ISSN: 2639-7455

Research article

Earth & Environmental Science Research & Reviews

Assessment of the Levels of Potentially Toxic Metals in Selected Poultry Feeds Sold in Makurdi Metropolis, Benue State, Nigeria

Ande S[1]*, Obolo I[2], Aondo T[1], Aloko, J L[1] and Amaechi J[1]

[1]*Department of Chemistry Federal University of Agriculture PMB 2373 Makurd, Nigeria*

[2]*Department of Chemistry, Federal College of Education (Technical), Akoka Lagos State, Nigeria*

***Corresponding author**
Sesugh Ande, PhD MCSN MRSC MSEGH, Department of Chemistry Federal University of Agriculture PMB 2373 Makurd, Nigeria.

Submitted: 16 Aug 2020; **Accepted**: 22 Aug 2020; **Published**: 24 Aug 2020

Abstract

Eight (8) selected poultry feed samples from four (4) different brands namely; Hybrid, Chikun, Amo Byng and Vital were purchased from Makurdi Metropolis. The samples (HS, HF, CS, CF, ABS, ABF, VS and VF) denote Hybrid starter, Hybrid finisher, Chikun Starter, Chickun Finisher, Amo Byng Starter, Amo Byng Finisher, Vital Starter and Vital Finisher respectively. Toxic metals content was determined using Atomic Absorption Spectrophotometry and expressed in mg/kg. The results showed that Cd was only present in CF (0.80). Chromium was found only in ABS (15.4) and ABF (34.9). The concentration of Cu in (HS, HF, CS, CF, ABS, ABF, VS and VF) was 10.3, 15.0, 24.7, 27.9, 6.90, 9.70, 4.70 and 5.20 respectively. The concentration of Fe in (HS, HF, CS, CF, ABS, ABF, VS and VF) was 338,378, 307, 273, 389, 289, 398 and 405 respectively. The concentrations of Mn in (HS, HF, CS, CF, ABS, ABF, VS and VF) were 103, 95.3, 110, 97.4, 94.0, 103, 25.8 and 77.9 respectively. Lead was not detected in all the samples. The concentrations of Zn in (HS, HF, CS, CF, ABS, ABF, VS and VF) were 78.6, 75.1, 156, 177, 100, 67.2, 5.1 and 96.5 respectively. Copper, Fe, Mn, and Zn were the most abundant toxic metals found in the poultry feed samples. Lead was generally below the allowable limit. Chromium in ABS and ABF was higher than the permissible level. The concentrations of Fe, Mn and Zn in all the feeds were found to be above the limits. Copper found in ABS, ABF, VS and VF was within the limits permitted but levels in CS and CF were far above the limit. The concentrations of most of the trace elements were found to be higher than recommended levels which may pose some environmental and health risk if not properly regulated.

Keywords: Metals, Poultry, Feeds, AAS, Contamination, Environment

Introduction

Poultry feed is food for farm poultry, including chickens, ducks, geese and other domestic birds. Feed for poultry mostly consists of grains, minerals and trace elements [1]. Toxic elements in poultry feeds are significant of both human beings and animal's life although the content of each trace element is less than 0.01% which are contributory in metabolism and maintain the dynamic balance in the body with variety of forms [2]. Poultry is chiefly a source of economical, palatable and healthy food protein [3]. It has been noted that most commercial feeds failed to meet up with the national requirement of birds and in many ways the source of raw materials for the production of the feeds can be associated with heavy metals pollution [3]. Certain mineral elements such as copper, zinc, manganese and iron are essential dietary nutrients for poultry. However, all mineral elements, whether considered to be essential or potentially toxic, can have an adverse food effect upon the humans and animals if included in the diet at excessively high concentration [4]. Although contamination of animal feeds by toxic metals cannot be entirely avoided given the prevalence of these pollutants in the environment, there is need for such contamination to be minimized, with the aim of reducing both direct effects on animal health and indirect effects on human health [5]. Some elements which are normally toxic are useful for some organism in certain cases [6]. However, the risk of heavy metals contamination in meat is of great concern for both food safety and human health because of the toxic nature of these metals at relatively minute concentrations [7]. Serious environmental problems caused by livestock and poultry wastes are attracting increasing interests because large amounts of additives are added in feeds during intensive farming [8]. Poultry feeds are known as a complete feed, since it is prepared in such a way to contain all the vitamins, minerals, energy, protein and other nutrients essential for proper health of the birds, egg production and growth [9]. Therefore, it's important to from time to time assess the concentrations of some of the materials in feeds particularly potentially toxic metals (PTMs) to ascertain the level of contamination or otherwise of the feeds.

Material and Methods

Materials

Chemicals or reagents used are Conc. HNO3 and Conc. HCl. All reagents or chemicals used were of analytical grade (> 98%) procured from World Corsica reagent store, Makurdi, Nigeria.

These shall be utilized without undergoing any further purification Distilled water was used for the analysis. The apparatus used are volumetric flask, Whatman No. 1 filter paper, conical flask, HI 9024 microcomputer pH meter (pH 4 buffer solution), electronic weighing balance, mortar and pestle, analytical weighing balance, spatula, beaker, sample bottles, hot plate, centrifuge tube, 2 mm sieve, Flame atomic absorption spectrophotometer (Varian SpectrAA 600 model).

Sample Collection and Pre-treatment

Samples of the poultry feeds (500 g each) were obtained from the market. The samples were placed into polyethylene bags and transported to the laboratory. Then the samples were air-dried for 3 weeks at room temperature in a storage room. The samples were gently grounded using mortar and pestle which was then passed through a 2 mm sieve after removing stones and other unwanted materials. The ground samples were stored in clean labeled plastic containers and covered tightly prior to digestion.

Poultry Feed Samples with Identification

The following four brands of poultry feeds were purchased for the study. Table 1 below shows the brands of poultry feeds used for the study.

Table 1: Brand of Poultry Feed Chosen for the Study

Feed Type/ Brand	Hybrid	Chikun	Amo Byng	Vital
Starter	HS	CS	ABS	VS
Finisher	HF	CF	ABF	VF

HS = Hybrid starter; HF = Hybrid Finisher; CS = Chikun starter; CF = Chikun Finisher; ABS = Amo Byng Starter; VS = Vital starter; VF = Vital Finisher

Analytical procedure

The analytical procedures followed in this work are described below:

The pH Measurement: The pH determination was performed according to [10]; About 5.0 g of each air-dried sieved sample into the 50 mL conical flask, after which 25 mL of distilled water was added. The conical flasks were closed firmly and place on the mechanical shaker for 1 hour, then removes and allowed to stand for 2 h. The pH was then measured in the suspension after calibrating the pH meter with the buffer solutions

Sample Digestions with *Aqua Regia*

The samples were digested using *aqua regia* which is the mixture of nitric acid (HNO3) and hydrochloric acid (HCl) in the ratio 1:3. Each of the sieved samples (0.50 g) was weighed into a conical flask. The 20 mL of the 1:3 nitric acid and hydrochloric acid mixture was added. The flask was heated gently on a hot plate in a fume chamber. Brown fumes evolved as the heating continued until a clear solution was obtained and white fumes of hydrochloric acid were observed. The flask was removed from the hot plate. The mixture was allowed to cool and then filtered using Whatman No. 1 filter paper into 50 mL volumetric flasks and made up to the mark with the distilled water. The sample solutions were then transferred into pre-washed sample bottles. Procedural blank which includes the reagents without the sample were also digested, filtered and brought to volume with distilled water and stored. The digests were analysed for the presence of seven toxic metals; Cd, Cr, Cu, Fe, Mn, Pb and Zn using Atomic Absorption Spectrophotometer (Flame atomic absorption spectrophotometer Varian SpectrAA 600 Model).

Results

Table 2 shows the result of the pH and concentration of Cd, Cr, Cu, Fe, Mn, Pb and Zn in the Poultry feed samples.

Table 2: The pH Values and Concentration (mg/kg) of Potentially Toxic Metals in the various Poultry Feeds

Feed type/ Brand	pH	Cd	Cr	Cu	Fe	Mn	Pb	Zn
HS	5.60	ND	ND	10.3	338	103	ND	78.6
CS	5.64	ND	ND	4.7	307	110	ND	156
ABS	5.57	ND	15.4	6.9	389	94.0	ND	100
VS	5.67	ND	ND	4.7	398	25.8	ND	5.1
HF	5.62	ND	ND	15.0	378	95.3	ND	75.1
CF	5.47	0.800	ND	27.9	273	97.4	ND	177
ABF	5.69	ND	34.9	9.7	289	103	ND	67.2
VF	5.73	ND	ND	5.2	405	77.9	ND	96.5

HS = Hybrid starter; HF = Hybrid Finisher; CS = Chikun starter; CF = Chikun Finisher; ABS = Amo Byng Starter; VS = Vital starter; VF = Vital Finisher; ND = Not detected

Discussions

The pH Values: The pH of the poultry feed samples ranged from 5.47 to 5.73 as shown in Table 2. The result indicated that all the samples were acidic in nature and lower than the result reported in [11] and [12] who reported pH ranges of 6.3 to 7.1 for various poultry feeds and a value of 6.9 for a starter feed respectively. The low pH values obtained in this study may be considered adequate since acidic environment generally creates barrier to entry of bacteria to the digestive tract of animals [13].

Levels of Potentially Toxic Metals in the Poultry Feeds

Considering the result of Cd in the various feeds as shown in Table 2, Cd was only present in CF (0.800 mg/kg). This value is relatively high but lower than the permissible limit of Cd (1.00 mg/kg) given in [14]. The ND of Cd in the samples may be attributed to the nature or sources of the raw materials used in the formulation of the feeds.

Chromium was not detected in (HS, HF, CS, CF, VS and VF). However, high concentration of Cr was found in ABS (15.4 mg/kg) and ABF (34.9 mg/kg) as shown in Table 2. These values are much higher than the maximum acceptable limit of 0.3 mg/kg [15] for poultry feeds. The high concentration Cr in the feeds may be due to elevated levels of the element in the raw materials used during the period of processing.

The concentrations of Cu in the samples HS, HF, CS, CF, ABS, ABF, VS and VF in mg/kg were 10.3, 15.0, 24.7, 27.9, 6.9, 9.7, 4.7, and 5.2 respectively with sample VS having the lowest concentration and CF having the highest concentration. Copper was referred to as micro-nutrient at (0.0 – 10 mg/kg) level in feed starters and (9 – 10 mg/kg) in feed finishers [15]. Samples HS, HF, CS, and CF are found to be above the range with the exception of sample ABS, ABF, VS and VF which are within the range. Comparing the result of copper for feed starters, Cu was found to be present in all the starters increasing in the order CS (24.7 mg/kg) > HS (10.3 mg/kg) >ABS (6.9) > VS (4.7). For feed finishers, Cu was also found to be present in all the feed finishers increasing in the order CF (27.9) > HF (15.0) >ABF (9.7) > VF (5.2).

The concentrations of Fe in the various samples (HS, HF, CS, CF, ABS, ABF, VS and VF) expressed in mg/kg were 338, 378, 307, 273, 389, 289, 398 and 405 mg/kg respectively with sample CF having the lowest concentration and VS having the highest concentration. Iron was found in all samples but above the permissible level of 45-80 mg/kg as stipulated by [14] and higher comparing with the range given by [16] for starter and finisher. Comparing the result of Fe obtained generally for feed starters, Fe was found to be present in all the feed starters increasing in the order VS (398) >ABS (389) > HS (338) > CS (307) mg/kg. For feed finishers, Fe was also found to be present in all the finishers increasing in the order VF (405) > HF (378) >ABF (289) >CF (273) mg/kg.

The concentrations of Mn in the samples (HS, HF, CS, CF, ABS, ABF, VS and VF) reported in Table 2 in mg/kg were 103, 95.3, 110, 97.4, 94.0, 103, 25.8 mg/kg and 77.9 respectively with sample VS having the lowest concentration and sample CS having the highest concentration. Manganese being part of the essential trace minerals is also present in the entire feed samples. SON [16] stipulated the concentration of Mn in both feed starters and feed finishers to be 55 - 60 mg/kg; the levels found in this study are well above this requirement. Manganese increased in the following order for feed starters thus CS (110) > HS (103) >ABS (94.0) > VS (25.8) mg/kg whereas for the feed finishers, Mn increased as follows: ABF (103) >CF (97.4) > HF (95.3) >VF (77.9).

Lead was not detected in the entire samples which may also be attributed to the sources of the raw materials used in the formulation of the poultry feeds. The permissible limit of Pb in poultry feeds in the UK is given 1.00 mg/kg [17]. However, the maximum acceptable limit of 5.00 mg/kg has been given by [14]. There is no value for Lead in this study but values were obtained by others such as 1.10 - 7.85 mg/kg and 23.2 - 32.6 mg/kg obtained by [3] and [4] in their analysis of poultry feeds respectively.

The concentrations of Zn in the feed samples HS, HF, CS, CF, ABS, ABF, VS and VF as presented in Table 2 in mg/kg were 78.6, 75.1, 156, 177, 100, 67.2, 5.1 and 96.5 respectively with sample VS having the lowest concentration of Zn and sample CF presenting the highest concentration of the metal. Zinc was mentioned as a nutrient at 40 - 55mg/kg in starter and finisher in poultry feed reference standard prepared by [17]. All the samples contained zinc above the micro-nutrient requirement with the exception of sample VF (5.1 mg/kg). However, these values were comparably lower than the range of 54.3 - 482.2 mg/kg obtained by [3] and higher than the range of 33.945 - 49.950 mg/kg obtained by [4] in their analysis of poultry feed. Comparing the result of Zn obtained for feed starters, Zn showed the following trend CS (156) >ABS (100) > HS (78.6) > VS (5.10) mg/kg. For feed finishers, Zn presented the following trend in the samples CF (177) > VF (96.5) > HF (75.1) >ABS (67.2).

Conclusion

Potentially toxic metals were present in measurable levels in poultry feeds sold in Makurdi Metropolis and the concentrations varied from feed to feed. The results indicate that poultry birds can be enriched with heavy metals through their feed and that the various sources of raw materials used for poultry feed production are likely associated with anthropogenic heavy metal pollution. The concentrations increased in the following order Fe > Zn >Mn> Cu > Cr > Cd. Cu, Iron, Mn, and Zn were the most abundant toxic metals found in the poultry feed samples. The concentrations of most of the trace elements were found to be higher than recommended levels which may pose some environmental and health risk if not properly regulated.

References

1. Babiker M S, Kijora C, Abbas S A, Danier J (2009) Nutrient Composition of Main Poultry Ingredients Used in Sudan and their Variations from Local Standard Table Values. *International Journal of Poultry Science* 8: 355-358.
2. Macharia, C, Kogi-Makau W, Muroki, N (2005) A comparative Study on the Nutritional Status of Childreir (6 - 59 Months) in a World Vision Project Area and a Non-Project Area in Kathonzweni Division, Makueni District, Kenya. *African Journal of Food Agriculture and Nutritional Development* 5: 1-13.
3. Mahesar S, Sherazi S, Niaz A, Bhanger M, Rauf A, et al. (2010) Simultaneous Assessment of Zinc, Cadmium, Lead and Copper in Poultry Feeds by Differential Pulse Anodic Stripping Voltammetry. *Food and Chemical Toxicology* 45: 2357-2360.
4. Okoye C O B, Ibeto C N, Ihedioha J N (2011) Assessment of Heavy Metals in Chicken Feeds Sold in South Eastern, Nigeria. *Advance in Applied science Research* 2: 63-68.
5. SCAN (2003) Opinion of the Scientific Committee on Animal Nutrition on Undesirable Substance in Feed.
6. Altundag H, Albayrak S, Dundar M S, Tuzen M, Soylak M, et al. (2015) Investigation of the Influence of Selected Soil and Plant Properties from Sakarya, Turkey, on the Bioavailability of Trace Elements by Applying an *In Vitro Digestion Model*.

Biological Trace Element Research 168: 276-285.
7. Santhi D, Balakrishan V, Kalaikannan A, Radhakrishnan K T (2008) Presence of Heavy Metals in Pork products in Chennai (India). *American Journal of food Technology* 3: 192-199.
8. Jiang S, Cui L, Shi C, Ke X, Luo J, et al. (2014) Effects of Dietary Energy and Calcium Levels on Performance, Egg Shell Quality and Bone Metabolism in Hens. *The Veterinary Journal* 295: 252-258
9. Bukar H, Saeed M (2014) Proximate Analysis and Concentration of some Heavy Metals in Selected Poultry Feeds in Kano Metropolis, Nigeria. *Bayero Journal of Pure and Applied Science* 7: 5-9.
10. BSI (2005) Soil Quality-Determination of pH. London. BS ISO 10390: 1-8.
11. Cox N A, Cason J A, Buhr R J, Richardson K E, Richardson L J, et al. (2013) Variations in Pre-enrichment pH of Poultry Feed and Feed Ingredients after Incubation Periods up to 48 hours. *Journal of Applied Poultry Research* 22: 190-195.
12. B r z ó s k a F, Ś l i w i ń s k I B, M i c h a l i k - R u t k o w s k a O (2013) Effect of Dietary Acidifier on Growth, Mortality, Post-slaughter Parameters and Meat Composition of Broiler Chickens. *Annals of Animal. Science* 13: 85-96.
13. Pearlin B V, Muthuvel S, Govidasamy P, Villavan M, Alagawany M, et al. (2020) Role of Acidifiers in Livestock Nutrition and Health: A review. *Animal Physiology and Animal Nutrition.* 104: 558-569.
14. FAO/WHO (2000) Report of the 32nd Session of the Codex Committee of the Food Additives Contaminants. Beijing People's Republic of China, 20 -24 March, 2000.
15. National Research Council (NRC), Board on Agriculture, Subcommittee on Poultry Nutrition (1994) Nutrients requirements of Poultry: Nutrient Requirements of Domestic Animals: A Series. Ninth Revised Edition. National Academies Press. Washington DC. pp176.
16. SON (2003) Nigeria Industrial Standard (NIS) 259: 2003.
17. Nicholson F A, Chambers B J, Williams J R, Williams R J (1999) Heavy metal contents of livestock feeds and animal manures in England and Wales. Bioresource Technology. 70: 23-31.