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Proximate and heavy metals analysis of selected poultry feeds from Kano Metropolis, Nigeria

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ABSTRACT

Proximate analysis and heavy metals determination were carried out in some selected commercially available poultry feed samples used as starter, grower, layer and finisher obtained from Kano Metropolis. The results of the proximate analysis shows the following composition: moisture ranged from 3.81-15.97%, crude fiber 1.70-38.75%, ash content 6.84-35.56%, lipid 1.47-9.20%, crude protein 2.80-34.56%, carbohydrate 15.73-78.90% and metabolizable energy 1737.30-4622.70kcal/kg. There was significant difference observed in moisture content ($p<0.05$). The results also indicated that different levels of cadmium, cobalt, copper, iron, manganese, nickel, lead, chromium and zinc were detected in all samples. They range from 0.53-03.19mg/kg for Cd, 0.13-3.33mg/kg for Co, 2.03-5.41mg/kg for Cu, 08.79-19.74mg/kg for Fe, 12.50-37.50mg/kg for Mn, 1.03-2.06mg/kg for Ni, 0.27-0.80mg/kg for Pb, 0.47-2.36mg/kg for Cr and 16.30-38.04mg/kg for Zn respectively. The levels of zinc, iron, manganese and copper were found to be below the requirement set by SON. Cadmium levels were found in all samples to exceed the permissible limit of EU and FAO/WHO which both are 1mg/kg; with exception of feed C grower (0.53mg/kg) which falls within the limit. The whole metals in the feeds were found to be statistically significant $p<0.05$.

Key words: Proximate analysis; Heavy metals; Poultry feed; AAS, FAO, WHO

INTRODUCTION

Poultry is a category of domesticated birds kept by humans for the purpose of collecting their eggs, or slaughtering for their meat and/or feathers. Poultry is the second most widely eaten meat in the world, accounting for about 30% of meat production worldwide, after beef at 38% [1]. Poultry is basically a source of economic, palatable and healthy food protein [2]. Poultry feed is food for farm poultry, including chickens, ducks, geese and other domestic birds. Feed for poultry mostly consists of grain [3]. The feed consist of grains such as corn, wheat or barley, oil seeds, cake meal (originating mainly from oil producing seeds such as soybeans) sunflower seeds, peanuts, cotton seed and protein products of animal origin such as fish meal, meat and bone meal [4]. Poultry feeds are known as a complete feeds, 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. Poultry farming is now one of the most important agricultural sectors in the world. It is expanding rapidly as an industry. Most of the commercial poultry farmers depend on commercial feeds for their stock. The role of these poultries is to meet up with the increasing demand for meats and eggs as protein. [5] Suggested that harmonization of feed qualities can only be possible when a given standard is adopted nationwide. Nowadays, it has been noted that some of the commercial feeds producers failed to meet up with standards for the requirement of poultry and in many ways, the source of raw material for the production of the feeds tends to be contaminated with heavy metal. Heavy metals which are defined as a metal with a specific density of more than 5g/cm^3, is a serious threat because of their toxicity, bioaccumulation and biomagnifications in food chain [6]. Although contamination of animal feeds by toxic metals cannot be entirely avoided given the prevalence of these pollutant 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 [7]. An important feature of heavy metals is that the chemical form in which they are present may change during passage through the intestine or storage in animal tissue, but they are not metabolized. Some mineral elements are essential dietary nutrients for poultry and livestock such as iron, manganese, copper and zinc. However, all mineral elements can have an adverse effect upon human and animals at excessively high or low concentration if included in the diet [8]. Therefore, it is important to control contamination of poultry feed by heavy metals and also check their nutritional constituents. The aim of this study is to determine the proximate analysis and levels of some heavy metals in selected commercially poultry feeds in Kano Metropolis.

EXPERIMENTAL SECTION

All the plastic and glass wares were washed with detergent and rinsed with water before immersion in 10% nitric acid solution. They were finally rinsed with deionized water. Analytical grade reagents and deionized water were used throughout the analysis.

Sampling

Four brands (starter, grower, layer and finisher) of four feeds (Animal care, Hybrid, Niger, Sovet, Superb, Top feed and Vital feed coded as A, B, C, D, E, F, G respectively) commercially available in Kano Metropolis were purchased from different locations within the metropolis.

Proximate Composition

Samples were subjected to proximate analysis in accordance with standard methods described by AOAC.

Moisture content Determination

A clean petri-dish with lid was dried in an oven at 105^{o}C for 3hours and then transferred to a desiccator to cool and weighed (W1). 3g of the sample was weighed in a petri-dish (W2). The dish was then placed in an oven and dried at 105^{o}C until a constant weight was achieved. After drying, the dish was then transfers to a desiccator to cool and then reweighed with its content (W3).

Lipid Content Determination

Sample of 3g was carefully weighed (W_1) into a folded fat-free filter paper. This was properly folded and weighed (W_2), and was carefully placed in soxhlet extractor. The whole apparatus was then connected after addition of about 300ml petroleum ether into the weighed extraction flask. The extraction was then carried out for 3 hours using the heating mantle and making sure there was continuous flow of water in the condenser. The sample was then removed, air-dried and then placed in an oven at 80^{o}C until a constant weight was obtained (W_3). The extractible lipid was then calculated as percentage lipid (%).

Crude Fibre Determination

The crude fibre was determined by subjecting 3g of the dried samples from moisture analysis and ether extraction to successive treatments with boiling 200cm^3 of 0.1275M H_2SO_4 acid under reflux for 30mins, washed several times with hot water until it is acid free. The residue was again subjected to the same treatment using 200cm^3 of 0.313M NaOH solution, washed thoroughly with hot water until it was base free. It was then dried to a constant weight in an oven at 100^{o}C, cooled in desiccators and weighed. The weighed sample was incinerated in a muffle furnace at 550^{o}C until a constant weight was obtained. The crude fibre was calculated as the loss in weight on ashing.

Crude Protein Determination

Exactly 0.15g of dried (moisture free) sample was weighed and the content was transferred into the kjeldahl digestion flask. 0.8g of the catalyst (0.7g sodium sulphate, 0.06g copper sulphate, and 0.04g mercury (II) oxide red) was added into the digestion flask; 2cm^3 of conc. sulphuric acid was also added. The mixture was heated on the heating mantle at an inclined position until the liquid became clear. The digest was cooled and made alkaline with 15cm^3 of 40% NaOH. The digest was then transferred to the steamed out apparatus. The ammonia steamed distilled into 10cm^3 of 2% boric acid solution with 5 drops of methyl red indicator for 15minutes. The distilled ammonia was the titrated with 0.02M HCl.

Total Ash Determination
Crucible was dried in the oven for 24hours, cooled and weighed (W1). 2g of dried (moisture free) sample (W2) was placed in the crucible and heated in the muffle furnace at 550^oC until a constant weight is obtained. The ash was then covered with a lid and placed in desiccators prior to weighing. This was then measured as W3.

Carbohydrate content Determination
The carbohydrate content was determined by difference:

Carbohydrate % = 100 - (crude fibre + lipids + crude protein + moisture content + Ash) as reported by [9].

Metabolizable Energy
That is calculated as follows:-
ME (kcal/kg) = 10[(3.5 x CP) + (8.5 x CF) + (3.5 x NFE)]

Where:
ME = Metabolizable Energy
CP = Crude protein.
CF = Crude Fibre
NFE = Nitrogen Free Extract and other values are constants.

NFE is also calculated thus;
NFE = 100 – (% moisture + % CP + % ash + % LP)

Where:
LP is Lipid
NFE is also called Carbohydrate.

Dry Ashing Digestion
The residual of ashes from total ash determination were dissolved using HNO_3 and then filtered using Whatman filter papers. The filtrates were individually poured into 50cm^3 standard flasks and made up to mark with deionized water. The sample solution was then kept in sample bottles for further analysis using AAS.

RESULTS AND DISCUSSION

Statistical Analysis
Data collected were subjected to one way analysis of variance (ANOVA) ($p<0.05$) to check the significant difference existing among the studied heavy metals in the feeds. All statistical calculations were performed using SPSS software.

Proximate Composition
Shown in the figures below are proximate analyses of the various poultry feeds to ascertain the level of the proximate composition of each feed. Generally all the feeds showed similar nutrients composition. There are seven figures each representing a different feed analysis.

In general, the moisture content ranges from 3.81-7.29%, 7.83- 9.60%, 7.40-8.59%, 5.90-15.00%, 07.78-15.97%, 05.36-13.28% and 7.60-08.96% for feed A, B, C, D, E, F and G, where feed A was observed to have the least in grower (3.81%) while feed E has the highest percentage in starter (15.97%). There is significant difference observed in the moisture content of the entire feeds sample ($p<0.05$). For the crude fiber content feed F and C however, showed the least percentage of crude fibre in F starter and C grower (1.70% & 2.99%) respectively. There was no significant difference observed for the entire feeds sample in crude fibre ($p>0.05$). Ash content of a poultry feeds relates to the inorganic mineral content. The percentage of the ash content in the feeds was found to be highest in feeds D and G with D grower (38.65%) and G starter (35.56%) while feed A has the least with grower (6.84%). There was no significant difference observed ($p>0.05$).

Figure 1: Showing the percentage of Moisture content in the feeds

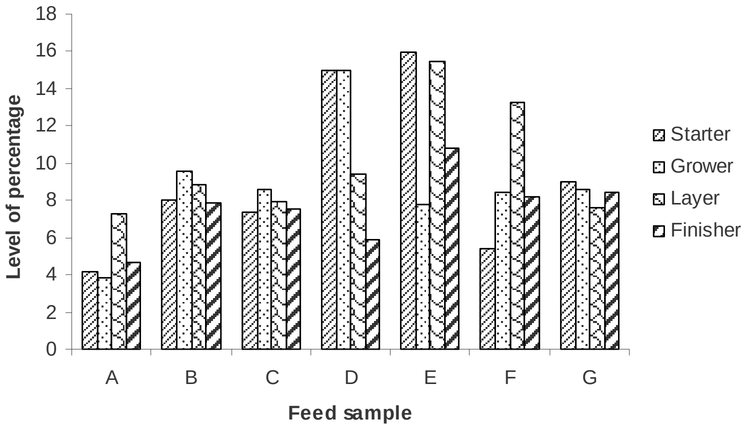


Figure 2: Showing the percentage of Ash content in the feed sample

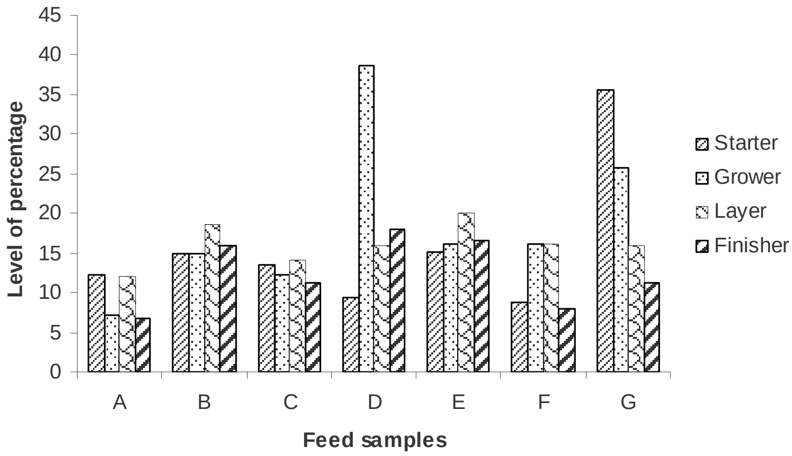
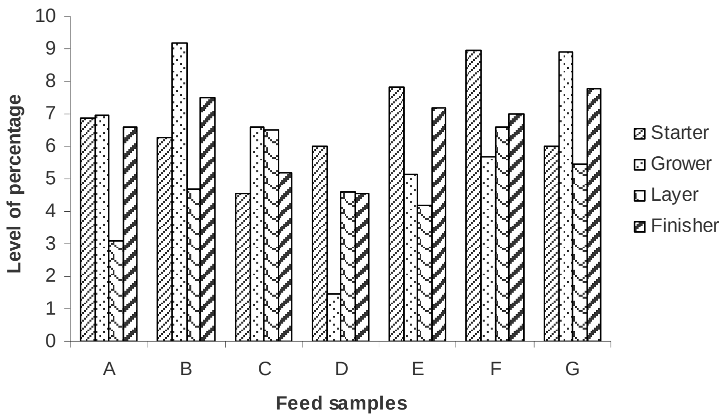


Figure 3: Showing the percentage of lipid in the feed sample



Lipids in poultry diets are often incorporated to enhance the energy levels [10]. The lipid content in the feed was found to be low with the least percentage in feed D grower (1.47%) and it is statistically insignificant ($p>0.05$).

Crude protein is one of the most important nutrient to quantify in a prospective feeds due to the fact that, it is one of the most expensive to supply and deficiency of protein has a drastic effect on growth and production. Feeds E and F shows the least in crude protein, E layer (2.30%) and F finisher (2.80%). There was no significant difference observed for the entire feeds sample for crude protein p>0.05.

Figure 4: Showing the percentage of crude protein in the feed samples

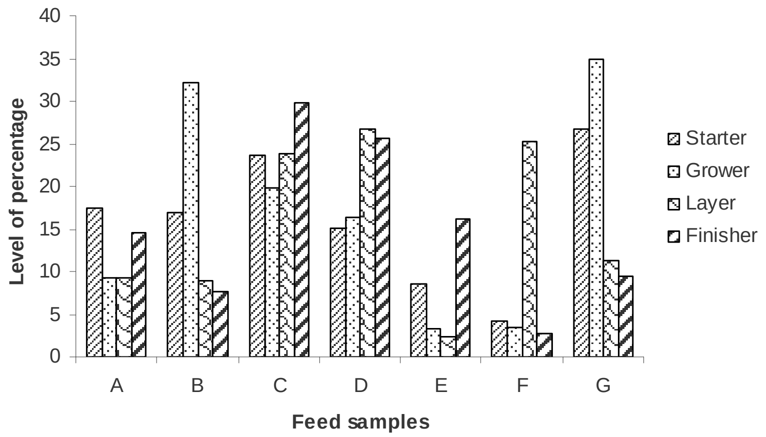


Figure 5: Showing the percentage of crude fibre in the samples.

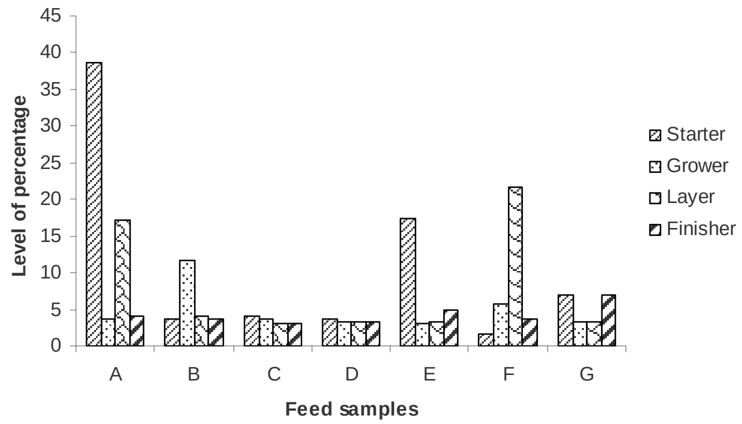


Figure 6: Showing the percentage of carbohydrate in the feed samples

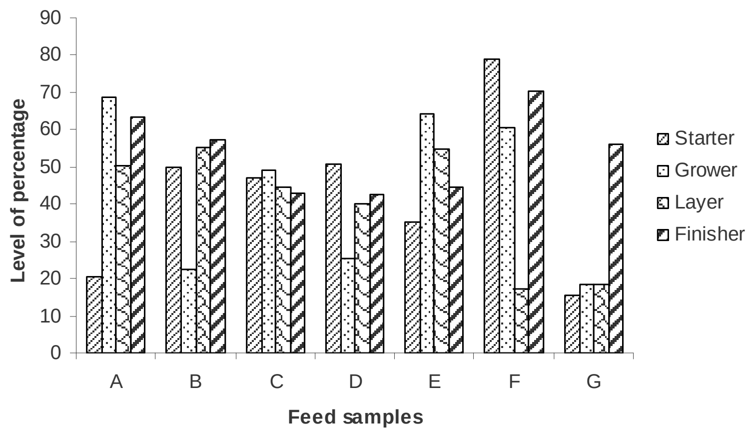
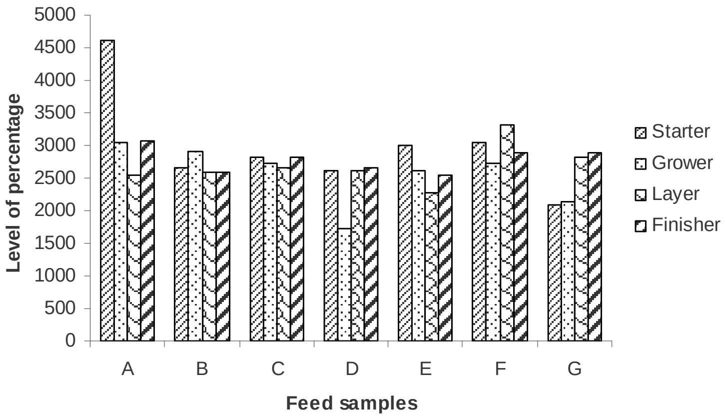


Figure 7: Showing percentage of Metabolizable energy in the feed samples



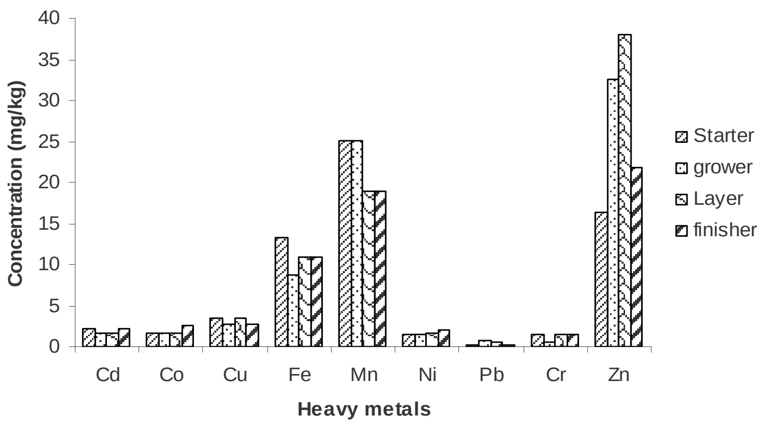
Generally, the carbohydrate which is also referred to as nitrogen free extract is high in all the feeds. Carbohydrates are essential source of energy. Carbohydrate was found in the range of 20.47-68.83%, 22.48-57.39%, 43.07-49.05%, 25.25-50.87%, 35.10-64.39%, 17.18-78.90%, 15.73-56.07% for feed A, B, C, D, E, F and G respectively. The least was found in feeds G starter (15.73) while the highest is in feed E starter (78.90). It is statistically insignificant ($p>0.05$).

Metabolizable energy which refers to the energy in which the poultry utilizes was found lowest in feed D grower (1737.30kcal/kg). The entire metabolizable energy is statistically insignificant ($p>0.05$).

Heavy metals

Figures 8-14 below show the results of the heavy metals concentration in mg/kg for the various feeds.

Figure 8: Showing concentration of heavy metals in feed A



In poultry feed reference standard prepared by the Standard Organization of Nigeria (SON), there are requirement of some heavy metals mentioned as micro-nutrient but no standard as a contaminant in terms of maximum acceptable limit for the heavy metals was mentioned. Copper, zinc, manganese and iron which are heavy metals are included in the requirement as micro-nutrient [11].

In general, zinc level were found in all the samples to be high but below the permissible limit of 500mg/kg as stipulated by European Union and zinc was mentioned as a nutrient at 40-55mg/kg in starter, grower and finisher and 30-40mg/kg in layer feed for layers. Feeds A, B and F are within the micro-requirement as stipulate by SON [11], for the layer feeds. However, comparing the results obtained in these analysis with that of Okoye et al., [12], it was found that some of the feeds are within the range while as others are below (33.945-49.950mg/kg). Cadmium levels were found in all samples to exceed the permissible limit of EU and FAO/WHO which both are 1mg/kg; with exception of feed C grower (0.532mg/kg) falls within the limit. Lead concentration level in all the samples were above the permissible limit of 1mg/kg in the United Kingdom [13], however they are within the maximum acceptable limit of 5mg/kg by European Union. Nickel was detected but all found to be below the maximum acceptable limit of 4.05mg/kg of the Act No. 21, [14]. However, comparing the values obtained with that of Okoye *et al.*,[12] of 2.250-4.875mg/kg, the values were found to be lower.

Figure 9: Showing concentration of heavy metals in feed B

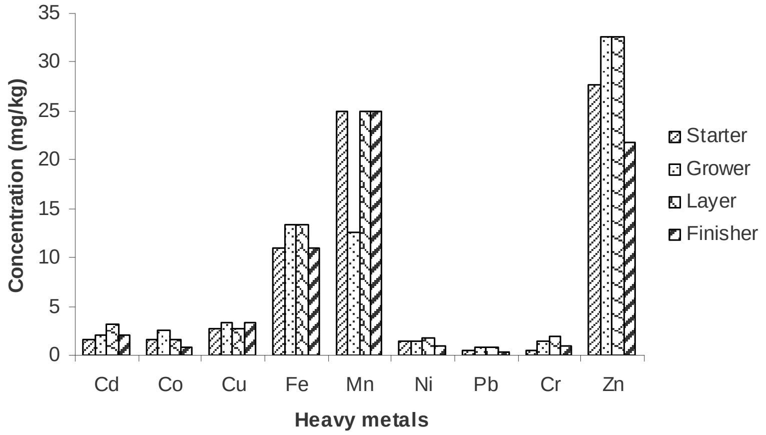


Figure 10: Showing concentration of heavy metals in feed C

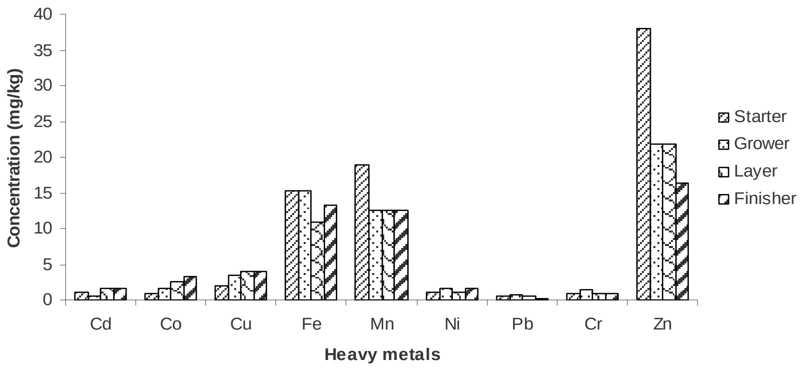


Figure 11: Showing concentration of heavy metals in feed D

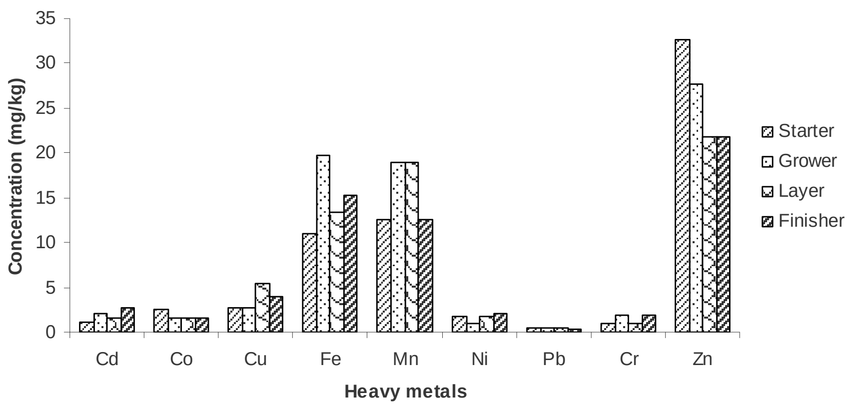


Figure 12: Showing concentration of heavy metals in feed E

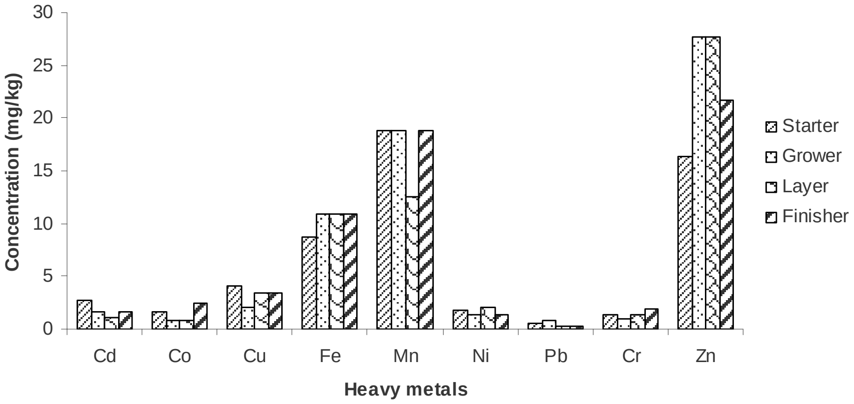


Figure 13: Showing concentration of heavy metals in feed F

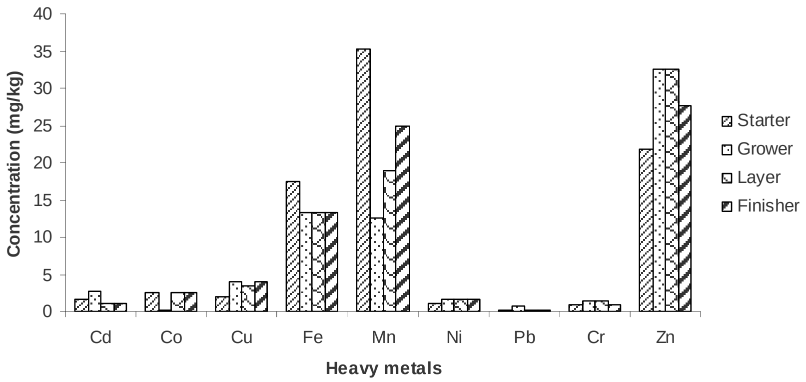
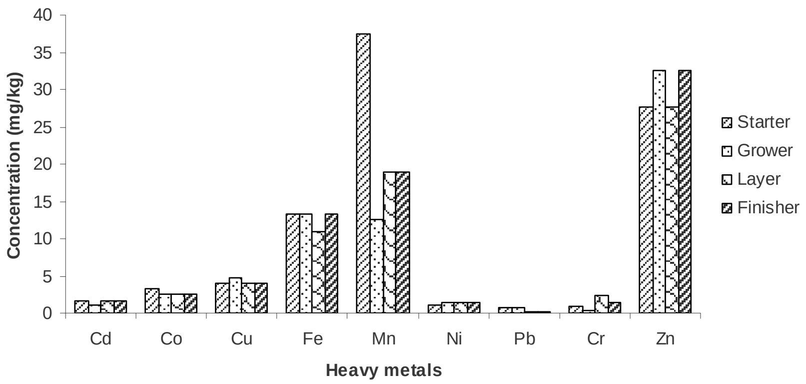


Figure 14: Showing concentration of heavy metals in feed G



Iron was found in all samples but below the permissible level of 45-80mg/kg as stipulated by FAO/WHO [15] and comparing with that of SON [11] (90-95mg/kg) for starter; grower and finisher while 50-60mg/kg for layer. In the analysis carried out, it was found out that all the feeds contained iron below the requirement. Feed A grower and feed E starter have lower contents of iron (08.79mg/kg) which will not suffice the nutritional requirement of the poultry. In the case of Cobalt, comparing the values obtained with the maximum acceptable limit of 1mg/kg as stipulated by FAO/WHO, only five (5) of the feed samples are within the limit. Manganese and Copper being part of the essential trace minerals are also detected in the entire feeds sample. Manganese which is also a micro-nutrient mentioned by SON [11] at 55-60mg/kg for starter and finisher, 30-40mg/kg for grower and 50-60mg/kg for layer. It was found that, all the feed samples are below the micro-requirement. Copper was referred to as micro-nutrient at

(0.0-10mg/kg) level in starter and (9-10mg/kg) in grower, layer and finisher. In the samples, the entire feeds sample for starter Cu is within the range (0.0-10mg/kg) but for the grower; layer and finisher was found to be below the range (9-10mg/kg) set by SON [11].

CONCLUSION

In conclusion, data obtained in the proximate analysis represent great variations among the quality of the poultry feeds from selected manufacturers. The essential elements zinc, iron, manganese and copper were found to be low in the feed and the nutritive values of the feeds are estimated from the concentration level of the essential elements. Some of the heavy metals are found to be above the maximum acceptance limit whereas majority falls within the limit. However, cadmium concentration was found to exceed the maximum acceptable limit with the exception of feed C grower. This makes the feeds contaminated with cadmium and not safe for poultry consumption since heavy metals are bio-accumulative and have the tendency to be transferred to human after consumption.

Therefore, extra measures need to be taken in order to eliminate/reduce the heavy metals from entering the feeds thereby reducing human exposure through feeding and there should be provision by Standard Organization Nigeria to provide maximum acceptable limit for heavy metals not only for the micro minerals. There is the need to also increase the quantity of supplements been added to the feeds so as to increase its nutritional values for the poultry.

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