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Effects of enzyme supplementation of raw bambara nut ((*Vigna subterranea* (L) verdc) waste diets on carcass and organ weights of broiler finishers

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Abstract

A study was conducted out to investigate the effects of graded levels of raw bambara nut waste and supplementary enzyme (Roxazyme G) on carcass and internal organ weights of broiler finishers. Ninety-six 6-week old broiler birds were randomly divided into 8 groups of 12 birds each. The groups were randomly assigned to 8 energetic (11.48-12.20 MJ of ME/kg) and nitrogenous (20.09-20.43% crude protein) diets in a 4 x 2 factorial arrangement involving four levels (0, 20, 30 and 40%) of raw Bambara nut waste (RBW) and 2 enzyme levels (0 and 0.02%). Each treatment was replicated 3 times with 4 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. The experiment lasted for four weeks. At the end of the experimental period when the birds were 10 weeks old, 3 birds per treatment (one per replicate) were randomly selected and weighed for carcass and organ evaluation. Results showed that increasing the levels of RBW did not result in any significant (P>0.05) increase in the relative weights of spleen and heart, while the relative weights of liver, kidney, empty gizzard, small and large intestines increased significantly (P<0.05). There were, however significant (P<0.05) decreases in the live body weight, dressed carcass weight and carcass dressing percent as the levels of RBW in the diets increased beyond 20 %. The results obtained in the present study shows that with Roxazyme G supplementation at 200mg/kg, up to 20% of raw bambara nut waste can be included in the diet of broiler finishers without any adverse effect on their carcass and internal organ weights.

Keywords: raw Bambara nut waste, enzyme, broiler finishers, carcass and organ weights

Introduction

There is need to increase the production and consumption of animals such as poultry, pigs and rabbits in order to solve the problem of acute shortage of animal protein in the diets of average Nigerians as reported by FAO (1997). Poultry in particular are highly prolific and very efficient in converting feed nutrients into high quality animal protein (Smith, 2001). Poultry require carbohydrates, fats, proteins, vitamins, minerals and water for maintenance, growth and high productivity. However the increasing cost of poultry feeds with the attendant increase in the cost of poultry products such as chicken and eggs is one of the major factors militating against increased animal production in Nigeria. The vegetable protein sources constitute the greater percentage of the cost of feed. Protein is very critical in poultry ration formulation because it is the most limiting nutrient, the most expensive nutrient and the best indicator of diet quality (Obioha, 1992). It is imperative, therefore, to explore the use of cheap and non-conventional feedstuff like bambara nut **(*Vigna subterranea* (*L*) Verdc)** waste. Bambara nut is widely cultivated in the Northern and Southern States of Nigeria. The seeds are milled into flour, processed and consumed as *moi moi* (Enwere, 1998). Bambara nut waste, a by-product of bambara nut milling industry contains18.30% 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 waste has been used in the feeding of poultry and rabbits (Ani, 2006; Ani, 2007; Ani and Omeje, 2007). A major factor limiting the use of bambara nut waste in the feeding of animals especially the monogastrics, is the presence of antinutritional factors such as protease inhibitors, haemaglutinnins, tannins, cyanogenic glycosides and flatulence factors in the raw bean (Doku and Karikari, 1981; Ensminger *et al*., 1996; Enwere, 1998). Another limitation to the use of bambaranut waste 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 amounts of fibre. The problem of high fibre content can be solved by dietary inclusion of enzymes. Acromovic (2001) and Bedford *et al*. (1992) revealed that enzymes increase digestibility of feed ingredients and reduce the incidence of weight losses which may result from the presence of non-starch polysaccharides (NSPs) in the diet. The enzyme being considered in this study is Roxazyme G, an enzyme complex derived from *Trichoderma viride* with glucanase and xylanase activity. The enzyme has been shown to increase digestibility of fibrous feed ingredients by disrupting the plant cell walls, and by reducing the viscosity of the

Table 1: Percentage composition of experimental diets

RBW level (%)	0		20		30		40	
Enzyme level (%)	0	0.02	0	0.02	0	0.02	0	0.02
Diets	1	2	3	4	5	6	7	8
Maize	53.0	53.0	33.0	33.0	23.0	23.0	13.0	13.0
Raw bambara waste	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
Vit/Min.Premix*	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
Roxazyme G	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
Total	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
Energy (mJ of ME/kg)	12.15	12.20	12.10	12.12	11.78	11.78	11.48	11.49

* Each 2.5kg of premix contains: vit. A, 10000000 IU; vit. D3, 2000000 IU; vit. E, 23000 mg; vit. K3, 2000mg; vit. B1, 1800mg; vit. B2, 5500mg; Niacin, 27500mg; pantothenic acid, 7500mg; vit. B6, 3000mg; vit. B12, 15mg; folic acid

gut contents, thereby enhancing nutrient absorption (Choct and Annison, 1992; Bedford *et al*., 1992; Acromovic, 2001). The present study was therefore conducted to determine the effects of graded levels of raw bambara nut waste and supplementary enzyme (RoxazymeG) on external growth parameters, carcass and internal organ weights of broiler finishers.

Material and methods

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

Animals and experimental diets

Ninety-six 6-week old broiler birds were randomly divided into 8 groups of 12 birds each. The groups were randomly assigned to 8 diets containing 11.48-12.20 MJ of ME/kg and 20.09-20.43% crude protein, in a 4 x 2 factorial arrangement involving four levels (0, 20, 30 and 40%) of RBW and 2 enzyme levels (0 and 0.02%). The composition of the diets is presented in Table 1.Each treatment was replicated 3 times with 4 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. The experiment lasted for four weeks. The birds were subjected to standard broiler management practices. Birds in each replicate were weighed individually at the beginning and at the end of the experiment.

Carcass and organ evaluation

At the end of the experimental period when the birds were 10 weeks old, 3 birds per treatment (one per replicate) were randomly selected and weighed for carcass and organ evaluation. The birds were starved overnight and slaughtered by severing the jugular veins, scalded in warm water for about a minute, and the feathers were plucked manually. The birds were eviscerated and weighed to obtain their dressed carcass weights. The kidney, liver, gizzard, heart, spleen, small intestine, large intestine, caeca, and air sac were removed and weighed using a sensitive electronic scale and grossly examined for any pathological changes. The Dressed carcass weight and the organ weights were expressed as percentages of the live weights.

Proximate and statistical analyses

Diets were analyzed for proximate composition using the methods of AOAC (1990). Gross energy of diets was determined in a Parr oxygen adiabatic bomb calorimeter. Data collected were subjected to analysis of variance(ANOVA) as described for completely randomized design (Steel and Torrie, 1980), and differences between treatment means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Results and discussion

Table 2 shows the proximate composition of the experimental diets. Data on carcass and organ weights of broiler finishers fed the experimental diets are presented in Table 3.

There were significant ($P<0.05$) differences among treatments in live body weight, dressed carcass weight and carcass dressing %. Birds in treatment 2(0%RBW diet with enzyme supplementation) had higher ($P<0.05$) live body weight than birds in other treatments. Birds in treatments 5-8 (30 and 40%RBW diets with and without enzyme supplementation) had the least ($P<0.05$) live body weight. Birds in treatments 1 and 2 (0%RBW diets with and without enzyme supplementation) had significantly ($P<0.05$) higher dressed

Table 2: Proximate composition of experimental diets

RBW levels (%)	0		20		30		40	
Enzyme levels (%)	0	0.02	0	0.02	0	0.02	0	0.02
Components(%)/Diets	1	2	3	4	5	6	7	8
Dry matter (%)	92.28	91.75	90.00	89.98	90.60	91.92	91.79	89.54
Crude protein (%)	20.18	20.18	20.17	20.17	20.24	20.25	20.26	20.27
Crude fibre (%)	5.89	5.02	8.25	8.08	9.86	8.98	11.06	10.86
Ether extract (%)	5.90	4.82	6.00	5.00	4.98	4.96	5.02	4.88
Ash (%)	6.4	7.20	7.60	8.70	8.10	9.04	9.01	8.89
Nitrogen-free extract (%)	53.14	53.29	46.08	46.64	46.10	45.50	46.11	42.37
Gross Energy (Mj/Kg)	12.00	12.38	13.01	13.77	13.52	13.87	14.02	14.86

carcass weight than birds in other treatments. Birds in treatments 7 and 8 had the least (P<0.05) dressed carcass weight. Birds in treatments 3 and 5(20 and 30 % unsupplemented RBW diets, respectively) had comparable dressed carcass weight. The dressing % values of birds in treatments1-4, 6 and 8 were similar and higher (P<0.05) than that of birds in treatments 5and 7(30 and 40 % unsupplemented RBW diets, respectively). There were significant RBW x enzyme interaction in live body weight, dressed carcass weight and dressing %. Enzyme supplementation increased (P<0.05) live body weight at the 0% RBW inclusion level; increased (P<0.05) dressed carcass weight at the 20, 30 and 40% RBW inclusion levels; and increased (P<0.05) dressing % at the 30 and 40% RBW inclusion levels. The relative weights of liver, kidney, heart, empty gizzard, small and large intestine, as well as the lengths of caeca, small and large intestines differed significantly (P<0.05) among treatments. Birds in treatment 7 (40% RBW diet without enzyme supplementation) had higher (P<0.05) relative weights of liver, kidney, empty gizzard, small and large intestine than birds in other treatments. Birds in treatment 6 had higher (P<0.05) relative heart weight than birds in treatments1-3. The caecal length of birds in treatments1-5 are shorter (P<0.05) than that of birds in treatments 6and 8. Birds in treatment 7 had longer (P<0.05) small intestine than birds in other treatments. Birds in treatments 7and 8 had longer (P<0.05) large intestine than birds in other treatments. There were significant (P<0.05) RBW x enzyme interactions in relative weights of liver, kidney, empty gizzard, small and large intestine. Enzyme supplementation increased (P<0.05) the relative weights of liver, kidney, empty gizzard, small and large intestine at all the RBW inclusion levels. There were also significant (P<0.05) RBW x enzyme interactions in the lengths of caeca, small and large intestines. . Enzyme supplementation increased (P<0.05) the lengths of small and large intestines at the 20, 30 and 40% RBW inclusion levels; and increased (P<0.05) caecal length at the 20 and 30% RBW inclusion levels.

As shown in Table 3, live body weight,

Table 3: Carcass and organ weights of broiler finishers

Raw bambara nut levels (%)	0		20		30		40		
Enzyme levels (%)	0	0.02	0	0.02	0	0.02	0	0.02	SEM
Parameters/Treatments	1	2	3	4	5	6	7	8	
Live body weight(g)	3120.00^{b}	3300.00^{a}	2850.00^{c}	3000.00^{bc}	2590.00^{ef}	2740.00^{de}	2520.00^{f}	2660.00^{ef}	55.30
Dressed weight(g)	27030.00^{a}	2750.00^{a}	2510.00^{c}	2660.00^{b}	2280.00^{c}	2320.00^{d}	2210.00^{f}	2240.00^{f}	10.37
Dressing %	87.50^{a}	83.33^{a}	88.07^{a}	88.67^{a}	78.05^{b}	84.67^{a}	73.85^{b}	87.70^{a}	3.10
Kidney wt as% of body wt.	0.42^{c}	0.30^{e}	0.53^{b}	0.35^{de}	0.59^{b}	0.41^{cd}	0.62^{a}	0.46^{c}	0.02
Liver wt as% of body wt.	1.98^{c}	1.91^{de}	2.30^{b}	1.70^{e}	2.60^{b}	1.91^{de}	3.02^{a}	2.24^{cd}	0.11
Heart wt as% of body wt.	0.38^{bc}	0.37^{c}	0.38^{bc}	0.40^{a}	0.41^{ab}	0.43^{a}	0.40^{ab}	0.40^{ab}	0.01
Gizzard wt as% of body wt.	3.54^{e}	3.03^{f}	4.24^{cd}	3.42^{ef}	4.98^{b}	3.88^{de}	5.54^{a}	4.07^{cd}	0.16
Spleen wt as% of body wt.	0.42	0.38	0.58	0.48	0.67	0.63	0.70	0.66	0.3
Ceaca wt. as% of body wt.	0.54	0.52	0.68	0.63	0.79	0.60	0.71	0.59	0.02
Caeca length(cm)	21.30^{de}	22.10^{d}	20.30^{e}	23.30^{cd}	24.10^{bc}	25.50^{a}	25.30^{ab}	26.40^{a}	0.44
Small intestine wt as% of body wt.	2.95^{e}	2.42^{f}	3.32^{d}	2.79^{e}	3.93^{ab}	3.45^{cd}	4.21^{a}	3.70^{bc}	0.12
Large intestine wt as% of body wt.	0.32^{c}	0.24^{d}	0.37^{b}	0.26^{d}	0.42^{a}	0.31^{c}	0.44^{a}	0.38^{b}	0.01
Small intestine length (cm)	220^{c}	220^{c}	220^{c}	210^{d}	250^{b}	206^{d}	280^{a}	214^{cd}	3.13
Large intestine length(cm)	13.60^{c}	12.29^{d}	14.50^{b}	13.10^{c}	15.79^{b}	14.80^{b}	18.20^{a}	17.50^{a}	0.43

a,b,..f=means on the same row with different superscripts are significantly ($P < 0.05$) different.

dressed carcass weight and carcass dressing % decreased significantly as the level of RBW in the diets increased above 20 %. The presence of anti-nutritional factors (ANFs) in the raw Bambara nut could have caused the observed reduction. These might have increased in concentration with increase in the level of RBW in the diets. Emenalom *et al*. (2004) in their report had attributed reduction in carcass weight to ANFs in raw velvet bean (*Mucuna pruriens*). The role of ANFs in growth depression and reduced carcass weight in broiler birds due to low metabolizable energy in feed had been earlier documented (Iyayi and Yahaya, 1999). However, the live body weight, dressed carcass weight and carcass dressing % of broiler finishers fed diets containing RBW and supplementary enzyme were improved significantly. Although the observed improvement in meat yield of some of the broiler finishers contradicts the report of Biswas *et al*. (1999), it is, nevertheless consistent with the reports of Jamroz *et al*. (1996); Pisarski and Wojcik (1995) and Lesson *et al*. (1996). Enzyme might have reversed the deleterious effects of the antinutritional factors by hydrolyzing soluble xylans and glucans thereby resulting in reduced digesta viscosity to enhance nutrient digestion, absorption and utilization by the broiler finishers (Ishikki *et al*., 1989; Ikegami, 1990). Friesen *et al*. (1992) and Maquardt *et al*. (1994) had reported that such antinutritional factors as β-glucans and arabinoxylase interfere with nutrient digestion and absorption thereby resulting in reduced feed conversion efficiency and growth rate, as well as reduced dressed carcass weight. The carcass dressing % values (73.85-88.07%) obtained in the present study are higher than the values (65.9-69.4% and 69.1-72.6%) reported by Ferriera *et al*. (2003) and Omojola and Fagbuaro (2005), respectively. Although the live body weight values of birds on treatments 6 and 8 (30 and 40% RBW diets with enzyme supplementation) were lower than the mean body weight of those fed the control diets, their dressing % values were comparable. Perhaps, birds that consumed the control diets had more feathers and viscera weights than those on treatments 6 and 8. The amount of feathers and viscera possessed by birds depend on their body surface area and weight, respectively (Broadbent *et al*., 1981; Adeniji, 2004) made similar suggestions. Increasing levels of RBW did not result in any significant increase in the relative weights of spleen and heart. This dis agrees with earlier observation in broilers fed raw velvet bean (Carew *et al*., 1998). However the relative weights of liver, kidney, empty gizzard, small and large intestines increased significantly with increase in RBW levels (Table 4). The increase in the relative weights of liver, kidney, empty gizzard, small and large intestines could be attributed to the ANFS in raw bambaranut waste. Wang *et al*. (1995) had shown that anti-nutrients exert their deleterious effects through reduced nutrient absorption following extensive structural and functional disruption of the intestinal microvilli. According to Lorenzson and Olsen (1982), the extensive structural and functional disruption of the intestinal microvilli could lead to the shedding of brush-border membrane and decreased villus length with consequent reduction in the surface area for absorption in the small intestine. The presence of antinutritional factors such as protease inhibitors, haemaglutinins, tannins, cyanogenic glycosides and flatulence factors in raw bambara nut had been reported (Doku and Karikari, 1981; Ensminger *et al*., 1996; Enwere, 1998). The increase in relative weights of liver and kidney may therefore represent the metabolic work of these organs in processing the raw bambara nut waste. Carew *et al*. (2000) made similar observation. Liver size is known to increase in response to several factors, especially deficiencies in protein and amino acids, and is usually due to accumulation of fat (Velu *et al*., 1971). Madhusudhan *et al*. (1986) had attributed liver enlargement to the ability of the liver to detoxify the antinutritional factors present in raw bean. Han (1997) had earlier reported some increases in the internal organ weights of broilers fed barley based diets supplemented with crude enzyme. Kidney enlargement has also been attributed to high deposition of uric acid related compounds (Opstevdt, 1988; Idowu and Eruvbetine, 2005). The increase in the relative weight of empty gizzard is in consonance with the report of Ibiyo and Atteh (2005) that the gizzard weight of chicks fed dietary rice bran increased with increase in the level of rice bran in the diets. Carew *et al*. (2000) also reported an increase in the relative gizzard weight of chicks that consumed raw velvet bean. The gizzard might have increased weight because of the extra muscular work required to digest the RBW diets which had higher fibre levels than the control diets. Increase in gizzard weight of chicks fed high fibre diets had earlier been reported (Iyayi and Egbarevba, 1998). Johnson and McNab(1983) and Adeniji (2004) had also shown that gizzard weight is determined by the amount of work required by the muscular wall of the organ to comminute feed particles. The gizzard therefore might have required extra muscular activity in order to comminute the bambara nut waste particles in the RBW diets. The marked effect of RBW in the diets was a significant increase in the size of the gastro intestinal tract. A similar increase was reported in chicks fed diet high in soluble and insoluble fibre (Brenes *et al*., 1993). Carew *et al*. (2003) also reported significant increase in relative weights of small and large intestines of growing chicks fed raw velvet bean.Various fibres in feed ingredients such as oligofructoses and other non starch polysaccharides (NSPs) are known to increase the size of the small intestine (Jorgensen *et al*., 1996; Iji, 1999; Yusrizal *et al*., 2002). Onimisi *et al* .(2006) also observed an increase in the gut of chicks fed ginger waste meal and attributed such increase to increased bulkiness of the feeds occasioned by increasing levels of ginger waste in the diets. The gut capacity had to enlarge to enable the birds cope with the high volume of the feeds. However the addition of enzyme to some of the diets reversed the negative effects of the RBW on the affected organs. Although the reversal observed in the present study contradicts the reports of Annison and Choct (1991), Rotter (1991) and Bedford (1995), it is in agreement with the reports of Wang *et al*. (1995) and Brenes *et al*. (2002). The results obtained in the present study tend to suggest that inclusion of more than 20% RBW in the diets of broiler finishers could have deleterious effects on both their internal organs. It is necessary, therefore, to process raw bambara nut waste before its inclusion at high levels in the diets of broiler finishers.

Conclusion

It is evident from the results obtained in the present study that with Roxazyme G supplementation at 200mg/kg, up to 20% of raw bambara nut waste can be included in the diet of broiler finishers without any adverse effect on their carcass and organ weights.

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