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ORIGINAL ARTICLE

Carcass Characteristics and Economics of Production of Finisher Broiler Chickens Fed Diets with Graded Levels of Decorticated Raw Sandbox (*Hura crepitans*) Seeds as Organic Source of Methionine

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Abstract

The need for organic sources of amino acids in broiler production cannot be overemphasized in order to guarantee precision and environmental friendly poultry production. This feeding trial was conducted to investigate the effect of graded dietary levels (0%, 0.1%, 0.2% and 0.3%) of decorticated sandbox seeds (SBS) as organic methionine source on carcass characteristics and economics of production of finisher broiler chickens. Four dietary treatments were formulated to include sandbox seeds at 0%, 0.1%, 0.2% and 0.3% and labelled as T1, T2, T3 and T4 respectively in a completely randomized design using one hundred and twenty four week-old broiler chickens. Data were collected on feed intake, final weight, carcass characteristics, weights of internal organs and economics of production. The experiment lasted for 28 days and data collected were subjected to one way Analysis of Variance and treatments' means were separated using Duncan multiple range test. The treatments were not significantly different in their effects on dressing percentage, relative weights of back, drumsticks and thighs but breast muscle was significantly highest ($P<0.05$) for treatment T3 (0.2% SBS). Treatment T4 (0.3% SBS) had the significantly lowest ($P<0.05$) effect on live weight (1513.00g) and dressed weight (1054.50g). Relative values for the internal organs fall within the normal range and were not significantly affected by the inclusion of the SBS. There were no significant differences ($p>0.05$) among the treatments in the cost of feed per kilogram but treatment T4 (0.3% SBS) gave the significantly lowest ($P<0.05$) profit of ₦1033.07 per bird while treatment T2 recorded the highest amount of profit (₦3730.27).It was concluded that dietary inclusion of decorticated sandbox seeds up to 0.3% without synthetic methionine has no detrimental effect on carcass characteristics and internal organs of broiler chickens. The inclusion of sandbox seeds resulted in a significantly higher profit and Sandbox seeds can serve as a good and more economical source of methionine in broiler production.

Keywords: Broilers, Carcass, Decorticated, Organic Methionine, Sandbox seeds

Introduction

The need for alternative feedstuffs in poultry nutrition cannot be overemphasized. Feed accounts for about 70% of the total cost of broiler production (Etuah *et al*., 2021; Atteh, 2003). Most feedstuffs used in poultry feeding are also being competed for by humans and the brewery industry and this has created several problems for the poultry industry. Protein feedstuffs like soya bean and groundnut are especially expensive as they are also being used as source of protein for humans. The quality of protein feedstuffs depends on the amino acid profile and most plant-based feedstuffs are deficient in one amino acid or the other. For instance, soya bean meal is deficient in methionine and this has necessitated the need for the addition of synthetic methionine thereby increasing the cost of feed.

Methionine is one of the limiting amino acids and it has marked effects on nutrients' digestibility and prima cuts of broiler chickens especially breast muscle (Wen *et al*., 2017). The current practice is the use of synthetic methionine in the form of DL- or L- to supplement methionine in the diets of broiler chickens. This has led to an increase in the cost of feed and also an increase in the price of poultry products. There is also the need to replace synthetic feedstuffs with organic feedstuffs due to the growing concern about the effects of synthetic materials in the residue of products and environmental concerns (Jalal *et al*., 2015). For instance, excess nitrogen based on crude protein formulation is excreted into the atmosphere and this has contributed to greenhouse gas emission and global warming (FAO, 2017).

The conventional method of feed formulation is to use crude protein requirement. However, NRC (1994) reports that poultry birds have amino acids requirements as against the commonly used crude protein requirement. Proteins are polymers of amino acids and the profile of the amino acids determines the quality of the protein feedstuff. Most commonly used feedstuffs are deficient in essential amino acids. For instance, soya meal which is the best plant protein is deficient in methionine. This study was therefore conducted to investigate the effect of graded inclusion of decorticated sandbox (*Hura crepitans*) seeds in the diets of finisher broiler chickens. Sandbox seed has relatively high protein value of 23.70% (Ozeudu *et al*., 2015) and 24.63% (Jimoh *et al*., 2023). The seeds also contain all the essential amino acids with methionine content of 1.34% (Jimoh *et al*., 2023) which is higher than that of soya bean meal (0.6%). The study specifically investigated the effect of sandbox seeds on carcass characteristics, visceral organs and economics of production of finisher broiler chickens.

Materials and Methods

Experimental Site

The study was conducted at Livestock Teaching and Research Farm of Joseph Sarwuan Tarka University, Makurdi, Benue State Nigeria. Makurdi has both dry and wet seasons with seven months of rain from April to October and dry season from November to March. Makurdi is located within Latitudes $7^0 14''$N and 9^0 52' N and longitudes $8^0 35''$E and 8^0 41'E (GPS, 2012).

Collection of Sandbox Seeds

Brown and matured sandbox fruits (*Hura crepitans*) were obtained from sandbox trees within the study area and its environ. The fruits were broken to remove the seeds and the seeds were later decorticated, sundried and milled. Reference was made to literature for the proximate composition and amino acid profile of Sandbox seeds (Jimoh *et al.*, 2023).

Composition of Experimental Diets

Four broiler finisher diets were produced to contain 0%, 0.1%, 0.2% and 0.3% of decorticated sandbox seeds (SBS) respectively as dietary treatments T1, T2, T3 and T4 as shown in table 1. The diets were formulated to be isocaloric and isonitrogenous.

Table 1: Composition of Experimental Diets

	Treatments			
Feedstuffs	T1	T2	T3	T4
Maize	65.2	65.2	65.2	65.1
Maize offal	2	2	2	2
SBM	22.23	22.23	22.23	22.23
Blood Meal	6.67	6.67	6.67	6.67
Bone	3	3	3	3
Lysine	0.15	0.15	0.15	0.15
Methionine	0.2	0.1	0	0
SBS	0	0.1	0.2	0.3
Salt	0.3	0.3	0.3	0.3
Broiler Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated Analyses				
CP, %	20.51	20.54	20.56	20.58
ME, Kcal/Kg	2924.85	2924.85	2924.85	2921.6
EE, %	3.73	3.73	3.73	3.72
CF, %	3.71	3.71	3.73	3.74
Lysine, %	1.37	1.37	1.37	1.37
Methionine, %	0.48	0.39	0.3	0.3
Calcium. %	1.12	1.12	1.12	1.12
Av. Pho., %	0.78	0.78	0.78	0.78

T1: Control treatment with DL-Methionine and no SBS , T2: Contained 0.1% DL-methionine + 0.1% SBS
T3: Contained 0.2% SBS without DL-methionine, T4: Contained 0.3% SBS without DL-methionine,
SBM: Soya bean meal, SBS: Sandbox Seeds, CP: Crude protein, ME: Metabolizable Energy, EE: Ether extract, CF: Crude fiber, Av. Pho.: Available phosphorus

Experimental Design and Birds Management

One hundred and twenty (n=120) four week old broiler chickens of uniform weight were obtained for the experiment. They were randomly allocated to the four dietary treatments (T1, T2, T3 and T4) in a completely randomized design with three replicates per treatment and ten birds per replicate. The experimental units were earlier cleaned and disinfected. The study was conducted in a deep litter housing system.

The housing system is open-sided and well ventilated and standard biosecurity measures were adopted including the use of foot dip. Electricity was used to supply light throughout the experimental period. The birds were supplied with feeding and drinking troughs and experimental feed and water were supplied *ad libitum* throughout the twenty eight-day experimental period. The study followed the laid down ethical guidelines for the use and care of experimental animals for research purpose.

Collection of Data

The initial weights of the birds were obtained at the commencement of the trial on replicate basis using a sensitive digital scale. The average feed intake was obtained as difference between initial feed offered and the left over on weekly basis divided by number of birds in each replicate. At the end of the fourth week of the study, a bird per replicate with body weight similar to the average weight of the birds in the replicate was removed from the unit and used for carcass analysis in line with standard operating procedure.

The bird was weighed and killed by cutting the jugular vein and allowing blood to drain out freely. It was later scalded and the head, neck, shanks and visceral organs removed. The dressed weight was taken and dressing percentage was calculated using the formula below.

$$\text{Dressing percentage} = \frac{\text{Dressed weight}x}{\text{Live weight}} x100$$

The carcass was cut into the primal cuts namely breast muscle, wings, thighs, drumsticks and back. Each cut part was expressed as a percentage of the dressed weight using the formula below.

$$\text{Relative Weight of Primal Cut (\%)} = \frac{\text{Weight of Primal Cut}nx}{\text{Dressed Weight!}} x100$$

Visceral organs were removed, weighed and expressed as percentage of the live weight as follows;

$$\text{Relative Weight of Visceral organ (\%)} = \frac{\text{Weight of Visceral Organ}}{\text{Live weight!}} x100$$

The price per kilogram of feedstuff was multiplied by the inclusion level of the feedstuff. These were added together to obtain the total cost of the feed which was later divided by the quantity of feed to arrive at the price per kilogram of feed. The cost of feed per bird was obtained as FCR multiplied by feed cost per kilogram. Revenue was obtained as live weight of the bird multiplied by price per kilogram of chicken using the prevailing marketing price.

Statistical Analysis

All data collected were subjected to one- way analysis of variance (ANOVA) suitable for a Completely Randomized design with the aid of Statistical Package for Social Science (SPSS, 2011). Significant difference among Treatments' means was determined using Duncan's Multiple Range test (Duncan, 1955) at 5% significance level..

Results

Carcass Characteristics of Finisher Broiler Chickens Fed Diets with Graded Levels of Decorticated Raw Sandbox (Hura crepitans) Seeds

The carcass characteristics of finisher broiler chickens fed diets with graded levels of decorticated raw sandbox seeds are shown in table 2. The final weight of birds on dietary treatment with 0.3% decorticated SBS (T4) was significantly lowest ($p<0.05$) compared to birds on treatments T1, T2 and T3. A similar trend was observed for dressed weight.

Treatment T3 (0.2% SBS) was significantly lowest in its effect on breast weight expressed as a percentage of dressed weight at 22.31% while other treatments were not significantly different among themselves with values of 34.66%, 44.70% and 39.02% respectively for treatments T1, T4 and T2. The treatments were not significantly different in their effects on the relative weight of thighs, back and drumsticks. The decorticated raw sandbox seeds had no significant effect on dressing percentage of the experimental birds across the treatments. However, the weight of the wings varied significantly as treatments T3 and T4 were significantly higher than treatments T2 and T1.

Table 2: Carcass Characteristics of Broiler Chickens Fed Diets with Graded Levels of Decorticated Sandbox (*Hura crepitans*) Seeds as a Source of Methionine

	Treatments					
Parameters	T1	T2	T3	T4	P-value	SEM
Live weight (g)	2231.33^{a}	2775.33^{a}	2218.00^{a}	1513.00^{b}	0.02	0.16
Dressed Weight (g)	1650.33^{a}	1973.67^{a}	1444.50^{a}	1054.50^{b}	0.03	140.84
DP (%)	72.81	71.58	64.15	69.72	0.69	2.50
Breast muscle (%DW)	34.66^{a}	39.02^{a}	22.31^{b}	34.70^{a}	0.00	2.08
Thighs (%DW)	17.63	16.79	18.59	16.25	0.35	0.47
Back (%DW)	16.93	16.57	19.46	17.05	0.34	0.60
Drumsticks (%DW)	17.98	15.95	18.96	17.43	0.29	0.55
Wings (%DW)	$12.80^{b,c}$	11.66^{c}	15.66^{a}	$14.57^{a,b}$	0.03	0.58

T1: Control with DL-Methionine but no SBS, T2: Diet contained 0.1% DL-methionine + 0.1% SBS
T3: Diet contained 0.2% SBS without DL-methionine, T4: Diet contained 0.3% SBS without DL-methionine,
DP: Dressing percentage, g: gram, %: percentage, %DW: Percentage of Dressed Weight

Relative Weight of Visceral Organs of Finisher Broiler Chickens Fed Diets With Graded Levels of Decorticated Raw Sandbox (Hura crepitans) Seeds

Treatments T2 and T3 are not significantly different in their effects on the relative weight of the heart and the spleen but their effects are significantly lower than the effects of treatments T1 and T4 on these visceral organs (table 3). There were no significant differences among the treatments in their effects on the relative weight of lungs, crop and proventriculus (glandular stomach). Treatments T1, T2 and T3 are significantly higher in their effects on the weight of the liver, kidney and gizzard compared to treatment T4.

However, the effect of treatment T4 on pancreas is significantly highest while treatments T1 and T2 are not significantly different in their effects on the weight of the pancreas. The length of the small intestine is not significantly different among the treatments except for treatment T4 which is significantly lower than others.

Table 3: Relative Weight of Visceral Organs of Broiler Chickens Fed Diets with Graded Levels of Decorticated Sandbox (*Hura crepitans*) Seeds as Organic Source of Methionine

	Treatments					
Organs	T1	T2	T3	T4	P-value	SEM
Heart (%LW)	0.55^{a}	0.39^{b}	0.36^{b}	0.63^{a}	0.01	0.04
Liver (%LW)	1.64^{b}	1.44^{b}	1.73^{b}	2.55^{a}	0.00	0.14
Lungs (%LW)	0.68	0.54	0.50	0.59	0.14	0.03
Kidney (%LW)	$0.62^{a,b}$	0.53^{b}	0.51^{b}	0.69^{a}	0.03	0.03
Spleen (%LW)	0.12^{a}	0.07^{b}	0.07^{b}	0.13^{a}	0.00	0.01
Pancreas (%LW)	0.20^{b}	0.20^{b}	0.14^{c}	0.26^{a}	0.01	0.02
Crop (%LW)	0.34	0.32	0.31	0.33	1.00	0.03
Proventriculus (%LW)	0.48	0.30	0.38	0.50	0.22	0.04

Gizzard (%LW)	1.49[b]	1.51[b]	1.47[b]	1.89[a]	0.04	0.06
Small Intestine (cm)	230.47[a]	197.33[a,b]	198.20[a,b]	190.90[b]	0.11	6.52

T1: Control with DL-Methionine but no SBS, T2: Diet contained 0.1% DL-methionine + 0.1% SBS
T3: Diet contained 0.2% SBS without DL-methionine, T4: Diet contained 0.3% SBS without DL-methionine,
%LW: Percentage of Live Weight, cm: Centimeter

Economics of Production of Finisher Broiler Chickens Fed Diets with Graded Levels of Decorticated Raw Sandbox (Hura crepitans) Seeds

Table 4 shows the economics of production for finisher broiler chickens fed diets with graded levels of decorticated raw sandbox seeds. Birds fed diet T2 (0.1% SBS+ 0.1% DL-methionine) had the significantly highest feed cost per bird (₦1335.46/bird) compared to birds fed other treatments. A similar trend was obtained for total cost of production. However, treatments T1 to T3 were significantly better (p<0.05) than treatment T4 in their effects on feed conversion ratio (FCR) and feed cost per kilogram weight gain. Treatment T2 gave the significantly highest (p<0.05) revenue and profit with values of ₦6660.80 and ₦3730.27 respectively while treatment T4 had the lowest values of ₦3631.20 and ₦1033.07 respectively for revenue and profit.

Table 4: Economics of Production of Broiler Chickens Fed Diets with Graded Levels of Decorticated Sandbox (*Hura crepitans*) Seeds as Organic Source of Methionine

	Treatments				P-value	SEM
Parameters	T1	T2	T3	T4		
Cost of bird (₦)	1500	1500	1500	1500	NA	NA
Cost of feed (₦/Kg)	379.35	377.45	375.55	375.25	NA	NA
Feed Intake (g/bird)	2819.50[b]	3538.10[a]	2894.50[b]	2673.00[b]	0.04	120
Feed Cost/bird (₦)	1069.57[a]	1335.46[b]	1067.03[a]	1003.04[a]	0.03	47.41
Final Weight (g)	2231.30[a,b]	2775.30[a]	2218.00[a,b]	1513.00[b]	0.02	164.72
Operational Cost	395.07	395.07	395.07	395.07	NA	NA
TCP (₦)	2664.27[a]	2930.53[b]	2682.10[a]	2596.11[a]	0.03	47.41
FCR	1.74[a]	1.55[a]	1.65[a]	2.53[b]	0.02	0.14
Feed Cost/Kg Weight (₦)	660.50[a]	584.60[a]	618.52[a]	948.14[b]	0.02	52.68
Revenue (₦)	5355.20[a,b]	6660.80[a]	5323.20[a,b]	3631.20[b]	0.02	395.33
Profit (₦)	2690.93[a,b]	3730.27[a]	2641.10[a,b]	1033.07[b]	0.03	271.07

T1: Control with DL-Methionine but no SBS, T2: Diet contained 0.1% DL-methionine + 0.1% SBS
T3: Diet contained 0.2% SBS without DL-methionine, T4: Diet contained 0.3% SBS without DL-methionine,
NA: Not analysed statistically, TCP: Total cost of production, FCR: Feed Conversion Ratio

Discussion

The quality of any protein feedstuff depends more on the amino acid profile than the crude protein content. Ordinarily, poultry birds have no requirement for crude protein but for individual amino acids (NRC, 1994). The most limiting amino acids in common plant-based feedstuffs are methionine and lysine. Methionine is known to have effects on several performance parameters like feed intake, weight gain as well as carcass characteristics like breast weight and overall meat yield (Pokoo-Aikins *et al.*, 2021). Results of ths study show that an increase in the inclusion level of sandbox seeds up to 0.2% without the synthetic methionine had no significant negative effect on the live weight and dressed weight of the birds. The availability of methionine is crucial in the utilization of feed as methionine is important in the initiation of protein synthesis. The non-significant difference between synthetic methionine-supplemented feed and SBS-supplemented feed is an indication of the availability of methionine in SBS. Methionine positively affects feed intake, body weight gain, FCR, weight gain and breast meat yield (Majdeddin *et al*., 2019; Lui *et* *al.*, 2005; Lui *et al.*, 2006). The breast meat yield in the present study also confirms the importance of methionine as the meat yield for SBS-supplemented diets were comparable with that of the control where synthetic form of methionine was used. The findings of this study also corroborate the findings of Pokoo-Aikins *et al*. (2021) which reported that an increase in organic methionine increases the performance of broiler chickens.

The non-significant difference in the relative weights of crop, proventriculus and small intestine may be attributed to the fact that the sandbox seeds have low crude fiber content. Fibre is known to increase the size of some digestive organs (Egbewande, *et al.*, 2017). The values of relative weight for internal organs obtained in this study are comparable with the values obtained by Olanloye *et al.* (2024) and Ukam *et al*. (2020) for broiler chickens and are similar to values for Ross 308 breed of broiler chickens as reported by Kokoszyriski (2017). The values also indicate that the source of methionine does not affect the relative weight of the internal organs measured.

Values of relative weight obtained for kidney, heart, spleen and pancreas are similar to values obtained by Egbewande *et al.* (2017). Rehman et al. (2019) reported that the weight of the gizzard can be affected by the level of methionine in the diet. The non-significant difference between the control (T1) and treatments T2 and T3 in this study is an indication that the sources of the methionine (synthetic and organic) have similar effects on the relative weight of the gizzard.

Several phytochemicals have been identified in sandbox seeds and these include Oxalate (2.04mg/100g), saponin (0.51%), alkaloids (12.11%), flavonoids (8.00%), tannins (2.17mg/100g), cyanide (1.37mg/100g) and phytate (1.12mg/100g) (Jimoh and Tarhemba, 2025). However, the non-significant difference among the treatments in their effects on the relative weights of the visceral organs may indicate that the ant-nutritional factors had no noticeable effect. This may be due to the low inclusion level of the sandbox seeds in the diets.

The non-significant difference in the price per kilogram of the dietary treatments even at the 0.3% SBS inclusion level could be attributed to the very low inclusion level and the relatively low cost of the SBS as the seeds were used raw without any additional processing which could have led to additional cost. The significant reduction in the feed cost per bird could be attributed to the reduced feed intake by the birds as the inclusion level increases from T2 to T3 and T4. Although, the feed cost per bird was statistically highest (worst) for treatment T2 compared to other treatments, the final weight was statistically highest (best) for the same treatment T2. The profit margin obtained in this study favours dietary treatment T2 (0.1% methionine + 0.1% SBS) although this is not significantly different from treatment T3 (0.2%SBS) and treatment T1 (control).

The implication of this could be that the higher levels of SBS at 0.2% and 0.3% both with no methionine were not enough to meet the methionine requirement of the birds. This may be responsible for the relatively lower final weight of the birds on treatments T3 and T4. The profit margin observed in this study indicates that the use of SBS at an inclusion level of 0.1% along with methionine has a numerically higher advantage although this is not statistically different from treatments T1 (control with no SBS) and T3 (0.2% SBS). For a typical farmer, a numerical profit margin over the control is a reason for economic advantage as every financial unit matters.

Conclusion

From the findings of this study, it can be concluded that organic methionine from sandbox seeds is readily available and could serve as an alternative to the synthetic methionine. This will ensure environmentally friendly broiler production. Addition of SBS resulted in reduced cost of production and more profit. However, an inclusion level of 0.3% without supplementation with synthetic methionine is not enough to meet the methionine requirements of broilers for optimum growth performance. There is therefore the need to investigate higher inclusion levels of the seeds beyond 0.3% to completely replace the use of synthetic methionine.

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