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Response of haco-cockerels fed graded levels of toasted bambara nut offal and supplementary enzyme

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Eighty 4 weeks old spotted cockerels (Harco strain) were used to determine the effect of toasted bambara nut offal (TBNO) and supplementary enzyme on growth performance, haematology and organ weights of birds. The birds were randomly divided into 8 groups of 10 birds each. The groups were randomly assigned to 8 energetic (11.30 MJ/kg Me) and nitrogenous (20.02 to 20.06% crude protein) diets in a 4 × 2 factorial arrangement involving four levels (0, 10, 15 and 20%) of TBNO and 2 enzyme levels (0 and 0.02%). Each treatment was replicated 2 times with 5 birds per replicate. Average final body weight (AFBW), average daily weight gain (ADWG), feed conversion ratio (FCR) and feed cost per kg weight gain were similar, while average daily feed intake (ADFI) was different (P<0.05) among treatments. Inclusion TBNO and supplementary enzyme in the diets of cockerels had significant (P < 0.05) effect on the apparent retentions of dry matter (DM), nitrogen, crude fibre (CF), ether extract (EE) and nitrogen-free extract (NFE). While there were significant interactions (P< 0.05) between TBNO and enzyme levels on DM, nitrogen, CF, EE and NFE retentions. Enzyme supplementation significantly (P < 0.05) increased DM, nitrogen, EE and NFE retentions at all the TBNO inclusion levels. Enzyme supplementation also increased (P < 0.05) CF retention at the 10, 15 and 20% TBNO inclusion levels. It is concluded that 20% TBNO can be included in the diet of growing cockerels without any deleterious effect on their growth performance.

Key words: Toasted bambara nut waste, enzyme, effect, cockerels, growth performance.

INTRODUCTION

The challenges of acute protein shortage in the diets of most Nigerians occasioned by high cost of poultry meat due to high cost of production inputs are indisputable (Babatunde and Hamza, 2005). The astronomical cost of cereal grains like maize and wheat and sources of protein ingredients like soya bean meal, groundnut meal, etc vis-à-vis their acute shortage and competitiveness between man and monogastric animals especially poultry over them calls for a paradigm shift from competitive, costly conventional feed ingredients (foodstuff) to alternative, cheap, non-conventional ingredients with less competetion. The use waste /by- products and residues as replacement for stable energy and protein feedstuff without deleterious effect on animals stand as a major breakthrough in solving the problems of competition of humans with animals over staples such as grains and the high cost of feed inputs which limits production. The by-product being considered in the present study is toasted

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Abbreviations: TBNO, Toasted bambara nut offal; **AFBW,** average final body weight; **ADWG,** average daily weight gain; **ADFI,** average daily feed intake; **DM,** dry matter; **CF,** crude fibre; **EE,** ether extract; **NFE,** nitrogen free extract.

bambara offal [*Vigina subterranean (L) verdc*] while the animal species under focus is the cockerel. Cockerels are good sources of protein meat in Nigeria and command high demand because they possess special flavour and toughness. However, the major problems with cockerels are their slow rate of growth, high feed intake, poor feed conversion efficiency and consequently high cost of production (Ojewola and Ozuo, 2006). The use of local by -products like Bambara nut offal can help to overcome high cost of production. Interestingly, Bambara nut is widely cultivated in both northern and southern Nigeria with a very high yield under good management. The seeds are processed into flour and consumed as moi moi (Enwere, 1998).

The young fresh seeds may be boiled and eaten as a snack in a manner similar to boiled peanuts. Bambara offal is the ultimate discard from the milling of Bambara nut. It has no direct feeding value for humans and in most places it is dumped indiscriminately thus constituting environmental problems/hazards. Bambara nut waste contains up to 16.40% crude protein (Okeke, 2000). It has been used in the feeding of poultry and rabbits (Ani and Okafor, 2004; Ani, 2006). The antinutritional factors in the raw beans such as protease inhibitors, haemaglutinin, tannins, cyanogenic glycosides and flatulence factors limit their nutrient potentials as feed ingredients (Doku and Karikari, 1971; Ensminger et al., 1996; Enwere, 1998). However, the toasting of the Bambara nut offal and the supplementation with Enzyme-Roxazyme G are known to counter the effects of the anti-nutritional factors. This study was therefore conducted to determine the effect of graded levels of toasted Bambara nut offal and supplementary enzyme (Roxazyme) on the growth performance of cockerel chicks.

MATERIALS AND METHODS

The study was carried out at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsuskka. Toasted Bambara waste and other feed ingredients used in the study were purchased at Nsukka and Enugu, in Enugu State, Nigeria.

Animal and experimental diets

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). Eighty 4- week old spotted cockerel chicks (Harco strain) weighing 252.50 to 276.50 g on the average were randomly divided into 8 groups of 10 birds each. The groups were randomly assigned to 8 energetic (11.30 MJ/kg Me) and nitrogenous (20.02 to 20.06% crude protein) diets in a 4 × 2 factorial arrangement involving four level (0, 10, 15 and 20%) of TBNO and 2 enzyme levels (0 and 0.02%). The percentage composition of diets is shown in Table 1. Each treatment was replicated 2 times with 5 birds per replicate placed in 2.6 × 3 m deep litter pens of fresh wood shavings. Feed and water were supplied *ad libitum* to the birds. The birds were properly vaccinated against Newcastle disease and gumboro disease. Prophylactic treatment with oxytetracyline based drugs was administered against bacterial infection and sulfaquinoxaline drugs against coccidioses. The experiment lasted for a period of 5 weeks during which feed intake, weight gain, feed conversion ratio and protein efficiency ratio were monitored. Feed intake was determined daily by the weigh back technique.

Live weights were recorded weekly for each bird. Feed conversion ratio was then calculated from these data as quantity (gram) feed consumed per unit (grams) weight gained over the same period.

Apparent nutrient retention by cockerel chicks

During the 5th week of experimental period, a seven-day excreta collection was made from one bird per replicate to determine the apparent retention of proximate components. Within that period, birds were housed individually in metabolism cages and weighed quantity of feed (90%) of the daily feed intake) was offered to birds daily. The birds were allowed two days to adjust to the cage environment before droppings were collected. Daily feed consumption was recorded as the difference between the quantity offered and the quantity left after 24 h. Faecal droppings were collected from separate cages in detachable trays placed beneath the wire mesh floor of the cages. Collected faecal samples were oven-dried and weighed over the seven days period. At the end of the collection period all faecal samples from each bird were bulked and preserved for analysis.

Proximate and statistical analyses

Feed and excreta samples were assayed for proximate composition by the method of AOAC (1990). Data collected were subjected to analysis of variance (ANOVA) in a completely randomized design (CRD) as described by Steel and Torrie (1980). Significantly, different means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance of cockerels

Table 2 shows the proximate composition of the experimental diets while data on growth performance of cockerels fed diets containing graded levels of toasted Bambara nut offal (TBNO) and supplementary enzyme are presented in Table 3. There were no significant ($P < 0.05$) differences among treatments in average final body weight (AFBW), average daily weight gain (ADWG), feed conversion ratio (FCR) and feed cost per kg weight gain. However, there were significant differences ($P < 0.05$) among treatments in average daily feed intake (ADFI). Birds on treatments 1 and 7 had comparable ($P > 0.05$) average daily feed intake values with those on treatments 2, 5, 6 and 8 and these were significantly ($P < 0.05$) higher than the ADFI values of birds on treatments 3 and 4. Birds on treatment 8 had comparable ($P > 0.05$) average daily feed intake values with those on treatments 2, 4, 5 and 6. Similarly, birds on treatment 3 had comparable ($P > 0.05$) average daily feed intake values with those on

Table 1. Percentage composition of experiment diets.

Ingredient	Diet*							
	1	2	3	4	5	6	7	8
Maize	47.50	47.50	44.00	44.00	41.20	41.20	39.00	39.00
Wheat offal	5.60	5.60	4.60	4.60	3.00	3.00	2.00	2.00
Soya bean meal	25.40	25.40	25.00	25.00	24.70	24.70	24.4	24.4
Bambara nut offal	0.00	0.00	10.00	10.00	15.00	15.00	20.00	20.00
Palm kernel cake	12.00	12.00	6.40	6.40	5.60	5.60	3.60	3.60
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Palm oil	0.00	0.00	0.50	0.50	1.00	1.00	1.50	1.50
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Oyster shell	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	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
Vit/min premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Enzyme	0.20	0.00	0.20	0.00	0.20	0.00	0.20	0.00
Total	100	100	100	100	100	100	100	100
Calculated composition								
Energy (Mcal/KgME)	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
Crude protein (%)	21.13	21.02	20.32	20.45	19.96	19.89	20.00	20.72
Crude fibre(%)	4.33	4.33	5.48	5.48	6.55	6.55	6.77	6.77

Diets*1(0% TBNO and 0% Enzyme); 2(0% TBNO and 0.02% Enzyme); 3(10% TBNO and 0% Enzyme); 4(10% TBNO and 0.02% Enzyme); 5(15% TBNO and 0% Enzyme); 6(15% TBNO and 0.02% Enzyme); 7(20% TBNO and 0% Enzyme); 8(20% TBNO and 0.02% Enzyme); ******Viamin Premix (2.5 kg/1000 kg): vitamin A (15,000 U.I); vitamin D_3(3,000.000 I.U) and vitamin E (30,000 I.U) vitamin k (2,500 I.U), Thiamin B, (2,000 mg), Riboflavin B_2 (6,000 mg). Pyridoxine B_0 (4000 mg), Niacin (40,000 mg), vitamin B_{12} (20 mg), panthothenic B_6 (10,000 MG), folic acid (1,000 mg), Biotin (80 mg), chlorine chloride (500 mg), antioxidant (12 g). managaness (96 g), zinc (60 g), iron (24 g), copper (69), lodine (1.4 g), selenium (24 g) and cobalt (12 g).

Table 2. Proximate composition of experiment diets.

Component	Diet*							
	1	2	3	4	5	6	7	8
Dry matter (%)	88.78	91.00	88.48	89.90	89.40	89.57	90.93	92.88
Nitrogen (%)	21.13	21.02	20.32	20.45	19.96	19.90	20.00	20.72
Ash (%)	12.02	12.65	10.40	11.25	10.20	12.10	12.42	12.98
Crude fibre (%)	4.95	4.10	5.35	5.25	4.62	4.80	4.62	5.20
Ether extract (%)	2.54	3.03	2.09	3.54	3.04	2.42	2.26	3.01
Nitrogen- free extract (%)	48.14	50.21	50.31	49.41	51.56	50.35	51.62	50.97

Diets*1(0% TBNO and 0% Enzyme); 2(0% TBNO and 0.02% Enzyme); 3(10% TBNO and 0% Enzyme); 4(10% TBNO and 0.02% Enzyme); 5(15% TBNO and 0% Enzyme); 6(15% TBNO and 0.02% Enzyme); 7(20% TBNO and 0% Enzyme); 8(20% TBNO and 0.02% Enzyme).

treatments 2, 4, 5 and this was significantly ($P < 0.05$) lower than the ADFI values of birds on treatments 1, 7 and 8. There were no significant interactions ($P > 0.05$) between toasted bambara nut offal and enzyme levels in ADFI. There was no incidence of chicks' mortality throughout the period of the experiment. As shown in Table 3, the average daily feed intake (ADFI) was significantly influenced by the inclusion of toasted Bambara nut offal in the diets. The ADFI varied from 39.06 to 39.69 g. However, the feed intake result obtained in the present study does not agree with the reports of Apata and Ojo (2000) and Ani and Omeje (2007) which showed that

Table 3. Performance of cockerels fed graded levels of toasted Bambara nut wastes and supplementary enzyme.

Parameter	Treatment*								
	1	2	3	4	5	6	7	8	SEM
Average initial body weight (g/bird)	285.00	293.50	261.00	269.00	242.00	263.00	279.00	284.00	16.63
Average final body weight (g/bird)	684.00	685.00	707.00	680.00	664.00	689.00	681.00	664.00	13.83
Average daily weight gain (g/bird/day)	11.40	11.19	12.74	11.74	12.06	12.17	11.49	11.43	0.52
Average feed intake (g/bird/day)	39.60^{a}	39.33^{abc}	39.06^{c}	39.13^{bc}	39.41^{abc}	39.40^{abc}	39.69^{a}	39.53^{ab}	0.18
Feed conversion ratio	3.48	3.52	3.08	3.34	3.27	3.24	3.46	3.48	0.16
Feed cost/kg gain (₦)	291.33	295.510	259.40	281.87	274.53	272.48	391.41	293.69	40.84
Cost of total feed intake (₦)	115.53	115.72	114.94	115.53	115.72	116.07	116.96	116.93	0.69
Protein	8.32	8.31	7.99	8.00	7.84	7.88	8.22	7.91	026
Protein efficiency ratio	1.37	1.35	1.59	1.47	1.54	1.54	1.40	1.45	0.26
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-

^{abc} Rows with different superscripts are significantly different ($P < 0.05$); SEM: standard error of mean; Treatments*1(0% TBNO and 0% Enzyme); 2(0%TBNO and 0.02%Enzyme); 3(10% TBNO and 0% Enzyme); 4(10% TBNO and 0.02% Enzyme); 5(15% TBNO and 0% Enzyme); 6(15% TBNO and 0.02% Enzyme); 7(20% TBNO and 0% Enzyme); 8(20% TBNO and 0.02% Enzyme).

feed intake in broiler chicks fed diets containing cowpea testa and raw bambara nut waste, respectively increased with increasing levels of cowpea testa and raw bambara nut waste in the diets.

The result also contradicts the report of Nnamani (2010) which showed that feed intake in growing cockerels decreased significantly beyond 10% RBO inclusion level in the diets of the cockerels. Perhaps, toasting of the bambara nut offal might have influenced the feed intake pattern obtained in the present study. The comparable ADFI values observed amongst the TBNO dietary treatments contradicts earlier report (Apata and Ojo, 2000) which showed that feed intake decreased with increase in cowpea testa level in the diets of broiler chicks. Reduction in feed intake had also been reported in chicks fed diets containing processed sesame seed meal and dehulled pegion pea seed meal (Amaefule and Obioha, 2001; Akanji et al., 2003). The reduction in feed intake was attributed to the non-palatable nature of the diets containing those legume seed meals. Perhaps, the heat treatment applied to the raw Bambara nut prior to its inclusion in the diets helped to improve its texture, palatability and nutritive value by destroying or inactivating the heat – labile toxic compounds and anti-nutritional factors such as protease inhibitors, haemaglutinins, tannins, cyanogenic glycosides and flatulence factors present in the raw Bambara nut (Enwere, 1998; Ensminger et al., 1996; Liener, 1986; Liener and Kakade, 1980). Earlier report (Enwere, 1998) had shown that heat treatment applied to legume foods improved their texture, palatability and nutritive value by destroying or inactivating heat – labile toxic compounds and other enzyme inhibitors. Palatability in particular had been shown to influence feed intake and hence the overall performance of animals (Jurgens, 2002; Holness, 2005). Evidently, the palatability of the control diet was not superior to that of the diets containing toasted Bambara nut offal (TBNO) considering the comparable feed intake values of birds fed diets containing the heat-treated Bambara nut offal and those fed the control diets. It does appear that it is more beneficial to include processed toasted Bambara nut offal in the diet of chicks as this would not help birds fed dietary Bambara nut offal to have comparable feed intake with those fed the control diet. This would also help to conserve feed and consequently lead to reduction in the cost of feed.

The results also contradict the report of Ani and Omeje (2007) which showed that the feed intake of chicks increased as the level of raw Bambara nut waste in the diet increased to 20%. Incidentally, enzyme supplementation did not have any significant effect on feed intake (Table 2). The present observation is not in consonance with the reports of Ranade and Rajmane (1992), Samarasinghe et al. (2000), Ani and Omeje (2007) and Nnamani (2010) which showed that enzyme supplementation resulted in decreased feed intake at all the levels of raw Bambara nut waste inclusion in the diets. The non-significant effect of supplementary enzyme on feed intake could be as a result of the use of processed (toasted) Bambara nut waste in the present study as against the raw Bambara nut waste used by Ani and Omeje (2007) and Nnamani (2010). Since feed intake was not adversely influenced by the inclusion of toasted Bambara nut offal in the chicks' diets, therefore, the inclusion of enzyme in some of the diets did not play any significant role in regulating the amount of feed

Table 4. Effect of toasted Bambara nut offal and supplementary enzyme on apparent retention of nutrients by cockerels.

Parameter	Treatment*								
	1	2	3	4	5	6	7	8	SEM
Dry matter	40.26^{b}	41.30^{a}	39.52^{d}	40.02^{c}	36.81^{f}	37.15^{e}	35.50^{h}	36.52^{g}	0.51
Nitrogen	57.19^{b}	57.42^{a}	55.72^{f}	56.00^{d}	54.92^{h}	55.76^{e}	55.01^{g}	56.56^{c}	0.25
Crude fibre	54.22^{a}	54.22^{a}	52.56^{d}	53.22^{b}	52.28^{e}	52.99^{c}	51.51^{g}	51.74^{f}	0.25
Ether extract	58.69^{b}	60.20^{a}	55.76^{d}	56.95^{c}	52.77^{f}	54.81^{e}	50.51^{h}	50.67^{g}	0.86
Nitrogen- free extract	49.39^{b}	49.45^{a}	48.13^{e}	48.80^{c}	47.19^{g}	48.17^{d}	47.19^{h}	48.03^{f}	0.29

$^{ab,...,h}$Rows with different superscripts are significantly different ($P < 0.05$); SEM: Standard error of mean; Treatments*1 (0% TBNO and 0% Enzyme); 2(0% TBNO and 0.02% Enzyme); 3(10% TBNO and 0% Enzyme); 4(10% TBNO and 0.02% Enzyme); 5(15% TBNO and 0% Enzyme); 6(15% TBNO and 0.02% Enzyme); 7(20% TBNO and 0% Enzyme); 8(20% TBNO and 0.02% Enzyme).

consumed by the birds.

Effect of toasted Bambara nut offal and supplementary enzyme on apparent retention of nutrients by cockerels

Data on Table 4 show the effect of toasted Bambara nut offal and supplementary enzyme on apparent retention of nutrients by cockerels. Dry matter (DM) apparent digestibility (%), nitrogen (N) apparent retention, crude fibre (CF), apparent digestibility (%), ether extract (EE) apparent digestibility (%) and nitrogen-free extract (NFE) apparent digestibility (%) were significantly ($P < 0.05$) affected by treatments. Birds on treatment 2(0% TBNO diet with enzyme) had significantly ($P < 0.05$) higher DM apparent digestibility (%) than birds on other treatments. Similarly, birds on treatment 1(0% TBNO diet without enzyme) had significantly ($P < 0.05$) higher DM apparent digestibility (%), than birds on treatments 3 to 8. Birds on treatment 7 had the least DM apparent digestibility (%) ($P < 0.05$). The nitrogen retention of birds on treatment 2 was significantly ($P < 0.05$) higher than that of birds on other treatments. Similarly, birds on treatment 1(0% TBNO diet without enzyme) had significantly ($P < 0.05$) higher nitrogen retention than birds on treatments 3 to 8. The least nitrogen retention was observed in treatment 5 ($P < 0.05$). Birds on treatments 1 and 2(0% TBNO diet with and without enzyme, respectively) had significantly ($P < 0.05$) higher apparent CF digestibility (%) than birds on other treatments. Birds on treatments 7 and 8 (20% TBNO diet with and without enzyme) had significantly ($P < 0.05$) lower apparent CF digestibility (%) than birds on other treatments. Birds on treatment 7 had the least apparent CF digestibility (%) ($P < 0.05$).

The EE apparent digestibility (%) of birds on treatment 2 was significantly ($P < 0.05$) higher than those of birds on other treatments. Similarly, birds on treatment 2(0% TBNO diet with enzyme) had significantly ($P < 0.05$) higher EE apparent digestibility (%) than birds on treatments 3 to 8. Birds on treatment 7 had the least EE apparent digestibility (%) ($P < 0.05$). Birds on treatment 2(0% TBNO diet with enzyme) had significantly ($P < 0.05$) higher NFE apparent digestibility (%) than birds on other treatments. Similarly, birds on treatment 1 had significantly ($P < 0.05$) higher NFE apparent digestibility (%) than birds on treatment 3 to 8. Birds on treatment 4 (10% TBNO diet with enzyme) had significantly ($P < 0.05$) higher NFE apparent digestibility (%) than birds on treatments 3, 5, 6, 7 and 8. Birds on treatment 7 had the least NFE apparent digestibility (%) ($P < 0.05$). There were significant ($P < 0.05$) interactions between TBNO and enzyme levels on DM apparent digestibility (%), nitrogen apparent retention, and CF, EE and NFE apparent digestibility (%). Enzyme supplementation significantly ($P < 0.05$) increased DM apparent digestibility (%), nitrogen apparent retention, and EE and NFE apparent digestibility (%) at all the TBNO inclusion levels. Enzyme supplementation also increased ($P < 0.05$) CF apparent digestibility (%) at the 10, 15 and 20% TBNO inclusion levels.

As shown in Table 4, the apparent digestibility (%) of dry matter, apparent retention of nitrogen, and crude fibre, ether extract and nitrogen-free extract apparent digestibility (%) decreased with the increase in the levels of TBNO in the diets. The observed reduction in the apparent digestibility (%) and retention of these nutrients could have been as a result of the high fibre content of the TBNO containing diets. Decrease in nutrient digesti-bility with increasing dietary fibre level has been earlier documented in poultry (Babatunde and Hamzat, 2005) and in rabbits (Jokthan et al., 2006). It has been shown by Deaton et al. (1997) that insoluble dietary fibre exerts certain physiological effects on the gastrointestinal tract of animals by inhibiting digestive enzymes and by combining with mucin layer covering the villi of the small intestine to affect nutrient absorption. Besides, Choct and Annison (1992) reported that the increased bulk and viscosity of the intestinal content led to a decrease in the

rate of diffusion of substrate and thereby hindered the effective interaction at the mucosal surface. Reduction in apparent nutrient digestibility had been attributed to higher rate of passage of digester in animals that were fed high fibre diets (Kass et al., 1980; Fielding, 1991). Kung and Grueling (2000) had reported that high level of dietary fibre tends to limit the amount of intake and the retention of the available energy by birds and contributes to excessive nutrient excretion. However, supplementation of some of the diets with enzyme resulted in great improvement in the apparent digestibility (%) and retention; and in the utilization of these nutrients due to enhancement in their digestion and absorption.

Evidently, the performance of birds that were fed the enzyme-supplemented diets was not inferior to that of birds on the control diets. This agrees with earlier reports (Bedford, 1997; Annison and Choct, 1991; Acromovic, 2001; Toibipont and Kermanshashi, 2004) that enzymes increase digestibility of feed ingredients by reducing the viscosity of the gut contents. This results in increased nutrient absorption and in the reversal of the adverse effects of NSPs on growth of birds.

Conclusion

It is evident from the results obtained in the present study that up to 20% toasted Bambara nut offal can be included in the diet of growing cockerels without any deleterious effect on their growth performance.

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