Growth, nutrient retention and serum metabolites of broiler chickens fed high fibre hulled sunflower seed cake

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Abstract

The nutrient value of high fibre (22% Crude protein) hulled sunflower cake (HFSC) substituted at 0, 25, 50 and 75 for soybean cake on protein for protein was assessed using 180 day-old unsexed Anak broiler chicken. The diets contained about 23 and 20% crude protein as well as 2.95 kcal/g and 2.85kcal/g metabolizable energy at the starter and finisher phases respectively. At the starter phase, inclusion of HFSC above 25% significantly ($P<0.05$) reduced body weight (BW) and protein efficiency ratio (PER). At the finisher phase, inclusion of HFSC up to 50% increased crude fibre retention while 25% HFSC increased PER. There were significant ($P<0.05$) reduction in values of glutamate oxalate pyruvate transaminase and glutamate pyruvate transaminase at the starter and finisher phases. At the starter phase total protein (TP) and glucose (GL.) concentrations were reduced at 75% HFSC diets, while above 25% HFSC inclusion reduced creatinine and urea nitrogen concentrations. At the finisher phase TP and albumin concentrations were reduced significantly ($P<0.05$) when above 25% HFSC was included. There were significant increase in glucose concentration except at 75% which did not differ from values obtained with 0% HFSC diet. There were significant ($P<0.05$) decreases in concentration, of creatinine and urea nitrogen except at 50% and 25% HFSC inclusion respectively. At the overall (starter and finisher) live weight and feed efficiency of 50% did not differ ($P>0.05$) from values obtained with 0% HFSC. This study suggested that not more than 50% of HFSC could replace soybean cake in broiler chicken diets.

Key words: High fibre hulled sunflower cake, soybean cake, nutrient utilization, growth and serum metabolites.

Introduction

The diet of an average Nigerian has for long been characterized by a dearth of animal protein, which is being aggravated by the alarming population growth and competition between man and livestock (particularly poultry) for food (Sobamiwa 1998, Balogun et al 2001). The logical option therefore is the utilization of unconventional, locally available under exploited

feedstuffs (Emehalom 2004). The utilization of under-exploited feedstuffs will not only increase productivity but profitability of the industry if they are successfully incorporated. In realization of this, there is need to evaluate the nutritional adequacy of such feedstuffs. (Shittu et al 2004). The potentials of sunflower seed production and utilization of the resulting hulled cake have been assessed (Lee et al 1982, Green et al 1987 and Adeniji and Ogunmodede 2001 as well as Adeniji

2005). The findings indicated that the fibre content (12-22%) of hulled sunflower seed cake is the major constraint in the utilization of its nutrients, particularly protein. Therefore there is need to understand the effects of the fibre in the utilization of hulled sunflower seed cake nutrients using broiler chickens. This is because high nutrient digestibility and efficient utilization are paramount in broiler chicken production. Consequently, this study was designed to assess the performance, nutrient utilization and serum metabolites with the aim of evaluating the adequacy of high fibre hulled sunflower seed cake nutrients in meeting the nutritional need of broiler chicken.

Materials and Methods

Experimental birds and their diets.

A total of 180-day-old unsexed Anak broiler chicks were used. They were randomly allocated to four treatments and their replicates giving 15 chicks to each replicate and 3 replicates per treatment. The experiment was conducted at the Teaching and Research Farm of the University of Ibadan, Oyo State, Nigeria. The birds were kept in tier brooder cages for three weeks where adequate heat was supplied and were later moved into deep litter house. Hulled sunflower seed cake (HFSC) used was obtained from Talon Nig. Ltd. Lagos, Nigeria. The four dietary treatments were formulated each for the starter and finisher phases which lasted for a period of five and four weeks respectively. Protein supplied by soybean cake in the control diets (0% HFSC) was taken to the 100%. In other diets, HFSC was used to replace 25, 50 and 75% of soybean cake protein. Both experimental diets (Table 1) were made to be isocaloric and isonitrogenous at the starter and finisher phases. Feed and water were provided *ad-libitum*.

Parameters measured, chemical and statistical analyses.

At the beginning of the experiment the chicks were weighed as individual replicate groups. Weekly feed intake and weight gain were recorded from which feed conversion ratio (feed

intake/weight gain) and protein efficiency ratio (weight gain/protein intake) were calculated. At the 5th and 9th week, two metabolic trials were carried out for the determination of nutrient utilization, while some serum metabolites were also assessed. Total protein (TP) by the Biurette method as described by Weichelaum (1946), albumin and globulin assayed by the method of Dumas and Briggs (1972) and Rodkey (1965). Creatinine by Folin- Wu filtrate method, urea nitrogen (UN) by diacetyl monoxine method. Glucose was determined by the method of Cooper and McDaniel (1970) and Frings *et al* (1970). Glutamate-oxalate pyruvate transaminase (GOT) and glutamate pyruvate transaminase (GPT) as described by Schmidt and Schmidt (1957). Proximate analysis of feed and droppings were done as outlined by the methods of A.O.A.C (1984). The method described by Eknam (1940) was used for the analysis of faecal nitrogen. The data obtained were subjected to Analysis of Variance and significant difference of means were evaluated using Duncan's Multiple Range Test (Gomez and Gomez, 1984). Age and treatment interaction was also carried out.

Results

The nutrient composition of HFSC and SBC used is presented in Table 2. The results of performance characteristics are shown in Table 3 while Tables 4 and 5 showed the results of nutrient utilization and selected serum metabolites at the 5th and 9th week respectively. HFSC had higher values of crude fibre, ether extract and nitrogen free extract while SBC had higher protein and ash contents.

Feed intake was not significantly ($P>0.05$) affected by the treatments at the starter phase. At the finisher phases 25 and 75% HFSC caused significant ($P<0.05$) reduction in feed intake while throughout the study period inclusion of 25% did not significantly ($P<0.05$) affect feed intake. Inclusion of HFSC above 25% resulted in significant ($P<0.05$) reduction in body weight gain and PER at the starter phase.

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Table 1: Percentage composition of experimental diets

Ingredients	Starter				Finisher			
	Replacement level of HFSSC (%)							
	0	25	50	75	0	25	50	75
Maize	55.00	43.70	33.79	22.00	55.42	47.74	38.47	28.08
Soybean	26.30	19.72	13.15	6.50	21.08	15.81	10.54	5.27
HFSC	0.00	11.13	22.25	33.88	0.00	8.92	17.84	26.75
Brewers dried grain	6.00	10.25	13.81	17.46	13.00	15.53	18.60	23.60
Oil	2.00	4.50	6.30	9.46	0.70	2.20	4.75	6.50
Constant ingredients*	10.70	10.70	10.70	10.70	9.80	9.80	9.80	9.80
Calculated value								
Metabolisable energy (kcal/g)	2.96	2.95	2.92	2.92	2.85	2.84	2.85	2.84
Crude protein (%)	22.84	22.76	22.58	22.49	20.02	19.89	20.03	19.89
Methionine (% of diet)	0.38	0.46	0.55	0.63	0.33	0.40	0.46	0.53
Lysine (% of diet)	1.32	1.29	1.25	1.22	1.07	1.05	1.02	1.00
Determined analysis (dry matter basis)								
Crude protein	22.87	22.63	22.56	22.54	20.05	20.08	20.09	20.13
Crude fibre	3.54	3.88	6.26	6.59	3.46	5.45	6.98	6.42
Ether-extract	3.07	3.48	3.48	4.42	4.43	5.90	9.13	10.76

* All starter diets contained 4% fish meal, 3% blood meal, 2.10 bone meal, 1.10% oyster shell, 0.25% salt and vitamin mineral premix while finisher diets contained 2% fish and blood meal, 3.15% bone meal, 2.15% oyster shell, 0.25% salt and vitamin-mineral premix. Each kg of the diet contained 12,500 IU vitamin (vit) A, 2850 IU vit. D₃, 15 I.U vit. E, 2 mg vit. K, 1.5mg vit. B1, 6mg chlorine chloride, 20mg zinc bacitracin, 90mg lasolocid, 100mg manganese, 50mg iron, 45mg zinc, 2mg copper, 1.5mg iodine, 0.225mg cobalt and 1mg selenium.

Table 2: Percentage nutrient composition of high fibre sunflower seed cake and soybean cake.

Parameters	HFSC	SBC
Dry matter	92.00	91.85
Crude protein	28.00	45.34
Crude fibre	22.00	5.56
Ether extract	11.00	4.07
Nitrogen free extract	26.00	27.74
Ash	5.00	9.14

At the finisher phase, 25% HFSC inclusion significantly ($P<0.05$) increased PER and crude fibre retention and the latter also at 50% HFSC inclusion. On the overall experimental period (starter and finisher) body weight gain and PER

were significantly ($P<0.05$) reduced, while above 25% HFSC inclusion significantly ($P<0.05$) reduced PER. There were significant ($P<0.05$) reduction in the levels of GOT and GPT at both phases with increase in HFSC except with 50%

Table 3: Performance characteristics of broilers chickens fed HFSC as a replacement for SBC

	0	25	% HFSC		SEM	HFSC age interaction.
			50	75		
Feed intake (g)						
Start phase (0-5 weeks)	1603.20	1560.30	1605.20	1665.60	20.60	NS
Finisher phase (6-9 weeks)	3563.10 ^a	3220.50 ^c	3542.60 ^{ab}	3328.00 ^{bc}	63.60	Sig.
Starter and Finisher (0-9 weeks)	5166.30 ^a	4790.80 ^b	5147.80 ^a	4993.60 ^{ab}	74.10	Sig.
Final live weight/bird (g)						
Starter phase (0-5 weeks)	721.80 ^a	679.80 ^{ab}	611.70 ^{bc}	599.70 ^c	19.70	NS
Finisher phase (6-9 weeks)	941.50	916.00	923.10	874.80	40.70	NS
Starter and Finisher (0-9 weeks)	1663.20 ^a	1595.80 ^{ab}	1534.90 ^{ab}	1472.50 ^c	36.30	NS
Feed intake/weight gain (g/g)						
Starter phase (0-5 weeks)	2.20	2.60	2.60	2.80	0.20	NS
Finisher phase (6-9 weeks)	3.80	3.50	3.80	3.80	0.07	NS
Starter and Finisher (0-9 weeks)	3.10 ^{bc}	3.00 ^c	3.40 ^{ab}	3.50 ^a	0.07	NS
Weight gain/protein Intake (g/g)						
Starter Phase (0-5 weeks)	2.00 ^a	1.90 ^a	1.70 ^b	1.60 ^b	1.30	Sig.
Finisher phase (6-9 weeks)	1.30 ^b	1.40 ^a	1.30 ^b	1.30 ^b	0.03	Sig.
Starter and Finisher (0-9 weeks)	1.70 ^a	1.70 ^a	1.50 ^b	1.50 ^b	0.03	Sig.

Means with the same superscripts in horizontal rows are not significantly different ($P > 0.05$).

NS – not significant

Sig. – significant

HFSC diet at the starter phase. At the starter phase there were significant ($P < 0.05$) reduction in TP and glucose concentrations at 75% HFSC inclusion. While above 25% HFSC inclusion significantly ($P < 0.05$) reduced creatinine and urea nitrogen concentrations.

At the finisher phase, TP and albumin concentrations were significantly ($P < 0.05$) higher at 25% HFSC inclusion, compared to other levels of inclusion. The concentrations of globulin and creatinine were significantly ($P < 0.05$) increased

with the inclusion of HFSC except for creatinine concentration at 25% HFSC inclusion. Above 25% HSFC in the diet significantly ($P < 0.05$) reduced urea nitrogen concentration, while glucose concentrations were significantly ($P < 0.05$) increased when less than 75% HFSC were included in broiler chicken diets. Age and treatment interactions showed significant ($P < 0.05$) differences in PER, nitrogen retention, total protein, albumin, globulin, creatinine and urea nitrogen.

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Table 4: Nutrient retention values of broilers chickens fed HFSC as a replacement for SBC

	% HFSC				SEM	HFSC age interaction
	0	25	50	75		
5th week						
Dry matter digestibility	62.77	56.09	61.39	56.09	3.43	NS
Nitrogen digestibility	83.29	79.71	81.31	78.69	1.87	NS
Nitrogen retention	59.05	51.31	64.47	59.96	3.78	Sig.
Crude fibre retention	39.83 ^b	35.51 ^b	54.47 ^a	47.66 ^{ab}	3.61	NS
Ether extract retention	94.64	94.14	94.39	95.36	0.40	NS
9th week						
Dry matter digestibility	70.26	73.09	70.60	62.71	4.48	NS
Nitrogen digestibility	82.10	84.21	79.40	82.48	1.10	NS
Nitrogen retention	53.95	58.63	40.70	44.23	4.07	Sig.
Crude fibre retention	27.22 ^b	36.74 ^a	36.77 ^a	29.08 ^b	1.89	NS
Ether extract retention	95.35	92.19	97.40	98.04	2.05	NS

* Means with the same superscripts in horizontal rows are not significantly different ($P > 0.05$).

SEM – Standard error of means

n.s – not significant

sig – significant

Table 5: Serum metabolite values of broiler chickens fed HFSC as a replacement for SBC

	% HFSC				SEM	HFSC age interaction
	0	25	50	75		
5th week						
GOT (unit/m/)	46.67 ^a	38.67 ^b	33.33 ^c	24.33 ^d	0.84	NS
GPT (unit/ml)	18.00 ^a	12.67 ^b	17.33 ^a	10.00 ^b	1.02	NS
Total protein (g/dl)	5.63 ^{ab}	5.89 ^a	5.65 ^b	5.53 ^c	0.02	Sig.
Albumin (g/dl)	2.08	2.62	2.73	2.54	0.20	Sig.
Globulin (g/dl)	3.55	3.27	2.92	2.99	0.20	Sig.
Creatinine (mg/dl)	2.54 ^b	2.80 ^a	2.32 ^c	2.04 ^d	0.03	Sig.
Urea nitrogen (mg/dl)	27.65 ^b	30.46 ^a	25.31 ^c	22.65 ^d	0.28	Sig.
Glucose (mg/100ml)	74.52 ^b	77.85 ^a	74.75 ^b	72.61 ^c	0.33	NS
9th week						
GOT (unit/ml)	46.33 ^a	39.33 ^b	35.33 ^c	28.00 ^d	0.76	NS
GPT (unit/ml)	19.33 ^a	15.00 ^b	15.67 ^b	11.33 ^c	0.81	NS
Total protein (g/dl)	6.11 ^b	6.50 ^a	5.37 ^c	5.31 ^c	0.03	Sig.
Albumin (g/dl)	4.72 ^b	5.03 ^a	3.86 ^c	3.71 ^d	0.01	Sig.
Globulin (g/dl)	1.39 ^c	1.51 ^b	1.51 ^b	1.60 ^a	0.44	Sig.
Creatinine (mg/dl)	2.20 ^b	2.07 ^c	2.38 ^a	1.96 ^d	0.02	Sig.
Urea nitrogen (mg/al)	24.40 ^a	25.74 ^a	21.62 ^b	21.12 ^b	0.03	Sig.
Glucose (mg/100ml)	73.07 ^c	78.03 ^a	74.33 ^b	72.72 ^c	0.33	NS

* Means with the same superscripts in horizontal rows are not significantly different ($P > 0.05$)

SEM – Standard error of means

n.s – not significant

sig – significant

Discussion

It has been established that birds eat primarily to satisfy their energy requirement. The birds on HFSC diets were able to satisfy their energy requirement with less feed, due to increase in productive energy with the use of high oil levels as advocated by Valdivie (1976) and Raj *et al.* (1987). The improved energy availability could have allowed birds to meet their energy requirement with less feed. However, it seems that the birds were unable to meet the requirement for other essential nutrients (particularly amino acids), due to the effect of oil on other nutrients whose availability and utilization might have been affected (Vohra 1967, Velu *et al* 1972 and Jonsson and McNab 1983). Also for improved utilization of feed nutrients, the concept of overall balance particularly between energy and protein component has been stressed (Lewis *et al* 1982 and Amubode 1982). The inability of the diets to meet these could have predisposed them to imbalances which could have reduced the nutrient utilization and subsequent tissue formation. Also the possibilities of high fibre and methionine levels in accentuating this was considered, especially at higher levels of HFSC inclusion, while the improved efficiencies of feed and protein observed at 25% HFSC could have resulted from its better amino acid profile (Table 1) methionine and lysine which is closer to the birds requirement than other HFSC diets as reported in our earlier studies (Adeniji 2005, Adeniji and Ogunmodede 2001, 2004). While the high cruder fibre of other HFSC diets may have reduced nutrients absorption. Generally, the performance of broilers on HFSC diets were better at the finisher than starter phase which may be due to the less stringent requirement for tissue formation at this phase.

Nutritional deficiency, organic breakdown or penetration of foreign materials are known to alter blood composition. Hence, blood chemistry among others are employed as useful indices in

appraising nutritional status of animal. With insufficient energy, transaminase enzymes promote the removal of the amino acid group of the amino acids to yield corresponding acids, which enter tricarboxylic acid cycle for additional energy generation. This could be explained by the fact that in cases where energy is insufficient transaminase enzymes promote the removal of the amino acid group of the protein to yield corresponding acids. Which later enter tricarboxylic acid cycle for additional energy. The high oil levels used in this study may have reduced the need for such transamination processes. This tends to confirm that HFSC diets as formulated were sufficient in energy. Results obtained with total protein at both phases showed that 25% HFSC was superior to other diets. Though this statement might appear not to support the observed growth performance of the birds, which was not higher than those of broilers on control diet. The discrepancy could have resulted from the higher oil used, which might have interfered with the ability of the diets to completely meet other nutrients requirement apart from energy as earlier explained. This reason may also hold for 50% HFSC diet at starter phase, while the general reduction observed with 75% HFSC and 50% at finisher phase seem to suggest or confirm the inferiority of their proteins (particularly 75%) when compared with other diets. Albumin concentration of 25% HFSC at the finisher phase seem to confirm the superiority of its protein and general tendency of HFSC to decrease protein adequacy at higher level of inclusion. The low creatinine and urea concentrations seem to suggest proper protein utilization while the high level observed with 25% HFSC diets may be an indication of high protein content, however since isonitrogenous diets were formulated this might not be true, but could be an indication of improper protein utilization (as high levels are associated with high protein content and improper protein utilization via deamination). This might be necessary due to the low dry matter digestibility

or high indigestible organic matter which may require extra energy to transport the indigestible organic matter along the gut (Hakansson and Erikson 1976). However, this may have little effect as the differences were not significant. Glucose concentration results showed that higher levels of energy were available to birds on 25% at both phases and birds on 50% HFSC diet at the finisher phase. The higher oil used could have enhanced glucose availability; while reduction observed with birds on 75% at the starter phase could have resulted from higher level of crude fibre HFSC diet which reduced glucose availability. The inability of the birds to completely cope with the crude fibre could have caused this effect. This may support the fact that the HFSC diets were preferred at the finisher phase probably due to the ability of the birds to cope better with fibre or their less stringent nutrient requirements. In conclusion the results obtained from this study reflect that HFSC protein could replace 50% of SBGP if live weight is the goal of the producer.

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