Feed Analyses of Proximate Composition and Heavy Metals: A Case Study of Some Poultry Feeds Distributed in Aba, Southeastern, Nigeria

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ABSTRACT

Proximate and heavy metal analysis of eight brands of poultry feed, Top Starter (TS), Top Layer (TL), Top Grower (TG), Top Finisher (TF), Vital Starter (VS), Vital Layer (VL), Vital Grower (VG), and Vital Finisher (VF) of two feeds from two brands namely Top and Vital were investigated. The samples were analyzed for moisture content, ash content, crude fat, crude fiber and crude protein. The heavy metal analysis such as Manganese, chromium, lead, zinc and iron were also analyzed.

It was found that VS had higher moisture content than other samples, while ash content was higher in VL. VF had more crude fat whereas TG and TF had crude fiber of 5.50% and 10.74% respectively. AAS analyses of the samples showed that chromium and lead were not detected in the starter sample of Top feed. All other metals found were below the permissible level required by regulatory bodies. This study gives details about some proximate and heavy metals and their toxicity in poultry feeds along with their health effects.

(Keywords: poultry feeds, proximate analysis, heavy metals, atomic absorption spectrophotometry, public health).

INTRODUCTION

Chicken eggs and poultry meats are produced globally as human food without major taboos on their consumption. They are not only rich in the most important amino acids for humans such as lysine, threonine, and the sulfur bearing amino acids (methionine and cysteine), but also important vitamins and minerals (FAO, 2013). These nutrients are critical but are not present in most staple foods (rice, cassava, and corn) in the same proportion as in eggs and poultry meats. Eggs are also rich in lutein which lowers the risk of cataracts and macular degeneration, particularly among people living in developing countries (Leskanich and Noble, 1997; Sparks, 2006; Smith and Wiesman, 2007; Windhorst, 2008; Alder and Pym, 2009). As a valuable source of protein and almost all the essential nutrients, the role of poultry in human nutrition is overwhelming. The availability of poultry products are on the increase owing to the massive production of poultry feeds worldwide.

In the production of poultry feeds, certain measures when not in place could make poultry products harmful to humans as have been reported so far (Thorns, 2000; Stein, et al., 2008; Swayne and Thomas, 2008; Alder and Pym, 2009; Mcleod and Mack, 2009; Senior, 2009). Feeds play a major role in the production of chicken in Nigeria. They include starter chicken feed, grower chicken feed, layer chicken feed, mash, crumble, pellets, shell grit, and chicken scratch. These feeds are produced from different foodstuffs such as rice, corn cobs, corn and cornmeal, bananas, avocado seed, apples, bluegrass straw, and many more.

The exposure of these feedstuffs to various anthropogenic pollutants, such as heavy metals alters the food chain, and creates a negative impact on public health. Manganese (Mn), chromium (Cr), tin (Sn), lead (Pb), and Zinc (Zn) are toxic elements, with severe accumulative effects. They belong to those trace heavy metals that are of major interest in environmental protection, due to their high toxicity. They are extremely important elements in the environmental, biological, agricultural, foods, and industrial processes. The determination of these metals in environmental and food samples plays an important role in the monitoring of environmental pollution and the associated health hazards to terrestrial and aquatic lives

(Adcock and Hope, 1970; WHO, 2012; Chinyere, 2013).

Heavy metals are naturally occurring elements, however, they occur as a result of industrialization in manufacturing processes causing significant contamination in air, dust, soil, water, sediments and food. The resultant pollution comes from many sources, such as coal-burning power plants, refineries, run-off from factories and industrial wastes. They also enter the environment from such sources as automobile exhausts, sewage treatment plants, medical and dental facilities, and water run-off from mining operations. The health scares concerning these elements have been many as most of their toxic contamination in humans is from foods and drinks (USEPA, 1986; Okoye, et al., 2011).

There is a lot of existing regulations to monitor the accumulation of these toxic metals in the environment, such as the “Clear Air Act” first enacted in 1970 in the United States to mandate levels of air pollution, including Mn, Cr, Sn, Pb, Zn, and Fe (Alkhalaf, et al., 2010). Likewise, the Environmental Protection Agency of the United States of America (EPA) has set water quality criteria for levels of metals in both fresh and saltwater systems. It is necessary to achieve a safe concentration level for these metals because getting rid of them when high levels are found in the environment is however another problem. The regulatory requirements of heavy metals are becoming more stringent in Nigeria, and other developing countries due to their importance in environmental, biological and food samples. While certain mineral elements are essential dietary nutrients for poultry feeds, they can as well have a serious adverse effect upon the humans and animals if included in the diet at excessively high concentration (Suleiman, et al., 2015).

Hence, this work was aimed at evaluating the proximate composition and heavy metal analyses of these eight brands of poultry feeds in other to ascertain whether they are within the permissible limit of regulatory bodies.

GEOGRAPHICAL LOCATION OF THE STUDY AREA

Abia State is located between longitude 07 ° 00 'and 8 ° 09' North, and latitude 06 ° 00' and 04 ° 45 'East. It is located in the east Imo State and shares common boundaries with Anambra, Enugu, and Ebonyi States to the North West, North East, and North, respectively. To the East and Southeast, it is bounded by Cross River and Akwa Ibom State and by Rivers State to the South. It occupies the landmass of 5,833.77 square kilometers.

The state is about 596 kilometers from Lagos and approximately 498 kilometers from Abuja. Abia state is composed of seventeen (17) local government areas. The rock system and the geological history of this area is because of the events that occurred between the Mesozoic and Cenozoic era respectively. Its structure is divided into three, namely, Upper coal measure, False-bedded sand stones, and Lower coal measure. The upper part of the formation of the size of the coal is the largest geological formations in the region. It consists mainly of coarse grains, alternating sedimentary sand gray, dark shales which contain impure coal sand in the vertical horizon.

The research area has two distinct climatic seasons, the dry and wet seasons. The dry season starts from October and ends in March when the rainy season starts from April and ends in September. This season caused by fluctuations in the north-south from the discontinuity between the continent (Sahara) of dry air and moist Atlantic air (Ifediegwu, 2019). Harmattan period is marked by cold, dry and windy weather while the rainy season is marked by heavy, heavy rainfall.

The main agricultural products in the region are rice, cassava, bananas, maize, cassava, okra, and pineapple. It is also the 5th most developed state in the country and has the fourth highest index of human development in the country, with a lot of economic activity and a rapidly growing population as recorded by the United Nations beginning in 2018. The state also houses the largest cattle market in Nigeria is located at the Enugu-ph highway in the town of Umu Nneochi LGA. The city became a collection point for agricultural products following the British made railway running through it to Port Harcourt. Aba is a big city, residential, and commercial center in an area surrounded by small villages and towns. In 2016, Aba has an estimated population of 2,534,265 (Citypopulation, 2010). The geographical map of the study area is shown in Figure 1.

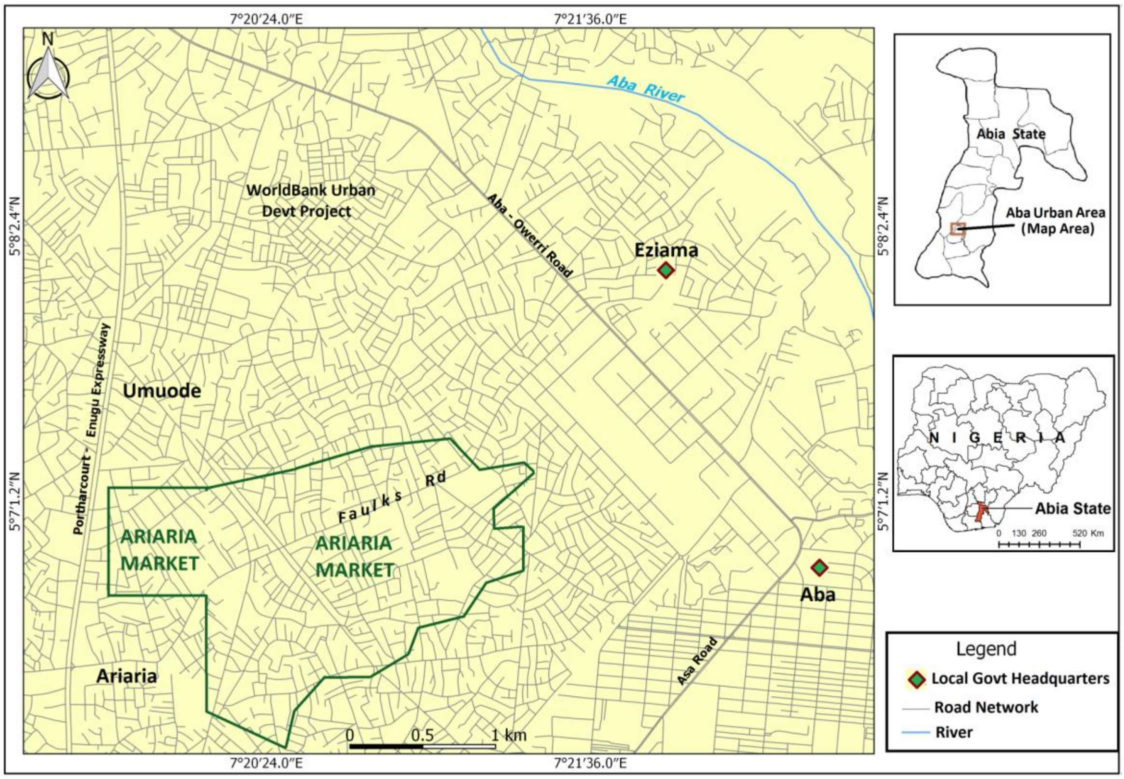

Figure 1: Ariara Market in Aba Urban Area, Aba; Abia State, Nigeria.

MATERIAL AND METHODS

Sampling

During the sampling trip, eight brands of feeds (Top Starter, Top Layer, Top Grower, Top Finisher, Vital Starter, Vital Layer, Vital Grower, and Vital Finisher) were taken from two different types of poultry feeds (Top and Vital). Hence, a total of sixteen (16) samples were collected in August, 2018. Aba was selected for investigation because of the massive agricultural products following the British made railway running through it to Port- Harcourt and is a big city residential and commercial center in an area surrounded by small villages and towns. The samples were kept in clean sterilized bottle and taken to the laboratory.

Sample Preparation and Analyses

Sample preparation for heavy metal analyses were carried out following methods in the works of literatures (Scott, et al., 1982; AOAC, 1984; AOAC, 1990; Carew, et al., 2005; Suleiman, et al., 2015). A quantity of each brand of the same feed sample obtained from different markets in Aba metropolis was mixed, homogenized thoroughly and 1g each of TS, TL, TG, TF, VS, VL, VG, and VF were weighed using a Mettler weighing balance (Mettler E. 200).

Each sample was then transferred into a 50 mL Kjeldahl digestion flask, 25-30 cm^3 of aqua regia was added. The mixture was swirled gently and heated at about 370^oC in a digestion block. Increasing the temperature slowly to about 450^oC for 15 min, after the appearance of white fumes, the digested samples were allowed to cool.

The samples were dissolved using 10 mL of distilled water and then filtered using Whatman filter papers. The filtrates were poured individually into 50 cm^3 prewashed sample bottles followed by triplicate measurement of the sample solutions for manganese, chromium, lead, zinc, and iron at the peculiar wavelength for each element using atomic absorption spectrophotometer (AA-7000 Schimadzu, Japan), and average values recorded.

The samples were analyzed for proximate compositions such as moisture content (%), ash content (%), crude fat (%), crude fiber (%), crude protein (%), and heavy metal analysis such as Mn, Cr, Sn, Pb, Zn, and Fe. The proximate analysis of the samples was carried out following reported methods (Scott, et al., 1982; Carew, et al., 2005).

RESULTS AND DISCUSSION

Proximate Composition of Poultry Feeds

The results of the proximate analysis of the poultry feed samples are shown below in Table 1. In the results, the data obtained for both the moisture and ash contents varied among the feed samples. Significant variation in the crude protein content of the feed samples was also observed. In all the samples, crude protein content was grossly inadequate. The pattern of low protein content observed for these feeds would result in low feed intake and slow growth of flocks. Reports have indicated that modern hybrid layers can lay over 300 eggs per annum, while broilers should attain more than 2 kg live weight in eight weeks.

It is evident that chickens fed with these diets would produce at low rates, having inadequate fat and crude fiber required (FAO/WHO, 2000; European Commission, 2003B). The crude fiber content of the sample was far below the recommended values for poultry diets. It is necessary and highly demanding for poultry farmers to take proactive measures to optimize the quality of the feeds with the requite supplements. The benefits with these practices are to guarantee the safety and better results, rather than dwelling on the labels or deceptive descriptions given by the manufacturers.

Heavy Metal Analysis

The results of the heavy metals concentration (mg/kg) in poultry feeds (Top and Vital feeds) are shown in Table 2.

Table 1: Proximate Composition of Poultry Reeds (in percentage).

Chemical composition (%)	TS	VS	TL	VL	TG	VG	TF	VF
Moisture content	4.52	4.82	3.23	3.53	4.52	2.87	4.78	2.86
Ash content	6.67	6.05	9.94	11.24	8.69	6.11	5.09	6.45
Crude fat	6.20	6.05	4.34	4.20	5.50	5.69	7.45	7.60
Crude fibre	3.69	3.50	4.30	4.48	5.50	5.20	4.89	5.00
Crude protein	7.01	3.08	9.35	3.64	4.75	6.12	10.74	5.61

Table 2: Heavy Metal Concentration in Top and Vital Feeds (mg/kg).

Heavy Metal	Top Feed				Vital Feed				Mean (± SD)
	Starter	Grower	Layer	Finisher	Starter	Grower	Layer	Finisher	
Manganese	1.588	1.912	1.329	2.171	0.130	1.556	1.264	1.134	1.386± 0.258
Chromium	0.000	0.058	0.000	0.058	0.000	0.058	0.000	0.000	0.023± 0.003
Lead	0.000	0.500	0.075	0.000	0.000	0.500	0.000	0.000	0.134± 0.102
Zinc	1.229	1.342	0.969	1.212	0.589	0.831	1.039	0.875	1.011± 0.030
Iron	10.515	10.759	8.314	2.934	13.083	10.026	16.139	12.349	10.515± 9.79

Table 3: Nutrient Requirement (minimum) of Commercial Layers.

Parameter	std
Calcium (%)	2% max
Phosphorus (%)	0.7% max
Manganese (mg/kg)	90
Zinc (mg/kg)	60
Iodine (mg/kg)	1
Copper (mg/kg)	12
Cd mg/kg	1
Pb (mg/kg)	5
Chromium mg/kg	0.3
Fe mg/kg	45-80
Cobalt mg/kg	1
Moisture content	12% max
Crude protein	40% Min
Crude lipid/fat	7% Max
Ash	18% max
Carbohydrate	32.0% max
Crude fiber	8.0% max

FAO/WHO

FAO of the united nations: Bangladesh: feed and feed ingredient standards – FAO. www.fao.org/fishery/affris/ban.... assessed 1/4/2020

The experimental results obtained from the analysis of the poultry feed for heavy metals showed that the mean concentration of manganese in all the samples is 1.386 ± 0.258. Top finisher had more of the manganese than top Grower. Manganese was also higher in vital grower than other vital feeds. None of the feed samples had the minimum quantity of manganese needed for poultry. Very little manganese present in these feeds could lead to slow blood clothing and other alteration in metabolism. The requisite amount of manganese is vital in birds to check unnecessary interference with normal growth, bone formation and reproduction (AOAC, 1984; USEPA,1986; AOAC, 1990; European Commission, 2003B; Carew, et al., 2005; Alkhalaf, et al., 2010; Okoye. et al., 2011; Chinyere, 2013; Suleiman, et al., 2015; Alum and Orji, 2018).

Chromium was found in Top grower, Top finisher and vital grower in the same concentration. The lead was found in Top grower and vital grower. Its concentration was below the acceptable limit of 5 mg/kg as stipulated by the European Union. Exposure to lead has been associated with elevated pressure and hypertension but does not imply that the overall absence in some sample is recommended (European Commission, 2003B).

Zinc and Iron are essential minerals for many biological processes and have a positive influence on livestock growth and reproduction. In the experiment, it was observed that the concentration of zinc in all the samples was high but below the permissible limit of 500 mg/kg as stipulated by the European Union. It was expected that zinc as a nutrient would have values between 40 – 55 mg/kg in starters, growers and finisher, and 30-40 mg/kg in layers. Due to low concentration of zinc in the samples, animals fed with these feeds will certainly suffer the loss of appetite, decreased immune function, poor growth and production (European Commission, 2003B; Okoye, et al., 2011)

Zinc like chromium is needed by animals. Zinc contents in some home-grown feeds compared with recommendations and varying bioavailability, supplementation of the metal is necessary for birds, and ought to be added to their diets as mineral supplements. Iron like other metals in the feed samples had lower concentration. In all the samples, the mean concentration of Iron was 10.515 ± 9.79, which was far below the permissible levels of 45-80 mg/kg as stipulated by FAO/WHO and other regulatory bodies (FAO/WHO, 2000).

CONCLUSION

Feed analyses of proximate composition and heavy metals of some poultry feed distributed in Aba have been successfully carried out. All elements studied were present in a concentration below the stipulated limit of regulatory bodies. In order to enhance performance and productivity, poultry farmers are encouraged to make up for the inadequate nutrients with the requisite supplements.

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