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CARCASS AND CONFORMATIONAL CHARACTERISTICS OF BROILER FINISHERS FED DIETARY RAW BAMBARA NUT ((*Vigna subterranea* (L) VERDC) WASTE

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ABSTRACT
The effects of graded levels of raw Bambara nut waste (RBW) on carcass weights, internal organ weights and conformational characteristics of broiler finishers were investigated. Ninety-six 6-week old broiler birds were randomly divided into 4 groups of 24 birds each and assigned to 4 diets [11.48-12.20 MJ of ME/kg and 20.09-20.43% crude protein] containing four levels (0, 20, 30 and 40%) of RBW. Each treatment was replicated 3 times with 8 birds per replicate. Feed and water were supplied *ad libitum* to the birds during the four weeks experimental period. Body, shank, neck, thigh and wing lengths, as well as the thigh diameter were estimated at day old and subsequently on weekly basis using a tailor's tape. At 10 weeks, 3 birds per treatment (one per replicate) were randomly selected and weighed for carcass and organ evaluation. Results showed that there was no significant (P>0.05) increase in the relative weights of spleen and heart as the level of RBW in the diets increased, while the relative weights of liver, kidney, empty gizzard, small and large intestines increased significantly (P<0.05). Live body weight, body length, neck length, dressed carcass weight and carcass dressing % decreased significantly (P<0.05) beyond 20% RBW inclusion level, while shank length and thigh diameter were decreased at the 40% RBW inclusion level. It was concluded that up to 20% of raw Bambara nut waste can be included in the diet of broiler finishers without any adverse effect on carcass yield, relative organ weights and conformational traits of birds.

KEY WORDS: raw Bambara nut waste, diets, broiler finishers, carcass and organ weights, conformational characteristics.

INTRODUCTION

The poultry industry is one of the fastest growing segments of the livestock industry. Poultry 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. Growth and high productivity of poultry can be achieved by the selection of genotypes with potentials for long thighs and necks as this will enable them to efficiently pick feed and water from varying types of troughs with minimal waste. The sizes of the head, neck, shanks, and thigh are often associated with the size of the skeletal frame work and hence can serve as a measure of growth in birds. According to Gillespie (1997), animals grow by increases in the size of muscles, bones, organs, and connective tissues. 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 (Ani and Omeje, 2012). 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). There is therefore, the need to explore the use of cheap and non-conventional feeding stuff 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 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 waste has been used in the feeding of pigs, poultry and rabbits (Onyimonyi 2002; Onyimonyi and Onukwufor 2003; Ani and Omeje, 2007; Ani 2008; Ani , 2009). 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, haemaglutinins, tannins, cyanogenic glycosides and flatulence factors in the raw bean (Ensminger *et al.,* 1996; Enwere, 1998). Another limitation to the use of bambaranut waste is its high fibre content (Ani 2007). Poultry cannot utilize high fibre diets fully because they lack the digestive framework that can elaborately digest large amount of fibre. Against this backdrop, the present study was therefore conducted to determine the dietary effects of raw bambara nut on carcass weights, internal organ weights and conformational characteristics of broiler finishers.

MATERIALS 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.

Experimental Birds 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). Ninety-six 6-week old broiler birds were randomly divided into 4 groups of 24 birds each. The groups were randomly assigned to 4 caloric (11.48-12.20 MJ of ME/kg) and nitrogenous (20.09-20.43% crude protein) diets containing four levels (0, 20, 30 and 40%) of RBW. 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 birds were subjected to standard broiler management procedure. Birds in each replicate were weighed individually at the beginning and at the end of the experiment. Estimation of lengths of the body, shank, neck, thigh and wing, as well as thigh diameter was done at day old and subsequently on weekly basis using a tailor's tape.

TABLE 1: Composition of broiler finisher diets (%)

	Raw Bambara nut levels (%)			
	0	20	30	40
Ingredients/Diets	1	2	3	4
Maize	53.0	33.0	23.0	13.0
Raw bambara waste	0.0	20.0	30.0	40.0
Groundnut cake	15.0	15.0	15.0	15.0
Fish meal	1.50	0.5	0.4	0.2
Palm kernel cake	5.50	9.50	10.60	12.80
Soybean meal	10.00	7.00	6.00	4.00
Wheat offal	10.00	10.00	10.00	10.00
Bone meal	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25
Vit/Min.Premix*	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated analysis				
Crude protein (%)	20.10	20.09	20.41	20.43
Crude fibre (%)	4.28	7.72	9.66	10.99
Energy (MJ of ME/kg)	12.15	12.10	11.78	11.48

***** 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, 750mg; biotin H2, 60mg; choline chloride, 300000mg; cobalt, 200mg; copper, 3000mg; iodine, 1000mg; iron, 20000mg; manganese, 40000mg; selenium, 200mg; zinc, 30000mg; antioxidant, 1250mg

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 and caeca 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 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

Carcass and relative organ weights

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

TABLE 2: Proximate composition of broiler finisher diets

	Raw Bambara nut levels (%)			
	0	20	30	40
Components/ Diets	1	2	3	4
Dry matter (%)	92.28	90.00	90.60	91.79
Crude protein (%)	20.18	20.17	20.24	20.26
Crude fibre (%)	5.89	8.25	9.86	11.06
Ether extract (%)	5.90	6.00	4.98	5.02
Ash (%)	6.4	7.60	8.10	9.01
Nitrogen-free extract (%)	53.14	46.08	46.10	46.11
Gross Energy (Mj/Kg)	12.00	13.01	13.52	14.02

TABLE 3: Carcass and organ weights of broiler finishers

	Raw Bambara nut levels (%)				
	0	20	30	40	
Parameters/Diets	1	2	3	4	SEM
Live body weight(g)	3120.00^{a}	2850.00^{ab}	2590.00^{bc}	2520.00^{c}	55.30
Dressed weight(g)	2703.00^{a}	2510.00^{a}	2280.00^{b}	2210.00^{c}	10.37
Dressing %	87.50^{a}	88.07^{a}	78.05^{b}	73.85^{b}	3.10
Kidney wt as% of body wt.	0.42^{c}	0.53^{b}	0.59^{b}	0.62^{a}	0.02
Liver wt as% of body wt.	1.98^{c}	2.30^{b}	2.60^{b}	3.02^{a}	0.11
Heart wt as% of body wt.	0.38	0.38	0.41	0.40	0.01
Gizzard wt as% of body wt.	3.54^{d}	4.24^{c}	4.98^{b}	5.54^{a}	0.16
Spleen wt as% of body wt.	0.42	0.58	0.67	0.70	0.3
Ceaca wt. as% of body wt.	0.54	0.68	0.79	0.71	0.02
Caeca length(cm)	21.30^{b}	20.30^{b}	24.10^{a}	25.30^{a}	0.44
Small intestine wt as% of body wt.	2.95^{c}	3.32^{b}	3.93^{a}	4.21^{a}	0.12
Large intestine wt as% of body wt.	0.32^{c}	0.37^{b}	0.42^{a}	0.44^{a}	0.01
Small intestine length (cm)	220^{c}	220^{c}	250^{b}	280^{a}	3.13
Large intestine length(cm)	13.60^{c}	14.50^{b}	15.79^{b}	18.20^{a}	0.43

^{a,b,c}means on the same row with different superscripts are significantly (P < 0.05) different.
SEM =Standard error of mean

Live body weight, dressed carcass weight, carcass dressing %, and relative weights of kidney, liver and gizzard were significantly (P<0.05) influenced by dietary treatments. Birds that consumed 0% (control) and 20% RBW diets had similar live body weight values and these were higher (P<0.05) than the live body weight value of birds that consumed the 40% RBW diet. Birds that were fed 20 and 30% diets had comparable live body weight values, while those that were fed 30 and 40% RBW diets also had comparable live body weight values. Birds that were fed 0 and 20% RBW diets had similar dressed carcass weight values and these were significantly (P<0.05) higher than the dressed carcass weight values of those fed 30 and 40% RBW diets, while birds that were fed 40% RBW diet had the least dressed weight. The dressing % values of birds that were fed 0 and 20 % RBW diets were similar and these were higher (P<0.05) than the dressing % values of birds that were fed 30 and 40 % RBW diets , which also had similar dressing % values. Birds that consumed 40% RBW diet had significantly (P<0.05) higher relative weights of liver and kidney than birds that were fed other diets. Birds that were fed 20 and 30% RBW diets had similar relative weights of liver and kidney, while those that were on the control diet had the least relative weights of liver and kidney. Birds that were fed the fed 40% RBW diet had significantly (P<0.05) higher relative gizzard weight value than those that were fed other diets, while birds that were fed the control diet had the least relative gizzard weight. Birds that were fed 30 and 40 % RBW diets had similar caecal length values and these were higher (P<0.05) than the caecal length values of birds that were fed 0 and 20 % RBW diets , which also had similar values. Birds that were fed 30 and 40 % RBW diets had similar relative weights of small and large intestines and these were higher(P<0.05) than those of birds that were fed 0 and 20% RBW diets. Birds on the control diet had the least relative weights of small and large intestines. Birds that were fed 30 and 40 % RBW diets had similar lengths of small and large intestines and these were higher(P<0.05) than those of birds that were fed 0 and 20% RBW diets. Birds that were fed 0 and 20 % RBW diets had similar lengths of small intestines, while birds that were fed 20 and 30% RBW diets also had similar lengths of large intestines. Birds on the control diet had the least lengths of small and large intestines. Dietary levels of RBW had no significant (P>0.05) effect on relative weights of heart, spleen and ceaca.

Conformational characteristics

Table 4 shows the effect varying dietary levels of raw bambara nut waste on external growth parameters of broiler finishers. Dietary levels of raw bambara nut waste had significant (P<0.05) effects on the lengths of body, neck, shank, thigh and wing. Thigh diameter and feather weight were also affected by varying dietary levels of raw bambara nut waste.

TABLE 4: Conformational characteristics of broiler finishers

	Raw Bambara nut levels (%)				
	0	20	30	40	
Parameters/Diets	1	2	3	4	SEM
Body length(cm)	23.00[a]	21.20[b]	21.50[b]	20.40[b]	0.31
Neck length(cm)	12.60[a]	11.30[b]	10.40[c]	10.00[c]	0.22
Shank length(cm)	9.50[a]	8.50[b]	8.80[b]	8.40[b]	0.16
Thigh length(cm)	15.30[a]	15.40[a]	15.00[ab]	14.80[b]	0.16
Thigh diameter(cm)	7.80[a]	7.50[a]	7.40[ab]	7.00[b]	0.16
Wing length(cm)	25.00[a]	23.40[ab]	21.00[b]	20.50[b]	0.43
Feather weight(g)	230.00[a]	200.00[b]	180.00[b]	180.00[b]	9.46

[a,b,c]means on the same row with different superscripts are significantly ($P < 0.05$) different.
SEM =Standard error of mean.

Birds fed 0% RBW diet had significantly ($P<0.05$) higher body length, neck length shank length and feather weight than birds fed other RBW diets. Birds fed 20, 30 and 40% RBW diets had similar body length, shank length and feather weight. Birds fed 20% RBW diet had longer neck than those fed 30 and 40%RBW diets. Birds fed 30 and 40%RBW diets had similar neck length. Birds fed 0 and 20% RBW diets had similar thigh length and thigh diameter values with those fed 30% RBW diet and these were significantly ($P<0.05$) higher than the thigh length and thigh diameter values of birds fed 40% RBW diet. Birds fed 30 and 40%RBW diets had similar thigh length and thigh diameter values. Birds fed 0% RBW diet had similar wing length value with those fed 20% RBW diet and this was significantly ($P<0.05$) higher than the wing length values of birds fed 30 and 40%RBW diets. Birds fed 20, 30 and 40% RBW diets had similar wing length values.

DISCUSSION

Carcass and relative organ weights

As shown in Table 3, the marked effect of dietary levels of RBW was significant decreases in live body weight, dressed carcass weight and carcass dressing %, especially as the level of RBW in the diets increased beyond 20 %. Perhaps the anti-nutritional factors (ANFs) in the raw Bambara nut could have been responsible for the observed reduction. These might have increased in concentration with increase in the level of RBW in the diets. In an earlier report (Emenalom *et al* 2004) reduction in the carcass weights of birds fed dietary raw velvet bean (*Mucuna pruriens*) was attributed to ANFs in the raw velvet beans. The role of ANFs in growth depression and reduction in carcass weight in broiler birds as a result of low nutrient availability had been earlier documented (Iyayi and Yahaya 1999). 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. As shown in Table3, increasing levels of RBW did not result in any significant increase in the relative weights of spleen and heart. This disagrees 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 3). 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 in particular 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; Brenes *et al.,* 2002). 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. 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 carcass yield and internal organs of birds. It is necessary, therefore, to process raw bambara nut waste before its inclusion at high levels in the diets of broiler finishers.

Conformational characteristics

As shown in Table 4, increasing levels of RBW in the diets significantly reduced the lengths of body, neck and shank, and feather weight of birds. While thigh length and thigh diameter were decreased at the 40% RBW inclusion level, the wing length was decreased at the 30 and 40% RBW inclusion levels. The decrease in shank length is in consonant with earlier report (Songunle *et al.,* 2005).The reduction in these external growth indices might be as a result of growth depression observed in these birds as reported by Ani and Omeje (2007). Antinutritional factors (ANFs) such as protease inhibitors, haemaglutinins, tannins and cyanogenic glycosides in the raw bean (Doku and Karikari, 1981; Enwere, 1998) had been implicated for growth depression in animals (Ensminger *et al.,* 1996). The result obtained in the present study tends to suggest that inclusion of more than 20% RBW in the diets of broiler finishers could have deleterious effects on the growth of some of the birds' external organs.

CONCLUSION

It is evident from the results obtained in the present study that up to 20% of raw bambara nut waste can be included in the diet of broiler finishers without any adverse effect on carcass yield, relative organ weights and conformational traits of birds.

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