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Nutrients and Anti-Nutrients composition of Three Different Poultry Feeds in Ondo State, South Western Nigeria

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Abstract: Animal production is the fastest bridge of animal protein deficiency in the developing countries and is supported by increased production of formulated feeds. Feed quality and economics of feeding the birds are the major determinant factors in successful poultry farming. This research work was carried out to determine the nutrients and anti-nutrients composition of three commonly used broiler feeds (A, B and C) by commercial poultry farmers in Ondo State, Nigeria using standard analytical procedures for feedstuffs. The feeds used for this research work were purchased from designated animal feeds seller in Akure, Ondo State, Nigeria. The proximate analysis showed: moisture content of the feed samples ranged from8.46±0.07 to 7.85±0.06%, ash content ranged from 9.09±0.11 to 8.54±0.01%, crude protein ranged from 15.84±0.13 to 14.16±0.02% and carbohydrate ranged from 59.09±0.23 to 56.99±0.04%. The mineral contents (mg/100g) showed: phosphorus (P) ranged from 0.63±0.35 to 0.763±0.42, calcium (Ca) ranged from 1.952±0.35 to 0.151±0.10, manganese (Mn) ranged from0.55±0.06 to 0.021±0.01 and potassium (K) ranged from1.005±0.07 to 7.93±0.04.The result of anti-nutrient factors in mg/100g revealed phytate range from 0.305±0.01 to 0.103±0.03, oxalate ranged from0.703±0.01 to 0.503±0.01, tannin ranged from0.96±0.01 to 0.65±0.06. Percentage saponin ranged from 0.452±0.02 to 0.363±0.04 and % alkaloid ranged from 0.315±0.07 to 0.164±0.06. Results revealed that sample B recorded the highest crude protein which was significantly ($p<0.05$) higher than sample A which was in turn higher ($p<0.05$) than sample C. Sample A was significantly ($p<0.05$) higher in moisture content, ash and crude fiber. There was no significantly ($p>0.05$) different in their ether extract while sample C has significantly ($p<0.05$) higher NFE. The crude protein (CP) content of the samples was lower that the recommended CP for broilers finishers.

Keywords: Feed composition, Feed quality, Livestock, Minerals, Proximate analysis.

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1. Introduction

Livestock is an important component of human diet (MacLeod et al., 2018; Van Kernebeek et al., 2016; Van Zanten et al., 2016). It is a major source of animal protein, which builds the body and replaces worn out tissues, source of employment and income to farmers and foreign exchange to the nation (Appleby and Fuentesfina, 2015; Igben, 2000). It involves rearing of animals like pigs, rabbit, turkey, broilers, laying hens etc. Animal production is the fastest bridge of animal protein deficiency in the developing countries and is supported by increased production of formulated feeds (Herrero et al., 2013; Thornton and Herrero, 2015).

Nigerian poultry industry is facing the problems of high cost of feed ingredients precipitated by inadequate supply of these ingredients and inaccurate formulation of feeds. Poultry feed is the most expensive aspect of poultry production accounting for about 60-70% of the total cost of intensive poultry production in Nigeria (Yunusa et al., 2015; Olomu, 2011; Dafwang, 2006; and Babatunde et al., 2002). This situation has forced many poultry farmers to fold up most especially now that Nigeria currency is on regular devaluation compare with dollar and most of the feed ingredients are imported, especially protein sources.

Feed quality and economics of feeding the birds are the major determinant factors in successful poultry farming. In fact, profit of poultry production mainly depends upon the economics of feeding the birds and accurate mixing of the formulated feeds (Akinsanmi et al., 2017; Yunusa et al., 2015; Ogbe et al., 2013). For Nigeria to have a sustainable poultry industry that will take care of the high demand by the ever increasing population of the nation; there is the need to diversify and expand the raw feed materials resource base for poultry ration formulation (Ogunbodede et al., 2014; Abeke et al., 2008) and regulate the standard of formulated feeds. The problem of high cost of feed has been attributed in part to inadequate production of farm crops to meet both human which is ever increasing and domestic animal's needs (Iyayi and Tewe, 1994).

Feed nutrients are the chemical properties of feeding ingredients which includes; crude proteins, ether extract (crude fat), crude fiber, ash, carbohydrates, minerals and vitamins that enhance proper growth and general well-being of poultry birds (Abdel-Hafeez et al., 2018). The nutrient requirements of chickens are essential to satisfy the physiological and other needs of the body. Poultry convert feed into animal products quickly and efficiently. Their high rate of productivity results in relatively high nutrient needs (Applegate and Angel, 2014). Broilers are male and female chickens, which have genetic potential for growing fast and are therefore kept purposely for meat production. These characteristics together with their ability to efficiently utilize feed make them to remain the fastest source of animal protein. Feeding poultry for optimum growth production requires that the birds consume appropriate, balance diets. It is important that poultry be fed diets that meet their nutritional requirements (Yacout, 2016; Suleiman et al., 2015; Agbede et al., 2003).

Nutrient requirement is a function of the amount of feed eaten and the nutrient levels in the diet. The nutrient levels in the diet can be classified as protein, carbohydrates, vitamin, fat, minerals and water. These optimum nutrients level in the diets promote fast growth and best performance of the broiler (Cowieson et al., 2018). On the other hand, deviation or poor adjustment in the nutrient requirements would lead to poor performance of the birds. Nutrient recommendations are different for each species and the purpose of the birds as well as the stage of growth and production (Suleiman et al., 2015; Beutler, 2007). Good quality of feed with optimum nutrients requirement is determined by the composition and quality of feed ingredients used. Oluyemi and Roberts, (1979) reported that imbalance of nutrients (too much or too low), leads to excessive fat deposition in the carcasses and poor performance. The nutritional analyses of these ingredients are carried out to estimate the different components of feed (Fasuyi and Arire 2015; Orwa et al., 2009). Nigeria poultry industries rely on the supply of ready to use feed from feed mills. These packaged feeds constitute the main source of feeds from poultry farmers. Therefore, the accuracies in formulation and proper storage of the feeds go a lot in sustainability of poultry production. These inform the basis of this study.

2. Materials and Methods

2.1 Sample Location and Collection

Akure is a city in south-western Nigeria and is the capital city of Ondo State. The city had a population of 484,798 as at the 2006 population census. Akure (7.15°N, 5.12°E) is about 700 km Southwest of Abuja and 311 km north of Lagos State (Falodun and Ajewole. 2006).A bag of 25kg each of three different company poultry feeds product (broiler finisher) were purchased from a designated popular livestock feed vendor in Akure, Ondo State, Nigeria. The feeds were taken to the laboratory within 1hour of purchase and were coded samples A, B and C. A representative sample was taken from the bulk sample for laboratory analysis.

2.2. Proximate Analysis

Proximate analyses of the feed samples were carried out using the AOAC (2000) method.

2.3. Moisture Content Determination

Moisture content was measured using an air-oven (GENLAB prime oven) following official methods of Association of Official Analytical Chemists (2000). Sample was dry to constant weight and the %MC calculated.

2.4. Ether Extract

Determination of ether extract content was carried out using solvent extraction method via soxhlet apparatus. Petroleum ether was used for the extraction for 8hours. The percentage was calculated.

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2.5. Determination of Nitrogen Free Extract

Nitrogen free extract (NFE) was calculated by difference after analysis of all other parameters of the proximate analysis.

NFE = (100-% moisture + % CP + % crude fat+ % CF + % ash)

Where CP is crude protein; CF, crude fibre; NFE nitrogen free extract.

2.6. Determination of Crude Fiber

A moisture free and ether extracted sample of crude fiber was first digested with dilute H_2SO_4 and dilute KOH solution. The undigested residue collected after digestion was ignited and loss in weight after ignition was recorded as crude fiber.

2.7. Determination of Ash

Samples were weighed into cleaned empty crucible earlier pre-weighed before placed in a muffle furnace at 600 ^{o}C for hours to ensure total combustion of the sample. Combustion of sample is complete when the sample turned whitish.

2.8. Mineral Determination

Mineral contents of the samples were determined by atomic absorption spectrometry, flame photometry and spectrophotometry according to the methods of AOAC (2000). Wet digestion was used for the samples using nitric acid. The mixture was left to cool down and the contents of the tubes were transferred to 100 ml volumetric flasks. The volume of the content was made to 100 ml with distilled water. The wet digested solution was transferred to plastic bottles and labeled properly. The digest was used for mineral determination. Atomic Absorption Spectrophotometer (AAS) (Model 210 VGP, Buck Scientific) was used for the determination of iron (Fe), manganese (Mn), zinc (Zn). Sodium (Na) and potassium (K) were determined using Flame Photometer (Model FP 902, Buck Scientific). Calcium (Ca) and magnesium (Mg) were determined using titrimetric method.

2.9. Anti-nutrients Determination

Total oxalate was determined according to Day and Underwood (1986) procedure. To 1 g of the ground powder, 75 ml of 15N H_2SO_4 was added. The solution was stirred with a magnetic stirrer for 1hour and filtered using Whatman No 1 filter paper. 25 ml of the filtrate was then collected and titrated against 0.1 N $KMnO_4$ reagents. The endpoint was a faint pink color that persisted for 30seconds. Phytate was determined (Reddy and Love, 1999) soaking the ground sample (5 g) 100 ml of HCl (2%) for 5 hours and subsequently filtered. Obtained filter (25 ml) and ammonium thiocyanate solution (0.3%, 5ml) were mixed and titrated with Iron (III) chloride solution until a brownish-yellow color persisted for 5 min.

Saponin was determined using the method of Birk et al., (1963) as modified by Hudson and El-Difrawi (1979). Aqueous ethanol (20%, 20 ml) was added to 10 g of the ground sample and agitated with a magnetic stirrer for 12 hours at 55°C. The solution was filtered using Whatman No.1 filter paper and the residue re-extracted with 200 ml 20% aqueous ethanol. The extract was reduced to 40 ml under vacuum and 20 ml diethyl ether was added in a separating funnel and shaken vigorously. The combined butanol extracts were washed twice (10 ml of 5% NaCl) and evaporated to dryness in a fume cupboard to give a crude saponin and weighed.

Tannin was determined using the method of Trease and Evans (1978). Methanolic extract (1 ml) was treated with 5 mL Folin Denn is reagent in a basic medium and allowed to stand for color development. The absorbance of the reaction mixture of sample was measured at 760 nm using a spectrophotometer.

2.10. Quality Control

Equipment used were calibrated and standardized according to standard operating procedure and manufacturer's instruction before use. All chemicals used were of analytical grade (99% purity). Distilled water was used for the preparation of reagents.

Table 1. Proximate composition of poultry feed samples.

Parameter/Sample (%)	A	B	C
Moisture content	8.46 ± 0.07^{a}	7.85 ± 0.06^{b}	8.12 ± 0.15^{b}
Ash content	9.09 ± 0.11^{a}	8.99 ± 0.08^{a}	8.54 ± 0.01^{b}
Crude Fat	4.88 ± 0.01^{a}	4.88 ± 0.24^{a}	4.68 ± 0.49^{b}
Crude Fibre	5.60 ± 0.07^{a}	3.65 ± 0.09^{c}	5.24 ± 0.09^{b}
Crude Protein	14.96 ± 0.13^{b}	15.84 ± 0.12^{a}	14.16 ± 0.02^{c}
Nitrogen Free Extract	56.99 ± 0.04^{c}	58.73 ± 0.13^{b}	59.09 ± 0.23^{a}

Note: values with different superscripts in each row are significantly different ($p<0.05$).

Table 2. Labeled nutrient contents of the poultry feed samples by manufacturers

Parameters	Sample A	Sample B	Sample C
Crude Protein (%)	18.00	19.50	17.00 (Min.)
Fat (%)	6.00	3.80	10.00 (Max.)
Crude Fibre (%)	6.00	3.00	15.00 (Max.)
Calcium (%)	1.00	1.20	0.80 (Min.)
Available Phosphorus (%)	0.42	0.44	0.35 (Min.)
Methionine (%)	0.35	0.50	-
Lysine	0.35	1.20	-
Salt	0.30	-	-
Metabolizable Energy (Kcal/kg)	2,900 (Min.)	3,100	3,000 (Min.)

De-ionized water was used for elemental analyses. Laboratory apparatus were washed with detergent, rinsed with distilled water and oven-dry before use. Samples were analyzed in triplicates.

2.11. Statistical analysis

The statistical analysis was performed using statistical package for social science (SPSS) version 16.00. Data obtained were analyzed in triplicate and expressed as mean ± standard deviation (SD) and statistical significance was assigned at $p<0.05$ levels (Smith, 2015).

3. Results and Discussion

The proximate compositions of feed samples are presented in Table 1. Table 2 presents labeled nutrient composition of the samples by manufacturers. The percentage moisture content (%MC) of sample A was significantly ($p<0.05$) higher than others. There was no significant ($p>0.05$) difference in the %MC of sample B and C. %MC was not indicated by the manufacturers. High moisture content in livestock feed aid microbial growth and spoilage (Hussain et al., 2009). Percentage crude protein content were14.96±0.13, 15.84±0.12 and 14.16±0.02 for sample A, B and C respectively, as against the range of 17.50 to 19% reported in the labels of the feeds by various manufacturers. Sample B was significantly ($p<0.05$) highest followed by A then C in crude protein. However, the values were less than 18-21% CP recommended by NRC (1994) for broiler finishers. There was no significant difference in the ash contents of sample A and B, but sample C recorded significantly ($p>0.05$) lower ash content. Percentage ash content was not included in all the manufacturer's labels. Ash content of feedstuff is the mineral content of such feedstuff when all the organic contents have been completely combusted. Low ash content is of nutritional advantage because low ash content of 2.5 or less has been reported to be desired for compounding of animal feeds (Oyewusi et al., 2007).

Ether extract content was not significantly ($p>0.05$) different among the three samples. Ether extract content of the samples was within the range recommended by NRC (1994) for broiler chickens. Nguyen and Ly (2002) observed that fat influences and improves the digestibility of feed in animals because the oil in the feed will slow the movement of the feed in the alimentary tract thereby aid digestion of the feed. The % crude fibre (CF) content for sample A was significantly ($p<0.05$) highest in CF followed by C, while sample B recorded the lowest CF. The CF content of sample B falls within the NRC (1994) recommended value for broilers while the other samples were higher than recommended CF levels. There were significant ($p<0.05$) differences in the nitrogen free extract of the samples.

Table 3. Minerals composition of samples

Element (mg/100g)	Sample A	Sample B	Sample C
P	0.623 ± 0.36^{b}	0.763 ± 0.35^{a}	0.463 ± 0.42^{c}
Ca	1.952 ± 0.35^{a}	1.254 ± 0.01^{b}	1.151 ± 0.10^{b}
Mg	1.812 ± 0.35^{a}	0.143 ± 0.35^{b}	0.132 ± 0.02^{c}
Zn	0.045 ± 0.04^{b}	0.084 ± 0.57^{a}	0.094 ± 0.49^{a}
Fe	0.073 ± 0.35^{b}	0.021 ± 0.28^{a}	0.113 ± 0.35^{a}
Mn	0.021 ± 0.01^{c}	0.041 ± 0.00^{b}	0.055 ± 0.06^{a}
Na	0.051 ± 0.01^{c}	0.063 ± 0.04^{b}	0.112 ± 0.02^{a}
K	0.901 ± 0.07^{a}	0.793 ± 0.04^{c}	0.908 ± 0.96^{a}
Ca/P	3.133 ± 0.01^{a}	1.643 ± 0.00^{c}	2.486 ± 0.02^{b}

Note: values with different superscripts in each row are significantly different ($p<0.05$).

Table 4. Anti-nutritional factors of samples

Anti-nutrient/Sample	A	B	C
Phytate (mg/100g)	3.05± 0.01[a]	1.58±0.01[b]	1.03±0.03[c]
Oxalate (mg/100g)	7.03±0.01[b]	7.36±0.04[a]	5.03±0.01[c]
Tannin (mg/100g)	0.96±0.01[a]	0.65±0.06[b]	0.73±0.01[b]
Alkaloid (%)	2.13±0.09[b]	1.64±0.06[c]	3.15±0.07[a]
Saponin (%)	4.52±0.02[a]	3.63±0.04[c]	4.32±0.02[b]

Values with different superscripts in each row are significantly different (p<0.05).

The mineral contents of the samples (A, B and C) as presented in Table 3revealed that the phosphorus (P) content of sample B (0.763±0.35 mg/100g)was significantly the highest followed by sample A(0.623±0.36 mg/100g) and the lowest concentration was observed in sample C (0.363±0.42 mg/100g)

Calcium content of sample A (1.952±0.35 mg/100g) was significantly higher than others. Sample A and C were able to meet the Ca/P ratio of 2: 1 recommended by NRC (1994). Magnesium concentration of sample A (1.812 ±0.35 mg/100g) was higher than sample B (0.143±0.35 mg/100g) and sample C (0.132±0.02 mg/100g). Sample C recorded the highest concentration of zinc (0.094±0.49 mg/100g). Iron contents ranged from 0.073±0.35 mg/100g in sample A to 0.113±0.35 mg/100g in sample C. The ranges of other minerals fall within the recommended values of the individual mineral element for poultry birds.

Anti-nutrient contents of the samples were expressed in Table 4. There was significant difference (p<0.05) in the phytate composition of the three samples. Phytate inhibits the absorption of minerals by forming complex substance with some minerals (Ca, P, Fe, Mg and Zn) leading to their low bioavailability in the diet (Bora, 2014; Smitha, 2013; Walter et al., 2002). Oxalate in feeds disallowed the digested feed nutrient inaccessible to the body of the animal (Habtamu and Nugussie, 2014). Oxalate reacts with the mineral in the body by inducing their deficiency in animal which may likely cause bone mobilization osteodystrophy fibrosa (Rahman and Kawamura, 2011). There were significant (p<0.05) differences in the oxalate contents of the three samples. The tannin content of sample A (0.96±0.01 mg/100g), was significantly (p<0.05) higher than that of sample C (0.73±0.01 mg/100g) and sample B (0.65±0.06 mg/100g). According to Habtamu and Nugusie (2014), tannins are known to be heat stable and that they decrease protein digestibility in animals and man by making protein unavailable or by inhibiting digestive enzymes, tannin is present in foodstuff and it inhibit the activities of amylase and lipid it reduces feed intake and growth rate. The beneficial effect of tannin is that it helps in reducing parasite burden, prevents bloat and increase qualities in animal products, increase efficiency of protein utilization, reduces proteolysis during ensilage (Ajayi et al., 2014; Muller, 2010; Adesogan, 2004; Mabusela et al., 2018). Alkaloid has effects on the nervous system, disrupting or inappropriately augmentation of electrochemical transmission. Alkaloids consumption causes rapid heartbeat, paralysis and in fatal case can lead to death (Habtamu and Nugussie, 2014). The alkaloid and saponin composition of the three feeds differ significantly (p<0.05) from each other but were within the tolerance range of poultry birds. Saponin are secondary compound generally known as non-volatile, decreases the uptake of certain nutrient in chickens it also reduce growth rate, feed efficiency and it interferes with the absorption of dietary lipids and vitamins (A and E) according to Jenkins and Atwal (1994). Saponin has beneficiary effects. It acts as an antibacterial and anti-protozoal (Avato et al., 2006). Saponin helps in lowering cholesterol, immune protentiating, anticancer and serves as an antioxidant (Blumert and Liu, 2003). Saponin decreases the uptake of certain nutrients including glucose and cholesterol at the gut through intra-lumenal physicochemical interaction. Hence, it has been stated to have hypocholesterolemin effect (Umaru et al., 2007). Proper processing methods have been known to improve feed quality (Smitha et al., 2013; Soetan and Oyewole, 2009). The ranges of the ant-nutrients contents of the samples were not higher than the tolerance levels of poultry birds.

4. Conclusion

In conclusion, the three feeds examined are good nutrients source for diets in terms of nutrient, mineral and anti-nutrients composition. The nutrient and mineral composition of sample A was better than the other two samples, but the anti-nutrient composition of sample A was the highest compare to other samples (B and C). However, the determined crude protein content of the three samples was not up to what is recommended for broiler finisher and also in contrast with what was on the label of each feed samples. It is important to place quality at the fore front of feed production for better livestock management from time to time by constant evaluation of the feeds.

Author Contribution: A.A. Designed the research, wrote the introduction, methodology and carried out the laboratory analysis of the research. A.S.K. was involved in analysis and interpretation of data of the research. A.G. was Involved in the laboratory analysis of the research. A.A.O. performed proof reading of earlier draft and editing final version. All authors read and agreed with the final draft of manuscript.

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List of abbreviations: %MC, percentage moisture content; AAS, Atomic Absorption Spectrophotometer; CP, crude protein; CF, crude fibre; NFE, nitrogen free extract; SPSS, statistical package for social science; SD, standard deviation.

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