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Comparative Assessment of Heavy Metals in variety of Chicken feeds available in Makurdi Metropolis,Benue State, Nigeria

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Abstract:
The research work aimed at investigating some heavy metals in some chicken feeds that are commonly consumed in poultry farms in Benue metropolis. The research analyzed eight (8) metals (zinc, lead, manganese, copper, cadmium, nickel, chromium and iron) in eight (8) samples of chicken feeds from four (4) production companies (top feed, hybrid feed, oracle feed and vita feed), two (2) from each (i.e starter and finisher of each) using atomic absorption spectrophotometer (AAS).In all the samples analyzed, the mean concentration of the metals in the four (4) chicken feeds companies were; vita feed Zn 0.18,Pb 0.75, Cu 0.11, Cd 0.00, Ni 0.31 Cr 0.23, & Fe 3.85, top feed Zn 0.31, Pb 0.25, Cu 0.13, Cd 0.00, Ni 0.10,Cr 0.09, & Fe 2.75,oracle feed Zn 0.19,Pb 0.25,Mn 0.70,Cu 0.15, Cd ND,Ni 0.82, Cr 0.06,& Fe 1.88 and hybrid feed Zn 0.18, Pb 0.63, Mn 0.24, Cu 0.05, Cd 0.00, Ni 0.41,Cr 0.09 & Fe 0.43. This shows that the concentration of the metals was below the WHO acceptable limit. This means that the chicken produced from these feeds are safe for human consumption.

Keywords: heavy metal, chicken feeds, assessment. Comparative

INTRODUCTION

Before the twentieth century, poultry were mostly kept on general farms and foraged for much of their feeds, eating insects, grain spilled by cattle and horses and plants around the farm. This was often supplemented by grain, household scraps, calcium supplements such as oyster shell, and garden waste. As farming became more specialized, many farms kept flocks too large to be fed in this way, and nutritionally complete poultry feeds were developed. Modern feeds for poultry consist largely of grain, protein supplements such as soybean oil meal, mineral supplements and vitamin supplements (Harvey,2019). The quantity of feeds and the nutritional requirements of the feeds, depend on the weight and age of the poultry, their rate of growth, their rate of egg production, the weather (cold or wet weather causes higher energy expenditure) and the amount of nutrition the poultry obtain from foraging. This results in a wide variety of feeds formulations. The substitution of less expensive local ingredients introduces additional variations (Encyclopedia 2018).

Diseases can be avoided with proper maintenance of the feeds and feedser. A *feedser* is the device that supplies the feeds to the poultry. For privately raised chickens, or chickens as pets, feeds can be delivered through jar, trough or tube feedsers. The use of poultry feeds can also be supplemented with food found through foraging. In industrial agriculture, machinery is used to automate the feedsing process, reducing the cost and increasing the scale of farming. For commercial poultry farming, feeds serve as the largest cost of the operation (Wikipedia, 2019).
Poultry (chicken) 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), manganese (Mn) and iron (Fe) 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. 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. Hence, the feeds that broiler chicks are fed should be able to cater for their nutritional requirements, of which minerals and certain heavy metals, are extremely integral component; iron being major component of hemoglobin and cytochromes, zinc is needed for DNA structure motifs while copper, manganese, selenium and zinc too are required for proper functioning of enzymes. Zinc and selenium are important for strengthening the immune system and feathering. Arsenic promotes growth and also acts as a coccidiostats. However, Cu deficiency in birds can lead to rupture of the aorta. Diets deficient in Zn causes 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 (Nasiru *et-al.,* 2015).

Children are highly susceptible to iron toxicity as they are exposed to maximum of iron containing products and chickens are not an exception (Blessing, 2014).

Heavy metals on the other hand are ubiquitous and are being released continuously from man-made sources into the aquatic and terrestrial ecosystems, threatening the health of man and animals. They are potentially dangerous due to their toxicity, bioaccumulation and biomagnification abilities when found within living tissue, and are stored more quickly than they are excreted. The increase in urbanization, industrialization and agricultural activities has been shown to release heavy metals into the environment. In early 2010, there was an incidence of heavy metal poisoning in Zamfara State, Nigeria due to indiscriminate mining by the locals. 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) 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 feeds to confirm this speculation and there is no report of such from the study area (Nasiru *et al*., 2015). In view of the foregoing, coupled with the fact that Benue State is also a northern state as Zamfara State where heavy metal poisoning was recently reported, this study is to embark in order to determine the levels of these metals in commercially made chicken feeds available in Makurdi, Benue state, Nigeria.

Chickens are the main sources of protein for Nigerians and Benue population as well where there are lots of poultry farms and abundant market. Feeds for poultry and sources of raw materials for the production of poultry feeds have been associated with heavy metals pollution (Muhammad *et al*.,2019). Heavy metal pollution has become a serious health concern in recent years because of agricultural and industrial activities (Nasiru *et al*., 2015). Heavy metals toxicity is a major current environmental health problem and is potentially dangerous because of bioaccumulation and biomagnifications through the food chain and can cause hazardous direct effect on poultry and indirect effect on human health. The impacts of pollution on poultry result in serious economic losses. The risk of heavy metal contamination in meat is of great concern for both food safety and human healthbecause of the poisonous and toxic nature of these metals at relatively minute concentration (Thirulogachandar et al., 2014). This research work is aimed at comparing the level of heavy metal concentration in chicken feeds from different manufacturing companies that are available or sold in Makurdi,,Benue State, Nigeria.

MATERIALS AND METHODS

Study Area

Makurdi is the Headquarter and capital of Benue State located at latitude 6°25′ & 8°8′N and longitude 7°47′ & 10°0′E in middle belt or North central Nigeria with area of 34,059 km^2. The State is the 9th most populous (population of 4,253,641 in 2006 census) Nigerian States, bounded to Nasarawa at the North, Taraba at the East, Ebonyi at the South, Enugu at the South-West and Kogi State at the West. At the South-Eastern part of Benue State, is also bounded with Cameroon.

The town of Makurdi is divided by the River Benue into the north and south banks, which are connected by two bridges: the railway bridge, which was constructed in 1932, and the new dual carriage bridge commissioned in 1978.The southern part of the town is made up of several wards, including Central Ward, Old GRA, Ankpa Ward, Wadata Ward, High Level, Wurukum (Low Level), New GRA etc. Important establishments and offices located here include the Government House, The State Secretariat, The Federal Secretariat, The Central Bank of Nigeria Regional headquarters, Commercial Banks, Telecommunication companies, Police Headquarters, Nigeria Prisons Service, Aper Aku Stadium, Nigeria Air force Base, Makurdi, The Makurdi Modern Market, the Federal Medical Centre, Nigeria Railway Station, Benue Printing and Publishing Company Limited, Radio Benue, Nigerian Television Authority (NTA), Nigerian Postal service, Benue Hotels Makurdi, Benue Plaza hotel, Benue State University, Benue State Breweries (Wikipedia, 2018).

The North bank area of the town have houses among other establishments, the Federal University of Agriculture, the Nigerian Army School of Military Engineering, the headquarters of the 72 Airborne Battalion and the State Headquarters of the Department of Customs and Excise (Wikipedia, 2018).

All these made Makurdi the centre of commercial activities in the State with population of 300,377 in census 2006 & 405,500 projected 2016 (Wikipedia, 2017) and it is characterized with numerous poultry farms which lead to high consumption chicken in restaurants, local food vendors and domestically, as a result, chicken feeds of different companies are available in the metropolis both in wholesales and retails. Therefore, the samples were collected from High level, Low level, Wurukum, North bank market and SRS junction of the Makurdi metropolis.

Figure 1: Map of Benue State showing the sample site (Makurdi).
Source; (Converfresh Team, 2018)

Sample Collection
Eight samples of chicken feeds were collected from four (4) different companies (starter and finisher from Oracle, Vital, Top feeds and Hybrid feeds). The samples were randomly collected by fetching from the bag randomly using hand covered with a extensible hand gloves into a sterilized polythene bag transported immediately to the laboratory for further preparation and analysis.

Sample Preparation
Exactly 2.0 g of each brand of the sample was weighed into different crucibles. 1 cm^3 of concentrated 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 2-3 hrs after which they were allowed to cool. The cooled samples were dissolved using 5 cm^3 of 30% HCl (hydrochloric acid) and then filtered using Whatman filter papers. The filtrates were individually poured into 50 cm^3 standard volumetric flask and made up to mark with deionized water. These were immediately transferred into prewashed sample bottles (Okoye, 2011; Nasiru, 2015 & Bukar, 2014).

Method of Analysis
The samples in the prewashed sample bottles were then conveyed for analysis of the trace metals using atomic absorption spectrophotometer (Nasiru, 2015 & Bukar, 2014.)

Statistical Analysis
Data obtained from the parameters were evaluated using mean, standard deviation and coefficient of variation percentage. Analysis of variance (ANOVA) was carried out to examine the levels of heavy metals concentration from each brand of sample and across the brand of same

and different companies' understudy. Statistical significance was accepted at a probability level of P less or equal to 0.05 ($P \leq 0.05$).

RESULTS AND DISCUSSIONS

Results

Table 1; Metal concentration (Mg/Kg) of vita feeds

Metals	VTFS	VTFF	$\bar{X}$	S.D	CV%
Zn	0.27	0.10	0.19	0.03	15.79
Pb	0.75	0.75	0.75	0.00	0.00
Mn	0.58	0.39	0.49	0.04	8.16
Cu	0.06	0.16	0.11	0.02	18.18
Cd	ND	0.00	0.00	0.00	0.00
Ni	0.41	0.21	0.31	0.04	6.45
Cr	0.29	0.18	0.24	0.02	8.33
Fe	7.58	0.12	3.85	1.41	36.62

VTFS=Vita feeds starter, VTFF=Vita feeds finisher, $\bar{X}$ =mean, SD=Standard deviation, CV =Coefficient of variation percentage & ND=Non detected.

Table 2; Metal concentration (Mg/Kg) of Top feeds

Metals	TPFS	TPFF	$\bar{X}$	S.D	CV%
Zn	0.58	0.04	0.31	0.10	32.26
Pb	0.50	0.00	0.25	0.09	36.00
Mn	0.88	0.39	0.64	0.18	28.13
Cu	0.16	0.10	0.13	0.01	7.69
Cd	0.00	0.00	0.00	0.00	0.00
Ni	0.21	0.00	0.11	0.04	36.36
Cr	0.06	0.12	0.09	0.01	11.11
Fe	4.65	0.86	2.76	0.72	26.09

TPFS=Top feeds starter, TPFF=Top feeds finisher, SD=Standard deviation, CV%=Coefficient of variation percentage& $\bar{X}$=mean.

Table 3; Metal concentration (Mg/Kg) of oracle chicken feeds

Metals	OAFS	OAFF	$\bar{X}$	S.D	CV%
Zn	0.08	0.30	0.19	0.04	21.05
Pb	0.25	0.25	0.25	0.00	0.00
Mn	0.68	0.71	0.70	0.00	0.00
Cu	0.13	0.16	0.15	0.01	6.67
Cd	ND	ND	ND	0.00	0.00
Ni	0.82	0.82	0.82	0.00	0.00
Cr	0.12	0.00	0.06	0.02	0.86
Fe	0.10	3.67	1.89	0.67	035.45

OAFS=Oracle feeds starter, OAFF=Oracle feeds finisher; SD=Standard deviation, CV%=Coefficient of variation percentage, $\bar{X}$ =mean and ND=Not detected

Table 4; Metal concentration (Mg/Kg) of hybrid chicken feeds

Metals	HBFS	HBFF	$\bar{X}$	S.D	CV%
Zn	0.22	0.14	0.18	0.02	11.11
Pb	0.75	0.50	0.63	0.05	7.94
Mn	0.29	0.19	0.24	0.02	8.33
Cu	0.06	0.03	0.05	0.00	0.06

Cd	ND	0.00	0.00	0.00	0.00
Ni	0.31	0.51	0.41	0.04	9.76
Cr	0.18	0.00	0.09	0.03	33.33
Fe	0.49	0.37	0.43	0.02	4.65

HBFS=Hybrid feeds starter, HBFF=Hybrid feeds finisher, SD=Standard deviation, CV%= Coefficient of variation percentage & $\overline{X}$ =mean, ND=Not detected.

Table 5; Mean concentration (Mg/Kg) of chicken feeds companies

Metals	VTF	TPF	OAF	HBF	$\overline{X}$	S.D	CV%	WHO 2014 STD(mg/kg)
Zn	0.18	0.31	0.19	0.18	0.22	0.02	9.09	40-55
Pb	0.75	0.25	0.25	0.63	0.47	0.08	17.02	10
Mn	0.49	0.63	0.70	0.24	0.52	0.06	11.51	20-60
Cu	0.11	0.13	0.15	0.05	0.11	0.01	9.09	20-60
Cd	0.00	0.00	ND	0.00	0.00	0.00	0.00	3
Ni	0.31	0.010	0.82	0.41	0.39	0.08	20.51	4.5
Cr	0.23	0.09	0.06	0.09	0.12	0.02	16.67	50
Fe	3.85	2.75	1.88	0.43	2.33	0.41	17.60	45-80

VTF=Vita feeds, TPF=Top feeds, OAF=Oracle feeds, HBF=Hybrid feeds, SD=Standard deviation, CV=Coefficient of variation percentage, ND=Not detected & $\overline{X}$=mean.

DISCUSSION

Concentration of Heavy Metals in Chicken Feeds.

Some heavy metals such as iron, manganese, copper, zinc are very important for human life. However, excessive level of these metals can be detrimental. Non-essential heavy metals of particular concern are cadmium, chromium, and lead, although all metals whether essential or non-essential are toxic to animals as well as humans if exposure levels are sufficiently high. The heavy in this work were classified as principal pollutants and toxic for human beings.

Iron (Fe) is an essential element that facilitates the oxidation of carbohydrate, protein and fats. In vita, top and hybrid feeds, the levels of Fe concentration were higher in starter and lower in finisher. In vita feed, the concentration Fe was 7.58 Mg/Kg in starter and 0.12 Mg/Kg in finisher, in top feeds it was 4.65 Mg/Kg in starter and 0.86 Ppm in finisher. In hybrid feeds the concentration was 0.49 Mg/Kg in starter and 0.37 Mg/Kg in finisher. While in top feeds the concentration of Fe was higher in finisher (3.67 Mg/Kg) and lower in starter (0.10 Mg/Kg). The mean concentration of Fe concentration values measured across the companies were 3.85 Mg/Kg, 2.75 Mg/Kg, 1.88 Mg/Kg, 0.43 Mg/Kg, in vita, top, oracle and hybrid feeds respectively. The mean concentration was higher in vita feeds (3.85 Mg/Kg) lowest in hybrid feeds (0.43 Mg/Kg) (Table .5). The values of Fe concentration recorded in this research were within the maximum acceptable limits of 45-80 Ppm for human consumption. The different results obtained from these companies could be attributed to the soil and processing of the raw materials for the production of these feeds from different companies. Bukar & Sa id (2014) reported a higher mean concentration of Fe in chicken feeds of 8.79Ppm. Rohma *et al* (2014) got a higher mean concentration of Fe in poultry feeds (91.86 ± 8.98 Ppm).

The analysis of variance (ANOVA) presented in appendix I revealed that from the sample collected. Starter and finisher have mean values of 0.65 ±1.5 and 0.34 ± 0.66 respectively. The levene's test with p-value of 0.144, indicates non-violation of the assumption for homogeneity of variance. Thus, result of ANOVA (F (1.62 ± 1.141, p=0.290) shows there is no significant statistical differences (p≥ 0.05) in detection of elements between starter and finisher within and across the different companies. The ANOVA between companies feeds samples as presented in appendix II indicates mean values of 0.74 (± 1.84) for Vita feeds, 0.5 (± 1.14) for Top feeds 0.49 (± 0.90) for Oracle feeds and 0.24 (± 23) for Hybrid feeds. The levene's test with p-value of 0.318 indicates non-violation of the assumption for homogeneity of variance. There was no significant statistical difference ($p \geq 0.05$) between the companies sampled at (F (3.60) = 0.481 p=0.697). Furthermore, a Turkey pos hoc test affirmed to the ANOVA results indicating no significant difference ($p \geq 0.05$) within either of the companies.

The ANOVA between the element tested for as presented in appendix III indicates mean values of 0.09 (± 0.08) for zinc, 0.45 (± 0.28) for lead 0.51 (0.23) for manganese, 0.11 (±0.05) for copper, 0.001 (± 0.001) cadmium,0.41 (± 0.30) for nickel, 0.12 (± 0.10) for chromium and 2.23 (± 2.78) for iron. The levene's test with p- value of 0.000 indicates a total violation of homogeneity of variance. There was significant statistical difference ($P \leq 0.05$) between the quantity detected per element at (F (7.56) =4.274, P=0.001). Moreover, a Turkey pos hoc test conducted to verify where the difference lies shows significant variation between iron and all the other variables tested. This implies that, the value of iron detected in all feeds varies significantly with other element sampled.

Chromium (Cr) is used in metals alloys and pigments and other materials. Low level exposures to chromium can irritate the skin and cause ulceration. Long term exposures can cause kidney and liver damage and damage circulatory and nerves tissues too (Thirulogochandar, 2014).

Chromium concentration was found higher in starter of all the feeds except top feeds. In vita, chromium concentration was 0.29 Mg/Kg in starter and 0.18 Mg/Kg in finisher, 0.12 Mg/Kg for starter and 0.00 Mg/Kg in finisher for oracle feeds, 0.18 Mg/Kg in starter and 0.00 Mg/Kg in finisher of hybrid feeds. While in top feeds, the concentrations were e 0.06 Mg/Kg in starter and 0.12 Mg/Kg in finisher. The mean concentration of the values of chromium measured across the companies were 0.24, 0.09, 0.09 and 0.06 Mg/Kg for vita, top, hybrid and oracle feeds respectively. The highest concentration of chromium was detected in vita starter was 0.29 Mg/Kg (Table 1) and the lowest in oracle finisher was 0.06 Mg/Kg (Table 3). The values of chromium concentrations discovered in this research were within the W.H.O standard (0.3 Mg/Kg) for human consumption. The different values obtained may be due to the different location where the raw materials were obtained for the feeds production. The chromium content of the feeds was lower compare to the one obtained by Muhammad *et al.,* 2017 (3.02 mg/kg). It was also lower than Imran *et al.,* 2014 (2.32 ± 2.69 Ppm) which was above the W.H.O standard.

The result of analysis of variance (ANOVA) presented in appendix I proved no significant difference ($p \geq 0.05$) in detection of chromium between the starter and finisher within and across the different companies. The ANOVA result between companies feeds as presented in appendix II showed no significant statistical difference ($p \geq 0.05$) between the various companies sampled. The ANOVA of Cr showed significant difference ($p \leq 0.05$) in the concentration of Cr examined within and across the companies. However, the mean concentration of Cr was completely at variance with other companies.

Nickel (Ni) is needed by human body in just small amount to produce red blood cells, however in excessive amount can become mildly toxic. Short term exposure to Ni is not known to cause any health problem but long-term exposure can cause decrease in body weight, heart and liver damage, skin irritation (Thirulogachandar, 2014).

In vita and top feeds Ni concentration was high in starter and low in finisher, oracle feeds have the same concentration in both starter and finisher while in hybrid feeds finisher, has higher concentration of Ni than the starter. In vita the concentration of Ni was 0.14 Mg/Kg for starter and 0.21 Mg/Kg for finisher, 0.21 Mg/Kg in starter and 0.00 Mg/Kg in finisher for top feeds, 0.82 Mg/Kg in both starter and finisher for oracle feeds while in hybrid feeds starter 0.31 Mg/Kg and 0.51 Mg/Kg in finisher.

The mean concentration of Ni across the companies was 0.82, 0.41, 0.31 and 0.11 Mg/Kg for oracle, hybrid, vita and top feeds respectively. The highest average was obtained in oracle feeds (0.82 Mg/Kg) (Table 3) while the least was found in top feeds (0.11 Mg/Kg) (Table 2). The Ni concentration value recorded in this work were within the standard range of W.H.O (4.5 Mg/Kg) for the consumption of human.

The variation in the values obtained in this research may be as a result of environmental pollution (Rohma, *et al.,* 2014). The values obtained in the research were above the one obtained by Nasiru, *et al.,* 2015 (0.00-0.19 µg/ml). and below the one in the research of Rohma, *et al.,* 2014 (0.79-4.14 Ppm).while vita starter, hybrid starter, oracle starter and finisher were not detected.

The average concentrations of Cd values calculated across the companies were 0.00 Ppm and non-detected. The 0.00 Ppm was from vita, top and hybrid feeds while the not detected was from oracle feeds (Table 1, 2, 3.4, 4 respectively). The values recorded were within the standard limit of W.H.O (5 Ppm), ERC, 2005 (10 Ppm) and EU (0.5 Ppm). The differences in the values of Cd concentration could be due to its presence in water from tanneries were by the raw materials for the feeds production absorbed it in the soil (Rohma *et al.*, 2014).

These research values were below the one of Rohma *et al*., 2014 (0.44 ± 0.31 Ppm) and also lower than the one obtained by Nasiru, 2015 (0.04-0.46 µg/ml).

The ANOVA result revealed no significant differences ($p \geq 0.05$) in the concentration of Ni between the starter and finisher within and across the different companies. The ANOVA result between companies feeds as presented in appendix (II) showed no significant statistical difference ($p \geq 0.05$) between the various companies sampled. The ANOVA result of Ni showed significant difference ($p \leq 0.05$) in the concentration of Ni detected within and across the companies. But the mean concentration of Ni completely varies with other companies.

Manganese is a very common element that can be found everywhere on earth especially, food stuffs that contain manganese are grains (Thirulogochandar, 2014). The concentration of manganese in vita, top and hybrid were higher in starter than in finisher while in oracle feeds the reverse is the case. The manganese concentration were 0.58 Mg/Kg, 0.39 Mg/Kg, 0.88 Mg/Kg , 0.39 Mg/Kg , 0.29 Mg/Kg , 0.19 Mg/Kg , 0.68 Mg/Kg and 0.71 Mg/Kg in vita starter, vita feed finisher, top starter, top finisher, hybrid starter, hybrid finisher oracle starter, oracle finisher respectively. The highest concentration of manganese was detected in top feeds finisher (0.88 Mg/Kg) (Table 2) and the lowest in hybrid finisher (0.19 Mg/Kg) (Table 4).The mean concentration of manganese was 0.70 Mg/Kg , 0.64 Mg/Kg , 0.49 Mg/Kg and 0.24 Mg/Kg oracle, top, vita and hybrid feeds respectively. The highest manganese mean concentration was in oracle feeds (0.70 Mg/Kg) and the lowest from hybrid feeds (0.24 Mg/Kg).

The values obtained were below the W.H.O limit of (20-60Ppm) for human consumption. The differences in the values of manganese concentration could be traced back to the tanneries as it is present in the effluents being released from tanneries to be absorbed in the soil by plant which may serve as raw materials for the feeds production (Rohma *et al.,* 2014). The values obtained is far lower than that of Okoye, 2011 (26.91-16.74µg/ml) and is within the range obtained by Rohma *et al*., 2014 (0.96 ± 0.01Ppm).

The analysis of variance (ANOVA) result of Mn presented in appendix I showed no significant statistical difference ($p \geq 0.05$) in the analysis of Mn between starter and finisher within and across the various companies. The ANOVA result between the companies' feeds (appendix II) also proved no statistical difference ($p \geq 0.05$) between the various companies sampled. The ANOVA result showed significant difference ($p \leq 0.05$) in the concentration of Mn detected within and across the companies. Also, the mean concentration of Mn completely varies with other companies.

Cadmium (Cd) is highly toxic at midlife. It is a cancer-causing agent and Potentially mutation causing, with sub lethal and lethal effect at low environmental concentration (Rohma *et al.*, 2014).

In vita and hybrid feed, cadmium concentration was not detected in starter while in their finishers was in extremely low amount (0.00 Mg/Kg). In top feeds, the concentration of cadmium was also extremely low in both starter and finisher (0.00 Mg/Kg) while in oracle feeds cadmium concentration was completely not detected in both starter and finisher. In all the samples, the concentration of Cd was negligible in starters and finishers in all the sampled companies. The average concentration of Cd values calculated across the companies 0.00 Mg/Kg and non-detected. The 0.00 Mg/Kg was found in vita, top and hybrid feeds while the non-detected value of Cd was in oracle feeds (Table1, 2, 4 & 3 respectively).

The values recorded were within the standard limit of W.H.O. The differences in the values of Cd could be due to its presence in water from tanneries where by the raw materials for the feeds production absorbed it in the soil (Rohma *et al.,* 2014).

This research values is below the one of Rohma *et al*., 2014 (0.44 ± 0.31) and also lower than the one obtained by Nasiru *et al.*, 2015 (0.04 -0.46µg/ml).

The ANOVA result presented in appendix I indicates no significant difference ($p \geq 0.05$) in the concentration of Cd between the starter and finisher within and across the different companies. The ANOVA result between companies feeds presented in appendix II showed no significant difference ($p \geq 0.05$) between the various companies sampled. The ANOVA result of Cd in appendix III revealed a significant difference ($p \leq 0.05$) in the concentration of Cd analysed within and across the companies. And the mean concentration of Cd was completely at variance with other companies.

Copper (Cu) is an essential element for living organism especially human at low concentration. It is also regarded as micro nutrient in human and function as a co factor for human enzymes (Bukar & Sa id 2014). Too low amount of Cu causes packed cell volume and hence affect healthy growth (Rohma *et al*., 2014). The concentration of Cu in vita and oracle feeds is higher in finisher and low in starter while in top and hybrid feeds the reverse is the case. The concentration of Cu is 0.06 Mg/Kg in vita starter,0.16 Mg/Kg in vita finisher, 0.13 Mg/Kg in oracle starter, 0.16 Mg/Kg in oracle finisher while top feeds starter contain 0.16 Mg/Kg , top feeds finisher 0.10 Mg/Kg , hybrid starter 0.06 Mg/Kg and hybrid finisher 0.03 Mg/Kg . The highest concentration of Cu was from vita starter, oracle finisher and top feeds starter (0.16 Mg/Kg) and the least was from hybrid finisher (0.03 Mg/Kg). The mean concentration of Cu were 0.15 Mg/Kg, 0.13 Mg/Kg, 0.11 Mg/Kg and 0.05 Mg/Kg in oracle, vita, top and hybrid feeds across the companies respectively.

The values recorded for Cu concentration were below WHO ranged (20-60Ppm) or standard. The differences in values may be because of environmental factor where the raw materials were obtained for the feeds production. The values obtained in this work are within the range obtained by Nasiru *et al.*, 2015 (0.04-1.2µg/ml) and is below that of Rohma *et al.*, 2014 (3.18± 1.02Ppm).

The ANOVA result of Cu presented in appendix I showed no significant statistical difference ($p \geq 0.05$) in the amount of Cu between the starter and finisher within and across the different companies. The ANOVA result between the companies feeds as presented in appendix II indicates no significant difference ($p \geq 0.05$) between the various companies sampled. The result of the ANOVA of Cu in appendix III revealed significant difference ($p \leq 0.05$) in the concentration of Cu obtained within and across the companies. And also, the average concentration of Cu was completely at variance with other companies.

Lead being a non-essential element that has direct health concern to both poultry and human, it is therefore contaminant than nutrient (Costa, 2000).

In vita and oracle the concentration of lead was the same for both starter and finisher while in top feeds and hybrid feeds the lead concentration was higher in starter and lower in finisher. The lead concentration was 0.75 Mg/Kg in both vita starter and finisher, 0.25 Mg/Kg in both starter and finisher of oracle feeds, 0.5 Mg/Kg and 0.00 Mg/Kg in top feeds starter and finisher respectively and 0.75 Mg/Kg and 0.5 Mg/Kg in hybrid starter and finisher respectively. The highest concentration was found in vita starter, finisher and hybrid finisher (0.75 Mg/Kg) while the lowest was from top feeds finisher (0.00 Mg/Kg). The mean concentration of lead was 0.75 Mg/Kg , 0.25 Mg/Kg , 0.25 Mg/Kg and 0.24 Mg/Kg for vita, top, oracle and hybrid feeds respectively. The highest value was found in vita (0.75 Mg/Kg) while the lowest (0.24 Mg/Kg) was found in hybrid. The values of lead could be attributed to its presence in the effluent from tanneries which generally emit lead concentration of 4.362 mg/kg (Rohma *et al.*, 2014). The values of lead analyzed are within the W.H.O standard (5Ppm) and is also within the range found by Islam *et al.*, 2007 (0.60-20µ/ml). But the values were lower compare to that of Rohma *et al*, 2014 (4.07 ± 1.81 Ppm).

The analysis of variance (ANOVA) result of Pb showed no significant difference ($p \geq 0.05$) for lead concentration between starter and finisher within and across the companies. The ANOVA result of Pb presented in appendix II revealed no significant difference ($p \geq 0.05$) between the various companies sampled. However, the ANOVA result of Pb presented in appendix III showed a significant statistical difference ($p \leq 0.05$) in the concentration of Pb tested within and across the companies. The mean concentration of Pb as well was completely at variance with other companies.

Zinc (Zn) plays an important role in biochemical path ways and its deficiency can interfere with many biochemical systems such as gastrointestinal tracks, nervous system, skeletal system, immune and reproductive system (Okoye, 2011). Zinc concentration in vita, top and hybrid is high in starter than finisher while in oracle feeds, the concentration was higher in finisher than starter (Table 1, 2, .3 and 4 respectively). The highest concentration of zinc was found in top feeds starter (0.58 Mg/Kg) while the lowest in top feeds finisher (0.04 Mg/Kg). The mean concentration of zinc were 0.31 Mg/Kg , 0.19 Mg/Kg , 0.19 Mg/Kg and 0.18 Mg/Kg in top feeds, vita feeds, oracle feeds and hybrid feeds respectively. The highest average concentration was in top feeds (0.31 Mg/Kg) and the lowest from hybrid feeds (0.18 Mg/Kg) (Table 4.2 and 4.4 respectively). The concentration of Zn in this research is far below the W.H.O standard (40-55 Ppm). Differences in zinc values could be due to industrial waste which can be absorbed by the raw material in their greenish level from soil (source). The zinc content in the feeds is lower than that of Suleiman *et al.*, 2015 (11.65 ± 1.43 µg/ml), Rohma et al 2014 (40.54 ± 6.81 Ppm) and Bukar & sa id, 2014 (32.61 ± 0.01 Ppm).

The analysis of variance (ANOVA) result of Zn realized no significant differences ($p \geq 0.05$) in zinc concentration between starter and finisher within and across the companies (appendix I).In same vein, the ANOVA result of Zn between the companies feeds in appendix II showed no significant statistical difference ($p \geq 0.05$) between the companies sampled. The ANOVA result of Zn in appendix III on the other hand revealed a significant difference ($p \leq 0.05$) in the concentration of Zn examined within and across the companies. The mean concentration of Zn was extremely at variance with other companies.

CONCLUSION

The study has presented data on the comparative assessment of heavy metals in chicken feeds available in Makurdi, Benue State, Nigeria. Heavy metals such as zinc, manganese, lead, nickel, chromium, cadmium, copper and iron were investigated in starter and finisher of four companies (vita, top, oracle and hybrid feeds). The average concentration of the metals were 0.22 Ppm for zinc, 0.47 Ppm for lead, 0.52 Ppm for manganese, 0.11 Ppm for copper, 0.00 Ppm for cadmium, 0.39 Ppm for nickel, 0.12 Ppm for chromium and 2.33 Ppm for iron. And all the mean concentration of the metals falls within the permissible limit of W.H.O for human consumption but needs to be monitored from time to time because it can be bioaccumulated after a long period of time in human bodies after consumption of these chickens.

The result of analysis of variance (ANOVA) revealed that there is no significant statistical difference in detection of the element between the starter and finisher samples. The ANOVA between the companies' feeds showed that there was no significant statistical difference between the companies sampled. The ANOVA between the elements tested showed that there was a significant statistical difference between the quantities detected per element.

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