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Effects of various protein seed cakes as replacement for full fat soybean meal on the growth performance, carcass, and organs characteristics of broiler chicken

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Abstract
The survival of the poultry industry is currently threatened in the majority of developing nations, particularly in Nigeria, by the shortage and high cost of conventional poultry feed ingredients. The poultry sector is essential for producing high-quality animal protein quickly enough for the world's expanding population. The main objective of this study is to determine the effect of non-conventional protein seed cakes that will be used in the replacement of full fat soybeans on broiler chicken production. A total number of 300 day old broiler (Cobb-500) chickens were purchased from Olam farm, Chukun hatchery. The chicks were randomly allotted to five dietary treatments with four (4) replicates. The birds were kept under deep litter management system and timber shaving was used as litter materials to cover the floor. The study comprised of four iso-nitrogenous and iso-caloric dietary treatments in both the starter (23% CP, 2800kcal/kg ME) and finisher rations (20% CP, 3000kcal/kg ME). The rations-based diets were Full fat Soybean meal, Soybean cake, Groundnut cake, Sesame seed meal and Palm kernel cake designated as diet T1, T2, T3, T4 and T5 respectively for both the starter and finisher diets. The results for the performance of broilers fed with Protein seed cake sources at the starter, finisher and overall phases revealed a very high significant difference ($P < 0.001$) in all the parameters, daily feed intake (DFI), daily weight gain (DWG), and feed conversion ratio (FCR), where diets T2, T1, T3 and T4 were the highest, while diet T5 was the least, however, the mortality rate was not significantly different ($P>0.05$) among the treatment means. The results of carcass characteristics revealed that there were very high significant differences ($P<0.001$) among the treatment means for live weight., Plucked Weight, Eviscerated, Carcass, Neck, Leg, Drumstick, Breast weights. A high significant difference ($P<0.01$) was obtained in Thigh and Head weights, while a significant difference ($P<0.05$) was found in dressing percentage where diet T2 is the highest in all the parameters while the least was in diet T5. Based on the results obtained in this study, it can be concluded that, with the exception of Palm kernel seed cake, all the other non-conventional protein seed cakes (Soybean cake, Groundnut cake, and Sesame seed cake) can effectively replace full fat soybean meal for effective growth performance, carcass and gut characteristics of broiler chickens.

Keywords: Broilers chickens, Full fat Soybean, Non-conventional protein seed cakes, Growth performance and Carcass

Introduction
The population of humans and animals is growing quickly, which is leading to an increase in the requirement for food and feed in less developed nations. (Odunsi, 2003) [7]. The increasing demand for protein sources coupled with the high cost and scarcity of conventional feedstuffs such as ‘’Soya bean’’ has great competitive opportunity between human and livestock industry which results to increase cost of feed in the livestock sector. Many farmers are diverting from the commercial poultry industry today due to high cost of feeding (Ubosi and Sekuna, 2000; Taiwo *et al.*, 2001) [12, 11], in poultry industry feed account for almost

70-80 percent cost of production (Asghar, 2000) [4]. The poultry business has to take use of non-conventional protein concentrate meal, which is readily available and inexpensive. This might lower the cost of poultry production and boost the farmer's profit margin. In poultry production, due to the quantity and quality of its protein and amino acids, soybean meal is the main and preferred source of protein for all varieties of poultry. (Waldroup *et al*., 2008) [14]. However, conventional protein sources are very expensive when compared with unconventional sources especially the oil meal by-products (Ground nut cake, palm kernel cake, soybean cake, and sesame seed meal), the high cost of conventional feed ingredients increased the total cost of production and reduces the profit margin of the farmer. Therefore, in order to expand the protein resource base and thereby raise livestock output, it is imperative to maximize the use of unconventional feedstuffs. (Andy, 2012) [3]. This research tends to find out other alternative non-conventional protein feed sources that will be used in replacement of full fat soybeans in order to reduce the rate of alarming competition between human and livestock industry, scarcity and cost.

Materials and methods

Experimental Sites

The research was conducted at research and teaching farm, Federal College of Education (Technical) Gombe. Gombe State is located within the Northern Guinea Savannah region of North-Eastern geographical zone of Nigeria. Located between latitude 10^0 to 10^0 $20^/$ N and longitude 11^0 $01^/$ E and 11^0 $19^/$ E with an average temperature of 26^0C (Abba *et al*., 2010) [1].

Experimental Birds and their Management

A total number of 300-day old broiler (Cobb-500) chickens were purchased from Olam farm, Chukun hatchery. Thereafter, the birds were randomly allotted to five dietary treatments and four (4) replicates, 15 birds per replicate. The birds were kept under a deep litter management system and the floor is covered with timber shaving as litter materials. Veterinary services was administered to ascertain the birds health condition, the birds were vaccinated with Gumboro (IBDV) at the 1st and 4th week and Lasota (NDV) at the 3rd week of aged, antibiotics, coccidiostats and vitamins drugs were administered as it may be necessary.

Treatments and Experimental Diets for Broilers

The study used four iso-nitrogenous and iso-caloric dietary treatments in both the starter (23% CP, 2800kcal/kg ME) and finisher rations (20% CP, 3000kcal/kg ME). The rations based diets were Full fat Soybean meal, Soybean cake, Groundnut cake, Sesame seed meal and Palm kernel cake designated as diet T1, T2, T3, T4 and T5 respectively, for both the starter, Table 1, and the finisher table 2. The birds were fed the starter experimental ration from 1st - 4th weeks, while the finisher ration was fed from 5th – 8th weeks, *ad-libitum.*

Table 1: Dietary Composition (%) and Calculated Analysis of Broiler Starter Diets (2 - 4 weeks)

Levels of Inclusion in % of Feed ingredients					
Diets:	**T1**	**T2**	**T 3**	**T4**	**T5**
Maize	42.92	49.50	50.38	47.57	36.24
FFSB	38.38	-	-	-	-
SBC	-	31.80	-	-	-
GNC	-	-	30.92	-	-
SSC	-	-	-	33.73	-
PKC	-	-	-	-	30.00
Rice bran	10.00	10.00	10.00	10.00	10.00
Fish meal	5.00	5 .00	5.00	5 .00	20.06
Bone Meal	2.00	2 .00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Palm oil	0.029	0.025	0.017	1.17	2.60
Total	100.00	100.00	100.00	100.00	100.00
CP%:	23.00	23.00	23.00	23.00	23.00
ME kcal/kg	3000.00	3000.00	3000.00	3000.00	3000.00

T1=Full fat soyabean, T2= Soybean cake, T3= Groundnut cake, T4= Sesame seed cake, T5= Palm kernel cake

Table 2: Dietary Composition (%) and Calculated Analysis of Broiler Finisher Diets (5 - 8 weeks)

Levels of Inclusion in % of Feed ingredients					
Diets:	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	49.68	55.10	55.83	53.51	32.06
FFSB	31.62	-	-	-	-
SBC	-	26.20	-	-	-
GNC	-	-	25.47	-	-
SSC	-	-	-	27.79	-
PKC	-	-	-	-	35.00
Rice bran	12.00	12.00	12.00	12.00	12.00
Fish meal	3.00	3 .00	3.00	3.00	14.24
Bone Meal	2.00	2 .00	2.00	2.00	2.00

Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Palm oil	0.025	0.021	0.014	0.54	0.985
Total	100.00	100.00	100.00	100.00	100.00
CP%:	20.00	20.00	20.00	20.00	20.00
ME kcal/kg	3000.00	3000.00	3000.00	3000.00	3000.00

T1= Full fat soybean, T2= Soybean cake, T3= Groundnut cake, T4= Sesame seed cake, T5= Palm kernel cake

Data Collection Procedure

Feed Intake The difference between feed given and left over was used to calculate feed intake

Determination of the daily feed consumption: is the ratio between the total Quantity of Feed Consumed (QFC) on a given period over the Number of birds fed.

Weight Gain: Initial body weights of the birds was taken at the start of the study and thereafter, at the end of each period of seven days; the birds were weighed individually to determine body weight gain

Feed Conversion Ratio: The Feed Conversion Ratio (F.C.R.) was calculated by dividing total feed intake (g) by total weight gain (g)

Determination of the rate of mortality: The rate of mortality is the ratio between the number of the dying birds and the initial total number of birds in the batch multiplied by 100

Carcass Measurement for Broilers

At the end of the feeding trial two (2) birds (male and female) from each replicate were randomly selected and starved overnight (12 hours). Each bird was weighed (Live weight) and Slaughtered. The slaughtering was done by slitting the throat and jugular veins with a sharp knife for proper bleeding. Thereafter, the birds were scalded in warm water for about a minute, defeathered, eviscerated and dressed to determine carcass characteristics. The Plucked Weight (PW), Eviscerated Weight, and Carcass Weight were taken, the intestinal and caecal lengths and weights were measured while the gizzard, spleen, thigh, shank, breast, wings, neck, lung, drum stick, pancreas, heart, liver and kidney. Each cut-up parts and organs were weighed separately using a sensitive electronic scale, lengths were measured using measuring tape and each part is expressed as a percentage of dressed weight. The weight of the carcass and internal organs were taken to determine the effects of the diets on the organs.

The dressing percentage was calculated using the mathematical relationship below:

$$\text{Dressing Percentage} = \frac{\text{Carcass Weight}}{\text{Live weight}} \text{ X } \frac{100}{1}$$

Results and Discussion

The performance of broilers fed with Protein seed cake sources at the starter, finisher and overall phase (table 3,4, and 5) revealed a very high significant difference ($P < 0.001$) in all the parameters; daily feed intake (DFI), daily weight gain (DWG), and feed conversion ratio (FCR), where diets T2, T1, T3 and T4 were the highest, while diet T5 was the least, however, the mortality rate were not significantly different ($P>0.05$) among the treatment means. The highest feed intake and weight gain of the birds fed diets T1 and T2 indicated their palatability and high quality of both the feeds although, a very good feed conversion ratio (2.42) was shown in diet T2 (Soybean cake based diet) indicating its superiority over the entire feeds. Moreover, Superior performance of birds in T1 and T2 groups was due to high content of lysine and methionine in soybean meal which is in close agreement with the findings of Ghadge (2009) [5]. While the low feed intake, low weight gain and poor feed conversion ratio of the birds fed diet T5 shows its non-palatability and low quality of the diet as palm kernel meal contents low crude protein as compared with the other diets, the result is in agreement with the findings of Ramiah *et al*. (2019) [10] which observed lower growth performance of broilers fed with treated PKC groups than the those fed the control (untreated) diet. While Alshelmani *et al* (2016) [2] stated that, because of the high CF, coarse texture, and gritty appearance of PKC, there is a restriction on its use in monogastric animal diets. PKC has not been used widely in pig and poultry diets. This is primarily due to its unpleasant taste and substantial fibre content (150 g/kg DM). This lessens how easily it can be digested by these animals.

Table 3: Performance of Broilers Fed with Various Protein seed cakes Sources Starter Phase (0-4 Weeks)

Parameters	T1	T2	T3	T4	T5	SEM
Initial body wgt	43.00	42.00	42.10	40.5	42.00	2.34NS
Final weight	1816.67	2200.00	1733.33	1650.00	900.00	69.92***
DFI (g)	55.11 a	54.07 a	35.42 c	51.95 a	900.00 43.66b	3.05***
DWG (g)	25.54ab	31.40 a	14.28c	22.70 b	12.31 c	3.23***
FCR	2.26 b	1.72 b	2.49 b	2.29 b	3.80 a	0.46**
Mortality (No)	2	0	0	1	1	-

[abc] Means bearing different superscripts within the same row differ significantly

Table 4: Performance of Broilers Fed with Various Protein seed cakes Sources at Finisher Phase (5 – 8 Weeks)

	T1	t2	T3	T4	T5	SEM
DFI (g)	110.85[a]	106.92[a]	97.81[b]	85.96[c]	79.92[c]	3.89***
DWG (g)	37.04[a]	35.22[a]	31.58[a]	23.37[b]	20.20[b]	3.06***
FCR	2.99[c]	3.04[c]	3.10[bc]	3.68[ab]	3.96[a]	0.30*
Mortality (No)	1	0	1	0	0	-

[abc] Means bearing different superscripts within the same row differ significantly

Table 5: Performance of Broilers Fed with Various Protein seed cakes Sources Overall Phase (0 – 8 Weeks)

Parameters	T1	T2	T3	T4	T5	SEM
DFI (g)	82.98[a]	80.50[a]	66.61[b]	68.92[b]	56.79[c]	4.38***
DWG (g)	31.29[a]	33.31[a]	22.93[b]	23.04[b]	16.25[c]	1.45***
FCR	2.65[bc]	2.42[c]	2.90[bc]	3.01[b]	3.94[a]	0.23***
Mortality (No)	3	0	1	1	1	-

[abc] Means bearing different superscripts within the same row differ significantly
* = (p < 0.05) ** = (p < 0.01) *** = (p < 0.001) NS = not significant
SEM = Standard Error of the mean DFI = Daily Feed Intake DWG = Daily Weight Gain
FCR = Feed Conversion Ratio T1 = Full fat soya bean Based Diets T2 = Soybean cake Based Diet T3= Groundnut cake Based Diet T4 = Sesame seed cake Based Diet T5 = Palm kernel cake Based Diet

The results of carcass characteristics of broiler fed with various Protein seed cakes sources (Table 6) revealed that there were very high significant differences (P<0.001) among the treatment means for live weight., Plucked Weight, Eviscerated, Carcass, Neck, Leg, Drumstick, Breast weights. A high significant difference (P<0.01) was obtained in Thigh and Head weights, while a significant difference (P<0.05) was found in dressing percentage where diet T2 is the highest in all the parameters which were similar to diet T1 and T3 while the least was in diet T5. The highest body weight components of the diet 2 on live weight, plucked weight, carcass weight, eviscerated weight. and dressing percentages of the broiler chickens indicates that, there are variations in the nutritive contents of protein seed cakes sources and it also signifies the superiority of diet 2 (Soybean cake-based diet) over other protein seed cakes diets. While the low body weight components of the broiler chickens fed diets 5 compared to other diets show its poor utilization, possibly, due to the high fibre content of the palm kernel cake which is in agreement with findings of Alshelmani *et al* (2016[b]) [2] that Insoluble and soluble fibers present in PKC are the main reasons for a lower nutrient digestibility in monogastric animals.

The highest gizzard weight of birds fed diet T1 indicates increased activity of the gizzard in handling the diet materials (Oyawoye and Nelson, 1999) [9]. The non-significant (p<0.05) effect of the spleen signifies the safe used of the various protein seed cakes in broiler chickens. The result shows that there was no significant difference (P>0.05) among the treatment for the GIT components; small intestine, large intestine except caecal length which significantly (p<0.05) difference. This finding is in conformity with the finding of (Negasa *et al*. 2021; and Ombugu: 2022) [6, 8] who reported that the relative weight and length of intestine were not significantly affected by substitution of soybean meal with Lin seed meal, as well as castor seeds meal sources as dietary protein for broilers.

Table 6: Carcass and Organs Characteristics of Broilers Fed with Various Protein seeds cakes Sources

Parameters	Replacement Level of Soybean with Various Protein seeds cakes Sources					
	T1	T2	T3	T4	T5	SEM
Weight of Body						
Live Weight (g)	1816.67[b]	2200.00[a]	1733.33[bc]	1650.00[c]	900.00[d]	69.92***
Plucked Weight (g)	1660[b]	2100.00[a]	1600.00[b]	1450.00[b]	850.00[c]	105.89***
Eviscerated Wght (g)	1250.00[b]	1725.00[a]	1250.00[b]	1000.00[b]	500.00[c]	120.07***
Carcass Weight (g)	110000[b]	1425.00[a]	1050.00[bc]	875.00[c]	450.00[d]	95.74***
Dressing Percentage	60.56[ab]	64.76[a]	60.72[ab]	52.59[bc]	50.00[c]	57.73*
Head Weight (g)	46.40[a]	45.80[a]	42.85[a]	46.10[a]	31.50[b]	2.90**
Neck Weight (g)	89.85[a]	95.10[a]	80.23[a]	79.25[a]	38.00[b]	8.16***
Leg Weight (g)	165.95[b]	222.60[a]	168.60[b]	148.10[b]	85.75[c]	20.70***
Thigh Weight (g)	93.80[b]	127.35[a]	101.80[ab]	82.75[b]	49.70[c]	12.62**
Drumstick Wght (g)	72.15[b]	94.25[a]	66.80[b]	65.35[b]	36.05[c]	8.73***
Breast Weight (g)	260.80[b]	440.65[a]	276.15[b]	158.35[c]	103.40[c]	44.17***
Weight of Viscera Organs						
Gizzard (%)	59.75[a]	52.00[b]	43.05[c]	45.55[c]	43.50[c]	6.27***
Lung weight (%)	8.10[ab]	8.70[ab]	9.80[a]	6.90[bc]	4.65[c]	1.03**
Kidney weight (%)	6.70[b]	9.05[a]	8.25[a]	6.00[b]	5.90[b]	0.44***
Spleen weight (%)	1.90	2.15	1.75	1.85	0.75	0.47[NS]
Heart weight (%)	7.85[ab]	8.90[a]	7.80[ab]	6.55[b]	4.00[c]	0.99**
Small intestine weight (%)	85.90[a]	85.75[a]	71.45[b]	63.10[b]	43.8[c]	6.27***
Large intestine weight (%)	3.00	2.75	4.10	2.05	5.15	1.18[NS]
Caecal weight (%)	14.35[a]	15.35[a]	10.45[b]	9.05[bc]	6.10[c]	1.35***
Abdominal fat weight (%)	41.15[a]	51.10[a]	17.25[b]	37.70[a]	13.05[b]	6.91***

Pancreatic weight (%)	3.25^{bc}	6.10^{a}	3.85^{b}	4.50^{b}	1.85^{c}	0.69***
Liver weight (%)	37.70^{a}	30.70^{b}	28.55^{b}	32.30^{ab}	14.45^{c}	2.48***
Length of GIT Components (cm)						
Small intestine length	245.60	220.30	225.30	220.70	195.40	15.83^{NS}
Large intestine length	10.15	10.05	8.20	5.20	5.40	2.58^{NS}
Caecal length	20.10^{a}	15.40^{ab}	20.05^{a}	15.40^{ab}	10.70^{b}	2.40**

^{abc} Means bearing different superscripts within the same row differ significantly, * = ($p < 0.05$), ** = ($p < 0.01$), *** = ($p < 0.001$), NS = not significant and SEM = standard Error of the mean

T_1 = Full fat soya bean Based Diets T_2 = Soybean cake Based Diet

T_3 = Groundnut cake Based Diet T_4 = Sesame seed cake Based Diet

Conclusion

Based on the results obtained in this study, it can be concluded that, with the exception of Palm kernel seed cake, all the other non-conventional protein seed cakes (Soybean cake, Groundnut cake, and Sesame seed cake) can effectively replace full-fat soybean meal in broiler chickens without having any negative effects on growth performance, carcass and gut characteristics.

Recommendation

Based on the findings of the study, the following recommendations were made;

1. Farmers and feed industries should embrace the use of non-conventional protein seed cakes for broiler feed production so that, full - fat soybean can be cheaper and available for human nutritional diets
2. Non-conventional protein seed cakes utilization in poultry feed production can reduce the existing competition between human and livestock feed industries on Full fat soybean
3. Further research is needed in using these non-conventional protein seed cakes for other classes of poultry

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