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Research Article

Effects of Kolanut Husk Formulated Feed at Graded Levels on Growth Performance and Health of Ross Broilers with and Without Enzyme Inclusion

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Abstract

Yellow maize was replaced with 10%, 30% and 50% graded levels of milled kolanut husk with and without digestive enzyme. One hundred and twelve Ross broiler chicks were randomly divided into seven treatments in replicates including the control. Data obtained on growth performance and haematology was subjected to General Linear Model (GLM) of SAS. Results obtained showed broilers fed 10% kolanut husk formulated feed and the control feed to have best growth performance. There was no significant difference within inclusion levels with or without enzyme however, significant difference was observed between inclusion levels. Blood samples of broiler from each treatment were within the avian haematological reference range of healthy birds. Inclusion of more than 10% kolanut husk to replace maize at graded levels was detrimental to the growth performance of Ross broilers but not to their health.

Keywords: Kolanut Husk; Ross Broiler; Feed; Enzyme; Haematology; Growth Performance

Introduction

Poultry are domesticated birds used for production of meat or egg either for commercialization or personal consumption which are fed as appropriate with required mixed ingredient called feed [1]. Feed is composed primarily of a mixture of different ingredients such as cereal grains, animal by product, soybean, fats, vitamin and mineral premixes. Combination of these ingredients with water provides energy and nutrients required [2]. However, feed formulation requires a technique which enhances the use of local feed stuffs in balanced ratio putting into consideration; the specific nutrient required at each stage of growth, availability of raw materials, price of raw materials and presence of anti-nutrients [3].

In poultry feed formulation, the major cereal grain utilized is maize due to its high energy content available for use by animals and low soluble non-starch polysaccharides. Although, its nutritional value varies widely across regions due to climate changes during growth, harvest, processing and storage [4]. In Nigeria for example, high cost of maize has led to hick in price of poultry, which could be attributed to unfavourable weather condition for the growth of the cereal grain. Currently, Nigeria is experiencing flood in some parts of the country with some been major producers of this cereal grain. Also, the obvious competition between man and his animal for same food is also considered a contributively factor to high cost of the cereal. A way to salvage this situation however is to source for suitable alternative ingredient that could replace maize either partially or totally for the production of poultry feeds. Agricultural residues over time have been looked into by various researchers as a suitable alternative ingredient because they are nutritious and abundant in agricultural producing areas. Kolanut husk and testa are examples of agricultural wastes abundant in south-western region of Nigeria, in states such as Oyo, Ondo, Osun and Ekiti [5] which could serve as suitable ingredient in place of maize for poultry feed production in these states.

Kola is an economic cash crop for used for cultural, industrial and trading purposes. Kolanut has world production of 300,000 tons with Nigeria accounting for a total of 70% of the total world production as at year 2011 as reported by Asogwa., *et al*. [5] The pod/husk and testa of kolanut constitutes over 50% kola fruit and has been a farm waste to date. The use of by-products from cocoa, coffee, cashew, palm kernel, cassava and kolanut wastes for producing animal feed has been reported [6]. However, these by-products although nutritive contains some antinutrients which could affect; digestion of carbohydrates, utilization of minerals and stimulation of immune system that may cause a damaging hypersensitivity reaction just to mention a few [7], depending on the type of antinutrient available in the by-product.

Naturally, poultry produce enzymes that aid in the digestion of nutrients available in their feed unfortunately, they don't produce enzymes with ability to break down plant fiber totally and in this case will require exogenous enzymes to aid in its digestion. This problem was subsequently resolved by the advent of digestive enzymes by animal nutritionist who identified the indigestible of some compounds by poultry birds (Khattak., *et al*. 2006). Addition of enzyme to animal feed has been seen to improve weight gain, feed efficiency, digestibility of starch/proteins and reduce intestinal viscosity [8,9]. The aim and objective of this study is thus to know the probable effect(s) of feeding kolanut husk formulated feed at graded levels on poultry with and without the inclusion of digestive enzyme at the finisher growth phase, on the health and growth performance of broilers.

Methodology

Sample collection

Kolanut husk and testa was obtained from a kolanut farm in Ilara-Mokin, Ondo State, Nigeria.

Proximate, mineral and cyanide composition of kolanut nut waste.

Proximate, mineral and cyanide composition of dried kolanut samples was determined according to the method described by Association of Official Analytical Chemist methods [10].

Preparation of experimental diets.

Kolanut husk used as energy source to replace maize was subjected to solid state fermentation, after which it was sun dried and grounded using a mechanical milling grinder. Maize was replaced at 10%, 30% and 50% graded levels with milled kolanut husk with and without enzymes (10% a, 30% b, 50% c and 10% A, 30% B, 50% C represents the treatments, with and without digestive enzyme – polyzyme respectively). Other ingredients used for the feed formulation such as soya bean meal, groundnut cake, wheat offal, bone meal, limestone, premix, lysine, methionine and salt were added in appropriate proposition. The starter phase feed contained approximately 22% Crude Protein while those for the finisher phase contained approximately 18% crude protein. Commercially produced feed with trade name "Top feed" was used as the control feed in the experiment.

Experimental design and animal management

Completely randomized design was the experimental design employed in this study. One hundred and twelve (112) Ross broiler breeds were obtained from Agritech hatchery Ibadan, Oyo state, Nigeria. The feed was a graded level replacement type of feed formulation in which, kolanut husk meal replaced certain percentage of maize. A 10%, 30% and 50% graded level of kolanut husk was used individually to replace maize. Each treatment and control feed were randomly divided into seven treatments each replicated. There were therefore six (6) treatments and one (1) control. They were subjected to same environmental condition, feed and water was provided at ad libitum. They were reared in a chicken house for four (4) weeks before transferring them to a constructed cage in an open environment.

Administered vaccine and drugs

Vaccine and drugs administered included: laSota and Gomboro (100 dose each was administered twice for each vaccine). Vitalyte, vitacox and doxzogen were the drugs administered as at when due. Determination of growth performance.

The weight of Ross broilers was determined on weekly bases and the carcass weight using a digital weighing balance.

Haematological analysis

Two broiler chickens from each treatment group were randomly picked for blood sample collection. Blood sample was collected after eight weeks breeding and 5 ml blood sample was collected from the jugular vein into EDTA bottles for haematological analysis and labeled accordingly. The parameters determined included: red blood cell count (RBC), pack cell volume (PCV), erythrocytes (Ery), leukocytes (Leu), hemoglobin (Hb), neutrophile (Neu), monocyte (Mono), eosinophile (Eos) and basophile (Baso). All parameters were determined according to the methods described in the manual of veterinary laboratory techniques.

Result

The proximate and vitamin composition of kolanut husk measured in percentage as presented on table 1 was observed to have moisture content of 11.8 while that of kolanut testa was 13.70.

Kolanut husk had higher percentages of protein (3.78) and fiber (7.39) than kolanut testa, while the testa on the other hand had higher percentages of ash (1.92) and fat (1.81). For the vitamin content measured in mg/100g, kolanut husk was observed to be higher retinol (0.51) than in the kolanut testa (0.34). Riboflavin, thiamine, niacin and ascorbic acid content were measured to be more in kolanut testa as compared to kolanut husk.

Measured parameters	Husk	Testa
Proximate composition		
Moisture (%)	11.8 ± 0.20^{b}	13.7 ± 0.26^{a}
Ash (%)	1.83 ± 0.04^{b}	1.92 ± 0.01^{a}
Protein (%)	3.78 ± 0.06^{a}	3.52 ± 0.01^{b}
Lipid (%)	1.67 ± 0.02^{b}	1.81 ± 0.01^{a}
Fiber (%)	7.39 ± 0.70^{a}	6.79 ± 0.05^{b}
dry mat (%)	88.20 ± 0.25^{a}	85.96 ± 0.40^{b}
NFE (%)	85.33 ± 0.20^{b}	86.30 ± 0.32^{a}
Vitamins		
Retinol (mg/100g)	0.51 ± 0.01^{a}	0.34 ± 0.02^{b}
Riboflavin (mg/100g)	0.19 ± 0.01^{b}	0.31 ± 0.01^{a}
Thiamine (mg/100g)	0.12 ± 0.01^{b}	0.26 ± 0.01^{a}
Niacin (mg/100g)	0.58 ± 0.02^{c}	1.85 ± 0.03^{a}
Ascorbic acid (mg/100g)	38.01 ± 0.02^{d}	41.58 ± 0.04^{a}

Table 1: Proximate composition and vitamin content of kolanut husk and testa.

Table 2 shows the mineral, cyanide and vitamin composition of kolanut waste, kolanut husk had higher composition of copper (Cu), potassium (K), Manganese (Mn), Sodium (Na), phosphorus (P) and zinc as compared to kolanut testa, all measured in mg/100ml. Calcium (Ca) and Iron (Fe) were minerals noted to be higher in kolanut testa measuring 15.9 and 0.69 as compared to 10.70 and 0.4 of kolanut husk correspondingly. The cyanide content measured in µg/100g was observed to be 0.001 and 0.0115 in kolanut husk and testa respectively.

The weekly weight of broiler chicken fed kolanut husk formulated feed measured in grams (g) (Table 3). The minimum and maximum weight of day old broilers purchased from hatchery was 45.21 g and 51.08 g respectively with no level of significance. The weights of broilers across treatments by the end of first week of breeding was observed as follows; 95.81g, 72.30 g, 77.90 g in broilers fed ten, thirty and fifty percent kolanut husk formulated feed while the control weighed 90.55 g with significant difference ($P < 0.05$). Their weight at the end of eight weeks of breeding was;

Minerals	Husk	Testa
Ca (mg/100ml)	10.7 ± 0.56^{b}	15.9 ± 0.06^{a}
Cu (mg/100ml)	0.4 ± 0.05^{a}	0.37 ± 0.0^{3}b
Fe (mg/100ml)	0.4 ± 0.02^{b}	0.69 ± 0.01^{a}
K (mg/100ml)	4.5 ± 0.14^{a}	3.75 ± 0.00^{b}
Mg (mg/100ml)	1.67 ± 0.04^{b}	2.35 ± 0.07^{a}
Mn (mg/100ml)	0.64 ± 0.04^{a}	0.44 ± 0.00^{b}
Na (mg/100ml)	6.86 ± 1.37^{a}	6.61 ± 1.54^{b}
P (mg/100ml)	4.0 ± 0.28^{a}	3.9 ± 0.28^{b}
Zn (mg/100ml)	1.45 ± 0.07^{a}	1.02 ± 1.17^{b}
Cyanide (µg/100g)	0.0015 ± 0.0007^{b}	0.0115 ± 0.0007^{a}

Table 2: Mineral composition and cyanide content of kolanut husk and testa.

Key: Ca- calcium, Cu –copper, Fe- Iron, K- potassium, Mg- magnesium, Mn- manganese, Na- Sodium,

P- phosphorus, Zn- zinc.

1425.0 g, 923.75 g, 837.50 g and 1881.25 g for broilers feed the ten percent, thirty percent, fifty percent and the control feeds respectively with significant difference ($P < 0.001$). There was no significant difference in the weekly weight gain of broilers feed with and without enzyme inclusion in their feed.

Table 4 presents the haematology of blood samples (collected from jugular vein) from broilers after eight weeks of breeding. The values obtained were compared with the avian haematological reference standard, and it was observed to be within the normal range for healthy chickens. Erythrocyte level ranged from 3.0 to 8.0 mm, PCV ranged from 22 to 29%, RBC ranged from 7.3 to 10.0 (x 10,000/cubic mm). The lymphocyte (LYM), neutrophile (Neu), monocyte (Mono), eosinophile (EOS), basophile (BASO) ranged from: 58-62%, 20-27%, 9-15%, 2-3% and 1-2% respectively. The values obtained for pack cell volume, hemoglobin, monocyte and basophile were not significantly different across the treatments for each parameter. Erythrocyte, red blood cell, lymphocyte and neutrophil were significantly different at $P < 0.05$ while eosinophile was at $P < 0.01$.

Discussion

Proximate, mineral, cyanide and vitamin composition of milled kolanut husk and testa were determined in order to adequately formulate the broiler feed that will enhance good growth performance. Also, based on the proposition of the components determined, kolanut husk was more adequate nutritionally than the testa. The

Weeks	10% A	10%a	30%B	30%b	50%C	50%c	control	Probability level	Level of significance
0	51.038	50.825	45.213	46.213	45.250	48.863	47.575	0.3507	NS
1	95.814^{a}	93.500^{ab}	72.300^{b}	73.713^{b}	77.900^{ab}	73.650^{b}	90.550^{ab}	0.0492	*
2	179.05^{abc}	198.94^{a}	155.43^{bc}	146.55^{c}	150.45^{bc}	146.39^{c}	219.34^{a}	0.0096	**
3	287.36^{bc}	340.86^{b}	256.64^{c}	238.99^{c}	228.25^{c}	205.95^{c}	457.09^{a}	0.0001	***
4	426.65^{bc}	520.81^{b}	379.98^{cd}	360.79^{cd}	312.98^{d}	309.65^{d}	735.89^{a}	0.0001	***
5	589.20^{b}	610.19^{b}	487.73^{bc}	457.84^{c}	409.80^{c}	388.71^{c}	920.83^{a}	0.0001	***
6	930.76^{b}	1074.75^{b}	685.95^{c}	609.00^{c}	591.98^{c}	571.55^{c}	1274.00^{a}	0.0001	***
7	1162.50^{b}	1225.00^{b}	871.25^{c}	768.75^{c}	643.75^{d}	637.50^{d}	1731.25^{a}	0.0001	***
8	1425.00^{b}	1393.75^{b}	923.75^{c}	936.25^{c}	837.50^{c}	853.75^{c}	1881.25^{a}	0.0001	***

Table 3: Weekly weight of Ross broiler chickens fed commercial and formulated diet feed using kolanut husk at graded levels.

^{ab}= Means on the same row with different superscripts are significantly different; *=P<0.05, **=P<0.01,*** P<0.001, NS= Not Significant

Where you have (ab) as superscript, it implies that the mean is similar to the one with (a) or (b) superscripts 10% A – broiler fed with 10% husk inclusion; 10% a –broiler fed with 10% husk inclusion + enzyme; 30%B – broiler fed with 30% husk inclusion; 30% a – broiler fed with 30% husk inclusion + enzyme; 50% C – broiler fed with 50% husk inclusion 50% c –broiler fed with 50% husk inclusion + enzyme; Control - broiler fed with commercial feed (Top feed).

Blood parameters	10% A	10%a	30%B	30%b	50%C	50%c	control	Level of significance
ESR	4.50^{ab}	6.50^{a}	5.00^{ab}	4.00^{ab}	4.00^{ab}	3.50^{b}	4.50^{ab}	*
PCV	27.50	24.50	26.00	28.00	27.00	28.50	27.50	NS
RBC	237.00^{ab}	188.50^{b}	216.00^{ab}	251.00^{ab}	233.50^{ab}	257.00^{a}	243.50^{ab}	*
Hb	9.15	8.15	8.65	9.35	9.00	9.50	9.15	NS
LYM	61.50^{ab}	62.50^{a}	61.00^{ab}	60.50^{ab}	61.00^{ab}	61.00^{ab}	59.00^{b}	*
NEU	23.50^{ab}	21.50^{b}	22.00^{b}	26.00^{a}	23.50^{ab}	24.00^{ab}	26.00^{a}	*
MONO	12.00	12.00	13.50	10.00	11.50	11.00	12.00	NS
BGSO	2.00	2.50	2.00	2.50	2.50	2.00	2.00	NS
EOS	1.00^{b}	1.50^{ab}	1.50^{ab}	1.00^{b}	1.50^{ab}	2.00^{a}	1.00^{b}	**

Table 4: Haematology of jugular blood collected from slaughtered Ross broilers fed commercial and formulated diet using kolanut husk at graded levels at eight weeks.

^{ab}= Means on the same row with different superscripts are significantly different; *=P<0.05, **=P<0.01,*** P<0.001, NS= Not Significant

Where you have (ab) as superscript, it implies that the mean is similar to the one with (a) or (b) superscripts

10% A – broiler fed with 10% husk inclusion; 10% a –broiler fed with 10% husk inclusion + enzyme; 30%B – broiler fed with 30% husk inclusion; 30% a –broiler fed with 30% husk inclusion + enzyme; 50% C – broiler fed with 50% husk inclusion 50% c –broiler fed with 50% husk inclusion + enzyme; Control - broiler fed with commercial feed (Top feed).

ESR- Erythrocyte; PCV –Pack Cell Volume; RBC- Red Blood Cell; HB- Hemoglobin; LYM- Lymphocyte; NEU- Neutrophile; MONO- Monocyte; BGSO- Basophile; EOS- Eosinophile.

proximate composition of kolanut husk meal in this study is in variance with that reported by Emiola., *et al.* [11] who reported crude protein to be 9.98%, fiber 16.74%, 42.39% for NFE and dry matter 90.02%. This could be as a result of difference in species of kolanut husk used and environmental condition from which the samples were obtained. Also, a possible reason is difference in treatment of the waste such as subjecting samples to fermentation as done in this study. Fabunmi and Arotupin [12], documented the proximate composition of fermented and unfermented kolanut husk thus reporting that the fiber content of unfermented kolanut husk sample is high as compared to those subjected to fermentation. A major reason why the agricultural waste was subjected to solid state fermentation in this study was to reduce its bulkiness due to its high fiber. Hamzat and Babatunde [13], had previously reported the use of kolanut husk as replacement for certain percentage of maize in poultry feed due to its nutritive value but that the fiber content needed to be reduced for birds to have good growth perform. Based on research conducted in recent years, the inclusion of moderate amounts of fiber from different sources in poultry feed improves the development of digestive organ, enzyme secretion, helps improve nutrient digestibility, growth performance, gastrointestinal tract health and animal welfare [14-16].

The amount of protein in kolanut husk used in this study was 3.78%, which is low compared to the required protein for broilers and so other proteinous ingredient was included such as bone meal, methionine, and lysine. Methionine and lysine are amino acids which help in synthesis of other proteins to meet up with required protein level [17]. The fat content of kolanut husk meal was measured to be 1.67% in same range and lower than those obtained by Yuli (2012) and Sundu., *et al*. [18] who reported fat content of cassava skin as 1.99% and palm kernel as 8-17% respectively while Ogba and George [19], recorded 1.71% in melon husk. Fat is important in poultry diet because it helps; supply energy, improve absorption of fat-soluble vitamins, reduces passage rate of digesta in the gastrointestinal tract (which allows for better absorption of all nutrients present in diet) and increases the efficiency of consumed energy [20]. Cassava peels, melon husk, palm kernel and a host of other agricultural residues have been employed as ingredient for formulation of poultry feed with yield of good performance in poultry birds.

Kolanut husk meal has considerable about of minerals and vitamins as observed from the study. Fabunmi and Arotupin [6] reported for the presence of ascorbic acid and antioxidants in different species of kolanut waste (husk and testa). Ogba and George [19], have reported the presence of minerals such as the ones determined in this study, as useful in poultry feed. Minerals such as magnesium prevent sudden death, iron and copper prevents anaemia, zinc prevents poor feathering and short bones, calcium prevents rickets. Vitamins such as niacin prevents inflammation of tough and mouth cavity, thiamine (B1) prevents loss of appétit and death, riboflavin (B2) prevents curly-toe paralysis and poor growth, ascorbic acid (Vit C) prevent damage stimulated by heat stress were all contained in kolanut husk as analyzed. The recommended levels of mineral and vitamins for poultry in general are depended on environmental conditions, stressor level, genetic line and age [21].

The daily weight gain of broiler placed on 10% A, 30% B, 50% C (without enzyme) and 10% a, 30% b, 50% c (with enzyme) feed treatment was not significantly different within treatments but significantly different between treatments (Table 3). A decline in feed intake was recorded in birds fed with 30% B and 50% C kolanut husk as compared to 10% A feed treatment which corresponds with the work of Ukachukwu [22] who recorded decline in feed intake of birds fed cassava meal diets. Reduction in feed intake had drastic effect on growth rate and performance of Ross broilers fed higher levels of kolanut husk generally. Hassan., *et al*. [23] reported a decrease in daily weight gain of broiler birds when cassava flour was substituted with maize at graded levels. Zanu., *et al*. [24] also reported low growth performance when 75 and 100% inclusion levels of cassava meal were added to poultry fed. They reported that 25% inclusion level of cassava meal had no adverse effect on performance of broiler. However, inclusion of kolanut husk above 10% had advance effect on broiler growth performance as observed from this study. They documented that a contributively factor to poor growth performance in poultry is their inability to retain crude fiber in feed ingredient within the system which could as be the case in this study.

Research on using palm kernel meal as inclusion in broiler feed has been documented by Sundu., *et al*. [25] and they reported inclusion levels of 20% and as high as 40% in broiler diet without ill effect on them, irrespective of the fact that palm kernel contains fiber as high as 21-22% compared to 7.39% of kolanut husk. Report of Sundual and co-workers showed amino acids and metabolizable energy as important factors to consider in poultry diet with high fiber content. From the fore going therefore, supplementation with other essential amino acid (such as tryptophan, arginine, valine) other than methionine and lysine might be necessary in kolanut husk based poultry feed to suffice for proteins trapped in the cell walls not accessible for utilization by the chickens. Decline in feed intake by poultry birds was suggested by Abioye., *et al*. [26] to be due to high crude fiber in agricultural residues used for their feed formulation. Fiber increases the bulkiness of diet and imposes a physical limitation on the intake of such feed and also, level of fiber and feeding determines its digestibility.

Research work carried out by Savory and Gentle, (1976) on birds showed high fiber diets has effect on weight gain of birds as compared to diets with low fiber content. Diarra., *et al*. [27] reported that digesta retention time in the gastrointestinal tract is usually increased when fiber content in diets is high thus lowers feed intake. In comparing fiber content of kolanut husk used in formulating broiler feed to values documented by other authors who have worked on feed, it will be agreed that fiber is not the major limiting factor for good growth performance in this study. Low feed intake will preferably be attributed to astringency associated with kolanut waste generally. The astringency is increased as the quantity of husk meal added to poultry feed increased and this effect needs be balanced if good performance is expected. The amount of energy consumed per day from a feed has drastic effect on the proportion of metabolisable energy obtained from each gram of feed, and thus determine weight gain or loss. The ill effect observed in growth performance of birds in this research could apart from taste, be due to high or low bulk density and water holding capacity of kolanut husk as reported by Sundu., *et al*. [25] to determine the rate at which feed passes the digestive tract. These parameters even though not studied in this work could be a limiting factor

Kolanut husk is also known to contain a number of antinutrients (such as phytate, tannin, alkaloid, flavonoid, oxalate) as reported by Fabunmi and Arotupin [6] which could interfere with nutrient absorption at high concentrations. Antinutrients such as phytate affects bioavailability of minerals, tannin chelates metals, inhibits digestive enzymes and precipitates proteins [28,29]. These are possible factors that could have contributed to the ill growth performance observed in this study. Ross broilers fed controlled commercial diets consumed more feed and invariably gained more weight than those on kolanut husk diet-based meal. Oluokun and Oalokun [30] documented improved weight gain and feed intake in rabbits fed kolanut husk diets. Abioye., *et al*. [26] made a submission that such was possible because rabbit could utilize protein contained in cellulose rich feeds unlike poultry animals which cannot economically feed on cellulose. Cellulose rich material in agro-products such as kolanut husk can be broken down with the help of symbiotic microorganisms and enzymes.

Performance of broiler chickens fed kolanut husk diet supplemented with enzyme (polyzyme) showed no significant difference in weight gain when compared with those fed diet without enzyme, most especially birds on 30% and 50% graded level diets. McCracken., *et al*. [31] documented a non-improvement in chicken performance fed diets with enzyme supplement which concurs with the observation of this study. This same trend was also observed by Troche., *et al*. (2007) but nutrient digestibility was improved. Iyayi and Davies [32] however documented positive effect of supplementing palm kernel meal diet with enzyme as compared to the growth of broilers fed corn-soy diet. Luis, (2002) made similar report on the use of mannan degrading enzymes as support for maximum growth of broiler. An explanation for ineffectiveness of polyzyme utilized in the broilers as observed could be attributed to delay in supplementing the diet with the enzyme. The enzyme was included in their diet at fourth week of breeding. The ineffectiveness of enzyme preparations has been documented to also vary between and within species **(**Danicke., *et al*. 1999).

Also, for an enzyme to be effective in poultry diet, it is suggestive that an adequate enzyme to substrate ratio should be present in the diet. In this study for instance, 25g of polyzyme was added to 25kg of formulated feed. The quantity might have been too small in relation to the substrate. Another factor considered is that, the enzyme has the tendency of responding differently to various ingredients making up the formulated poultry diet. Such differences can arise from presence of limiting factors (such as antinutrients), substrate location in the ingredient and difference in accessibility or solubility of the enzyme [33]. When nutrient digestibility is increased by supplementing high fiber diet with enzyme, it apparently increases the metabolisable energy and decreases the moisture content of faece which helps to cope with the problem of wet feces [18]. During the first four weeks of breeding, wet feces was passed out by the chickens which improved on addition of enzyme to their diet. A suggestive way therefore to cope with the problem of decline in weight or weight loss in broiler chickens fed kolanut husk based-fed is to formulate the diet based on digestible amino acids, digestible nutrient, metabolisable energy in the ingredients and supplement with adequate amount of enzyme at onset of breeding.

When rate of weekly weight gain of broilers during the first four weeks was compared to weight gain at subsequent weeks (5-8), the weight gain was observed not to be proportionate. This same trend was observed by Rjoup [34] who reported decline in growth rate of Hubbard classic broiler birds at sixth week of breeding. Goliomytis., *et al*. [35] also reported that the growth rate of birds increased steadily up to the sixth week of age and then declined, in agreement with finding of this study. They indicated that such reduction was not expected but could be associated with high environmental temperature during the last weeks of experiment thus affecting body weight gain of birds just as documented by Feddes., *et al*. [36] also. This present study however agrees with their submission because the experiment was conducted at a period when heat was at its peak (between September to November 2017 in Akure Ondo State, Nigeria). Supplementing the diet with Saccharomyces cerevisiae during the hot season was reported by Buba [37] and co-workers to significantly improve apparent digestibility of feed. The work of

Alkhalf [38] also suggested that the presence of probiotic bacteria might improve the body weight, weight gain, consumption of feed and feed conversion ratio of chickens at such periods of heat stress.

The result of haematological analysis (Table 4) obtained in this study was within the avian reference range of healthy birds recorded in the exotic animal hematology and cytology by Campbell [39]. Unigwe [40], Hassan., *et al*. [23] and Zanu., *et al*. [24] all reported no detrimental effect on blood haematological parameter of broilers fed cassava diet as compared with those fed maize diet. Less than 4% (2) mortality was recorded out of the fiftysix birds breeded, indicating no significant effect of dietary treatments on birds. One died on transport from hatchery due to stress while the other death recorded from the 50% feed treatment was due to chocking because the bird was observed to be gasping for air while feeding [41-47].

Conclusion

Generally, growth performance of broilers fed ten percent inclusion level of kolanut husk (10%) was better as compared to those fed 30% and 50% graded level kolanut husk. The inclusion of enzyme in formulated feed had no significant effect on growth performance of Ross broilers in terms of weight gain in the study. The inclusion of kolanut husk at the graded levels used did not have any detrimental effect on the health of Ross broilers. Kolanut waste is quite nutritive but cannot be used at more than 10% graded level to replace maize in broiler diet for good growth performance if digestive enzyme is to be added at finisher phase of breeding. It is therefore recommended that digestive enzyme be included in kolanut based poultry feed from the starter phase as oppose the finisher phase used in this study. Also, supplementation with essential amino acid other than methionine and lysine might be necessary in kolanut husk based poultry feed because of its bulkiness to suffice for proteins trapped in the cell walls not accessible for utilization by the chickens. A number of wastes have been used for the formulation of feed with good performance yield. A central collection centre can be introduced for agricultural waste collection to discourage indiscriminate disposal into the environment.

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