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COMPARATIVE EVALUATION OF DIFFERENLY PROCESSED SOYA BEAN MEAL WITH RED SORGHUM ON PRODUCTIVE PERFORMANCE AND COST BENEFIT ANALYSIS OF BROILER CHICKENS IN SEMI-ARID ZONE OF BORNO STATE, NIGERIA

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Abstract*: The study examined the response of broiler chickens to differently processed full-fat soya beans with red sorghum as an energy source on growth performance, carcass characteristics and cost benefit analysis of broiler chickens. Three hundred day-old broiler chicks were used for the study in a completely randomized design (CRD) managed on deep litter for eight weeks. Feed and water were given ad libitum. Differently processed soya bean i.e. raw (diet1), soaked (diet 2), boiled (diet 3), roasted (diet 4) and conventional soya bean meal (SBM) diet 5. The chicks were fed with differently processed full full-fat with red sorghum as an energy source. The experiment revealed that, the heat-treated method of the processing soya beans, i.e. diets 3, 4 and 5 had better performance (P<0.05) for all the parameters considered than those on diets 1 and 2 i.e. raw and soaked. However, the boiled method had superior performance among the heat-treated methods for all the parameters considered. Similarly, carcass and organs weight followed similar patterns all in favour of heat-treated diets than birds on diets 1 and 2. The feed cost per kg gain was lowest on birds fed diet 3 (boiled soya bean) while the least was on diet 1 (raw soya bean). It was concluded that heat treatment is the best method in eliminating or reducing anti-nutritional factors in soya beans when feeding to broiler chickens without compromising the performance, carcass yield and at reduced cost. Also it is concluded that boiling is the best option among the heat-treated methods when evaluating the performance of broiler chickens.*

Keywords: *Differently, Processed, Soya Bean, Sorghum.*

Description of problem

The need to meet animal proteins demands of ever growing world population currently at approximately 6.8 billion (1) is set at increase of even greater rate as the economics of developing countries improve and their growing affluent populace alter their dietary habits. The impact of extra food to feed these people (mainly in developing countries) and additional feed predicted to support our livestock growth with total 525 million metric tons/year needing 167 million hectares of additional arable land, which is not now

available (2), makes the future uncertain. Thus in order to meet the protein requirement of this populace especially developing countries like Nigeria, there is need to search for feedstuffs that are highly nutritious, readily available and affordable by an average person. The answer lies on the use of soya bean as a source of protein to broiler chickens. Soya bean which is used extensively as animal feed is a very good protein source widely grown in Nigeria. It has a range of adaptability, resistance to drought and tolerance to poor soils (3). This must be increased beyond current production level of about 246 million metric tons (4).

Soya bean (*Glycine max L.*) are an annual leguminous crop that belongs to subfamily *papilanadeae* of the family *leguminosae*. It is not only a source of high quality protein edible for humans, but also high quality vegetable protein in animal feed worldwide (5). Its universal acceptability in animal feed has been due to favourable attributes such as relative high energy content (3300 MEkcal/kg), high protein content (40.00 — 44.00 % CP), low fibre content (3.00-5.90%), and suitable amino acid profile except methionine; others are adequate levels of calcium and phosphorus, minimal variations in nutrient content, relative freedom from anti-nutritive factors if properly processed (6,5). Soya bean meal is the most dominant protein supplement used in poultry diets and it has become the standard to which all protein sources are compared e.g. groundnut cake, and other similar plant protein sources cost 3 to 9 times more than soya bean and contains less protein (5). Also attention has been focused on soya bean utilization as an alternative protein source in animal diets due to the changing availability or allowed uses of animal protein coupled with the relative low cost. Soya bean represents two third (2/3) of the total world output of protein feedstuffs including all other major oil meals and fish meal (7). Its feeding value is unsurpassed by any other plant protein source (8). Soya bean meal is usually classified for marketing by its crude protein content (8). There are two categories of soya bean meal, the -'high protein" soya bean meal with 47.00 — 49.00% crude protein and 3% crude fibre, obtained from dehulled seeds, and the "conventional" Soya bean meal with 43.00 — 44.00% protein, that contains the hulls (9). Despite Soya bean pivotal role in animal production, it cannot be fed raw because there are a number of Anti-Nutritive Factors (ANFs) present that have a negative impact (toxic) on the nutritional/quality of the protein (10,5).

In furtherance of this, these substances cannot be digested by monogastric animals especially poultry. The elimination of these ANFs and those of less significance can be achieve through various processing methods (toasting/roasting and boiling, (cooking), soaking (fermentation etc.) (3, 11). These methods have different impact on the nutritional quality of the product derived such as full-fat soya bean and soya bean meal. This work is geared towards evaluating these processing methods and its effect of on the performance, carcass characteristics and cost benefit of broiler chickens fed red sorghum as energy source.

Materials and Methods

Location of experimental site

The study was conducted at the Livestock Unit of the Teaching and Research Farm, Department of Animal Production Technology, Ramat Polytechnic Maiduguri. Maiduguri, the Borno State Capital, is situated on latitude $11^0$51' N, longitude $13^0$09' E and at altitude of 354m above sea level (12). The area falls within the Sahelian region of West Africa which is noted for its great climatic and seasonal variation. It has very short

period (three to four months) of rainfall giving 645.9 mm/annum with a long dry season of about eight to nine months (12). The ambient temperature could be as low as 20^0C during the dry cold season and as high as 44^0C during the dry hot season. Relative humidity is 30-45% in August which usually drops to about 5% in December and January. Day length varies from 11-12 hours (13, 12).

Sources of Soya bean and Processing Methods Employed

The soya bean along with other ingredients such as maize, millet, white sorghum, red sorghum, fish meal, wheat offal, bone meal, premix, salt, lysine and methionine used for the experiments were purchased at Gomboru market, Maiduguri Metropolitan Council. Soya bean were winnowed to remove dirt. The processing methods were: Raw soya bean were milled and labelled as raw soya bean (RSB) (Diet 1). Soaking: the soya beans were soaked in water for 72 hours in a metal half-drum and sun-dried for 3 days and labelled as soaked (SSB) (Diet 2). Boiling: some soya beans were boiled at the temperature of 100^0C for thirty minutes and were considered boiled when felt soft upon pressed between fingers and later sun-dried for three (3) days and labelled as boiled (BSB) (Diet 3). Roasted: soya beans were toasted in a frying pan until they turn brownish and labelled as roasted (ROSB) (Diet 4). Conventional soya bean meal purchased at market within the study area and labeled as SBM (Diet 5). These soya bean were milled in a hammer mill (Model number EWT-4436-TF Manufactured by Bliss) to obtain the differently processed soya bean meals before chemical analysis and feed formulation.

Experimental stocks and their management

A total of three (300) hundred unsexed day-old *Abor acres* broiler chicks were randomly assigned to the five dietary experiments in a completely randomized design (CRD). Each treatment group of sixty birds (60) birds were further sub-divided into three replicates of twenty (20) chicks each on weight equalization and kept in pens measuring 4mx4m. Feed and water were provided *ad libitum* and birds subjected to standard management procedure.

Experimental diets

Five isonitrogenous, isocaloric experimental diets for each of the starter (23% CP) and finisher (20% CP) phases were formulated using differently processed full-fat soya bean as protein source with red sorghum as energy source. The processing methods were designated as raw, soaked, boiled, toasted/roasted and conventional soya bean meal. The composition of the starter and finisher diets containing red sorghum as energy source are presented in Tables 1and 2.

Table 1: Ingredients and Composition (%) of the Experimental Broiler Starter Diets containing Differently Processed Full-fat Soya Bean with Red Sorghum (Starter Phase) (1-4 weeks)

Ingredients (%)	Diets				
	1RSB	2SSB	3BSB	ROSB	5SBM
Red Sorghum	46.99	46.33	46.99	48.24	53.38
Soya bean meal	36.11	36.77	36.11	34.86	29.72
Wheat Offal	8.00	8.00	8.00	8.00	8.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Limestone	1.00	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis %					
Crude protein (CP)	22.66	22.61	22.61	22.43	24.71
Crude fibre (CF)	4.01	4.01	4.01	3.98	4.54
Ether Extract (EE)	4.48	4.75	4.96	4.17	3.37
Ash	3.34	3.25	3.28	3.28	4.54
Calcium (Ca)	1.36	1.35	1.34	1.34	1.34
Phosphorus (P)	0.86	0.82	0.85	0.85	0.94
Lysine	1.38	1.31	1.35	1.35	1.49
Methionine	0.63	0.59	0.63	0.63	0.65
Metabolizable Energy (ME)	2770.23	2770.65	2770.66	2770.66	2462.22

**Premix to supply the following per kg of feed: A =12,000.00IU, vitamin E = 15000mg, folic acid = 1000mg, panthotenic acid = 1500mg, vitamin B_{12} = 15000mg, vitamin B_6 = 2,500mg, vitamin K = 2,000mg, Choline = 50,000mg, Manganese = 10,000mg, vitamin D_3 = 25,000IU, Nicotinic Acid = 40,000mg, vitamin B_1 = 2,000mg, vitamin B_2 = 6,000mg, Biotin = 6,000mg, vitamin C = 3,000mg, Copper = 15,000mg, Cobalt = 250mg and Selenium = 1000mg.*

Table1 2: Ingredients and Composition (%) of the Experimental Broiler Finisher Diets containing Differently Processed Full-fat Soya Bean with Red Sorghum (Finisher Phase) (5-8 weeks)

Ingredients (%)	Diets				
	1RSB	2SSB	3BSB	4ROSB	5SBM
Red sorghum	50.02	50.47	50.09	50.06	50.33
Soya bean meal	30.98	30.53	30.10	30.94	30.67
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Palm oil	3.00	3.00	3.00	3.00	3.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50
Bone meal	1.50	1.50	1.50	1.50	1.50
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis %					
Crude protein (CP)	20.15	19.95	20.15	20.00	20.29
Crude fibre (CF)	4.57	4.05	4.05	4.02	4.50
Ether Extract (EE)	2.97	4.97	4.12	4.33	4.22
Ash	3.53	3.44	3.47	3.83	4.13
Calcium (Ca)	1.11	1.10	1.10	1.11	1.09
Phosphorus (P)	0.73	0.72	0.72	0.72	0.80
Lysine	1.24	1.18	1.24	1.21	1.44
Methionine	0.60	0.58	0.58	0.60	1.69
Metabolizable Energy (ME)	2929.58	2928.08	2929.58	2929.58	2965.58

**Premix to supply the following per kg of feed: A =12,000.00IU, vitamin E = 15000mg, folic acid = 1000mg, panthotenic acid = 1500mg, vitamin B_{12} = 15000mg, vitamin B_6 = 2,500mg, vitamin K = 2,000mg, Choline = 50,000mg, Manganese = 10,000mg, vitamin D_3 = 25,000IU, Nicotinic Acid = 40,000mg, vitamin B_1 = 2,000mg, vitamin B_2 = 6,000mg, Biotin = 6,000mg, vitamin C = 3,000mg, Copper = 15,000mg, Cobalt = 250mg and Selenium = 1000mg.*

Data collection

Feed intake, body weight gain, feed conversion ratio and mortality were the performance parameters measured. Initial live weight of chickens was taken at the beginning of each experiment, there after weekly weights were determined. These were in turn used to calculate the daily weight gain. Daily mean feed intake was also determined by subtracting the weight of left-over feed from the quantity served the

previous day. Adequate measures were taken to safeguard against spillage and related wastage. Feed conversion ratio (FCR) on the other hand, was calculated from the formula:

$$\text{FCR} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

Carcass characteristics

At the end of the finisher phase, forty birds (two per replicate), were randomly selected, and fasted for 12 hours before slaughter for carcass analysis. Each bird was bled by severing the jugular vein. They were dipped in warm water and defeathered. The neck, feet and viscera were separated using sharp knife. The wings were removed by cutting anteriorly, severing at the humeo-scapular joint. The cuts being made very close to the body line, lateral cuts were made through the rib heads to the shoulder girdle and the breast was removed intact by pulling anteriorly. The thighs, drumsticks and back were also dissected from each carcass. All these (parts and organs) were weighed and expressed as a percentage of live weight. Weights of carcass and internal organs were measured using a sensitive balance. Dressing percentage was calculated using the relationship:

Dressing % = CW/LW X 100

Where CW= Carcass weight

LW = Live weight

Economics of Production

The economic analysis of broiler production was calculated to assess the financial benefits of feeding differently processed full-fat soya bean in broiler chicken diets. Ordinarily, the following parameters were determined using the current market prices of ingredients as at the time of study; Feed cost per kilogram of each diet, the total cost of feed consumed per bird on each diet, feed cost per kilogram weight gain and Cost saving. Chemical Analysis: The proximate composition of test ingredients and experimental diets was determined according to the methods outlined by (16). For each nutrient, the sample was analysed four times, and an average was recorded as the representative value. Metabolizable energy was calculated according to the method of (6). This was done by multiplying the energy value of each nutrient by the quantity used in the formulation.

Data analysis: Data generated were subjected to analysis of variance (ANOVA) using the Statistical Package for Social Sciences (SPSS) version 23 (2013) (14). Differences between treatment means were separated using the Duncan's Multiple Range Test (15). The financial benefits using differently processing methods of soya bean were also determined using the current market prices of ingredients as at the time of study.

Results

The productive performance of broiler chicken fed differently processed full-fat soya bean with red sorghum as energy sources is presented in Table 3. The initial weights were all similar. Similarly, the body weights of broiler chickens at four weeks across the dietary treatments were all similar. The highest live

weight was obtained on birds fed diet 3 and was similar to those birds fed diets 4 and 5 while the least value was obtained on diet 1 and was also similar to diet 2. Results on total weight gain showed diet 3 had the heaviest weight, compared to other treatments and was similar to birds on diet 5 while the least was recorded on diet 1.The daily feed intake of broiler chicken across the dietary groups showed significant difference ($P<0.05$) amongst the treatment means. The highest value was obtained on diet 3 and was similar to those birds fed diets 4 and 5 while the least value was obtained on diet 1 and was similar to birds fed diet 2. The daily weight gain (DWG) of broiler chicks and differ significantly ($P<0.05$) across the treatment means. The highest body weight gain was obtained on diet 5 and was similar to those broiler chicks fed diet 4 and differ significantly ($P<0.05$) with other treatment means while the lowest was recorded on diet 1 and was similar to those broiler chicks fed diets 2, 3 and 4. The data on feed conversion ratio (FCR) revealed that broiler chicks fed diet 5 had superior compared to birds on other treatments and diet 2 recorded inferior and all showed significant differences ($P<0.05$)across the treatment means. Two deaths each were recorded in diets 1 and 5 while one each was recorded in diets 3, 4 and 5. The daily feed intake at the finisher phase varied. However, all the values were similar among the treatment means.

Table 3: Performance of Broilers Chicken Fed Differently Processed Full-fat Soya Bean with Red Sorghum as Energy Source

Parameters	Diets					SEM
	1RSB	2SSB	3BSB	4ROSB	5SBM	
Productive performance						
Initial wt. (g)	75.67	75.53	76.09	77.45	75.63	12.23^{NS}
4th Week wt (g)	334.35^{ab}	267.50^{b}	679.05^{a}	413.72^{ab}	453.69^{ab}	72.07*
Final weight (g)	968.87^{b}	1231.09^{b}	1935.57^{a}	1672.33^{a}	1780.55^{a}	95.74*
Total weight gain (g)	893.20^{d}	1155.56^{c}	1859.48^{a}	1594.88^{b}	1704.92^{ab}	17.57*
Starter phase (1-4 weeks) Daily feed intake (g)	51.26^{b}	56.04^{b}	88.29^{a}	75.98^{a}	85.45^{a}	6.45*
Daily weight gain (g)	9.24^{c}	10.50^{c}	17.95^{ab}	14.02^{b}	20.50^{a}	1.58*
FCR	5.43	5.56	5.13	5.55	4.22	0.63^{NS}
Mortality	2	1	1	1	2	-
Finisher Phase (5-8 weeks)						
Daily feed 98.86 intake (g)		108.00	126.32	121.01	109.42	9.38^{NS}
Daily weight gain (g)	2.66^{c}	30.77^{bc}	48.46^{a}	42.94^{ab}	40.39^{ab}	3.93*
FCR	4.36	3.51	2.61	2.81	2.71	0.61^{NS}
Mortality(Number)	1	2	2	1	1	-
Overall phase (1-8 weeks)						
Daily feed intake (g)	70.06	77.02	96.31	88.50	87.40	8.56^{NS}
Daily weight gain (g)	15.95^{c}	20.64^{bc}	33.21^{a}	28.48^{ab}	30.45^{a}	2.70^{*}
FCR	4.42	3.95	3.15	3.40	2.95	0.68^{NS}
Mortality (Number)	3	3	3	2	3	-

^{abcd} Means bearing different superscripts within the same row differed significantly (P<0.05).
*=(p<0.05), NS=Not significant, SEM=Standard Error of means

FCR= Feed conversion ratio

The daily weight gains of birds ranged from 22.66 to 48.46 g across the treatment means. The heaviest weight gains of 48.46 g were recorded on broiler chicken fed diet 3 and was similar to those birds on diets 4 and 5, while the least value of 22.66 g was on diet 1 (raw soya bean) and showed significant different ($P<0.05$) among the treatment. Diets 1 and 2 were inferior to diet 3. Feed conversion ratio at the finisher phase varied from 4.36-2.61 across the treatment means. However, all the value, recorded did not differ significantly ($P>0.05$). One death each was recorded in diets 1, 4 and 5 while two each were observed in diets 2 and 3.

Overall performance (1-8 weeks)

The overall daily feed intake (DFI) of the broiler chicken varied from 70.06 to 96.31 g across the dietary groups. However, all the values were not significantly affected by the dietary treatments. The overall daily weight gains of broiler chicken ranged from 15.95-33.12 g and was significantly different across the dietary treatments. The heaviest value of 33.21 g was obtained on diet 3 and was similar to those birds on diet 2 while the least value of 15.95 g was recorded on birds fed diet 1. Feed conversation ratio of broiler chicken varied from 4.36-2.61 across the treatment means and there was no significant effect among the dietary treatments. Three morality each was recorded on broiler birds fed diets 1, 2, 3 and 5 while diet 4 had 2 deaths.

The carcass characteristics, cut-up parts and organ weights are presented in Table 4. The live weight, bled weight and dressed weight did differ significantly ($P<0.05$) among the birds fed diets containing differently processed full-fat soya bean. The highest live weight was recorded on diet 3 and was significant different ($P<0.05$) from those birds on diets 1, 2, 4 and 5 while the least value was obtained on diet 1 and was similar to birds on diet 2, 3 and 4. Similarly, the highest value for dressed weight was recorded on diet 3 and differed significantly ($P<0.05$) amongst the treatment means while least value was obtained on diet 1 and was similar to those birds on diets 2, 3 and 4. The dressing percentage was similar among the dietary treatments. Cut-up parts expressed as a percentage of live weight such as breast, drum sticks and others did not differ significantly across the dietary treatments.

Table 4: Carcass Characteristics and Organ Weights of Broiler Chickens Fed differently processed Full-fat Soya Bean with Red Sorghum as Energy Source (Expressed as a percentage of live weight)

	Diets					
Parameters	1RSB	2SSB	3BSB	4ROSB	5SBM	**SEM**
Carcass measurements						
Live weight (g)	1549.50^{b}	1330.00^{b}	2027.50^{a}	1540.00^{b}	1430.00^{b}	217.43*
Dressed weight (g)	985.00^{b}	862.50^{c}	1440.00^{a}	985.00^{b}	1085.00^{b}	212.41*
Dressing %	63.52	64.64	70.93	64.29	76.43	11.36^{NS}
Cut up parts (percent live weight)						
Breast	29.76	27.89	31.87	29.77	28.07	4.39^{NS}
Neck	9.64	8.72	8.09	7.56	8.60	1.41^{NS}
Thigh	15.75^{b}	17.72^{ab}	21.37^{a}	18.30^{ab}	18.77^{ab}	3.29*
Drumstick	16.32	17.81	18.01	15.89	17.17	2.57^{NS}
Wings	13.80	13.85	14.80	14.75	14.21	1.10^{NS}
Thorax	10.32	12.89	13.22	13.96	15.72	3.34^{NS}
Back	15.89	15.73	13.92	13.02	17.48	3.07^{NS}
Organ weights (percent live weight)						
Shank	6.99^{b}	8.21^{a}	8.96^{a}	7.76^{ab}	7.75^{ab}	0.75*
Head	5.13^{c}	5.77^{a}	4.64^{d}	5.33^{bc}	5.69^{ab}	0.27*
Lungs	1.02	1.06	3.05	1.01	1.25	1.88^{NS}
Intestines	17.45^{ab}	19.88^{a}	12.75^{b}	20.12^{a}	17.19^{ab}	4.19*
Abdominal fat	2.48	1.25	2.48	1.27	2.22	1.14^{NS}
Proventriculus	1.18^{ab}	1.49^{a}	0.99^{b}	1.25^{ab}	1.24^{ab}	0.26*
Empty gizzard	3.70^{ab}	4.20^{a}	3.04^{b}	3.36^{b}	4.15^{a}	0.50*
Heart	0.80^{ab}	0.94^{a}	0.81^{ab}	0.82^{ab}	0.76^{b}	0.10*
Liver	4.97	4.12	3.25	4.99	4.24	1.09^{NS}
Spleen	0.14	0.15	0.13	0.16	0.14	0.04^{NS}

$^{abcd=}$Means bearing different superscripts within the same row differ significantly (P<0.05). *=(p<0.05), NS=Not significant, SEM=Standard Error of means

However, thighs, shanks and head did differ significantly (P<0.05) across the dietary treatments. The highest value for thighs was recorded on diet 3 and was similar to those birds fed on diets 2, 4 and 5 while the least value was obtained on diet 1. Shanks weight and were all similar for all the diets except diet 1 which and had the least value.

Visceral components were not affected by the dietary treatments. However, intestinal weight, proventriculus, empty-gizzard and heart were affected significantly (P<0.05) by the dietary treatments. The highest value for intestines was recorded on diet 4 and was similar to those birds on diet 1, 2 and 5 while diet 3 had the least value. The proventriculus value was highest on diet 2 and was similar to those birds on diets 1, 4 and 5 and diet 3 had least value. The highest value for empty-gizzard was obtained on diet 2 and was similar to those birds fed, diets 1 and 5 and least values were recorded on diet 3 and 4.

Cost of production of broiler chicken fed differently processed full-fat soya bean with red sorghum as energy source.

The cost of gain analysis is presented in Table 5. The total feed cost varied from ₦369.89 to ₦523.26. Total weight gains of the birds ranged from 0.89 kg in Naira per kilogram weight gain was found on diet 3 (boiled) and the highest (₦435.61) on diet 1 (raw soya bean).

Table 5: Cost of Production of Broiler Chickens fed Differently Processed Full-fat Soya Bean with Red Sorghum as Energy Source

Parameters	1RSB	2SSB	3BSB	4ROSB	5SBM
Total feed intake (kg)	3.92	4.31	5.39	4.96	4.90
Feed cost (₦/kg)	94.36	95.43	97.08	96.44	99.47
Total feed cost (₦)	369.89	411.30	523.26	478.34	487.40
Total weight gain (g)	0.89	1.16	1.86	1.59	1.70
Feed cost ₦/kg gain	415.61	354.57	281.32	300.84	286.71
Cost saving (₦)	-	61.04	134.29	114.77	128.90

Discussion

The main effect of productive performance of broiler chickens feed differently processed soya bean showed that they were significantly different (P<0.05) among the dietary treatments across the parameters studied. The highest values were recorded on birds fed diet 3 (BSB) 679.05 vs. 1935.57 vs. 1859.48 g for body weight at four weeks, final body weight and total weight gain, respectively, followed by birds fed diets 4 and 5 with established definite pattern for the parameters. Birds fed

diets 1 and 2 recorded the least values. The final body weight of this study for diet 4 (1672.33 g) was higher than the values (116.80-1217.50 g) reported by (17) that fed roasted soya bean with red sorghum as energy source in broiler finisher diets. The lowest weight gain obtained on the bird feds raw and soaked diets could be attributed to high anti-nutritional factors coupled with the use of red sorghum which is known to contain high tannin levels. Similar observations had earlier been made by (18) that weight gain reduced with higher levels of red sorghum and that digestibility of nutrients were less for red sorghum. (19) also reported poor performance of poultry fed high tannin sorghum (red sorghum) diet even when supplemented with soya bean. Feed intake at the finisher phases showed significant difference ($P<0.05$) with birds on diets (diets 3, 4 and 5) higher than those birds on other treatments (diets 1 and 2). Daily weight gain in all phases of growth showed higher intake with diets 1 and 2 recording inferior values. Daily feed intake at the starter phase followed the same pattern. However, at finisher phase there was a slight improvement, indicating a phase physiological adjustment (adaptation) as a result of developed digestive system. The improved body weight gain at this phase indicates compensatory growth, suggesting that adult broiler birds can tolerates high tannin in red sorghum than chicks. This view agreed with work of (20) and (17) who postulated that perhaps broiler finisher is more adapted to high intake of pigeon pea meal than at the starter phase. The mean daily weight gain for starter was lower that the values 20.00 g and 19.20 g fed roasted soya bean and red sorghum, respectively (17). Daily weight gains at finisher phase showed that birds fed heat treated diets performed better than those birds on other diets. The results for this study compared favourably to that of (21), and (22) who reported that cooking improved the nutrient content of rubber seed. The poor values recorded on birds fed diets 1 and 2 could be attributed to the poor accessibility of nutrients in the diets by digestive enzymes. (23) were of the opinion that haemogluttinins in raw jack bean caused alterations in some enzyme systems and loss of weight in rabbits. Also earlier scholars (24) and 25) reported that Japanese quails performed better on toasted Bambara nut and pigeon pea than on unprocessed meal.

Carcass characteristics of broiler chickens fed differently processed full-fat soya bean with red sorghum as energy source

The carcass weight showed significant differences ($P<0.05$) among the birds fed differently processed soya bean. The birds fed different heat-treated soya bean diets were significantly heavier than the birds fed diets 1(raw) and 2 (soaked). This agreed with the carcass yields of 65-70.00% reported by (26). The weight of cut-up parts expressed as a percentage of live weight for most parts were not significantly ($P>0.05$) influenced by the processing methods except for thighs that did showed significant ($P<0.05$) difference.

Cost of production of broiler chickens fed differently processed full-fat soya bean with red sorghum as energy source

Feed cost (₦) per kg gain decreased in broiler bird fed diet 3 (broiled soya bean). Hence diet 3 had the lowest feed cost (₦) per kg gain. This could be attributed to the improved daily weight gain of birds fed boiled soya bean. This is in line with the findings of (27) that reported better performance is terms of meat yield when boiled soya bean were fed to broiler chickens.

Conclusion

Based on the findings of this study, the following conclusion were reached.

The best performance of broiler chickens fed differently processed full-fat soya bean was obtained in broiler birds fed boiled soya bean (BSB). However, carcass yield was not affected by the dietary treatments. The boiled soya bean meal gave the highest cost savings of ₦134.29. The least cost savings of ₦61.04 was obtained soaked soya bean die 2. Red sorghum in mixture with boiled and roasted soya bean as well as SBM resulted in better performance for broiler chicken production. However, carcass yield was not affected by the diets

Based on the results of this study, the following recommendations were made. Generally boiled SB is superior to other products and is recommended for processing of soya bean meant for broiler diets. Moist and dry heat are effective in detoxifying anti-nutrients in soya bean.

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