ISSN 0189-0514
J. Anim. Prod. Res. (2016) 28(2):230-238

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EVALUATION OF PERFORMANCE CHARACTERISTICS, APPARENT NUTRIENTS AND MINERALS UTILIZATION OF BROILER STARTER FED TOASTED AFRICAN YAM BEAN (*SPHENOSTYLIS STENOCARPA)*SEEDS MEAL SUPPLEMENTED WITH PROTEASE ENZYME

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ABSTRACT

An experiment was conducted to evaluate performance characteristics, apparent nutrients and minerals utilization of broilers starter fed toasted African yam bean (*sphenostylis stenocarpa)* seed meal supplemented with protease enzyme (TAYBSM+E). Five treatments were formulated with treatment 1 without TAYBSM+E. Treatment 2, 3, 4 and 5 contained 10, 20, 30 and 40% TAYBSM+E respectively to replace soybean meal. A total of 200 day old broiler chicks marshal® strain were purchased but 195 chicks were used for the study that lasted for 35 days. Thirty nine (39) chicks were assigned to each of dietary treatment which was replicated thrice with thirteen (13) birds per replicate in a Completely Randomized Design (CRD). Experimental starter diets were assigned to the experimental birds from day old till the end of the experiment (35 days). Data were collected as at when due for performance and at 28 days (forth weeks), one bird per replicate was picked and transferred into the metabolic cage for apparent nutrient and minerals study that. Results of performance characteristics showed no significant ($P>0.05$) different on initial live weight, feed intake, feed conversion ratio (FCR), mortality while final live weight and weight gain showed significant ($P<0.05$) different. Apparent nutrients and minerals digestibility were significantly ($P<0.05$) influenced. Test diets in this study enhanced nutrients and minerals utilization and it was more pronounced in treatment three (20%TAYBSM+E) than other counterparts. It has great potential to replace soybean meal as alternative plant protein source in broiler chicks' ration and should be encouraged to replace soybean meal as alternative plant protein.

Keyword: broiler production, Crude protein, ether extract researched and utilization

INTRODUCTION

The poultry industry is undergoing a turbulent period (Okorie, 2006), some farmers have closed down and others have been forced to reduce their production capacity due to high cost of feed and feedstuffs (Esonu et al., 2001). The major reason for this scarcity and increased cost of poultry feed has been attributed to increased competition between man and livestock for major feedstuffs (Okorie, 2006). The high cost and irregular supply of the conventional feed sources have stimulated researches into unconventional feed materials that are biologically qualitative (Akpodiete, 2008) locally available, less expensive and non edible to man such as African yam bean. The increases in the cost of feed ingredients along with society's growing expectations of

reduced environmental pollution from animal agriculture have been fueling interest in the use of enzymes in animal diets. Research on the use of exogenous enzymes in broiler diets has been ongoing for decades; however, commercial use of enzymes is more recent. The practical use of phytase in chicken diets is well established and interest in research on the use of enzymes targeting other substrates has increased. Most commercial enzyme products currently available have more than one enzyme activity whereas fewer products have only one substrate specificity.

However, based on protein digestibility values reported in literature, it appears that valuable amounts of protein pass through the gastrointestinal tract without being completely digested (Lemme et al., 2004). This undigested protein presents an opportunity for the addition of specific exogenous proteases. The interpretation of results from studies conducted with protease is sometimes difficult because of confounding effects of the presence of more than one enzymatic activity in a single treatment. Inconsistent and variable results are also frequently found because of feed ingredient diversity and types of proteases that are often not clearly defined, as well as because of methodology differences (Marsman et al., 1997 and Simbaya et al., 1996). On the other hand, research done with products with only one protease activity allows for easier interpretation; however, literature on this type of study with chickens is scarce. Ghazi et al., (2002) reported positive effects of using a single component protease both *in vitro* and *in vivo,* when diets were deficient or marginal in amino acid (A A). In other studies, large differences in bird responses were found between protease sources in terms of true N digestibility but also on ME (Ghazi et al., 2003). It has been hypothesized that the apparent improvements in the digestibility of DM and energy found with supplemental proteases may result in part from negative feedback leading to a reduction in the endogenous production of proteases (Mahagna et al., 1995). Therefore, this study directed toward evaluation of performance characteristics, apparent nutrients and minerals utilization of broiler starter fed toasted African yam bean (*Sphenostylisstenocarpa*) seeds meal supplemented with protease enzyme.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the poultry unit, Teaching and Research Farm Oyo state College of Agriculture and Technology, Igbo-ora, Oyo State Nigeria. The experimental site is in savannah forest zone of Latitude 7.43^{o}N and longitude 3.8^{o}E, with an elevation 140 m above sea level. The average minimum temperature is about 21.50^{o}C and maximum temperature of 32.50^{o}C. The average humidity in the area is 58.00%. The double maximum rainfall is about 214.3 mm in June and 165.2 mm in September, (Sanusi, 2011).

Procurement of African yam bean and other ingredients

African yam bean was procured at Bodija market in Ibadan North local government, while Other ingredients like maize, Soybean meal, methionine, lysine, di-calcium phosphate, limestone were obtained from a reputable feed mill in Ibadan, Oyo State, Nigeria.

Sorting and processing of the test ingredient

The bean was sorted to remove stone, dirt and other spices apart from African yam bean seed (Brown variety) then toasted by using frying pan of 74.5cm by 38.00cm and placed on firewood as the source of heat, stirred continuously to ensure even distribution of heat within 3 to 5 minutes when beans become to crispy.

Chemical composition of African yam bean seeds

The chemical composition of toasted African yam bean was determined in the laboratory by using method of A.O.A.C. (2010). While the metabolizable energy was determined by using formula (Pauzenga, 1985). (37× Crude protein) + (81.8 × Crude fat) + (35.5 × Nitrogen free extract). While Nitrogen free extract was determined by differences as followed: 100 - (Crude protein - Crude fibre – Fat - Ash – Moisture content).

Experimental diets

Five diets were formulated to meet or exceed NRC recommendation (NRC, 1994). All diets were having percentage crude protein ranging between 20.58(%) to22.00 (%). Maize was the major source of energy while soybean meal and toasted African yam bean seeds meal were sources of protein. Treatment one was corn-soybean based (control) while toasted African yam bean seeds meal with protease enzyme was added to treatments 2, 3, 4, and 5 at the rate of 10, 20, 30 and 40% inclusion rate respectively to replace soybean meal (nutrient to nutrient replacement) as shown in table 1.

Table 1: Percentage Composition of broiler starter (0-5weeks)

Ingredients (kg)	T1(Control)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)
Maize	61.00	58.71	56.42	54.13	51.84
Soybean	35.00	31.50	28.00	24.50	21.00
TAYBS	0.00	5.79	11.58	17.37	23.16
DCP	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Premix (B)	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Enzyme (g)	0.00	15.00	15.00	15.00	15.00
Calculated nutrients					
ME (Kcal/kg)	3005.40	3048.91	3058.08	3067.25	3076.42
Crude Protein (%)	22.00	21.27	21.04	20.81	20.58
Ether Extract (%)	3.70	3.74	3.82	3.90	3.97
Crude Fibre (%)	1.92	1.74	1.61	1.53	1.50
Ash (%)	0.80	1.05	1.31	1.57	1.83
Calcium (%)	0.90	0.90	0.91	0.92	0.93
Phosphorus (%)	0.54	0.55	0.57	0.59	0.61

TAYBS= Toasted African yam bean seed. DCP: Di-calcium phosphate. ME= Metabolizable energy. Vitamin-mineral premix contains the following: Vitamin A,15000000i.u; Vitamin D3 3,000000i.u, Vitamin E, 30,000i.u, Vitamin K, 2,500mgr, Thiamin, B1,2,000mgr, Riboflavin, B2, 6,000mgr;Pyridxine B6 4,000 Niacin, 4,000mgr; Vitamin B12,20mgr; Pantothenic Acid,10,000mgr; Biotin,80mgr;Cholin Chl0ride 500mgr; Antioxidant, 125gr;Manganese 96gr; Zinc,60gr; Iron 24gr; Copper 60gr; Iodine 1.4gr;Selenim 240gr; Cobalt 120gr.

Experimental birds, design and their management

A total of 200 unsexed day-old marshal (R) strain broiler chicks were obtained from Obasanjo Farm Ltd., Igboora, Oyo State, Nigeria. The brooder house was cleaned, washed, disinfected and fumigated a week before the arrival of the birds. Drinkers, feeders and other equipments were also well cleaned and washed before the arrival of the birds. On arrival, they were gently unboxed into the brooding house that had previously been heated few hours to the arrival of the birds. 195 birds were randomly allotted to five (5) dietary treatments and were replicated three (3) times with thirteen (13) birds per replicate in a Completely Randomized Design (CRD). The birds were fed *ad-libitum* with the experimental feed from day old till 5 weeks, vaccination and medication were strictly adhered to throughout the experimental period of five weeks while litters were regularly turned and changed as and when due. Data was collected daily on feed intake. Records of body weight were taken weekly while records of mortality were kept throughout the period of study (5 weeks).

DATA COLLECTION

Feed Intake (FI)

Feed intake was determined by subtracting the weight gain of feed left over from the feed given.

Body weight gain (BWG)

The birds were weighed on weekly basis and the weight was calculated by subtracting the weight in the preceding week from the current week.

Feed conversion ratio (FCR) was calculated as the ratio of feed consumed to the weight gain

$$\textbf{FCR} = \frac{\text{feed intake}}{\text{Weight gain}}$$

$$\textbf{Mortality} = \frac{\text{Number of dead birds}}{\text{Number of stock bird}}$$

Metabolic (digestibility) Trial

At the end of the fourth weeks, 1 bird per replicate was randomly picked making 3 birds per treatment and put into metabolic cage. Both feed and water were supplied accordingly, they were allowed to acclimatize for the first four days, then polythene bag was tied underneath the cage and the feaces was collected from each bird for the remaining three days. Both wet and dry weight of feaces were taken and recorded. The feaces from each bird were air dried for a week and crushed to granules then mixed together and samples were taken for laboratory assay (crude protein, crude fibre, crude fat, ash, calcium, phosphorous, sodium, magnesium and chloride). Results were used to calculate the following parameters.

$$\text{Apparent nutrients digestibility (}\textbf{AND}\text{)} = \frac{\text{Nutrients feed intake} - \text{Nutrients in fecal}}{\text{Nutrients feed intake}} \times 100$$

i.e Nutrients in feed intake =Amount of feed intake x % nutrients of diet analyzed (**Z**)

Nutrients in fecal=Amount of fecal voided x % of nutrients in the fecal analyzed (**Y**)

Therefore, **AND =** $\frac{\mathbf{Z - Y}}{\mathbf{Z}}$

Apparent minerals digestibility (**AMD**) = $\frac{\text{Minerals in the feed intake – Minerals in fecal}}{\text{Minerals in the feed intake}} \times 100$

Minerals in the feed intake =Amount of feed intake x % minerals of diet analyzed (**M**)

Minerals in the fecal=Amount of fecal voided x % minerals in the fecal analyzed (**F**)

Therefore, **AMD =** $\frac{\mathbf{M - F}}{\mathbf{M}}$

STATISTICALANALYSIS

Data collected were subjected to analysis of variance (ANOVA) using (SPSS, 2012) .Means were separated by using Duncan multiple range test of the same software.

RESULTS

The results of performance characteristics of broiler chicks fed experimental diets are shown in table 2. The initial live weight, feed intake, feed conversion ratio and mortality of chicks showed no significant (P>0.05) differences but final live weight and weight gain were significantly (P<0.05) influenced by varying levels of toasted African yam bean seeds meal supplemented with protease enzyme (TAYBSM+E). The highest final weight (250.81g/b), weight gain (211.26g/b) and feed intake (922.01g/b) were observed from birds on diet 3 (20% TAYBSM+E) while least final weight (174.63g/b) and weight gain (135.08g/b) were recorded for birds on 10% TAYBSM+E diets but least feed intake (747.24g/b) was recorded from birds fed on T5 (40% TAYBSM+E). The feed conversion ratio (FCR) value for birds on diets T1 (3.33), T2 (4.63), T3 (3.77), T4 (3.90) and T5 (3.56) showed no significant differences (P>0.05) among the treatments. The percentage mortality rate showed similar pattern with FCR.

Table 2: Performance characteristics of broiler chicks (0-5 weeks)

Parameters	T1 (0%)	T2(10%)	T3 (20%)	T4 (30%)	T5 (40%)	SEM
Initial weight (g)	39.55	39.55	39.55	39.55	39.55	0.00NS
Final weight (g)	235.63^{bc}	174.63^{a}	250.81^{c}	194.18^{a}	210.70^{ab}	8.48*
Weight gain (g)	196.07^{bc}	135.08^{a}	211.26^{c}	154.63^{a}	171.15^{ab}	8.48*
Feed intake (g)	784.00	809.71	922.01	756.51	747.24	32.22NS
FCR	3.33	4.63	3.77	3.90	3.56	0.19NS
Mortality (%)	0.26	0.21	0.26	0.18	0.10	0.40NS

^{A,b,c} means within the same row differed significantly (P<0.05). SEM = Standard error of mean. FCR= Feed conversion ratio. NS=Non-significant *= Significant. SEM=Standard error of mean

The percentage apparent nutrients digestibility by broiler starter fed experimental diets is shown in table 3. The crude protein, ether extract, ash, dry matter and crude fibre considered were significantly (P<0.05) influenced. Birds fed dietary treatment three (20% toasted African yam bean seeds with protease enzyme supplementation) gave highest percentage utilization of crude protein (92.62), ether extract (92.85), crude fibre (86.83), ash (72.88) and dry matter (90.39) while birds fed dietary treatment five (40% toasted African yam bean seeds with protease enzyme supplementation) gave least percentage crude protein (61.79), ether extract (78.00), crude fibre (56.00), ash (14.21) and dry matter (69.15).

Table 3: Digestibility trial: percentage mineral retained by broiler birds fed diets containing graded levels of TAYBS+E (0-5weeks)

Parameters(%)	T1(0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	SEM
Crude protein	78.61^{b}	81.91^{c}	92.62^{d}	77.72^{b}	61.79^{a}	2.66*
Ether extract	82.00^{b}	87.58^{c}	92.85^{d}	88.81^{c}	78.00^{a}	1.42*
Crude fibre	65.43^{b}	70.02^{c}	86.83^{e}	79.29^{d}	56.00^{a}	2.87*
Ash	41.84^{b}	52.04^{d}	72.88^{e}	46.69^{c}	14.21^{a}	5.06*
Dry matter	76.78^{b}	82.03^{c}	90.39^{e}	84.19^{d}	69.15^{e}	1.92*

$^{A,b,c\ d}$ mean in the same row with different superscript (P<0.05) differed significantly
NS=Non-significant *= Significant. SEM=Standard error of mean

The percent apparent minerals retained by broiler starter fed diets containing graded levels of toasted African yam bean seed with protease enzyme (TAYBS+E) is shown in Table 4. The calcium, phosphorous, magnesium, sodium and chloride were significantly (P<0.05) influenced. Birds fed dietary treatment three (20%TAYBS+E) retained highest calcium (88.91%), phosphorous (81.53%), magnesium (87.20%), sodium (84.87%) and chloride (85.27%) while birds fed dietary treatment five (40% TAYBS+E) retained least calcium (47.20%), inversely, birds on 30%TAYBS+E retained least phosphorous (23.28%), magnesium (22.52%), sodium (1.33%) and chloride (18.84%).

Table 4: Digestibility trial: percentage mineral retained by broiler birds fed diets containing graded levels of TAYBS+E (0-5weeks)

Minerals (%)	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	SEM
Calcium	64.10^{c}	77.22^{d}	88.81^{e}	47.97^{b}	47.20^{a}	4.34*
Phosphorus	45.60^{c}	61.22^{d}	81.53^{e}	23.28^{a}	25.05^{b}	6.00*
Magnesium	43.35^{c}	71.86^{d}	87.20^{e}	22.52^{a}	23.81^{b}	6.91*
Sodium	39.45^{c}	39.61^{d}	84.87^{e}	1.33^{a}	33.60^{b}	7.12*
Chloride	44.34^{c}	69.33^{d}	85.26^{e}	18.84^{a}	19.53^{b}	7.10*

^{a,b,c,d,e} values in same row with different superscripts are significantly different (P<0.05)
NS=Non-significant *= Significant. SEM=Standard error of mean

DISCUSSION

The decrease in the feed intake witnessed in broilers fed test diets (TAYBSM+E) compared to the control was due to the addition of protease enzyme. This result is in agreement with the work of Fasiullah et al., (2010) who reported that feed intake of rabbits decreased due to addition of NATUZME ® plus enzyme. The improvement of weight gain in the birds fed diet 3 (20% TAYBSM+E) can be attributed to the enhancing effect of protease enzyme on micro flora growth in the gut and caecum as well as the increase in volatile fatty acids and nutrients digestibility. This result agreed with the finding of Abaza and Omara (2011) who reported that rabbits fed diets with KEMZYME enzyme showed an improvement remarkably in live body weight and weight gain compared with those fed with the control diet. The feed conversion ratio (FCR) value for birds on diets T1 (3.33), T2 (4.63), T3 (3.77), T4 (3.90) and T5 (3.56) showed no significant differences ($P>0.05$) among the treatments. The percentage mortality rate showed similar pattern with FCR. The result of this study revealed that birds fed T1 (control) and T5 (40% TAYBSM+E) gave best feed conversion ratio values of 3.33 and 3.56 respectively. This means that among test diets, T5 (TAYBSM+E) performed better in the ability to convert feed to kilogram meat than other test diets (10, 20 and 30% TAYBSM+E) this accord with the finding of Fasiullah et al., (2010) who opined that addition of NATUZYME plus ® enzyme to diet of growing rabbits increased the feed conversion ratio due to increase in nutrient digestibility. Non significant ($P>0.05$) mortality rate for birds across all treatments is an indication that TAYBSM+E had positive effect on growth performance of broilers which also indirectly shows health status of birds (Cao et al., 2005).

Birds placed on varying levels of toasted African yam bean seeds supplemented with protease enzyme (TAYBS+E) retained more nutrients in their body than control birds, this implies that birds fed on test diets had better nutrients in their diets and nutrients were available for utilization of the birds. But among test diets, birds fed dietary treatment three (3) i.e 20%TAYBS+E utilized better (highest) nutrients than other birds fed on test diets. Test diets of this finding showed that both toasted and enzyme supplementation reduced anti-nutritional factors that might reduce nutrients availability to the birds. This finding is in accordance with Naveed et al., (1998) who reported improvement in nutrients digestibility of broiler diet with enzyme supplementation. It is also in line with the report of Adam, (2000) who opined marked improvement in the apparent coefficient of digestibility of nutrients and an increase in metabolizable energy content of the different feed grains when supplemented with commercial enzymes.

All the parameters measured (calcium, phosphorous, magnesium, sodium and chloride) showed significant ($P<0.05$) differences. Birds fed on 20% TAYBSM+E utilized (retained) more calcium, phosphorous, magnesium, sodium and chloride than control diet and other treatments. Treatment three (20% TAYBS+E) gave a good calcium phosphorous balance which is necessary for good, healthy and strong bone formation (Olomu, 1995). The higher magnesium, sodium and potassium retained by birds fed treatment 3 (20%TAYBS+E) is an indication that birds on these groups (20% TAYBS+E) had good minerals that transport to various parts of the body than other treatments and effectively retained higher minerals in their body which could have been ordinary passed out with feaces and dry up and decompose in the soil without any benefit to the birds.

CONCLUSION

Inclusion of toasted African yam bean seeds with protease enzyme supplementation enhanced efficient nutrient and minerals utilization considered and had good nutrient and mineral transportation to various parts of the body. Hence, toasting and protease enzyme supplementation had positive effect on anti-nutritional factors of test diets and more nutrients and minerals were released for the birds and it was more pronounced in treatment three (20% toasted African yam bean seeds with enzyme supplementation) and improved better than other counterpart (10, 30 and 40%) as well as control diet. Test diets of this study have great potential to replace soybean meal as alternative plant protein source in broiler chicks' ration.

RECOMMENDATION

Based on feed conversion ratio of this finding, toasted African yam bean seeds meal with protease enzyme supplementation as replacement for soybean can be successfully fed to broiler chicks up to 40% inclusion levels. But based on weight gain, nutrients and minerals utilization, 20% inclusion level of toasted African yam bean seeds meal with protease enzyme supplementation is recommended.

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