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Response of finisher broiler chickens to maize offal-based diets supplemented with combination of *Kingzyme*® and *Growinact*® enzymes

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Target Audience: Broiler Farmers, Feed millers, Animal Scientists

Abstract

The competitive nature and price fluctuating attributes of maize have necessitated the need for alternative energy feed stuff in poultry nutrition. This study was conducted to investigate the response of finisher broiler chickens to replacement of maize with maize offal supplemented with combination of Kingzyme® and GrowinAct® enzymes. Two hundred four-week old Ross 308 broiler chickens were randomly distributed to five dietary treatments. Diet 1 was the control (no maize offal and no enzyme) while diets 2, 3, 4 and 5 had maize offal supplemented with combination of Kingzyme® and GrowinAct® enzymes replacing 25, 50, 75 and 100% of maize respectively. There were four replicates per treatment with ten birds per replicate in a completely randomized design. Data were collected on growth performance indices, nutrients digestibility and blood profile and they were subjected to one way analysis of variance. Results show no significant difference among the growth performance parameters except for feed intake where treatments T1 and T2 had significantly higher feed intake compared to others. Nutrients digestibility values were not significantly different among the treatments. All serum biochemical and haematological values were not significantly different except for PCV and haemoglobin where treatment T4 was significantly lowest in each case. It was concluded that maize offal supplemented with combination of Kingzyme® and GrowinAct® enzymes have no detrimental effect on the observed parameters. It is therefore recommended that maize offal supplemented with combination of Kingzyme® and GrowinAct® enzymes can replace 100% of maize in the diets of finisher broiler chickens

Key words: Energy; Enzymes; GrowinAct; Kingzyme; Maize offal; Finisher

Description of Problem

Energy feedstuffs in poultry nutrition contribute a significant amount to the final feed. Commonly used energy feedstuffs are cereal grains like maize, wheat and guinea corn. The use of maize in poultry nutrition is increasingly becoming threatened because of its competition among industry, poultry and human beings. Maize accounts for about 40-60% of a typical poultry feed (1, 2). For such an ingredient, the availability and price will determine to a large extent the survivability and economics of production of the poultry industry. Thus, there is need for alternative feedstuff to replace maize. Several non-competitive materials like Palm kernel cake, rice offal and brewers dried grains have been evaluated for this purpose. However, the most common problem with this agro-industrial waste is the high fiber content which limits its utilization by poultry species.

The need for exogenous enzymes in poultry feeding has long been emphasized. Exogenous enzymes are used to improve the digestibility of feedstuffs that are ordinarily not digestible by livestock species especially monogastric animals. This is essential to improve the digestibility of alternative feedstuffs and reduce the cost of production as feed accounts for about 70% of the cost of poultry production **(**3**)**. The efficacy of exogenous enzymes has been reported especially for poultry nutrition. However, it has been postulated/observed that fiber is not a chemically uniform substance and the components/fractions vary from source to source. Thus, the efficacy of one exogenous enzyme will vary from one feedstuff to another. Also, the profile of exogenous enzymes varies in addition to the activity of each enzyme in the complex. Activity determines the extent to which the substrate can be digested. This has brought about the idea of enzyme cocktail which is used to describe the combination of different types of enzymes on the same feedstuff or feed.

Maize offal is a by-product of dry milling of maize. It is not conventionally used in poultry nutrition because of its relatively high fiber content. According to (4) maize offal has about 11.0 % crude protein and about 8.50 % crude fibre. Though the protein is slightly higher than that of maize (8.8%), the metabolizable energy is however lower than maize (2600 vs 3360Kcal/Kg). This could be attributed to the crude fiber content which is not easily digestible by poultry species. Report has it that use of maize offal beyond 40% could lead to reduced weight gain in broilers. However, this effect can be ameliorated by the addition of exogenous enzymes (5). It has been postulated that because of the heterogeneous nature of crude fiber, a single purpose enzyme may not be effective enough in alleviating the effect of fiber in poultry nutrition. This has led to the principle of enzyme cocktails which is a combination of several types of enzymes on the same feedstuff. For instance (6) observed that combination of xylanase, amylase, and protease resulted in improved retention of energy and protein in a corn and SBM-based diets for broilers compared to use of protease alone. Similarly, (7) reported that enzyme cocktails performed better than individual enzymes in improving the metabolizable energy value of palm kernel cake.

This study was therefore designed to investigate the response of finisher broiler chickens to maize offal-based diets supplemented with combination of Kingzyme and GrowinAct enzymes. Specific focus was placed on effect on growth performance, nutrient digestibility and blood profile.

Materials and Methods

Location: The experiment was conducted at the poultry unit of Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University (formerly Federal University of Agriculture), Makurdi, Benue State Nigeria. Makurdi lies between latitudes 7º 14′ N and 9º 52′ N and longitude 8º 35′ E and 8º 41′ E in the Guinea savannah zone of Nigeria. Temperature ranges from 26^0C to 40^0C (8)

Collection of Test Materials: Maize offal was obtained from milling operators at Wadata market, Makurdi. It is a product of dry milling of maize. It was further sun dried to reduce its moisture content. Kingzyme® and GrowinAct® enzymes were obtained from a commercial feed mill operator in Kaduna. Kingzyme enzyme consists of xylanase, beta-glucanase, mannase, pectinase, protease, amylase and cellulase. It is manufactured by WEIFANG KDN Tech. Co. Ltd, China and is to be included at 200g per tonne of feed. GrowinAct enzyme consists of xylanase, cellulase, beta-glucanase, beta mannanase, alpha amylase, beta galactosidase, pectinase, lipase and protease and is to be included at 100g per ton of feed.

Composition of Experimental Diets: Five broiler finisher diets were carefully formulated and produced to meet the nutrients requirements of the birds as recommended by (4). Maize offal supplemented with combination of both Kingzyme and GrowinAct enzymes replaced 0%, 25%, 50%, 75% and 100% of maize (60%) in the diets and labelled as Diet 1, Diet 2, Diet 3, Diet 4 and Diet 5 respectively. The diets were formulated to be isonitrogenous but with different metabolizable energy values as shown in Table 1.

Table 1: Composition of experimental broiler finisher diets

	Treatments				
Feedstuffs (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	60	45	30	15	0
Maize offal	0	15	30	45	60
Palm oil	1	1	1	1	1
SBM	32	32	32	32	32
Blood meal	2	2	2	2	2
Bone meal	2.5	2.5	2.5	2.5	2.5
Oyster shell	1.5	1.5	1.5	1.5	1.5
Lysine	0.2	0.2	0.2	0.2	0.2
DL-Methionine	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3
Premix	0.25	0.25	0.25	0.25	0.25
Kingzyme®	-	+	+	+	+
GrowinAct®	-	+	+	+	+
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Crude protein, %	22.00	22.00	22.00	22.00	22.00
ME, Kcal/Kg	2887	2773	2659	2545	2431
Crude fiber, %	3.58	4.75	5.92	7.09	8.26
Ether extract, %	4.37	4.33	4.23	4.24	4.19
Calcium, %	1.37	1.37	1.36	1.34	1.36
Av. Pho., %	0.50	0.49	0.48	0.46	0.45
Lysine, %	1.32	1.34	1.36	1.38	1.4
Methionine. %	0.53	0.52	0.53	0.53	0.53

Diet1: Control with 0% maize offal and no enzyme ; Diet 2: Maize offal + enzyme combination replaced 25% of maize; Diet 3: Maize offal + enzyme combination replaced 50%of maize; Diet 4: Maize offal + enzyme combination replaced 75% of maize ; Diet 5: Maize offal + enzyme combination replaced 100% of maize
SBM: Soya bean meal, ME: Metabolizable Energy, Av. Pho.: Available phosphorus
-: No enzyme
+: Enzyme (kingzyme® at 0.02% + GrownAct® at 0.01%)

Experimental Design and Management of Birds

Two hundred four- week old Ross® 308 broiler chicks were randomly allocated to five dietary treatments (Diet1, Diet 2, Diet 3, Diet 4 and Diet 5) each replicated four times with ten birds per replicate in a completely randomized design. The birds were raised on the floor and the experimental feeds and water were supplied *ad libitum* throughout the experimental period which lasted for 28 days.

Data Collection

Data were collected on growth performance parameters, nutrients digestibility and blood profile. Growth performance data were collected on feed intake, weight gain

and feed conversion ratio. Total feed intake per bird was determined as the difference between the initial feed offered and the weight of left over feed divided by the number of birds per replicate. Weight gain per bird was determined as the final weight minus initial weight of the birds per replicate and divided by number of birds in the replicate.

Nutrient digestibility trial was conducted at third week of the study. One bird per replicate was removed and taken to the metabolic cage for digestibility trial. The birds were allowed two days acclimatization period. Thereafter, a weighed amount of respective experimental diet was supplied and faecal collection was done every day for five days. The faecal collections were oven-dried to prevent spoilage. At the end of the fifth day, the faecal collections for each replicate were pooled together, weighed and samples taken for proximate analysis in accordance with the procedure of (9). Samples of the feed were also subjected to proximate analysis. Nutrients digestibility was calculated using the formula below.

$$\text{Apparent Nutrient Digestibility (\%)} = \frac{\text{Nutrient Intake (g)} - \text{Nutrient Output (g)}}{\text{Nutrient Intake (g)}} x\ 100$$

For blood profile, two millilitres of blood samples were collected into a bottle containing EDTA to avoid clotting. The blood samples were analysed for haematological parameters. Packed cell volume (PCV) was determined using Haemocrit reader. Red blood cells (RBC), White blood cells (WBC) and Haemoglobin were measured using an automated cell counter within twenty four hours of collection of the blood samples at Veterinary Teaching Hospital of Joseph Sarwuan Tarka University Makurdi. The mean corpuscular haemoglobin, mean corpuscular volume and mean corpuscular haemoglobin concentration were all determined in line with the procedure of (10) using the formulas below.

$$\text{MCH (pg/cell)} = \frac{\text{Haemoglobin(g/100ml)}}{\text{RBC counts (millions/}\mu\text{l)}}$$

$$\text{MCHC (g/dl)} = \frac{\text{Haemoglobin(g/100ml)x 100}}{\text{PCV (\%)}}$$

$$\text{MCV (FL)} = \frac{\text{10 x PCV(\%)}}{\text{RBC counts (millions/}\mu\text{l)}}$$

Another two millilitres of blood samples were also collected into a bottle without EDTA. The bottles containing the blood samples were shaken and then allowed to settle down. The serum was later analysed for albumin, glucose, creatinine, cholesterol and the liver enzymes (alkaline phosphatase, alanine amino transaminase and aspartate amino transaminase) using Randox kit (Randox Laboratories Ltd, County Antrim, United Kingdom).

Statistical Analyses

All data collected were subjected to one way analysis of variance using Statistical Package for Social Sciences software. Where necessary, treatment means were separated using Duncan multiple range test.

Results and Discussion

Growth Performance

The growth performance of finisher broiler chickens fed diets with graded levels of maize offal supplemented with combination of *Kingzyme* and *GrowinAct* enzymes (Table 1) shows that there was significant difference in the feed intake of the birds. Birds on the control diet (no maize offal and no enzyme) as well as birds on the diet with maize offal replacing 25% of maize had significantly higher ($P<0.05$) feed intake compared to birds on the other treatments (Diet3, Diet4 and Diet5). However, there were no significant differences ($P>0.05$) among the treatments in their effects on final weight, weight gain and feed conversion ratio (FCR).

The significantly different feed intake can be attributed to effect of the maize offal as fiber is known to reduce feed intake due to bulkiness (1). However, once enzymes are available the crude fiber is degraded to yield simple sugars which may have met the energy requirement of the animal thereby leading to a reduced feed intake compared to the control. Values of total feed intake obtained in this study are lower than 3452.96 -3815g obtained by (11) where maize offal-based diets were fed to finisher broiler chickens with no enzyme inclusion. Enzyme inclusion enhanced fiber digestion which released more energy compared to feed without enzyme and increased energy supply will lead to reduced feed intake by the birds. The non-significant difference in the weight gain and FCR for the finisher broiler chickens in this study is an indication that the increasing level of maize offal supplemented with the enzymes has no negative effect on feed utilization which has resulted in comparable weight gain and feed conversion ratio with the control. Fiber feedstuffs like wheat offal and maize offal at higher inclusion level are known to cause reduced weight gain in broiler chickens (12). Despite the high level of crude fiber in this study (ranging from 3.82 to 8.26%), there was no significant reduction in weight gain. This effect could only be attributed to the activities of enzymes that may have acted positively on the fiber in the feed to reduce its (fiber) negative effect on feed utilization especially for monogastric animals. Exogenous carbohydrase enzymes are known to have positive effects on non-starch polysaccharides components of crude fiber and this will lead to production of simple sugars like glucose that are used in generating energy to promotes the physiological and metabolic activities in the body. This has resulted in similar utilization of the feed as seen with the feed without enzyme and maize offals. Values of weight gain obtained in this study are higher than values obtained by (13) where nutrase xyla and maxigrain were used with maize offal and also higher than values obtained by (14) where palm kernel meal was supplemented with cellulase. These findings also buttress the fact that combination of enzymes could improve the utilization of the fibre feedstuff beyond the effect of individual enzyme. This effect could be due to the difference in the profile and activity of the components of the enzymes.

Table 2: Growth Performance of Finisher Broiler Chickens (5-8 weeks) Fed Maize offal-based Diets Supplemented with Combination of *Kingzyme* and *GrowinAct* Enzymes

	Treatments					
Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	P-value
Initial weight (g)	766.20	713.12	739.99	739.91	751.61	0.57
Total feed intake (g/b)	2996.38^{b}	2899.98^{b}	2744.47^{a}	2698.79^{a}	2368.96^{a}	0.04
Daily feed intake (g/b)	107.01^{a}	103.57^{a}	98.02^{b}	96.38^{b}	84.61^{b}	0.04
Final weight (g/b)	2053.37	1993.66	1888.49	2076.79	1944.38	0.23
Weight gain (g/b)	1287.18	1280.53	1148.51	1336.88	1192.77	0.12
Daily weight gain (g/b)	45.97	45.73	41.02	47.75	42.60	0.12
Feed Conversion Ratio	2.33	2.27	2.40	2.02	2.00	0.06

Diet1: Control with 0% maize offal and no enzyme; Diet 2: Maize offal + enzyme combination replaced 25% of maize; Diet 3: Maize offal + enzyme combination replaced 50%of maize; Diet 4: Maize offal + enzyme combination replaced 75% of maize; Diet 5: Maize offal + enzyme combination replaced 100% of maize

Nutrients Digestibility

The nutrient digestibility of finisher broiler chickens fed diets with graded levels of maize offal supplemented with combination of *Kingzyme* and *GrowinAct* enzymes is shown in Table 3. There were no significant differences (P>0.05) among the treatments in their effects on digestibility of crude protein, ether extract, crude fiber and nitrogen free extracts.

Digestibility of feed is directly related to the nutrient profile of the feedstuff. High level of fibre in the diet has negative effects on digestibility of key nutrients like protein, ether extract and nitrogen-free extract (15). However, enzyme supplementation is known to alleviate this problem by breaking down NSPs that encapsulate crude protein and other nutrients thereby making the protein accessible to the appropriate enzyme (16). The non-significant difference in digestibility of crude protein, ether extract and NFE in this study may be attributed to the effects of the enzymes. This could imply that the envisaged reduced digestion of crude protein, ether extract and NFE has been ameliorated by the action of the two enzymes. It could be inferred that the non-significant crude fiber digestibility may have been by the action of the enzymes to meet up the energy requirements in the diets especially for treatments T4 and T5. Values of digestibility obtained in this study are relatively high and indicate the effectiveness of the enzymes combination.

Table 2: Apparent Nutrient Digestibility by Finisher Broiler Chickens Fed Maize Offal-based Diets Supplemented with Kingzyme and GrowinAct Enzymes

	Treatments					
Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	P-value
Dry matter	86.85	84.35	84.33	82.32	80.44	0.74
Crude protein	82.27	79.12	79.84	76.46	74.38	0.78
Ether extract	91.58	90.92	92.27	88.51	88.18	0.44
Crude fiber	60.41	61.41	72.10	75.54	76.38	0.50
Nitrogen-free extract	92.02	90.07	89.29	87.62	86.39	0.50

a, b: Means within the same row with different superscript are significantly different (*P*=.05)
Diet1: Control with 0% maize offal and no enzyme ; Diet 2: Maize offal + enzyme combination replaced 25% of maize; Diet 3: Maize offal + enzyme combination replaced 50%of maize; Diet 4: Maize offal + enzyme combination replaced 75% of maize; Diet 5: Maize offal + enzyme combination replaced 100% of maize

Blood Profile (Haematology and Serum Biochemistry)

The haematological parameters of broiler chickens fed diets with graded levels of maize offal supplemented with combination of *Kingzyme*® and *GrowinAct*® enzymes are shown in table 3. Treatment Diet4 is significantly lower ($p<0.05$) than others (Diets 1, 2, 3 and 5) in their effects on Packed cell volume (PCV) and Haemoglobin. However, the treatments are not significantly different in their effects on Red blood cells (RBC), White blood cell (WBC), Neutrophil, Lymphocyte, Eosinophil, Monocyte and Mean corpuscular haemoglobin concentration (MCHC).

Alanine amino transaminase (ALT), Aspartate amino transaminase (AST), creatinine, cholesterol, glucose, total protein, albumin and globulin are not significantly different ($P>0.05$) among the treatments (Table 4). Alkaline phosphatase levels of the experimental birds were not significantly different across the treatments ranging from 88.67 to 127.00. Diets have effects on blood profile and haematology and serum biochemical components of animals are positively correlated to the quality of the diet (17, 18). For example, lowered red blood cell counts, haemoglobin and PCV have been linked to protein deficient diets. According to (19), reduction in PCV values can be due to presence of toxic factors which has adverse effects on blood forming activities. Values for haematological parameters obtained in this study are not significantly affected by dietary treatments. The PCV values obtained in this study are within the range as reported by (20) except for treatment T4

which is significantly lower. This indicate that the inclusion of maize offal supplemented with the enzymes have no detrimental effect on the blood forming ability of the birds. Haemoglobin values are also not negatively affected as values obtained, though significantly different among treatments, are still within the normal range of 7-13g/dl as reported by (20).

The MCV values obtained in this study for treatments with 50, 75 and 100% of maize replacement for maize offal are below the standard range (90.0-140.0fl) as reported by (21) athough the values are not significantly different from the control and diet T2 where maize offal replaced 25% of maize. This observation could be due to extraneous factor like pathological infections as maize offal is not known to interfere with the absorption of iron which deficiency can lead to low MCV. Values of MCH, WBC and heterophil observed in this study are also within the reference values for healthy birds as reported by (20). This could be attributed to the fact that maize offal supplemented with the enzymes has no adverse effects on the blood constituents. The monocyte and eosinophil values obtained in this study are lower than the normal reference range as reported by (20). This could mean that the birds were not challenged by diseases that would have warranted a higher level of these differentials. However, these values are not significantly different within the treatments.

Values of serum biochemical parameters obtained in the study are similar to standard reference values for chicken. For instance, glucose, protein and AST values are not significantly different and glucose and protein values fall within the normal range of 200-500mg/dl and 3-4.9g/dl respectively as reported by (22) and (23) while AST values for treatments T4 and T5 are numerically lower that the lower limit of the normal range (70-220). However lower than normal AST is not considered of concern and it may also indicate good liver functioning. This indicate that the lower AST values obtained in treatments T3 to T5 could imply that the addition of the maize offal supplemented with the enzyme enhanced good liver functioning. Serum glucose level is a measure of the level of digestion of dietary carbohydrate and the non-significant difference in the serum glucose levels in this study despite reduction in the metabolizable energy values and gradual reduction in the inclusion level of maize indicates that the enzyme combination was effective in producing absorbable simple sugars from the complex non starch polysaccharides in the maize offal. Similar reason may be adduced for the serum protein level as it could be inferred that the enzymes were effective in preventing the encapsulating effect of fiber on protein. According to (24), the total protein value is used as a reflection of the digestion of protein fed to birds and adequate serum value is an indication that dietary protein level is adequate in meeting normal serum protein level. Albumin values were also not negatively affected by the levels of maize offal supplemented with the enzymes combination and the values obtained are within the normal range of 10-25g/l as reported by (22). From the results of this study, it could be inferred that maize offal supplemented with combination of *Kingzyme* and *GrowinAct* enzymes did not impact any significant negative influence on serum biochemical and haematological attributes of the experimental birds.

The serum cholesterol values for the experimental birds though not significantly different among the treatments, are higher than reference values of 52-148 as reported by (21). Serum cholesterol is a function of the dietary fat as well as energy level of the diets. Elevated levels of cholesterol observed in this study may be attributed to the effective nature of the enzymes' combination which released energy from the maize offal and the excess energy is then converted to fat through the process of

de novo lipogenesis. Values of cholesterol obtained in this study are also higher 77.12-151.64 mg/dl obtained by (26) where turmeric and clove were used in pullet chicks.

Table 3: Haematological parameters of broiler chickens fed diets with graded levels of maize offal supplemented with cocktail of *Kingzyme* and *GrowinAct* enzymes

	Treatments						
Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	P-value	Reference value
PCV (%)	24.00[a]	23.67[a]	22.00[a]	18.33[b]	22.67[a]	0.03	22.00-35.00*
Haemoglobin(g/dl)	8.00[a]	7.87[a]	7.33[a]	6.10[b]	7.57[a]	0.03	7.0-13.0*
RBC ($x10^{12}$/l)	2.30	2.52	3.03	2.29	2.78	0.28	2.5-3.5*
MCV (fl)	103.67	96.67	73.00	77.00	82.00	0.08	90.0-140.0**
MCH (pg)	34.33	32.69	24.33	25.67	27.33	0.08	33.0-47.0*
MCHC (g/dl)	33.33	33.23	33.33	33.27	33.32	0.62	26-35**
WBC($x10^9$/l)	2.50	1.30	2.43	2.50	2.50	0.64	1.2-3.0*
Heterophil (%)	24.00	32.00	20.67	24.00	16.67	0.62	15.0-40.0*
Lymph. (%)	76.00	66.33	75.67	74.67	82.67	0.74	45.0-70.0*
Eosin. (%)	0.00	0.00	0.67	0.67	0.67	0.68	1.5-6.0*
Mono. (%)	0.00	1.67	1.67	0.67	0.00	1.00	5.0-10.0*
Basophil (%)	0.00	0.00	0.00	0.00	0.00	1.00	Rare

a, b: Means within the same row with different superscript are significantly different (*P*=.05)
Diet1: Control with 0% maize offal and no enzyme ; Diet 2: Maize offal + enzyme combination replaced 25% of maize; Diet 3: Maize offal + enzyme combination replaced 50%of maize; Diet 4: Maize offal + enzyme combination replaced 75% of maize ; Diet 5: Maize offal + enzyme combination replaced 100% of maize
*: Bounous and Stedman (2000) , **: Mitruka and Rawsley (1977)

Table 4: Serum Biochemical Parameters of Broiler Chickens Fed Diets with Graded Levels of Maize Offal Supplemented with Combination of *Kingzyme* and *GrowinAct* enzymes

	Treatments						
Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	P-value	Reference value
ALT (u/l)	7.33	8.00	11.00	11.33	9.00	0.42	9-38*
AST (u/l)	110.33	54.67	78.33	61.67	49.33	0.45	70-220 *
ALP (u/l)	89.00	88.67	96.00	127.00	126.67	0.07	125-200*
Cholesterol (mg/dl)	235.67	271.67	302.33	302.67	410.33	0.87	52-48**
Glucose (mg/dl)	211.33	211.67	211.00	191.00	213.67	0.38	180-250*
Total protein (g/l)	36.67	39.33	43.33	43.00	39.67	0.41	25.0-45.0 *
Albumin (g/l)	20.67	20.00	18.67	20.33	19.00	0.88	10.0-25.0*
Globulin (g/dl)	16.00	19.33	24.67	22.67	20.67	0.44	0.5-1.8 ***

a, b: Means within the same row with different superscript are significantly different (*P*=.05)
Diet1: Control with 0% maize offal and no enzyme ; Diet 2: Maize offal + enzyme combination replaced 25% of maize; Diet 3: Maize offal + enzyme combination replaced 50%of maize; Diet 4: Maize offal + enzyme combination replaced 75% of maize ; Diet 5: Maize offal + enzyme combination replaced 100% of maize
AST: Aspartate aminotransaminase, ALT: Alanine aminotransaminase ALP: Alkaline phosphatase
*: Meluzzi et al. (1992), **: Mitruka and Rawsley (1977), ***: Thrall (2007)

Conclusion and Application

From the findings of this study,

1. It is hereby concluded that the use of maize offal supplemented with combination of kingzyme® and GrowinAct® enzymes has no detrimental effect on growth performance, nutrients digestibility and blood profile of finisher broiler chickens.

2. It is therefore recommended that maize offal supplemented with combination of Kingzyme and GrowinAct enzymes can replace 100% of maize in the diets of finisher broiler chickens.

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