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RESEARCH ARTICLE

PERFORMANCE OF BROILER FINISHER BIRDS FED TOASTED BAMBARA NUT (*VIGNA SUBTERRANEAN (L) VERDC*) OFFAL WITH SUPPLEMENTARY ENZYME

[1*]Oyeagu, C. E., [1]Ani, A. O., [1]Egbu, C. F., [1]Akpolu, E. S., [2]Iwuchukwu, J. C. and [3]Omumuabuike, J. N.

[1]Department of Animal Science, University of Nigeria, Nsukka, Nigeria
[2]Department of Agricultural Extension, University of Nigeria, Nsukka
[3]Department of Animal Health and Production Technology, Anambra State College of Agriculture, Mgbakwu, Nigeria

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ABSTRACT

The objectives of the study were to evaluate the performance and cost implications of feeding varying dietary levels of toasted bambara nut offal (TBO) (0, 20, 30 and 40kg) with supplementary enzyme, 2 enzyme levels, (0 and 0.02kg) to one hundred and twenty 6-weeks old unsexed commercial broiler chicks (Anak strain) that were randomly divided into eight (treatments) groups of 15 birds each. Feed intake increased ($P<0.05$) significantly while Av final body weight, Av daily weight gain, Av tot al weight gain, feed efficiency and protein efficiency ratio decreased ($P>0.05$) significantly with increasing levels of TBO in the diets. Total feed consumed increased ($P<0.05$) significantly with increasing levels of TBO in the diets. Revenue and gross profit decreased ($P>0.05$) significantly in diets containing 30 kg and 40 kg levels of TBO with or without enzyme while diet containing 20 kg level of TBO with enzyme recorded the best ($P<0.05$) revenue and gross profit. It was concluded that up to 20 kg TBO can be included in enzyme supplemented broiler finisher diet without adverse effects on the performance and production (cost) efficiency of broiler finisher birds.

INTRODUCTION

Feed remains the most important cost of Animal production (**Atteh, 2002; Kehinde *et al.*, 2006**). The need for feed ingredients, which will reduce the cost of production, is the basis for most new ingredients that are been brought to limelight in livestock feed and production research. This is because man and his livestock are in competition for basic ingredients and such ingredients are not usually produced in sufficient quantities locally (**Oluyemi *et al.*, 1978; Omojola and Adesehinwa, 2007**). Therefore, availability of feed thus becomes the key factor limiting poultry production. Broiler feed is based primarily on cereal grains and vegetable protein meal, which is supplied for meeting most of energy and protein requirements in the poultry diet. Research into the use of cheaper industrial by products and wastes at various levels of dietary inclusion for poultry has therefore been intensified in the last few years to determine their efficiency of utilization in terms of growth and production (**Longe and Adetola, 1983; Adeniji and Balogun, 2002**).

Corresponding author: Oyeagu, C. E.,
Department of Animal Science, University of Nigeria, Nsukka, Nigeria.

Bambara nut offal is a by-product of bambara nut milling industry that contains 18.30% Crude Protein, 20% Crude fibre, 5.36% Ether extract, 41.64% Nitrogen-free extract, 10.2% moisture and 16.74MJ of gross energy (**Ani and Omeje, 2007**). Bambara nut is widely cultivated in the Northern and Southern States of Nigeria. The seeds were usually milled into flour, processed and consumed as *moi moi* (**Enwere, 1998**). Bambara nut offal has been used in the feeding of poultry and rabbits (**Ani and Okafor, 2004; Ani, 2006; Ani and Omeje, 2007**). However, it's uses in the feeding of monogastric animals is limited by the presence of such anti-nutritional factors (ANFs) as protease inhibitors, phytate, haemaglutinins, tannins, cyanogenic glycosides and flatulence factors in the raw been (**Ensminger, 1996; Enwere, 1998; Tiago, 2012; Hassan and Sultan, 2013**). To improve the nutritional quality and to provide effective utilization of legume grains for poultry, it is essential that anti-nutritional factors be removed or reduced (**Akande and Fabiyi, 2010**). Reduction of ANFs can be realized in various ways, by heat treatment and enzymatic degradation (**Carsten, 2013**). Hence, it is necessary to establish processing technique(s) to ensure its optimal utilization.

Processing technique such as toasting (heat treatment) is a means of improving the nutritional value and protein digestibility of foods (**Nergiz and Gokgoz, 2007; Iyayi *et al.*, 2008**). Toasting is a method of feed processing which involves adding about 5kg bambara nut offal into a hot, open cast-iron dry pan already set on fire. The bambara nut offal were toasted at an approximate temperature of 100^{oC} for 30mins, afterwards, the toasted bambara nut offal (TBO) were sprayed to cool before usage. This improves protein quality by inactivating anti-nutritional factors such as trypsin inhibitor and haemagglutinins and by unfolding the protein structure, thus making them more susceptible to attack by digestive endogenous enzymes (**Sathe *et al.*, 1984; Akande and Fabiyi, 2010; Carsten, 2013**). Besides anti-nutritional factors, another limitation is its high fibre content (**Ani, 2007**). Poultry cannot fully utilize high fibre diets because they lack the digestive framework that can elaborately digest large amount of fibre. It becomes necessary, therefore to incorporate exogenous enzymes into their diets in order to enhance the breakdown of the non-starch polysaccharides (NSPs) present in fibre. Exogenous enzyme has been shown to reduce the viscosity of gut content and improve the utilization of nutrients (**Acromovic, 2001; Khan *et al.*, 2006; Carsten, 2013**). Therefore, a trial was conducted to study the effect of graded levels of toasted bambara nut offal (TBO) with supplementary enzyme on the performance and cost of broiler finisher birds.

MATERIALS AND METHODS

The study was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Toasted bambara nut offal and other feed ingredients used in the study were procured from Nsukka and Enugu in Enugu State, Nigeria.

Processing of Bambara nut offal

Bambara nut offal (BNO) used in the formulation of the experimental diets was processed by toasting for 30 minutes at 100^{0}C. The toasting involved adding about 5kg BNO in an open cast-iron dry pan already set over fire. The BNO was steadily stirred to prevent it from sticking to the pan and from burning until it turned brownish and produced a sweet smelling aromatic flavor (**Udensi *et al.*, 2004; Ani, 2006**).

At this point, the toasted bambara nut offal was removed from the cast-iron pan and sprayed out to cool before incorporating it into the diets.

Animals and Management

The experiment was carried out in accordance with the provisions of the Ethical Committee on the use of animals and humans for biomedical research of the University of Nigeria, **Nsukka (2006)**.120 six-week old broiler birds were randomly divided into eight groups of 15 birds each. The groups were randomly assigned to eight diets containing 11.92-13.11MJ of ME/Kg and 20.10-20.43% crude protein diets in a 2 x 4 factorial arrangement involving four levels (0,20,30 and 40 kg) of toasted Bambara nut offal (TBO) and two enzyme levels (0 and 0.02 kg). The gross composition (%) of the diets is presented in Table 1. Each treatment was replicated three times with five birds per replicate placed in 2.6m x 3m deep litter pens of fresh wood shavings. Feed and water were supplied *ad libitum* to the birds from 42 to 70 day of age. A general flock prophylactic management strategy and routine vaccinations were administered as and when due.

Measurement of growth parameters

At the beginning of the experiment, birds in each replicate were weighed individually and subsequently on weekly basis. Feed intake was determined daily by the weigh-back technique. Feed conversion ratio was calculated from the data on live weights and feed intakes as quantity (g) of feed consumed per unit(g) weight gained over the same period (**Jabben *et al.*, 2004**). Protein efficiency ratio were also calculated as weight gain (g) divided by protein consumed (g) over the same period. feed consumed, revenue from a bird produced, and gross profit) were also considered at the end of the study.

Proximate and statistical analyses

Experimental diets were analyzed for their proximate components according to the methods of **AOAC (1990)**. Data collected were subjected to analysis of variance (ANOVA) in a completely randomized design(CRD) for 2 x 4 factorial arrangement as outlined by Steel and **Torrie (1980)** using Statistical Package for the Social Sciences (**SPSS, 2003**), windows version 17.0.

Table 1. Ingredients and nutrient Composition of experimental diets (kg as fed basis)

TBO Level (kg)	0		20		30		40	
Enzyme Level (kg)	0	0.02	0	0.02	0	0.02	0	0.02
Maize	53.0	53.0	33.0	33.00	23.0	23.0	13.0	13.0
Toasted bamabra nut offal	0.0	0.0	20.0	20.0	30.0	30.0	40.0	40.0
Groundnut cake	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Fish meal	1.50	1.50	0.5	0.5	0.4	0.4	0.2	0.2
Palm kernel cake	5.50	5.48	9.50	9.48	10.60	10.58	12.80	12.78
Soybean meal	10.00	10.00	7.00	7.00	6.00	6.00	4.00	4.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
VMP	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methioine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Safizym 800 GB	0.00	0.02	0.00	0.02	0.0	0.02	0.00	0.02
Total (kg)	100	100	100	100	100	100	100	100
Calculated analysis crude protein (%)	20.10	20.10	20.09	20.09	20.41	20.41	20.43	20.43
Crude fibre (%)	4.28	4.28	7.72	7.72	9.66	9.66	10.99	10.99
Gross energy (MJ/kg)	11.92	11.92	12.51	12.51	12.80	12.80	13.11	13.11
Cost (₦)/100kg	6853.5	6865.14	5427.5	5439.14	4821.3	4832.94	4128.9	4140.54

Significantly, different means were separated using Duncan's New Multiple Range Test (**Duncan, 1955**) option of the package. All measurements were taken between 8.00am and 12.00 noon. The cost implication (total feed consumed, cost of total

RESULTS AND DISCUSSION

Table 2 shows the proximate composition of the experimental diets while the effect of varying dietary levels of toasted Bambara nut offal (TBO) with supplementary enzyme on the performance of broiler finisher birds is presented in Table 3.

Performance of broiler finisher birds fed graded levels of TBO with supplementary enzyme

Table 3 shows the effects of dietary toasted bambaranut (TBO) offal and supplementary Enzyme on growth performance of broiler finisher birds. There were significant ($p<0.05$) Interactions between TBO and Enzyme levels on final body weight (FBW), average daily feed intake (ADFI), average daily weight gain (ADWG),average total weight gain (ATWG), feed conversion ratio (FCR), and protein efficiency ratio (PER).

The increase in feed intake may be attributed to the fibrous and bulky nature, coupled with the low nutrient (energy) content of the TBO containing diets. This seems to corroborate the report of **pond *et al.*, (1974)** as cited by **Ani *et al.* (2012)** that feed consumption and the quantity of feed required per kg of gain in Pigs increased with increase in the dietary fibre. They attributed such increase to the bulky nature and low total digestible nutrients of the feed. However, the feed intake of Birds that consumed Enzyme supplemented diets decreased significantly ($p<0.05$). The observed decrease agrees with the reported finding of **Ranade and Rajmane, (1992), Samarasinghe *et al.* (2000) and Ani and Omeje, (2007)** that Enzyme supplementation of poultry diets results in decrease in feed intake.

This could be attributed to improved energy availability and utilization for the growth of poultry (**Aboosadi *et al.*, 1996**). Animal therefore tend to consume less amount of feed when their nutrients requirement has been met (**Richter *et al.*, 1995**). However, the results contradict the findings of **lessen *et al.* (1996)**; **Augelovicova and Michalik, (1997), Daveby *et al.* (1998) and Alam *et al.* (2003)**.

Table 2. Proximate composition of broiler finisher diets

Proximate Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Moisture (%)	14.10	14.11	14.55	14.57	14.70	14.71	14.98	15.00
Ash (%)	11.89	11.90	10.70	10.75	9.30	9.31	9.01	8.98
Oil (%)	0.80	0.80	0.98	1.00	1.14	1.15	1.75	1.80
Fibre (%)	4.28	4.28	7.72	7.72	9.66	9.66	10.99	10.99
Crude protein (%)	20.10	20.10	20.09	20.09	20.41	20.41	20.43	20.43
Gross energy (Mj/kg)	11.92	11.92	12.51	12.51	12.80	12.80	13.11	13.11

Table 3. Performance of Broiler Finisher Birds fed graded levels of Toasted Bambaranut Offal (TBO) with Supplementary Enzyme

TBO Level (kg)	0		20		30		40		SEM
Enzyme Level (kg)	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	
Treatment	1	2	3	4	5	6	7	8	
Parameters									
Av initial body wt (g)	1.96	1.87	1.68	1.77	1.52	1.65	1.67	1.68	0.5^{NS}
Av final body wt (kg)	3.22^{a}	3.26^{a}	2.85^{ab}	3.09^{a}	2.01^{c}	2.18^{bc}	1.91^{c}	2.00^{c}	0.25
Av daily feed intake(g)	92.97^{d}	90.11^{d}	100.01^{c}	98.11^{c}	147.40^{b}	143.10^{b}	156.40^{a}	150.20^{ab}	0.99
Av daily wt gain (g)	46.20^{a}	47.90^{a}	41.02^{ab}	45.30^{a}	30.30^{bc}	34.40^{b}	$29.30b^{c}$	$30.10b^{c}$	0.98
Av total wt gain (kg)	1.26^{ab}	1.39^{a}	1.17^{b}	1.42^{a}	0.49^{c}	0.53^{c}	0.24^{d}	0.32^{cd}	0.04
Feed conversion ratio	2.01^{de}	1.88^{e}	2.44^{d}	2.21^{de}	4.86^{b}	4.16^{c}	5.33^{a}	5.00^{ab}	0.08
Protein efficiency ratio	1.49^{a}	1.50^{a}	1.40^{ab}	1.46^{a}	1.08^{c}	1.16^{b}	1.06^{c}	1.04^{cd}	0.11

^{a,b,c,d,e}; Row means with different superscripts differ significantly at $P<0.05$. NS= Not Significant. SME= Standard error of the mean.

Statistically, Birds fed the control diet (0 kg TBO, with or without Enzyme) had the least ADFI. While Birds fed 40 kg TBO (without Enzyme) had the highest ADFI. Birds fed 20 kg TBO compete favourably with the control (0 kg level TBO) diet and performed best when compared with diets containing 30 kg and 40 kg levels of TBO in all the parameters. Among the diets containing TBO (20 kg, 30 kg and 40 kg level of TBO) with or without Enzyme, 20 kg level TBO with Enzyme was better ($p<0.05$) than 30 kg and 40 kg level of TBO with or without enzyme on final body weight, average daily weight gain, total weight gain, feed conversion ratio and protein efficiency ratio. The present study shows that, feed intake increased with the increase in TBO levels. The present finding contradicts earlier reports (**Apata and Ojo, 2000; Ajaja *et al.*, 2003**).

The observed average daily weight gain, total weight gain, feed conversion ratio and protein efficiency ratio shows that 20 kg TBO inclusion level with supplementary Enzyme diet were capable of supplying adequate nutrients for a growth rate. This may have resulted from the activities of celluloses and glycanases contained in the Enzyme which might have caused a cleavage of Non-starch polysaccharides (NSPs) in TBO into smaller polymers, thereby preventing the formation of viscous digesta and enhancing nutrient digestibilities (**Choct *et al.*, 1995; Isikwenu *et al.*, 2012; Carsten, 2013; Bruno, 2012**). A similar improvement in broiler birds had been reported (**Agbede *et al.*, 2002; Shakouri and kermanshashi, 2004**). Average daily weight gain, total weight gain, feed conversion ratio and protein efficiency ratio decreased with increasing TBO levels.

A similar observation had earlier been reported (**Apata and Ojo, 2000**). The depression in performance at the 30 kg and 40 kg TBO levels may be attributed to the anti-nutritional factors (ANFs) presents in toasted bambaranut offal (**Apata and Qloghobo, 1994; Ensminger *et al.*, 1996; Ani *et al.*, 2012; Tiago, 2012**). Enzyme supplementation might improve broiler performance by at least two mechanisms: improving feed intake and nutrients digestibility. Both mechanism might be induced, at least partially, by a reduction of the viscosity to decreased retention time of digesta in the gut, and therefore improving growth and feed conversion ratio (**Lazaro *et al.*, 2003; Hajati *et al*., 2009; Caroline, 2012**). Feed conversion of broilers was better in Birds fed levels of TBO (0 kg, 20 kg, 30 kg and 40 kg) with Enzyme than levels of TBO (0 kg, 20 kg, 30 kg and 40 kg) without Enzyme. This finding is supported by **Scott *et al.* (1997)** and **Alam *et al.* (2003).** They reported that feed conversion was increased due to better feed utilization. Exogenous Enzyme compliments the digestive Enzyme of poultry by hydrolyzing the non-starch polysaccharides (NSPs) in cereals and vegetable proteins, thereby decreasing gut viscosity, and thus improves nutrient absorption (**Broz *et al.*, 1994; Zobell *et al.*, 2000**).

This may be due to the reduced total feed consumed recorded for Birds fed 20 kg TBO with Enzyme when compared with 30 kg and 40 kg levels of TBO with or without Enzyme. This is in line with earlier report from **Ani and Omeje (2007)**. Generally, cost of total feed consumed increased with increase in TBO level. The observed increase may be attributed to the increase in feed intake; poor feed conversion efficiency and depressed weight gain of Birds that consume TBO contain diets. However Enzyme supplementation of diets resulted in reduced feed cost. This is in line with the reports of **Ajaja *et al.* (2003), Caroline, (2012) and Ani *et al.* (2012)**.

A saving of this magnitude on feed production will be of great benefit to the farmer, since feed alone account for about 80 % of the recurrent expenditure in poultry production (**Isikwenu *et al.*, 2012**). Revenue from a bird produced was higher ($p<0.05$) on Birds fed 0 kg and 20 kg dietary levels of TBO with supplementary Enzyme, indicating that 20 kg level of TBO with Enzyme compete favourably with the control diet (0 kg TBO with Enzyme). Birds fed 20 kg level of TBO with Enzyme recorded the highest gross profit (GP) among all the experimental diets in this study.

Table 4. Cost implication of feeding graded levels of Toasted Bambaranut Offal (TBO) with Supplementary Enzyme

TBO Level (kg)	0		20		30		40		SEM
Enzyme Level (kg)	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	
Treatment	1	2	3	4	5	6	7	8	
Parameters									
Feed cost per kg (₦)	68.54	68.65	54.28	54.39	48.21	48.33	41.29	41.41	-
Total body weight (kg)	1.26^{ab}	1.39^{a}	1.17^{b}	1.42^{a}	0.49^{c}	0.53^{c}	0.24^{d}	0.32^{cd}	0.04
Total feed consumed (kg)	2.60^{c}	2.52^{c}	2.80^{b}	2.75^{b}	4.13^{a}	4.01^{a}	4.38^{a}	4.21^{a}	0.07
Broiler cost per kg (₦)	550.00	550.00	550.00	550.00	550.00	550.00	550.00	550.00	-
Cost of total feed consumed (₦)	178.20^{b}	173.00^{bc}	152.00^{c}	149.57^{cd}	199.11^{a}	193.80^{ab}	180.85^{b}	174.34^{bc}	1.02
Revenue from a bird produced (₦)									
Gross profit (₦)	693.00^{b}	764.50^{a}	643.50^{b}	781.00^{a}	269.50^{c}	291.50^{c}	132.00^{d}	176.00^{d}	5.08
	514.80^{b}	591.50^{ab}	491.50^{b}	631.43^{a}	70.39^{c}	97.70^{c}	48.85^{e}	1.66^{d}	5.95

^{a,b,c,d,e}; Row means with different superscripts differ significantly at $P<0.05$. SME= Standard error of the mean.

Feed Enzymes also have the ability to alter the bacterial population by digesting the long chain carbohydrate molecules utilized by some bacteria to colonize the tract, and this increases the quantity of protein amino acid digested in the pre caecal section of the tract (**Bedford, 1997; Gunal and Yasar, 2004; Carsten, 2013**).

Cost of feeding dietary levels of TBO with supplementary enzyme to broiler finisher birds

Table 4 shows the cost implication of feeding graded levels of toasted bambaranut (TBO) offal with supplementary Enzyme to broiler finisher birds. There were significant ($p<0.05$) differences between treatments in Total body weight (TBW), Total feed consumed (TFC), Cost of total feed consumed (CTFC), Revenue from a bird produced and gross profit (GP). It was observed that the four (4) levels of TBO (0 kg, 20 kg 30 kg and 40 kg) with supplementary Enzyme experienced an increase ($p<0.05$) in TBW and a reduced ($p<0.05$) TFC when compared with TBO levels (0 kg, 20 kg, 30 kg and 40 kg) without Enzyme. This may be attributed to an improved gut viscosity and nutrient digestibility due to Enzyme supplement. **Isikwenu *et al.* (2012)** and **Carsten, (2013)** also share the same view. Cost of feed consumed was lower ($p<0.05$) on Birds fed 20 kg TBO with Enzyme.

Finally, the economics of Enzyme supplementation with 20 kg level of TBO generated more profit than that of control (0 kg TBO with or without Enzyme) and other levels of TBO (30 kg and 40 kg) with or without Enzyme. The economic data clearly indicated that Enzyme supplementation is more feasible and economical to obtain maximum profitability from broiler production (**Khan *et al.*, 2006**). The increased profit (gross profit) for Enzyme supplementation to the TBO based diet in this study agreed with the findings of **Hosamani *et al.* (2001)** and **Rahman, *et al.* (2005).** They reported that profit increased due to low total cost and faster growth rate of broilers that was obtained by addition of an Enzyme.

Conclusion

It is evident from the result obtained in the present study that Enzyme supplementation (Roxazyme G at 0.02 kg) to 20 kg level of TBO based diet increased digestibility and can be used to improve performance of broiler and economic viability.

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