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ORGANOCHLORINE PESTICIDES AND TRACE METAL CONTAMINATION IN POULTRY FEEDS IN IWO AND ITS SURBURB, OSUN STATE, NIGERIA

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ABSTRACT

This study assessed levels of potentially toxic metals and organochlorine pesticides residues (OCPs) in poultry feed obtained from three feed mills in Iwo, Osun State, Nigeria. The proximate analysis was carried out using method described by Association of Official Analytical Chemists (AOAC), potentially toxic metal with AAS and OCPs with GC-ECD. The proximate analysis mean levels are as follows: moisture {broiler feed (6.33 ± 0.8%) layer mash (9.17 ± 4.9%)}; ash {broilers (8.33 ± 2.6%) layers (9.17 ± 4.9%)}; fibre {broilers (0.33 ± 0.2%) layers (0.20 ± 0.2%)}; dry matter {broilers (93.7 ± 0.8%), layers (93.0 ± 1.7%)}. The mean values of OCPs ranged from 0.34 ng/kg to 14.8 ng/kg in broilers and 0.07 ng/kg to 1.74 ng/kg in layers mash. In broilers feed, aldrin, endosulfan I and endrin, exceeded the Maximum Residue Limits (MRL) for Animal Feed for OCPs, while in layers mash, aldrin and endrin aldehyde exceeded the MRL limits. The levels of Cu Zn and Pb in broiler and layers mash obtained in this study were far below the maximum recommended concentrations as stipulated by European Union for animal feed. These results indicated the presence of OCPs in poultry feeds which could bioaccumulate and eventually lead to the contamination of table eggs and table meats as a result of these toxic materials.

Keywords: Toxicology, persistent organic pollutant, contamination, animal feed, monitoring.

INTRODUCTION

Pollution by heavy metals and pesticides is a predicament of escalating importance for ecological, evolutionary, nutritional and human health reasons Ozcan, (2015). Organochlorine (OC) pesticides, a group found within the persistence organochlorine pesticide (POPs), has become a potential toxic pollutant of the environment in the last few decades. They can be highly accumulated in the environment due to their properties which include; chemical inertness, persistence, lipophilic nature and very less biodegradability (Abulude *et al*., 2006). In the developed countries, the use of products containing OC are banned and/ or restricted, developing countries still derived application from the use of some of these OC pesticides. Their low cost relative to application in control of crop pest and plant vectors increased usage. Although most of them leave the products or degrade in soil, water and atmosphere, residues of these compounds are still found to some extent in various substances and can be transferred to human via consumption of agricultural products (Benbrok, 2002, Mahmond *et al.*, 2016). The consumption of OC by human through food items is potentially harmful to human health, hence, there is a need for further monitoring, to suggest reduction of OC in agricultural food products.

The consumption of food products from animal origin and environmental exposure remain the main sources of OCPs in human diets (Ozcan, 2015; Benbrrok, 2002). Researches confirmed that humans suffered from toxic accumulation of OCPs mostly via diet as compared to inhalation and dermal exposure (Mahmond *et al*., 2016). Their bioaccumulation and biomagnification abilities when found in living tissues are responsible in part to their high toxicity (Mahmond *et al*., 2016; Lehotay *et al*., 2005). Therefore, efficient monitoring, identification and extraction of OCPs in food of animal origin (i.e meat, milk, egg and other dairy products) is an important safety mechanism for human nutrition. Organochlorine pesticides entered into the animal food chain through contaminated feed and/or water ingested by animals (Lehotay *et al*., 2005). Application of pesticides in livestock area through treatment of building, equipment /tools, and other forms of disinfection and/ or quarantine is another pathway for the OCPs contamination in animal food (Abulude *et al*., 2006). According to (Salar-Amoli and Ali-Esfahardl, 2015), OCPs are carcinogenic in humans and animals. Immunology studies confirmed toxicity of selected OCPs and their metabolites in human foetus and neonatal via invitro (IARC, 1987) and invivo (Bulrha *et al*., 2013).

Poultry farming is one of the most important aspects of agriculture, contributing immensely to meet animal protein demand of increasing global population through egg, dairy products and meat production. The main means by which pesticides entered into animal body is through feed and fodder (Lavoie and Grasman, 2007). The pesticides accumulate in animal body tissues and in their associated products such as egg, milk and meat. According to (Suleiman *et al*., 2015; Aycicek *et al*., 2008), most of the organised OC pesticide residue-monitoring programmes are centred on food crops, vegetables and fruits with very few reports on status in feed and fodder consumed by livestock animals. Feed constituted 70% of the total cost of production in poultry farming (Oluyemi and Roberts, 2000). The composition and quality of feedstuffs used in feed manufacturing is an important part in the food chain and has implication on the associated poultry products consumed by man. Therefore, determination of trace metals and OCPs residue in animals (poultry) feed is highly essential.

The occurrence of trace metals in poultry meat can be from natural occurrence in the soil. Poultry birds may be fed with feeds compounded with contaminated plant origin. The use of contaminated fish powder as a protein source in feed manufacturing, or from the remnants of vehicle exhausts, which are hit by air to the source of fodder and water to drink used in poultry (Bernhoft *et al*., 2000; Bukar and Saeed, 2015). Chicken meat constitute an important part of the Nigerian diet and the content of toxic metal such as manganese, zinc, copper, Lead, cadmium and arsenic influences the quality of the final products.

In this study, Iwo and its environ is chosen, being an agrarian community, where many subsistent and large scale farming as well as large scale poultry farming is taking place. The use of herbicides and pesticides to control weed and preserve agricultural products is prevalent among the farmers. This study aimed at assessing the concentration of trace metals and organochlorine pesticides residue in poultry feed. The outcome of this study will be an eye opener to the people to understand the environmental position of poultry and poultry feed and respectively standardize effectual counter measure to control their pollution.

MATERIALS AND METHODS

Sampling

The Poultry feeds (broiler and layers mash) were collected from three Feed mills in Oluponna and Iwo, Osun state, Nigeria, namely:

Wale Farm is situated in Oluponna, a major town in Ayedire Local Government of Osun State while Joju Farm and Royal D are situated in Iwo, a semi-urban city in Osun State. These two towns are predominantly farmer and perhaps, teaching and other civil service.

Reagents and Chemicals

The entire reagents used are: Dichloromethane (GFS Chemicals, Inc.867 Mckinley Avenue, Columbus, OH 43223) and n-hexane (GFS Chemicals, Inc.867 Mckinley Avenue, Columbus, OH 43223) , Acetone, Silica (MerkKGaA, 64271 Darmstadt, Germany) and Sodium Sulphate (VMR International Ltd, Poole, England) Nitric acid- HNO_3 (BDH laboratory Supplies Poole, 1TD England), Tetraoxosulphate (IV) acid-H_2SO_4 (BDH Chemicals Ltd Poole, England), Sodium Hydroxide -NaOH, Methanol(GuangdondGuanghuaSci-Tech Co. Ltd, Shantou, Guangdong, China) Hydrogen Fluoride - HF and Perchloric acid (Kermel).

Proximate Analysis

The experimental samples were subjected to some proximate analysis which includes: moisture, ash, and crude fibre. In carrying out the analysis practically, methods used vary according to the food material being studied and also in details of evaluation, basically in accordance with standard methods described by the Association of Official Analytical Chemist (AOAC, 2005).

Ash Content

Ash content of the samples were determined by subjecting the sample with known weight (2 g) to ignition in a muffle furnace for 4 h at 300°C for 45 min to pre-ash the sample and at 550°C for 3 h 15 min to complete ashing, until a light grey ash was obtained, after which the samples was cooled in a desiccator and weighed. The percentage ash was calculated from the formula:

$$\text{Ash Content (\%)} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \times 100 \quad (1)$$

The percentage dry matter content = 100 - % Ash content.

Moisture Content

Moisture content of the samples was according to the standards of AOAC (2005). A known weight of the feed sample is subjected to drying in an oven at 105°C for 2 h. The loss in weight is reported as moisture content. This is calculated thus:

$$\text{Moisture Content(\%)} = \frac{\text{Difference in weight}}{\text{Original weight of sample}} \times 100 \quad (2)$$

The percentage dry matter content = 100 - % Moisture content.

Crude Fibre

The percentage crude fibre was determined as loss of ignition of dried lipid-free residue after digestion with 1.25 % H_2SO_4 and 1.25% NaOH. 10 ml of acetone was added to dissolve any organic matter. The percentage fibre was obtained with the formula:

$$\text{\%Crude Fibre} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Original weight of sample}} \times 100 \quad (3)$$

Trace Metal Analysis

One g of each sample was digested using 5 ml of nitric acid and 1ml of perchloric acid. The digested samples were later filtered and the digested solutions were made up to mark with distilled water into 25 ml standard flask. The digested solution was then analyzed by PG 990 Atomic Absorption Spectrophotometer available at Central Laboratory, Bowen University.

Extraction Procedure for OCPs.

The poultry feed samples were extracted using soxhlet extraction method (USEPA method 3540). A dried, sieved feed sample (20 g) was weighed into extraction thimble and placed in a soxhlet extractor. Extraction was done for 10 h using distilled dichloromethane. The extract was concentrated by distilling off part of the solvent. The concentrated extract was cooled to room temperature and was concentrated further to about 1 ml under a stream of nitrogen gas of 99.99% purity. The reduced extract was preserved for chromatographic clean-up prior to GC-ECD analysis.

Clean- up Procedure for OCPs

Clean-up method (USEPA Method 3630C) was used in this project work. A column of about 15 cm × 1 cm (internal diameter) was packed with about 5 g of activated silica gel prepared in a slurry form in n-hexane. About 0.5 cm^3 of anhydrous Sodium Sulfate was placed at the top of the column and allowed to sink below the sodium sulphate layer. Elution was done with 2 × 10 ml portion of the extracting solvent. The eluate was collected, dried with anhydrous Sodium Sulphate and then evaporated to dryness.

Gas Chromatography Electron Capture Detector Analysis.

Gas Chromatography from Central Laboratory, Nigeria Institute of Oceanography and Marine Research (NIOMR), Victoria Island, Lagos was used to determine the presence and levels of Organochlorine in both broiler's and layers mash. The dried eluate above was reconstituted with 1ml n- hexane and 0.5 ml of 20 ppm of the internal standard. Qualitative and quantitative analysis of the OCPs was carried out with the aid Agilent 78790A GC-ECD.

The system was fitted with DB 17(30 m×250 μm×0.25 μm) column. A 1 μl aliquot of prepared sample extract was injected into the column in splitless mode at an injector and interface temperature of 250°C. There was a split flow rate of 2 ml/min during an oven temperature program of 150°C which was increased to 280°C at 6°C/min, the total run time was 21.67 min.

Data Analysis.

The data were processed with Microsoft Excel software 2007 version. The data were subjected to descriptive analysis using Statistical Package for Social Sciences (SPSS) software 15 version. Two –way Pearson correlation was used to assess the strength of association between the OCPs compounds.

RESULTS AND DISCUSSION

Proximate Composition.

The proximate composition of broiler and layers mash obtained from three different feed mill is presented in Table 1. The ash content for broiler feed ranged from 5% to 10% with mean value of 8.33%. These values was in agreement with the % ash content of broiler feed produced in Kano having a range of 5% to 15%, while layers mash ranged from 5% to 12.5% with mean value of 9.17% (Bukar and Saeed, 2015). There was no significant difference between the two feed types in the three locations.

Crude Fibre is a measure of the quantity of indigestible cellulose, lignin, and other components of this type in present feeds. It is the residue of plant materials remaining after solvent extraction followed by digestion with dilute acid and alkali. These components have little food value but provide the bulk necessary for proper functioning in the intestinal tract. The result in Table 1, showed that the crude fibre content for broilers feed ranged between 0.20% and 0.58%, with mean value of 0.33% while layers mash ranged from 0.10% to 0.40% with mean value of 0.20%. The values obtained is lower than the recommended nutrient values which ranged from 5% to 7% for both broilers and layers mash, respectively, Olomu, (1979). The highest crude fibre content was obtained in the broilers feed from Joju Farm (0.58 %) and the lowest in the layers mash from Wale and Joju farms (0.10%).

Moisture content which is the amount of water in a material or substance ranged from 6.0% to 7.0% in broilers feed with a mean of 6.33%, these values are in agreement with 4% to 10% ranged for broiler feed, and 6% to 8% for layers mash obtained in Kano.(Bukar and Saeed, 2015) reported the % moisture content of broilers feed in Kano that ranged from 4% to 10% , while for Layers mash it ranged from 6.0% to 8.0% with a mean value of 7.0%, the values obtained are not too far from the the results which (Bukar and Saeed, 2015) reported as the % moisture content of layers mash in Kano that ranged from 7% to 14%. The highest % moisture content (8.00 ± 2.8%) obtained in layers mash was in Royal D farm, while the lowest (6.0 ± 0.0%) was obtained in Broilers feed from Wale farm.

The Dry Matter Content which is the amount of material remaining after removal of water, ranged from 93.0% to 94.0% in broilers feed with a mean of 93.7%, while for Layers mash, it ranged from 92.0% to 94.0% with a mean value of 93.0%. This implied that the feed is likely to be free from moldiness and the shelf life of the feed may be prolonged.

Table 1: Proximate Composition of Broilers feed and Layers Mash obtained from three feed mills

	Broilers Feed				**Layers Mash**			
Feed Mill	Ash (%)	Fibre (%)	Moisture (%)	Dry M (%)	Ash (%)	Fibre (%)	Moist (%)	Dry M (%)
Joju	5.00±0.0	0.58±0.3	7.00±0.0	93.0±1.4	12.5±3.5	0.10±0.0	7.00±0.0	93.0±1.1
Royal D	10.0±0.0	0.20±0.1	6.00±0.0	94.0±0.0	10.0±0.0	0.40±0.1	8.00±2.8	92.0±2.8
Wale	10.0±0.0	0.30±0.1	6.00±0.0	94.0±0.0	5.00±7.1	0.10±0.0	6.00±1.4	94.0±0.0
Mean	8.33±2.6	0.33±0.2	6.33±0.8	93.7±0.8	9.17±4.9	0.20±0.2	7.00±1.8	93.0±1.7

Concentrations of Organochlorine Pesticides Residue.

The distribution of OCPs in poultry feed for all three feed mills are presented in Tables 2 and 3. The results of the OCPs studied fell into three categories: Dichlorodiphenylethanes (pp-DDT), Cyclodienes (aldrin, dieldrin, endrin, endrin aldehyde, endosulfan I) and chlorinated benzenes / cyclohexane (Delta- BHC). The concentration (ng/kg) of detected OCPs in broilers feed obtained from three feed mills is shown in Table 2. Aldrin and endosulfan I was detected in all the feed mills while endrin aldehyde was not detected in all the feed mills. All the values of OCPs in broiler feed recorded in these farms were below the maximum residue limits.

The mean value of OCPs in Layers mash obtained from three feed mills is presented in Table 3. Joju Farm recorded the mean values (ng/kg) as follows: aldrin (3.44), Delta-BHC (0.20), pp-DDT (0.72) while dieldrin, endosulfan I, endrin and endrin aldehyde were below detection limit. These values were below the maximum residue limits. Royal D Farm had mean values (ng/kg) of aldrin (3.97), endosulfan I (3.63), endrin (1.95) while delta-BHC, dieldrin, endrin aldehyde and pp-DDT were below detection limit. Wale Farm had the mean levels (ng/kg) of Aldrin (1.77), endrin aldehyde (5.22), pp-DDT (0.89), delta-BHC, dieldrin while endosulfan I, and endrin were below detection limit. Similarly, the levels of the OCPs in Layers mash in these feed mills were below the maximum residue limits.

Table 2: Mean levels ± SD (ng/kg) of OCP in Broilers feed obtained from different Feed Mill

Feed Mill	Aldrin	δ-BHC	Dieldrin	EndoSul	Endrin	Endrin CHO	ppDDT
Joju	29.7± 0.1	BDL	4.99± 0.0	13.2± 0.1	BDL	BDL	1.19± 0.1
Royal D	2.58± 0.3	1.01± 0.0	BDL	2.02± 0.0	BDL	BDL	BDL
Wale	12.2± 0.0	BDL	BDL	3.18± 0.0	2.17± 0.1	BDL	0.6 ± 0.3
MRL (ng/kg)	1.0×10^{4}	2.0×10^{4}	1.0×10^{4}	1.0×10^{5}	1.0×10^{4}	2.0×10^{4}	5.0×10^{4}

NOTE: MRL-Maximum Residue Limits of European Union regulation guidelines in Animal Feed (CE396/2005); BDL- Below Detection Limit; Detection limit: 0.0001 ppm (mg/kg)

Table 3: Mean levels ± SD (ng/kg) of OCP in Layers Mash obtained from different Feed Mill

Feed Mill	Aldrin	δ-BHC	Dieldrin	EndoSul	Endrin	Endrin CHO	ppDDT
Joju	3.44± 0.2	0.20± 0.1	BDL	BDL	BDL	BDL	0.72± 0.3
Royal D	3.97± 0.0	BDL	BDL	3.63± 0.3	1.95± 0.0	BDL	BDL
Wale	1.77± 0.3	BDL	BDL	BDL	BDL	5.22 ± 0.1	0.89± 0.2
MRL (ng/kg)	1.0×10^{4}	2.0×10^{4}	1.0×10^{4}	1.0×10^{5}	1.0×10^{4}	2.0×10^{4}	5.0×10^{4}

Table 4 present the total mean values (ng/kg) of OCPs in broilers and layers mash of all the feed mills. Despite the presence of the three categories of OCPs in all the feed mills as presented in table 4, Endrin aldehyde and dieldrin were not detected in broilers and layers mash, respectively. All the detected pesticides did not exceed the MRLs established by European Union for each compound. However, aldrin has the highest level of OCPs of 14.8 ng/kg for broilers and 3.06 ng/kg for layers mash while delta-BHC has the lowest value of 0.34 for broilers and 0.07 ng/kg for layers mash. The presence of aldrin in this feed indicates a caution from public health point of view, because of the higher toxicity than other OCPs (Gillespie and Walters, 1989; Van Der Hoff *et al*., 1996). Statistically there was a significant difference in broilers and layers mash, with exception of endrin aldehyde. In feed composition, the percentage of energy and protein source i.e (maize, soya bean meal, groundnut cake etc) in broilers feed is always higher as compared to layers mash, hence increase in bioaccumulation of OCPs in broilers. However, despite the low energy and protein content of layers mash as compared to broilers mash, the accumulation over a period of time could lead to higher concentration of OCPs in layer birds.

The mean values of aldrin in broilers and layers mash obtained in this study were above the value in poultry eggs and chicken in Jordan which was found to be below the detection limit (Rafat *et al*., 2010). Rabinder *et al*., (2005) monitored the level of OCPs residues in poultry feed, chicken muscle and eggs in a selected farm in Punjab India and reported the value of 0.65 mg/kg for δ-BHC in poultry feed. This value is higher than the level of δ-BHC in broilers mash (0.34 ng/kg) and layers mash (0.07

ng/kg) obtained in this study (Table 3). In this study, dieldrin concentration in broilers is 1.66 ± 2.6 ng/kg but not detected in layers mash. Dieldrin was not also detected in the OCPs study in poultry feed in Jordan (Rafat *et al*., 2010). The presence of dieldrin in broiler field and endrin in both broilers and layers mash is a strong indication of epoxilation and conversion of aldrin to dieldrin and endrin (ATSDR, 2002). Dieldrin is the most prevalent and environmentally persistent among the cyclodiens, its low concentration in broilers and below detection limit in layers mash suggest fresh input of aldrin since dieldrin has a low biotransformation and evaporation ratio that suggest their persistent in the environment than aldrin (CETESB, 2008; Botaro *et al*., 2011). The concentration of pp-DDT in broilers (0.60 ng/kg) and in layers (0.53 ng/kg) in this study are much lower compare to 0.95 ng/g in poultry feed in Beijing, China (Tao et al. 2009). Evidence of OCPs have been found in poultry feed in Bangladesh (Tao *et al.,* 2009); food basket eggs in Tehran (Salar-Amoli and Ali-Esfahard, 2015); cheese in Turkey (Ozcan, 2015); and rabbit feed (Benbrook, 2002); all these have been traced to animal feed.

Table 4: Mean levels ± SD (ng/kg) of OCP in Broilers feed and Layers Mash

Feed Type	Aldrin	δ-BHC	Dieldrin	EndoSul	Endrin	Endrin CHO	ppDDT
Broilers	14.8±12.3	0.34± 0.5	1.66± 2.6	6.13± 5.5	0.72± 1.1	BDL	0.60±0.5
Layers	3.06 ± 1.0	0.07± 0.1	BDL	1.21± 1.9	0.65± 1.0	1.74 ± 2.7	0.53±0.4
MRL (ng/kg)	1.0×10^4	2.0×10^4	1.0×10^4	1.0×10^5	1.0×10^4	2.0×10^4	5.0×10^4

NOTE: MRL-Maximum Residue Limits of European Union regulation guidelines in Animal Feed (CE396/2005); BDL- Below Detection Limit; Detection limit: 0.0001 ppm (mg/kg)

Correlation Analysis of OCPs in all the Feeds.

The general approach for studying OCPs interaction was achieved by computing the Pearson's correlation coefficient. The data in Table 5 shows that aldrin was strongly correlated with dieldrin and endosulphan 1 while dieldrin was strongly correlated with endosulphan I at $p < 0.01$ level. All other OCPs were either weakly correlated or negatively correlated. A strong correlation indicates that the feeds are from the same source.

Table 5: Correlation of OCPs in Layers and Broiler mash

	Aldrin	δ-BHC	Dieldrin	EndoSul	Endrin	EndrinCHO	ppDDT
Aldrin	1						
δ-BHC	-0.344	1					
Dieldrin	0.938**	-0.245	1				
EndoSul	0.951**	-0.243	0.958**	1			
Endrin	-0.047	-0.356	-0.316	-0.044	1		
EndrinCHO	-0.324	-0.245	-0.2400	-0.366	-0.316	1	
pp-DDT	0.628	-0.560	0.632	0.435	-0.391	0.326	1

** Correlation is significant at the 0.01 level (2 tailed)

Trace Metal in Poultry Feed.

The concentration of trace metals in broilers feed is presented in Table 6. The concentration of Cu ranged from 18.0 to 20.6 mg/kg. Royal D Farm had the highest mean concentration of Cu while Wale Farm had the lowest concentration. The mean values of Cu in these feed mills were below the maximum acceptable concentration of 100 mg/kg for Cu in feed, as stipulated by European Union. However, these values were higher than 6.55 -12.60 mg/kg in chicken feed produced in South eastern Nigeria (Okoye *et al*., 2011) but lower than 22.56 mg/kg reported by Cang *et al*., (2004). Zinc concentrations ranged from 84.9 to 124 mg/kg while highest value recorded in Joju Farm and lowest in Wale Farm. Concentrations of Zn were below the maximum acceptable concentration of 500 mg/kg for zinc in feed as stipulated by European Union. However, these values were comparably lower than 35.78 - 482.2 mg/kg reported by (Mahesar *et al*., 2010); and 153.78 mg/kg reported by Cang *et al*., (2004). Manganese ranged from 77.1 to 126 mg/kg, Joju Farm had the highest concentration while Royal D Farm had the lowest. Okoye *et al*., (2011) reported values in the range of 45.76-56.30 mg/kg in Mn in their analysis of poultry feed. This ranged value is lower than the values obtained in this study. Lead was not detected in any of the poultry feed sampled.

Table 6: Mean levels ± SD (mg/kg) of trace metals in Broilers feed.

Feed Mill	Cu	Zn	Mn	Pb
Joju	20.4 ± 0.3	124 ± 2.8	126 ± 2.8	ND
Royal D	20.6 ± 0.3	124 ± 2.4	77.1 ± 1.4	ND
Wale	18.0 ± 1.4	84.9 ± 4.2	110 ± 0.0	ND

NOTE: ND- Not Detected

Concentrations of trace metals in layers mash is presented in Table 7. Copper ranged from 20.9 to 56.7 mg/kg with highest in Royal D and lowest in Wale Farm. Copper concentrations were below the maximum acceptable concentration of 100 mg/kg for copper in feed as stipulated by European Union. The value obtained in this study was higher than 12.3- 65.8 mg/kg reported by (Cang *et al*., 2004). Zinc ranged from 108 to 148 mg/kg with highest concentration in Joju Farm and lowest in Wale. These values were below the maximum acceptable concentration of 500 mg/kg for Zn in feed as stipulated by European Union. The values obtained in this study were higher than 38.50 - 43.75 mg/kg reported by Botaro *et al*., (2011) and lower than 153.78 mg/kg reported by Chan *et al*., (2004). Manganese ranged from 83.9 to 134 mg/kg while Royal D Farm had the highest concentration and Wale Farm had the lowest. ATSDR (2002) reported ranged value of Mn in layers as 46.93 - 64.88 mg/kg which was lower than the values obtained in this study. Lead concentrations were in the range of 4.18 to 7.00 mg/kg. Pb was not detected in Wale Farm. Lead concentrations were above the permissible limit of 1mg/kg in the United Kingdom.

Table 7: Mean levels ± SD (mg/kg) of Trace Metals in Layers mash.

Feed Mill	Cu	Zn	Mn	Pb
Joju	28.9 ± 1.4	148 ± 1.1	114 ± 2.8	4.18 ± 0.0
Royal D	56.7 ± 1.6	126 ± 3.5	134 ± 12.8	7.00 ± 1.4
Wale	20.9 ± 0.1	108 ± 2.1	83.9 ± 2.8	ND

NOTE: ND- Not Detected

Table 8 presents the mean levels (mg/kg) of trace metals in broilers and layers mash. For broilers feed, copper, zinc, manganese had a mean concentrations which were higher than the values reported by Okoye *et al.*, (2011) and Bukar and Saeed (2015).. Lead concentration was reported as 2.11 mg/kg by Okoye *et al*., (2011) which was lower than 3.73 mg/kg reported by Bukar and Saeed (2015) and the value obtained in this study.

For layers mash, Bukar and Saeed [2015] reported that the mean concentration of Cu ranged from 9 -10 mg/kg, while Okoye *et al*., (2011) reported concentration of 8.83 mg/kg. These values were both lower than the value obtained in this study. The mean value of Zn (127 mg/kg) was higher than 41.69 mg/kg reported by Okoye *et al*., (2011) and range value of 30-40 mg/kg reported by Bukar and Saeed (2015). Manganese concentration recorded in this study, is higher than the value reported by Bukar and Saeed (2015), (50 - 60 mg/kg) and 56.13 mg/kg reported by Okoye *et al*., (2011). Lead was not detected in layers mash. Lead contamination in all feed samples (starter, growers, developers, layers and rabbit feed) were reported by Okoye *et al*., (2011); Adbullah *et al*., (2010).

Table 8: Mean levels ± SD (mg/kg) of Trace Metals in Broilers feed and Layers Mash

Feed Type	Cu	Zn	Mn	Pb
Broilers	19.6 ± 1.5	111 ± 21	104 ± 22	3.73 ± 3.2
Layers	35.5 ± 17	127 ± 17	110 ± 23	ND

NOTE: ND- Not Detected

CONCLUSION

This study investigated proximate composition, level of trace metals and OCPs in broilers and layers mash, from selected farm mills in Iwo, Osun State, Nigeria. The data obtained in the proximate analysis represent great variations among the quality of the poultry feeds from selected feed mills. Each feed mill has its own formulation which doesn’t remain constant throughout the whole year but changes according to the feasibility of the constituents of the poultry feed. The existing information about the composition and nutritive value of the poultry feed permit the poultry farmers to select the better choice of feed and it’s ration for the better growth and health of the poultry on the basis of cost, palatability and energy.

Of all sixteen (16) OCPs compound analysed, only seven (7) were detected in the feed. The source of this could be as a result of use of herbicides, pesticides and other chemicals. Despite the ban of some OCP compounds for agricultural purposes, its continue use is still evident as revealed in the results obtained.

Four (4) trace metals were determined and their concentration were found to be low when compared with the maximum acceptance limit as stipulated by European Union.The broilers feed consistently had the lowest concentration of the metals analysed compared to the layers mash. It was observed that most of the concentrations of trace metals obtained in this study were higher than similar studies conducted in the South eastern and Northern part of Nigeria. This may be as a result of geochemical soil composition, the use of fertilizer and other environmental contaminants. However, lead was either not detected or very low in both broilers and layers mash obtained from the feed mill.

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