COMPARATIVE UTILIZATION OF SHEA BUTTER CAKE AND PALM KERNEL CAKE BY BROILER CHICKENS

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ABSTRACT

The utilization of Shea butter cake (SBC), a by-product of fat extraction from Sheabutter nuts *(Butyrospermum paradoxum)* was compared with Palm Kernel Cake (PKC) to establish its potential as a poultry feedstuff. A 2 x 3 factorial experiment combining two factors, SBC and PKC at three levels of inclusion (5%, 10% and 15%) was designed. The six dietary treatments were fed to a total of 180 day-old chicks up to 56 days of age. Broilers fed SBC diets consumed more feed (P<0.05) than those fed PKC diets between 0-28 days of age. During the finisher period (29-56d) and the entire period (0-56d) feed intakes of broilers were similar (P>0.05) on the treatment except the low consumption (P<0.05) by those fed 5% SBC. Broiler chicks fed 5% attained the heaviest weight gain (P>0.05) which compared with chicks fed 15% PKC between 0-28d. Between 29-56d. growth rates of broilers were uniformly higher (P<0.05) on PKC than SBC diets. Broilers fed 15% SBC had the least (P<0.05) weight gain at the three (0-28d; 29-56d and 0-56d) periods. Considering the entire period (0-56d), growth rates were not significantly (P>0.05) different on SBC diets up to 10%, and on PKC diets up to 15%. Feed efficiency and protein efficiency ratios of the broiler became poorer (P<0.05) with increasing levels of SBC in both growth phases unlike broilers fed PKC which had similar values irrespective of the levels of inclusion. The intestinal tracts and visceral organs were not influenced (P>0.05) by the sources and levels of test ingredients except abdominal fat which was higher on SBC than PKC at 10% and 15% levels of inclusion, and increased with the levels of SBC. 10% SBC level was optimal.

Key Words: Broilers; Sheabutter cake; Palm kernel cake; performance; organ measurements.

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INTRODUCTION

The feed and nutrition crises besetting monogastric livestock population in Nigeria, and conceivably other less developed countries, strongly indicate the need to expand the raw materials base for livestock feed formulations to accomodate unconventional feed resources and optimize the utilization of fibrous feedstuffs (Longe and Fagbenro-Byron, 1990 and Onifade, 1993). Fajimi *et al.* (1993) and Onifade (1993) indicated that the evaluation of unconventional feed resources alongside other strategies would reduce pressure on conventional feed ingredients, and accelerate the attaiment of feed security for monogastric livestock.

Sheabutter cake (SBC) a waste product of the indigenous technology for extraction of fat from the seed of Sheabutter plant, *Butyrospermum paradoxum* remains underexploited judging from the scanty and somewhat conflicting information on its utilization in llivestock species (Atta and Feye, 1996; Morgan and Trinder, 19980 and Adeogun, 1989). Adeogun (1989) stated that sheabutter cake could be fed at a maximum of 5% in broiler diets without deleterious consequences. Similarly Attah and Feyer, (1976) recommended a maximum of 5% for ruminants. However, Morgan and Trinder (1980) indicated that a maximum of 25% and 30% could be tolerated by the pigs and ruminants respectively.

Sheabutter cake tastes bitter and contains saponin (Morgan and Trinder, 1980) which could be the factor limiting its utilization by monogastric livestock. Aletor (1993) indicated that poor growth rate and feed effficiency were common charateristics of monogastric animals fed saponin - containing feedstuffs. Deriving from the objective to expand raw materials base of our monogastric feed formulation, and with vast accumulation of Sheabutter cake as a consequence of the burgeoning local production of Sheabutter fat as substitute to palm oil in rural savannah communities, the current research on SBC is justified. Furthermore, SBC is disposed via incineration. Consequently, the present effort investigated the nutritional value of sheabutter cake in comparison with Palm Kernel cake (PKC) a by-product of oil extration from the fruit of palm tree, *Elaeis guineensis* which had been fed successfully (Panigrahi and Powell, 1991 and Onifade, 1993; 1995) to broiler chickens. The study is envisaged to highlight the comparative nutritional potential of SBC as a feedstuff. This paper reports the feed intake, growth rate, feed efficiency, protein efficiency ration, visceral and intestinal organ measurements of broiler chickens fed various dietary levels of SBC and PKC.

MATERIALS AND METHODS

The SBC was obtained from local processing factories in Ifelodun Local Government Area of Kwara State, Nigeria. The samples were obtained semi-dried, but were properly sun-dried for 4 days before incorporation into the diets. The chemical composition of the test ingredients are shown in Table 1. A 2 x 3 factorial design was employed. There were two factors namely, SBC and PKC, both were included at three dietary levels viz: 5%, 10% and 15% giving rise to a total of six treatment combinations. The six diets for the starter chicks (0-28d) and finisher chickens (29-56d) contained approximately 22% and 18% crude protein respectively. Composition of the diets are shown in Tables 2 and 3.

180 one-day old mixed sex broiler chicks of Hubbard strain were randomly allocated to the six dietary treatments at the rate of 30 chicks per treatment. The chicks were further randomly divided to give 10 chicks per replicate. Each replicate group of chicks was separtely brooded in an electrically heated deep litter compartment for 28 days. They were fed broiler starter diets for this period. Between 29 and 56 days of age, the chicks were placed on finisher diets. Feed and water were offered to the broilers *ad libitum* throughout the 56-day experiment.

Data on feed intake, weight gain, feed efficiency and protein effeciency ratio were recorded weekly on replicate basis. On the 56th day, six birds per treatment were sacrificed after overnight fasting, and the fresh weights of the liver, kidney, heart, pancreas, spleen, crop, proventriculus, gizzard,, small and large intestine, caecum and abdominal fat were measured. The respective organs were expressed as percentages of the dressed weight. Proximate analyses of sheabutter cake, palmkernel cake, and the diets were carried out according to the method of AOAC (1990). The data were subjected to the analysis of variance and Duncan's multiple range test (when necessary) as outlined by Steel and Torrie (1980).

TABLE 1: PROXIMATE COMPOSITION OF SHEABUTTER AND PALM KERNEL CAKES (g/100g DM).

Components	Sheabutter cake	Palm kernel cake
Dry matter	90.85	91.60
Crude protein	17.49	18.00
Ether extract	14.76	6.50
Crude fibre	19.57	12.10
Ash	5.98	5.67

RESULTS

Table 4 depicts the feed intake, weight gain, feed efficiency and protein efficiency ratios of broiler chickens on the treatments. Broilers fed on SBC consumed more feed ($P<0.05$) than their counterparts on PKC between 0-28d. However, during the finisher period. (29-56d) and the entire experimental period (0-56d) feed intakes of broilers were similar ($P>0.05$) on the treatments except the significantly ($P<0.05$) low consumption by those fed 5% SBC. When the consumption pattern from 0-56d was appraised, there appeared a strong tendency ($P>0.05$) for the birds to consume more feed as the levels of SBC increased, whereas broilers fed PKC diets

TABLE 2: COMPOSITION OF EXPERIMENTAL DIETS FED TO BROILER CHICKENS BETWEEN 0 - 28 DAYS OF AGE

	Sheabutter cake			Palm Kernel Cake		
	5%	10%	15%	5%	10%	15%
Ingredients	1	2	3	4	5	6
Sheabutter Cake	5.00	10.00	15.00	-	-	-
Palm Kernel Cake	-	-	-	5.00	10.00	15.00
Yellow maize	59.25	54.25	49.25	59.25	54.25	49.25
Soyabean meal	26.00	26.00	26.00	26.00	26.00	26.00
Fishmeal	3.00	3.00	3.00	3.00	3.00	3.00
Bloodmeal	3.00	3.00	3.00	3.00	3.00	3.00
Bonemeal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00
Premix[a]	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Chemical analysis						
Dry matter %	91.46	90.84	89.86	90.38	89.18	89.05
Crude protein %	21.84	22.10	22.34	22.07	22.50	22.87
Ether extract %	4.24	5.18	5.97	3.80	4.12	4.50
Crude fibre %	4.31	4.94	5.38	3.56	4.25	4.86
Ash %	5.85	6.08	6.39	4.96	5.27	5.86
Metabolizable Energy[b] KJ/kg	12.25	11.95	11.67	12.22	11.92	11.65

[a] Premix supplied the following vitamins and minerals per kg of diet:
A, 10,000i.u; D, 3,000, i.u; E, 8.0i.u; K, 2.0mg; B^{1}, 2.0mg; B^{6}, 1.2mg; B^{12}, 0.12ug; niacin, 1.0mg; panthotenic acid, 7.0mg; Folic acid, 0.6mg; Choline chloride, 500mg; Fe, 60mg; Mn, 80mg; Mg 100mg; Cu, 8.0mg; Zn, 50mg; Co, 0.45ug; I, 2.0mg and Se, 0.1mg.

[b] Calculated.

were not significantly different (P>0.05) in their consumption rate. Broiler chicks fed 5% SBC attained the heaviest weight between 0 - 28d which was comparable (P>0.05) to the weight gained by the chicks fed 15% PKC. However, the least (P<0.05) weight gained at this period was by chicks fed 15% SBC. During the finisher phase between 29-56d, growth rate of broilers were uniformly higher (P<0.05) on PKC than SBC diets, with broilers fed 15% SBC having the least (P<0.05) weight gain. When the overall results (0-56d) were considered, growth rates were not significantly different (P>0.05) on SBC diets up to 10% and PKC diets up to 15%. The inclusion of 15% SBC in the diet significantly (P<0.05) depressed weight gain of broilers.

Feed efficiency became significantly (P<0.05) poorer with increasing levels of SBC in both growth phases unlike for broilers fed PKC diets where feed efficiency was unaffected (P>0.05) irrespective of the levels of PKC inclusion. It was remarkable that broilers fed 5% SBC had the best numerical feed efficiency between 0 - 28d. Protein efficiency ratio (PER) was increasingly poorer (P<0.05) with increasing levels of SBC in the diet. The treatment containing 5% SBC supported a comparable (P>0.05) PER with broilers fed PKC diets between 0-28d and 0-56d periods. The PER of broilers fed PKC diets were (P>0.05) comparable, but the values decreased numerically as the dietary levels of PKC increased.

Although there were significant differences (P<0.05) in the relative weights of the organs (Table 5), most observations did not present a particular trend except in a few cases. Hepatic weights were numerically bigger in broiler chickens fed SBC than PKC, while the opposite was the case with spleenic weights of

TABLE 3: COMPOSITION OF EXPERIMENTAL DIETS FED TO BROILER CHICKENS BETWEEN 29 - 56 DAYS OF AGE.

Ingredients	Sheabutter cake 5% 1	10% 2	15% 3	Palm Kernel Cake 5% 4	10% 5	15% 6
Sheabutter Cake *	5.00	10.00	15.00	-	-	-
Palm Kernel Cake	-	-	-	5.00	10.00	15.00
Yellow maize	68.74	63.74	58.74	68.74	63.74	58.74
Soyabean meal	19.01	19.01	19.01	19.01	19.01	19.01
Fish meal	1.50	1.50	1.50	1.50	1.50	1.50
Blood meal	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00
Premix [a]	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Chemical analysis						
Dry matter %	89.22	89.48	88.78	90.14	89.28	88.94
Crude protein %	18.15	19.56	18.74	18.04	18.47	18.68
Ether extract %	3.45	3.68	4.14	3.04	3.22	3.94
Crude fibre %	4.01	4.24	4.56	3.85	3.98	4.1
Ash %	5.24	5.44	5.68	4.87	4.94	5.18
Metablizable energy[b] KJ/Kg	12.64	12.30	12.05	12.61	12.26	12.20

[a]. Premix: See Table 2. [b]. Calculated.

chickens on the treatments. Crop weight was insignificantly bigger (P>0.05) in broilers fed PKC than SBC diets. The weights of the gizzard increased slightly with increase in the levels of both test ingredients but the increase was only significant (P<0.05) for the PKC diets. The ceaca were unaffected (P>0.05) by the sources or levels of the test ingredients. Abdominal fat of broilers increased (P<0.05) with increasing levels of SBC.

DISCUSSION

Feed consumption of broilers on SBC diets which increased with the levels of the SBC indicated that the bitter taste and saponin content of the SBC had no adverse effect on this parameter. Indeed, the influence of saponin in feedstuffs on feed intake remains equivocal (Aletor, 1993). The trend of feed intake of broilers fed SBC paralleled previous observations (Onifade, 1993, Sobamiwa and Longe, 1994) when broilers were fed increasing levels of fibrous feedstuffs. The interpretation of the nonsignificant difference in feed intake of birds fed PKC up to 15% inclusion is that the caloric content of the diet was not drastically affected to stimulate higher feed intake. Onifade (1993) drew a similar conclusion when graded levels of PKC were fed to broiler chickens.

Growth of an animal is a comple and highly integrated process involving exogenous supply of nutrients, intestinal enzyme transformation, and hormonal control. Nevertheless, dietary supply of nutrients can be the most limiting factor since the quality of the exogenous nutrient supplied largely determines the growth response of the animal. Based on the foregoing, the superior weight gain of broilers fed 5% SBC at 0-28d which was irreproducible between 29-56d could not be explained. A salient observation in this study is that SBC inclusion at more than 10% in the diet precipitated lower performance at both phases. Thus, the weight gain of broilers observed in this experiment suggests inclusion of SBC up to 10%; a level higher than 5% stipulated by Adeogun (1989). On a comparative basis, the similar weight gain by broilers on PKC levels attested further to the

TABLE 4: EFFECTS OF SHEABUTTER CAKE AND PALM KERNEL CAKE DIETS ON THE PERFORMANCE CHARACTERISTICS OF BROILER CHICKENS.

	Sheabutter cake (%)			Palm Kernel Cake (%)			
	5	10	15	5	10	15	
	1	2	3	4	5	6	SEM
Feed intake (g/broiler/day)							
0 - 28d	35.74^{b}	38.21^{a}	39.98^{a}	34.18^{b}	35.95^{b}	33.15^{b}	3.14
29 - 56d	83.11^{b}	91.93^{a}	80.36^{b}	88.50^{a}	$85.17^{a,b}$	91.81^{a}	5.41
0 - 56d	59.41^{b}	65.07^{a}	62.67^{a}	$61.34^{a,b}$	$60.56^{a,b}$	62.48^{a}	2.20
Weight gain (g/broiler/day)							
0 - 28d	14.97^{a}	12.52^{b}	10.77^{c}	12.58^{b}	12.25^{b}	$13.69^{a,b}$	1.53
29 - 56d	28.18^{b}	29.00^{b}	23.11^{c}	32.112^{a}	30.90^{a}	32.30^{a}	3.51
0 - 56d	$21.58^{a,b}$	$21.30^{a,b}$	16.95^{c}	22.35^{a}	$21.57^{a,b}$	23.21^{a}	1.12
Feed Conversion Efficiency (feed: gain)							
0. 28d	2.38^{a}	3.05^{b}	3.71^{c}	2.72^{a}	$2.94^{a,b}$	2.42^{a}	0.31
29 - 56d	2.95^{a}	3.17^{b}	$3.74^{b,c}$	2.76^{a}	2.76^{a}	2.84^{a}	0.22
0 - 56d	2.75	3.06^{b}	3.70^{c}	2.74^{a}	2.81^{a}	2.69^{a}	0.22
Protein Efficiency ratio							
0 - 28d	1.88^{a}	1.65^{b}	1.41^{c}	1.78^{a}	1.72^{a}	1.79^{a}	0.04
29 - 56d	1.49^{b}	1.45^{b}	$1.25^{b,c}$	1.75^{a}	1.67^{a}	$1.58^{a,b}$	0.05
0 - 56d	1.69^{a}	1.55^{b}	1.33^{c}	1.77^{a}	1.70^{a}	1.69^{a}	0.04

a,b,c: Means in the same row not followed by the same superscript are significantly different. ($P < 0.05$).

TABLE 5: EFFECTS OF SHEABUTTER CAKE AND PALM KERNEL CAKE DIETS ON THE VISCERAL AND INTESTINAL ORGAN MEASURMENTS OF BROILER CHICKENS

	Sheabutter cake (%)			Palm Kernel Cake (%)			
	5	10	15	5	10	15	
Organs	1	2	3	4	5	6	SEM
Heart	$0.81^{a,b}$	0.93^{a}	0.89^{a}	0.88^{a}	0.98^{a}	0.87^{a}	0.02
Liver	3.79^{a}	4.01^{a}	3.91^{a}	$3.68^{a,b}$	3.74^{a}	$3.59^{a,b}$	0.10
Kidney	$1.17^{a,b}$	1.34^{a}	1.33^{a}	$1.20^{a,b}$	1.44^{a}	$1.15^{a,b}$	0.04
Pancreas	0.42	0.52	0.46	0.43	0.50	0.43	0.02
Spleen	$0.21^{a,b}$	$0.24^{a,b}$	$0.21^{a,b}$	$0.25^{a,b}$	0.30^{a}	0.32^{a}	0.02
Crop	0.65^{a}	0.68^{a}	$0.62^{a,b}$	0.71^{a}	$0.62^{a,b}$	0.71^{a}	0.03
Proventriculus	0.69^{b}	0.80^{a}	0.81^{a}	0.82^{a}	0.80^{a}	0.71^{a}	0.03
Gizzard	$3.98^{a,b}$	4.14a	4.33a	3.78b	$3.85^{a,b}$	4.12^{a}	0.10
Small Intestine	7.46	7.96	7.51	7.09	7.05	7.43	0.05
Large Intestine	0.28	0.26	0.28	0.29	0.25	0.28	0.01
Caecum	1.20	1.23	1.26	1.16	1.27	1.76	0.03
Abdominal fat	1.83^{a}	2.53^{b}	2.74^{b}	2.10a	2.13^{a}	1.89^{a}	0.10

1: The measurments (weights) were expressed as percentages of dressed carcass weights

a,b: Means in the same row not followed by the same superscript are significanlty ($P < 0.05$) different.

lack of dietary energy deficit in the diets up to 15% inclusion of PKC. The decreasing feed conversion efficiency sequel to increasing levels of SBC is a reflection of the diminishing quality of the diet as the SBC levels increased. The corollary of the comparative observation on PKC showed that it is superior to SBC, since its inclusion up to 15% did not compromise feed efficiency. Comparative inferiority of the crude protein in SBC to PKC was indicated by the decreasing protein efficiency ratio (PER) of broilers fed increasing levels of SBC. The relatively good amino acid composition of PKC (Onwudike, 1986) suffices to explain the better protein nutrition of broilers fed PKC than SBC as evidenced by the PER values.

Most of the visceral organ and intestinal tract measurements were within reported ranges (Summers and leason, 1986; Ande, 1992; Fajimi *et al.* 1993; Onifade, 1993; 1995; Sobamiwa and Longe, 1994) showing no influence of the sources and levels of the test ingredients. This is an indication that feeding SBC poses no serious consequences on organs function and development. Nevertheless, heavier value of organs most probably represent hypertrophy (Koong *et al.*, 1985; Pond, 1989, and Pond *et al.*, 1989); but the elucidation of predisposing factors in this experiment is more complicated by the insignificant difference among the values. Perhaps the bigger hepatic weights in broilers fed SBC is resultant from the chronic toxicity of saponin, while the bigger crop weights in broilers fed PKC could be due to high bulk density of PKC (Longe and Fagbenro-Byron, 1990; Ande, 1992) since the crop is the receptacle for feed in poultry. Gizzard hypertrophy on more fibrous diets is well documented among others, and this explains the slightly enlarged gizzard in broilers fed higher levels of the test ingredients. The higher abdominal fat of broilers fed SBC may not be unconnected with higher residual fat content (saturated fatty acids) in SBC than PKC.

It is evident from this study that Sheabutter cake can be fed up to 10% dietary level without any deleterious effect on feed intake, weight gain, feed efficiency, protein efficiency ratio, visceral organs and intestinal tracts development. Beyond 10% dietary level of SBC, the nutritional inferiority of SBC to PKC became manifest.

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