Nigerian J. Anim, Sci. 2024, 26 (2): 164-172

Effect of Dietary Enzyme Supplementation on Nutrient Retention in Broiler Chickens Fed Sorghum - Based Diets

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Abstract

The demand for enzyme supplements has increased due to the use of unconventional feedstuffs. This study evaluated the effect of dietary enzyme supplementation on nutrient retention and cost/ benefits of broiler chickens. A total of 330, day-old Hyline broiler chicks were assigned to 11 diets replicated thrice with 10 birds each, using a completely randomized design. Two basal diets were formulated: maize - soybean meal (positive control) and sorghum – soybean meal (negative control) with the sorghum diet subdivided into 10, with nine diets containing Phytase (PHY), Xylanase, Amylase, Protease (XAP) and Xylanase, β-Glucanase (XB) at three levels (250, 500 and 750 mg/kg) each .Faecal and feed samples were collected from 59th - 66th day. Result showed significant ($p<0.05$) differences in the percentage nutrient retention. The addition of enzymes to sorghum diets especially 500 mg PHY enabled birds to retain more nutrients. There was no significant ($p>0.05$) difference in cost/kg gain, but was significantly ($p<0.05$) higher when 500 mg of XB was added. The feed cost to produce one kg weight was reduced up to 10.85% for PHY and XAP at 500 mg/kg. The study concluded that incorporation of multi-enzymes (Phytase and Xylanase, Amylase, Protease) at 500 mg/kg in broiler chicken diets was most beneficial and economical as it enhanced the profit margin.

Keywords: Blood; cassava; chicken; cost; growth; sandbox

Description of problem

In Africa, there has been a declining growth rate of poultry species due to low food resources especially that of grains including maize and rice [1]. FAO [2] report showed that Africa's population is about 870 million and over 750 million people are living in a state of malnutrition out of which 70% are in rural communities. This situation is further aggravated due to the 2020 projection for increased global animal protein demand and population growth [2]. Therefore, there is urgent need to develop strategies for increased animal productivity to bridge the animal protein deficit.

In recent times there has been global pressure on maize production and emphasis is placed on its utilization for export, and biofuel production [3]. Since broiler chickens have similar gastro- intestinal tract with humans, this has created a great competition between humans and animals for food especially

grains such as maize and wheat which are sources for both humans and livestock. This competition has translated to higher cost of production. Current researches are geared towards exploring alternative feed ingredients that could replace the conventional cereal grains in poultry production [4].

Therefore, current researches are geared towards improving the quality of these feed ingredient. The demand for microbial enzyme supplement has been increased due to the increase use of unconventional feed ingredients. Recent studies suggest the nutritional worth of these ingredient can be gotten through enzyme supplementation. Therefore, identification of anti - nutritional factors in the alternative ingredient and the development of the best enzyme combination for each diet is emphasized. There is an increase use of sorghum as alternative feed to maize in Nigeria [5; 6]. Recent studies have shown that, the use of sorghum in crop and livestock production is an important process or means of increasing sorghum utilization and consumption in Nigeria. Sorghum marketing is highlighted as one of the most challenging issues in developing the sorghum value chain. To overcome this, efforts is being geared towards linking sorghum farmers to organize markets to boost its international value.

Nevertheless, sorghum utilization in poultry feed is limited due to the high amount of tannins present. Sorghum cultivars with lighter seed coat colour have been reported to contain low tannin with good nutritional values than the darker coat colour [7]. Etuk *et al*. [8] outlined the different "anti- nutritional effects of tannins which include: reduction in voluntary feed intake due to reduced palatability, diminished digestibility and utilization of nutrients, adverse effect upon metabolism and toxicity. For effective utilization of sorghum by poultry, several strategies including enzymes supplementation are employed [9]. Khattak *et al*. [10] noted that, low feed efficiency is as a result of poultry not being able to produce enzymes for the hydrolysis of non - starch polysaccharides present in the cell wall of the grains and thus remain un-hydrolyzed. Enzymes currently incorporated into poultry diets include; β-glucanases, xylanases, phytases, proteases, lipases, and galactosidases [10]. These enzymes act by reducing digesta viscosity, enhancing digestion and absorption of nutrients (especially fat and protein), improving apparent metabolizable energy (AME) value of diet, increasing feed intake, weight gain, feed gain ratio, reducing beak implication and vent plugging, decreasing size of gastrointestinal tract, reducing water intake as well as reducing water content of excreta [11; 12; 13; 14]. Enzyme combinations have further improved the availability of several nutrients and feed utilization with significant effects on reduced cost of production [13; 15]. To improve sorghum utilization, exogenous enzyme supplementation is proposed. Nevertheless, limited reports on the application of phytases, xylanases-amylase-protease and B-glucanases mixtures in broiler diets comprising sorghum is noticed, thus which is the main thrust of this

study. This study determined the effect of dietary enzyme supplementation on nutrient retention and cost/ benefit analysis of broiler chicken production.

Materials and methods

The study was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar.

Management, design and experimental diets

A total of 330, day-old hyline broiler chicks were used in this study. The chicks were weighed (40 $\pm$ 0.55 g) and randomly allocated to 30 pens which consisted of the 11 treatments and 3 replicates per treatment with 10 birds per replicate cage, using a completely randomized design (CRD). All birds were managed under the deep litter system in line with good management practices throughout the 56 days feeding trial.

Prior to the arrival of the birds, the pens were sanitized using disinfectant (saponated cresol) to get rid of micro-organisms. The litter materials used (wood shavings and saw dust) were dried for a period of two weeks to avoid moulding, while an anti-stress vitalyte (anidone- vitadox) at 0.2 g/4litres of chlorine-free water was provided. Standard feeders and drinkers were provided with feed and clean water *ad-libitum* throughout the experimental period.

Two basal diets were formulated (standard corn-soybean and sorghum- soybean diets) for the broiler chickens (Table 1). Corn-soybean and sorghum-soybean diets served as positive and negative controls, respectively. To improve sorghum utilization by broilers, the single enzyme, phytase (PHY) and two enzyme mixtures, xylanase, amylase, protease and xylanase β -glucanase (XAP and XB) were supplemented into the sorghum diet according to the recommendations of Zhengyu *et al*. [15]. The sorghum diets were formulated in one batch then sub-divided into 10 experimental diets, with nine diets containing PHY, XAP and XB at three levels (250, 500 and 750 mg/kg of sorghum diet) each.

The eleven experimental treatments studied were:

T_1 - Corn-soybean diet – positive control
T_2 - Sorghum- soybean diet – negative control
T_3 - Sorghum- soybean diet plus supplemental PHY at 250 mg/kg
T_4 - Sorghum- soybean diet plus supplemental PHY at 500 mg/kg
T_5 - Sorghum- soybean diet plus supplemental PHY at 750 mg/kg
T_6 - Sorghum- soybean diet plus supplemental XAP at 250 mg/kg
T_7 - Sorghum- soybean diet plus supplemental XAP at 500 mg/kg
T_8 - Sorghum- soybean diet plus supplemental XAP at 750 mg/kg
T_{9-} Sorghum- soybean diet plus supplemental XB at 250 mg/kg
T_{10} - Sorghum- soybean diet plus supplemental XB at 500 mg/kg
T_{11} - Sorghum- soybean diet plus supplemental XB at 750 mg/kg

Table 1: Gross composition of experimental basal diets (%)

Ingredient	Sorghum- soybean diet		Standard corn – soybean diet	
	Starter	Finisher	Starter	Finisher
Yellow corn	0.00	0.00	50.00	55.00
Sorghum	50.00	55.00	0.00	0.00
Soybean meal	32.00	25.00	32.00	25.00
Palm kernel cake	4.45	4.45	4.45	4.45
Wheat offal	5.00	7.00	5.00	7.00
Crayfish dust	5.00	5.00	5.00	5.00
DCP	2.00	1.80	2.00	1.80
Methionine	0.30	0.20	0.30	0.20
Lysine	0.25	0.15	0.25	0.15
Vit. Min. Premix	0.50	0.20	0.50	0.20
Palm oil	0.25	1.00	0.25	1.00
Salt	0.25	0.20	0.25	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrients:				
% Crude protein	23.00	20.80	23.30	21.00
% Crude fibre	3.93	3.95	3.96	3.99
ME (Kcal/kg)	2,840.29	2,920.57	2,800.00	2,920.14
Determined nutrients:				
% Crude protein	22.84	18.74	23.60	18.36
% Crude fibre	4.06	4.19	4.15	4.24

Data collection:

The feeding trial lasted for 10 weeks and at the 56th day, two birds per replicate (six birds/treatment) of the similar body weight (2500 g) were carefully chosen, placed in individual metabolic cages and allowed 3 days acclimatization period prior to sample collection. At day 59, samples of the finisher diet and droppings were collected till day 66 (7 days collection period). Daily droppings collected were oven- dried at 65^{0}C for 24 hours. At day 66, the total dropping and die samples collected were pooled, weighed and milled. Exactly 100 g samples of the pooled diet and droppings were collected from each treatment for proximate analysis.

Digestibility and nutrient retention values were calculated using the index method.

Apparent Nutrient retained was calculated as:

Nutrient retention (%) = (Feed intake × Nutrient in diet) - (Faecal output × Nutrient in faeces × 100 (Feed intake × Nutrient in diet)

Cost benefit analysis of enzyme supplementation

The cost per kg feed of each experimental diet was determined by the summation of the cost of each ingredient and enzyme in the diet

and multiplied by the cost per kg of ingredient and enzyme used in the study (based on prevailing market prices in Calabar during the study period) and divided by 100 [16]. The total feed cost per broiler chicken was calculated as the product of total feed consumed and cost per kg by the feed conversion ratio [17], while the price per kg live weight was obtained by dividing the cost per broiler chicken by the live weight of the broiler chicken [18].

Statistical analysis

All data obtained in this study were subjected to one-way analysis of variance (ANOVA) in a Completely Randomized Design using the generalized model of the GENSTAT [19] software package. Significant means were separated using the Duncan multiple range test [20].

Results and Discussion

The impact of dietary treatments on the nutrient retention coefficients of broiler chickens is presented in Table 2. There were significant ($p<0.05$) differences in the percentage nutrient retention among birds fed maize, sorghum and enzyme supplemented sorghum diets. Results revealed that the addition of enzymes to sorghum diets especially with 500 mg PHY having a higher numerical value enabled the birds to retain more nutrients compared to those fed maize diets. This agrees with the findings of Liu *et al*. [21] who reported numerical improvement in weight gain, feed conversion efficiency and nutrient retention in sorghum- based diets following phytase supplementation (1000 FTU/ Kg). Diets with 500 mgBG, 750 mg XAP and 250 mg XAP led to higher crude fibre, dry matter and nitrogen free extracts retention in the birds, while the value for ash were higher for birds on maize diets compared with those supplemented with PHY, XAP and BG. Enzymes were found to have significant ($p<0.05$) effect on the retention of nutrients. Maximum percent retention of most of nutrients except CF was seen in bird's allotted T1 (corn - soybean) diet containing without supplemental enzyme. It differed significantly ($p<0.05$) with the rest of the diets. Only percent ether extract retention was maximum in groups 10, which were supplemented with β-Glucanase enzyme at 500mg/kg. While, corn-soy diet (T_1) had significant ($p<0.05$) effect on the percent retention of Ash, DM and NFE in groups 6 and 8, respectively. Therefore, the use of enzymes had no adverse effect on the percent nutrient retention in broiler chickens [22]. Higher percent NFE in corn fed birds was probably due to the presence of more digestible starch components in the corn than in sorghum grains. Earlier findings also showed that reconstitution of high tannin red sorghum resulted in reduction in its tannin concentration, but feeding of reconstituted sorghum-based diets could not improve nutrient utilization in broiler chickens Kumar *et al*. [7]. The presence of oxalate in sorghum has also been implicated for poor nutrient retention and utilization by broiler chickens [23].

Cost-benefit analysis

The economic implication of supplementing

diets with the three enzymes at the different levels (Table 3) indicated that all the economic indices considered except cost per kg of feed were significantly ($p<0.05$) influenced by dietary treatments. There was no significant ($p>0.05$) difference in cost/kg gain among the control, groups 5, 7, 9 and 10 but cost/kg gain was significantly ($p<0.05$) higher when 500 mg of XB was added. While the least was recorded for those supplemented with 250 mg of PHY. It was further observed that 750 mg of PHY also recorded higher feed cost per bird compared to the control. However, there was no significant difference between that of control and the Phytase group. Revenue accrued was higher when Phytase was fed compared to the control but this did not translate to better gross margin as there was no significant effect in gross margin between these groups, although phytase group had numerically higher value and better return. The feed cost to produce one kg weight was reduced up to 10.85% due to incorporation of PHY and XAP enzymes at 500 mg/kg in broiler diets. It was concluded that incorporation of multi – enzymes (Phytase and Xylanase, Amylase, Protease) at 500 mg in broiler chicken diets is most beneficial and fruitful and enhanced the profit margin [24].

Conclusion

This study has indicated that phytase (PHY)

Table 2: Nutrient retention coefficient of broiler chickens fed sorghum diets

Parameter (%)	Maize-Soybean	Sorghum-Soybean (SS)	SS-PHY(R)			SS-XAP(R)			SS-XB(R)			
			250mg	500mg	750mg	250mg	500mg	750mg	250mg	500mg	750mg	SEM
Crude Protein	68.75^{a}	69.13^{a}	69.33^{a}	69.77^{a}	65.99^{c}	64.65^{b}	66.54^{b}	66.31^{bc}	66.96^{ab}	65.90^{c}	66.55^{c}	5.77
Crude Fat	38.81^{f}	36.46^{g}	35.71^{h}	40.40^{e}	33.76^{i}	38.88^{f}	47.83^{b}	43.45^{d}	46.45^{c}	51.28^{a}	36.17^{g}	6.05
Crude Fibre	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	0.00
Ash	12.89^{a}	4.88^{f}	3.30^{h}	0.74^{i}	10.12^{b}	6.76^{d}	9.57^{c}	0.06^{j}	5.37^{e}	4.09^{g}	3.51^{k}	2.89
Dry Matter	48.03^{ab}	47.10^{c}	48.18^{a}	48.32^{a}	47.95^{b}	47.93^{b}	48.21^{a}	48.72^{a}	47.84^{bc}	47.84^{bc}	47.91^{b}	6.57
Nitrogen Free Extract	41.98^{b}	41.45^{bc}	41.09^{c}	40.23^{d}	43.01^{a}	43.30^{a}	41.66^{bc}	41.02^{c}	41.43^{bc}	41.37^{bc}	41.70^{bc}	5.88

TREATMENTS

^{abc} "Means with different superscripts on the same row differ significantly ($p<0.05$)"
"SEM = Standard error of means"
SS = sorghum-soybean based diet
PHY = phytase $^{(R)}$ Enzymes
XAP = xylanase - amylase- protease $^{(R)}$ Enzymes
XBG = xylanase - B-Glucanase $^{(R)}$ Enzymes

Table 3: Cost analysis following enzyme supplementations in a sorghum-based diets

Parameter (₦)	Dietary treatments											
	Maize-Soybean	Sorghum Soybean (SS)	SS 250mg PHY$^{(R)}$	SS 500mg PHY$^{(R)}$	SS 750mg PHY$^{(R)}$	SS 250mg XAP$^{(R)}$	SS 500mg XAP$^{(R)}$	SS 750mg XAP$^{(R)}$	SS 250mg XBG$^{(R)}$	SS 500mg XBG$^{(R)}$	SS 750mg XBG$^{(R)}$	SEM
Cost/kg feed	147.91	136.91	137.05	137.20	137.34	137.10	137.29	137.48	137.98	137.06	137.13	0.00
Cost/kg gain	333.89^{abcd}	322.51^{abcd}	306.01^{d}	302.94^{d}	323.10^{abcd}	319.88^{bcd}	355.73^{abc}	311.12^{cd}	360.64^{ab}	406.17^{a}	367.33^{ab}	13.97
Cost of feed / bird	813.43^{ab}	784.68^{abc}	810.65^{ab}	816.80^{ab}	817.80^{a}	778.23^{bcd}	765.64^{cd}	759.49^{cd}	795.67^{abc}	806.36^{ab}	745.94^{d}	11.72
Cost of feed/Week	101.68^{ab}	98.08abc	101.33ab	102.10ab	102.20a	97.28bcd	95.71cd	94.94cd	99.46abc	100.79ab	93.24	1.47
Price/bird	1984.00^{ab}	1979.00^{a}	2155.00^{a}	2192.00^{a}	2059.00^{a}	1979.00^{ab}	1771.00^{bc}	1989.00^{ab}	1813.00^{bc}	1627.00^{c}	1656.00	69.70

^{abc} Means with different superscripts on the same row differ significantly ($p<0.05$)
"SEM = Standard error of means"
SS = sorghum-soybean based diet
PHY = phytase $^{(R)}$ Enzymes
XAP = xylanase - amylase- protease $^{(R)}$ Enzymes
XBG = xylanase - B-Glucanase$^{(R)}$ Enzymes

and xylanase, amylase, protease (XAP) enzymes supplementation at 500 mg/kg improved nutrient digestibility and retention in chickens fed sorghum - soybean meal diet. The economic implication of supplementing these enzymes at the different levels to the diets indicated that all the economic indices considered except gross margin were positively enhanced.

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