode lamps for Pb, As, Cd, Cr, Hg, Ni, V and Cu at the proper wave length and other AAS conditions were employed in the determinations. Working solutions were prepared by dilution just before the use of standard solutions for atomic absorption spectroscopy.

Statistical Analysis: One way analysis of variance (Anova) was used to verify the significant levels of the heavy metals in the chicken feeds.

III. Results And Discussion

Table 1: Mean metal concentration in Chicken feeds (mg/g)

Element	Starter feed	Grower feed	Layer feed	Finisher feed	F – Test P. value
Pb	0.245 ± 0.005^a	0.293 ± 0.007^a	0.12 ± 0.004^b	0.235 ± 0.01^a	0.000
As	0.107 ± 0.002^a	0.088 ± 0.002^a	0.068 ± 0.003^a	0.167 ± 0.007^b	0.000
Cd	0.379 ± 0.004^a	0.281 ± 0.010^b	0.329 ± 0.042^a	0.335 ± 0.006^a	0.001
Cr	0.123 ± 0.013^a	0.082 ± 0.005^b	0.042 ± 0.002^c	0.212 ± 0.002^d	0.000
Hg	0.300 ± 0.004^a	0.486 ± 0.017^b	0.392 ± 0.015^c	0.339 ± 0.050^a	0.002
Ni	0.039 ± 0.002^a	0.064 ± 0.005^a	0.078 ± 0.003^a	0.172 ± 0.004^b	0.006
V	-	-	-	-	-
Cu	0.119 ± 0.003^a	0.069 ± 0.003^b	0.158 ± 0.006^c	0.205 ± 0.008^d	0.003

Metal concentrations with different superscripts are significantly different at $p < 0.05$ along the same row.

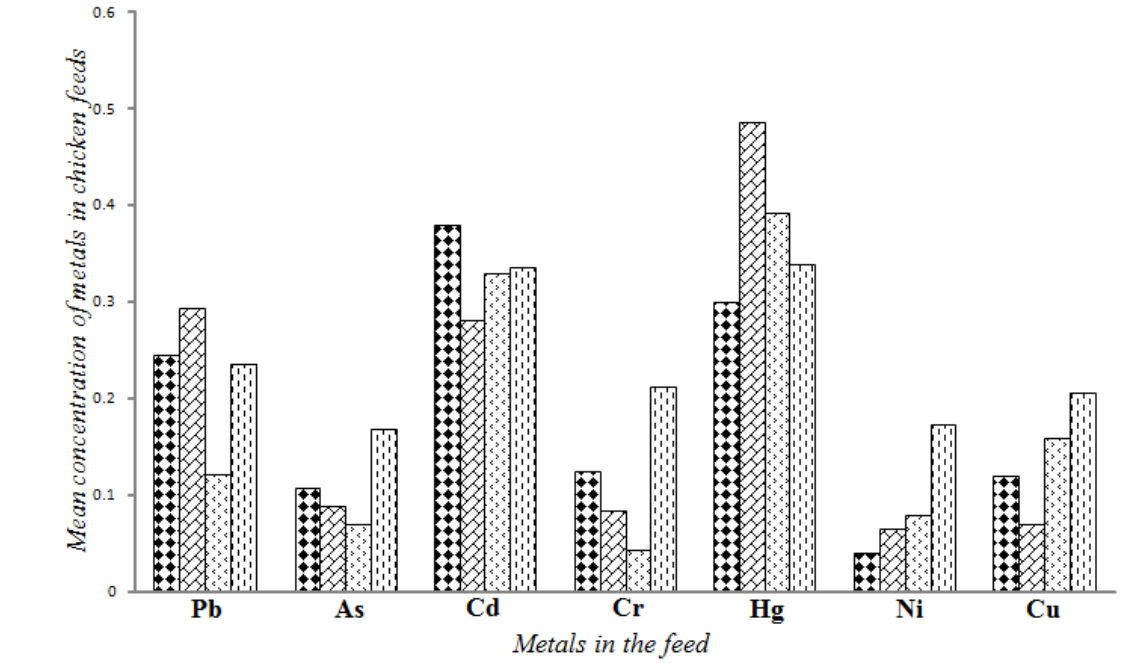

Fig. 1: Bar chart showing mean metal concentration in chicken feeds (mg/g)

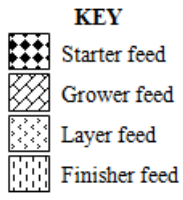

Table 2: Mean metal concentrations in the chicken litter (mg/g)

Sample	Pb	As	Cd	Cr	Hg	Ni	V	Cu
Broiler litter	0.017 ± 0.010	0.031 ± 0.008	0.019 ± 0.009	0.106 ± 0.134	0.043 ± 0.019	0.094 ± 0.051	-	0.130 ± 0.064
Layer litter	0.014 ± 0.008	0.044 ± 0.026	0.015 ± 0.007	0.143 ± 0.209	0.035 ± 0.009	0.276 ± 0.224	-	0.355 ± 0.090

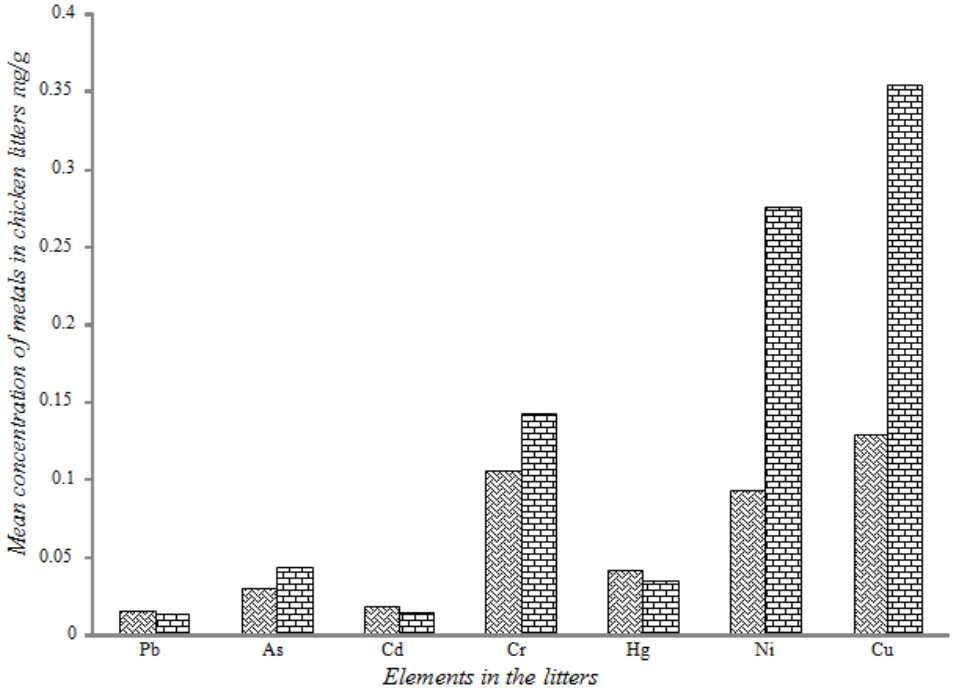

Fig. 2: Bar chart showing mean metal concentration in chicken litters

KEY

Broiler litter

Layer litter

Table 1 showed that the range of mean metal concentrations in the four brands of the feeds in mg/g here Pb; (0.120 – 0.293), As; (0.068 – 0.0167), Cd; (0.281 – 0.379), Cr; (0.042 – 0.212), Hg; (0.300 – 0.486), Ni; (0.039 – 0.172) and Cu; (0.069 – 0.205). As shown in fig 1, the order of the metal increase in the feeds were, Hg > Cd > Pb > Cr > Cu > As > Ni. Vanadium was not detected in the entire feed samples possibly because its concentrations are in parts per billion hence below the limit of its detection.

Hg, Cd, Pb and Cr across the feed samples were comparatively of higher concentrations tham the four other studied metals hence buttress (Demirezen et al; 2006 and Mariam et al., 2004) finding that the primary routes of heavy metals entry into chickens are feeds, water and processing. Also anthropogenic activities within the environment could have been a factor for the increased heavy metal load in the feeds through air particulate deposition. Anova analysis showed that this metal accumulated varied in the four brands of the feeds at $p < 0.05$. This has further showed that the brands are processed with different feed compositions.

Implications of increased heavy metal load on the growth and development of the chickens have been reported by (Hassan et al; 1998 and Ahmad et al; 2004). It include feed refusal, retarded growth, loss of appetite, anemia, liver and kidney dysfunction, decreased immune system and sometimes death.

(Okoye et al; 2010) noted that the primary sites of accumulation of heavy metals in the internal organs of higher and lower animals are the kidney and liver. The heavy metals were within the established permissible levels in the feeds except mercury on few occasions.

Table 2 showed that the range of the mean metal concentrations in the chicken litters in mg/g were Pb; (0.014 – 0.017), As (0.031 – 0.044), Cd; (0.015 – 0.019), Cr; (0.106 – 0.143), Hg; (0.035 – 0.-43), Ni; (0.094 – 0.276) and Cu; (0.130 – 0.355).

Fig 2 showed that the metal concentrations in the litters increased in the following order; Cu > Ni > Cr > Hg > As > Pb > Cd. This result is a confirmation of Zudja et al; 1999 finding that heavy metals are very bio

accumulative hence once absorbed cannot easily be excreted from the system. Cd, Pb, As and Hg were of the lowest concentrations in the poultry litters.

However, the heavy metal concentrations in the litters were found within the established permissible levels to be applied on land.(NRC, 1994).

The mean concentrations of heavy metals obtained in this study were lower than Pb, 0.55 ± 2.02mg/kg; Cd, 0.32 ± 0.34mg/kg; Cr, 11.2 ± 18.0mg/kg; Cu, 43.6 ± 17.7mg/kg; As, 49 ± 13.8mg/kg and Hg, 0.48 ± 0.67mg/kg reported by Delgado et al; 2014 in poultry litter applied to lands in Spain.(Onwuachu, 2012) obtained similar values of Ni, 0.080 – 0.157 mg/g and Pb, 0.050 – 0.227 mg/g in chicken feeds in Port Harcourt environment.

IV. Conclusion

Having analyzed for heavy metals in the chicken feeds commonly used by farmers within Awka metropolis and it environs, the study has shown that one of the primary route of its entry into the internal organs of the chickens were through their feeds. The study has also shown that the heavy metal loads in the soil can significantly be increased by consistent application of poultry litters. The heavy metal concentrations in the litters of the chicken raised within Awka metropolis and its environs were within the established permissible levels to be land applied. Finally, the heavy metal concentration analyzed in the brands of the feeds fed to chickens raised within Awka metropolis and its environs were within permissible levels with the exception of mercury on few occasions.

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