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Assessment of heavy metals in chicken feeds sold in south eastern, Nigeria

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ABSTRACT

This study was carried out to determine the concentration of zinc, iron, manganese, copper, lead, cadmium, nickel and cobalt in chicken feeds obtained in the south eastern part of Nigeria. All mineral elements, whether considered to be essential or potentially toxic, can have an adverse effect upon the humans and animals if included in the diet at excessively high concentrations. Heavy metals normally get into the environment through fossil fuels combustion and indiscriminate waste management. Various Organisms within a given ecosystem are actually contaminated along their cycles of food chain with heavy metals. Humans are also in turn exposed to them by consuming the contaminated plants and animals. Four brands (starter, grower, finisher and layer) of three feeds (Gold medal, Top and Vital) sold commercially, were purchased from different markets in the south east. The samples were prepared for analysis by dry ashing and the heavy metals determined by atomic absorption spectrophotometry. The concentrations obtained in mg/kg were in the range of 34.038 to 49.950, 50.575 to 170.075, 6.52 to 14.20, 1.10 to 7.85, 0.038 to 0.463, 2.250 to 4.875 and 0.613 to 3.200 for zinc, iron, copper, lead, cadmium, nickel and cobalt respectively. The essential elements were low in the feed and there were high concentrations of lead in the feed samples. This could be attributed to anthropogenic sources of lead pollution in the environment especially fossils fuels combustion. There is a great need to adopt the alternative renewable energy sources such as biodiesel and bioethanol.

Keywords: Heavy metals, chicken feeds, dry ashing, cadmium, biodiesel, bioethanol.

INTRODUCTION

Certain mineral elements such as iron, manganese, copper and zinc are essential dietary nutrients for poultry and livestock. However, all mineral elements, whether considered to be essential or potentially toxic, can have an adverse effect upon the humans and animals if included in the diet at excessively high concentrations.

Zinc is an essential element needed by your body in small amounts. Without enough zinc in the diet, there could be loss of appetite, decreased immune function, slow wound healing, and skin sores [1]. Human diets with too little manganese can lead to slowed blood clotting, skin problems, lowered cholesterol levels, and other alterations in metabolism. In animals, eating too little manganese can interfere with normal growth, bone formation, and reproduction [2]. Copper is an essential element for all known living organisms including humans and other animals at low levels of intake. However, exposure to higher doses can be harmful. Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea [3]. Lead exposure has been associated with elevated blood pressure and hypertension [4]. Cadmium toxicity has been linked to prostate cancer and cancer in liver, kidney and stomach [5]. The most serious harmful health effects from exposure to nickel are reduced lung function, and cancer of the lung respiratory tract irritation and asthma [6&1]. Excess cobalt in the body causes harmful effects in the body such as trouble breathing, serious effects on the lungs, asthma and skin rashes [7].

Various organisms within a given ecosystem are contaminated along their cycles of food chain [9] with heavy metals. There are several reasons for concern about the possibility of excessive mineral intakes by poultry. Natural water supplies can contain high concentrations of magnesium and iron. In addition, numerous toxic elements, especially heavy metals, can be added to ground water from hazardous waste sites, industrial pollution, and municipal waste systems. Another potential source of contamination is that resulting from human error during transport and mixing of ingredients and final delivery of a finished feed to the poultry house [9].

Heavy metals have been associated with automobile related pollution. They are often used as minor additives to gasoline and various auto-lubrication, and are released during combustion and spillage [10]. Cobalt occurs naturally in soil, rock, air, water, plants, and animals. Soils contaminated by airport traffic, highway traffic, or other industrial pollution may contain high concentrations of cobalt. Small amounts of cobalt may also be released into the atmosphere from coal-fired power plants and incinerators, vehicular exhaust [7]. Humans are also in turn exposed to these heavy metals by consuming the contaminated plants and animals. Most zinc enters the environment as the result of mining, purifying of zinc, lead, and cadmium ores, steel production, coal burning, and burning of wastes. These activities can increase zinc levels in the atmosphere [1]. Copper enters the environment through waste dumps, domestic waste water, combustion of fossil fuels and wastes, wood production, phosphate fertilizer production, and natural sources. Therefore, copper is widespread in the environment [3]. Infact, studies carried out on heavy metals analysis in blood of the urban population in Nigeria show high levels of the heavy metals attributed to environmental pollution from fossil fuels combustion and also indiscriminate waste disposal [11,12&13].

Chickens are one of the main sources of protein for the south east population especially in Nsukka where there are varieties of poultry farms and abundant market. The chickens are nourished by the feed they consume which as a result of heavy metal pollution in the country might be poisonous and therefore detrimental to the health of the human population that consume the chickens. There is insufficient data as to the nutritive content of feeds consumed by chickens in the country and possible contamination of the feeds by the nutritive elements. So far no work has been carried out to cover the south east. Therefore this study was carried out to determine the concentration of zinc, iron, manganese, copper, lead, cadmium, nickel and cobalt in chicken feeds obtained in the south eastern part of Nigeria.

MATERIALS AND METHODS

Sampling

Four brands (starter, grower, finisher and layer) of three feeds (Gold medal, Top and Vital) sold commercially, were purchased from different markets in the south east.

Sample Preparation

2g of each brand was weighed into different crucibles. 1ml of conc. nitric acid was added and then pre-ashed by placing the crucible on a heater until the contents charred. The pre-ashed samples were then transferred into a muffle furnace with a temperature of 480^oC for 2-3hrs after which they were allowed to cool. The cooled samples were dissolved using 5ml of 30% HCl and then filtered using Whatman filter papers. The filtrates were individually poured into 50ml standard flask and made up to mark with deionized water. These were then transferred into prewashed sample bottles for analysis of the trace metals [modified method of 14].

Determination of heavy metals

The sample solutions were then analyzed for zinc, iron, manganese, copper, lead, cadmium, nickel and cobalt at required wavelength using GBC atomic absorption spectrophotometer, model no A6600 AVANTA PM.

RESULTS AND DISCUSSION

As shown in Table 1, the mean concentrations of zinc were in the range of 34.038 to 49.950 mg/kg. Mean concentration of zinc was highest in the grower and finisher (42.213 mg/kg), while the starter had the lowest concentration. However, the Top feed brand had the highest mean concentration of 41.768 mg/kg. Comparing with the maximum acceptable concentration of 500 mg/kg for zinc in feed as stipulated by European Union, 2003, all the samples were below the acceptable concentration. However, this was comparably lower than 54.3–482.2 mg/kg obtained by Mahesar et al., [15] in their analysis of poultry feed.

Table 1: Mean concentration of zinc (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	38.125±15.10	33.945±0.89	34.038±2.04	35.369±6.01
Grower	42.125±13.08	40.522±2.09	43.988±4.33	42.213±6.50
Finisher	35.788±3.03	49.950±9.62	39.350±5.20	42.213±6.50
Layer	38.500±8.56	42.650±4.07	43.750±1.70	41.696±5.62
Mean±SD	38.635±9.69	41.768±4.17	40.280±3.32	

Table 2: Mean concentration of iron (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	118.188±15.00	50.575±12.20	104.360±4.35	91.041±35.72
Grower	170.075±61.59	74.238±6.10	94.238±14.65	112.850±50.56
Finisher	141.975±27.40	59.363±4.54	107.625±58.54	102.988±41.50
Layer	144.875±2.36	90.200±2.96	164.100±24.71	133.058±38.340
Mean±SD	143.8±21.21	68.594±17.40	117.58±31.53	

As shown in Table 2, the mean concentrations of iron were in a range of 50.575 to 170.075 mg/kg. The layer had the highest mean concentration of 133.058 mg/kg while the starter had the lowest concentration. However the gold medal brand had the highest mean concentration amongst all the brands.

Mean manganese concentrations were in a range of 26.913 to 76.738 mg/kg as shown in Table 3. The grower had the highest mean concentration of 61.046 mg/kg while the starter had the lowest. The gold medal also had a higher mean concentration of 55.578 mg/kg than the other brands.

Table 3: Mean concentration of manganese (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	43.213±0.65	26.913±28.97	54.200±3.25	41.442±13.73
Grower	76.738±7.09	43.688±15.36	62.713±8.08	61.046±16.58
Finisher	45.763±0.83	56.300±4.40	46.313±12.32	49.458±5.93
Layer	56.600±7.88	64.875±0.32	46.925±4.74	56.13±8.98
Mean±SD	55.578±15.25	47.944±16.50	52.538±7.67	

Mean copper concentrations were in a range of 6.52 to 14.20 mg/kg as shown in Table 4. Layer had the highest mean concentration while the starter had the lowest. The gold medal brand also had the highest mean concentration of 16.94 mg/kg. Comparing with the maximum acceptable concentration of 100 mg/kg for copper in feed as stipulated by European Union, [16], all the samples were far below the limit. The values gotten from this study was also lower than 12.3–65.8 mg/kg obtained by Mahesar et al., [15].

Zinc and copper are essential trace minerals required for many biological processes, particularly enzyme functions, and they have a positive influence on livestock growth and reproduction. Due to the low zinc and copper content in some home-grown feeds compared with recommendations and varying bioavailability, supplementation of these metals is necessary for most livestock species, and they are commonly added to dairy rations as mineral supplements [16&17]. However from this study, it is obvious that no supplements were added for these essential metals to the feed.

Table 4: Mean concentration of copper (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	6.52±1.61	7.03±1.87	6.59±1.01	5.973±1.46
Grower	8.85±1.91	6.37±0.03	11.40±9.55	8.873±2.52
Finisher	9.18±0.46	14.20±4.67	6.55±3.59	9.977±3.88
Layer	6.53±2.02	7.52±2.02	12.60±1.41	8.883±3.26
Mean±SD	16.94 ±17.55	8.78 ±3.64	9.285±3.17	

Table 5: Mean concentration of lead (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	6.74±0.74	5.13±0.46	1.92±0.83	4.59±2.45
Grower	7.33±3.57	5.62±4.22	2.36±3.16	5.10±2.52
Finisher	3.31±0.91	1.10±1.55	1.92±0.54	2.11±1.12
Layer	7.15±0.99	5.96±3.06	7.85±0.54	6.99±0.96
Mean±SD	6.133±1.89	4.453±2.26	3.513±2.89	

As shown in Table 5, the mean concentrations of lead in the different brands of feeds were in the range of 1.10 to 7.85 mg/kg. The highest mean concentration (7.85 mg/kg) was obtained in the gold medal brand while the layer of each brand had a mean concentration of 6.99 mg/kg which was higher than the other feed types while the finisher had the lowest. The vital brand had lowest concentrations for the starter and the grower. Comparing the values obtained with the maximum acceptable limit of 5mg/kg for lead in feed as stipulated by European Union, [18] eight of the feed samples exceeded the limit. However the values obtained in this study were lower than 23.2–32.6 mg/kg obtained by Mahesar et al., [15] in analysis of poultry feed.

As shown in Table 6, the mean values of cadmium obtained were in a range of 0.038 to 0.463 mg/kg. The layer also had a comparatively higher mean concentration compared to the other feed types while the finisher had the lowest. However the vital feed had higher mean concentration of cadmium. Comparing with the maximum acceptable limit of 1 mg/kg cadmium in feed as stipulated by European Union, [18] none of the samples exceeded the limit. However the values obtained in this study were lower than 3.8–33.6 mg/kg obtained by Mahesar et al., [15]. High concentrations of lead and cadmium have been reported in chickens in Nigeria. Fakayode and Olu-Owolabi [19], reported that concentrations of 0.59 mg/kg lead and 0.07 mg/kg cadmium in chicken eggs in Ibadan which were higher than levels reported in other countries e.g lead concentrations of 0.048 ppm and 0.489 ppm obtained in China and India respectively and cadmium concentrations of 0.01 ppm and 0.004 ppm obtained in Canada and Finland respectively.

Table 6: Mean concentration of cadmium (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	0.275±0.32	0.050±0.04	0.038±0.08	0.121±0.15
Grower	0.113±0.15	0.238±0.34	nd	0.176±0.25
Finisher	0.088±0.02	0.150±0.04	nd	0.119±0.03
Layer	0.413±1.95	0.438±0.37	0.463±0.02	0.435±0.78
Mean±SD	0.220±0.62	0.219±0.20	0.251±0.05	

Nd means not detectable

Table 7: Mean concentration of nickel (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	2.888±0.02	2.250±0.70	2.475±0.39	2.538±0.32
Grower	4.875±0.60	4.113±2.03	4.400±2.19	4.463±0.38
Finisher	4.375±0.88	3.075±1.025	2.813±0.44	3.421±0.83
Layer	4.400±0.85	3.850±2.05	5.188±0.19	4.479±0.67
Mean±SD	4.135±0.86	3.322±0.84	3.719±1.29	

Table 8: Mean concentration of cobalt (mg/kg) in all the brands of feed

Feed type	Gold medal	Top	Vital	Mean
Starter	1.613±0.69	0.688±0.55	0.663±0.05	0.988±0.54
Grower	1.113±0.30	2.150±1.62	1.175±0.56	1.479±0.58
Finisher	1.263±0.05	1.863±0.44	0.613±0.40	1.246±0.62
Layer	3.200±0.81	1.238±0.37	2.763±0.37	2.400±1.03
Mean±SD	1.797±0.96	1.485±0.65	1.304±1.01	

The mean concentrations of nickel were in the range of 2.250 to 4.875 mg/kg as shown in Table 7. The layer also had higher mean concentration of 4.479 mg/kg than the other feed types while the starter had the lowest. The gold medal brand had a higher mean concentration of 4.135 mg/kg than the other brands. The mean concentrations of cobalt in the feed samples were in the range of 0.613 to 3.200 mg/kg as shown in Table 8. The layer also had a higher mean concentration that the other feed types while the starter had the lowest.

CONCLUSION

The starter feed type consistently had the lowest concentration of the essential elements. The essential elements (zinc, iron, manganese and copper) were very low in the feed. Therefore, the nutritive values of the feed as estimated from the concentrations of the essential elements were very low. This shows that supplements were not added to the feeds as should have been expected. However there were very high concentrations of lead in the feed samples. This could be attributed to anthropogenic sources of lead pollution in the environment especially fossils fuels. There is a great need to adopt the alternative renewable energy sources such as biodiesel and bioethanol.

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