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Performance, relative organ weights and cost implications of rabbits fed graded levels of centrosema leaf protein concentrate

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ABSTRACT: The equi-protein replacement of groundnut cake (GNC) protein with centrosema leaf protein concentrate (CLPC) was evaluated in diets for weaned rabbits. Prior for the feeding trial, the CLPC was analyzed for its chemical composition with respect to proximate composition and gross energy. Thereafter, five dietary treatments were formulated with an average crude protein content of 19.18±0.52 and average energy content of 2321.72±12.69 Kcal ME/kg. The control (diet 1) contained 27% GNC whose protein was gradually replaced at 5, 10, 15, or 20% with CLPC in diets 2, 3, 4 or 5, respectively. Thus the inclusion level of CLPC was 2.99, 5.98, 8.97 or 11.96%, in whole ration for diets 2, 3, 4 and 5, respectively. A total of thirty-five weaned rabbits with mean weight of 587.15±50.13g was randomly assigned to the five dietary treatments with seven replicates and a rabbit per replicate. The average weight gain, live-shrunk weight and feed efficiency were not significantly ($p>0.05$) influenced by the dietary treatments. On the carcass traits measured, only the head weight showed no significant difference ($p>0.05$). Other carcass traits such as neck, loin, pelt, shoulder and thigh were significantly higher ($p<0.05$) at inclusion level of 10%-based CLPC and above. The aforementioned carcasses increased with increase in the level of CLPC in place of GNC. The relative organ weights of the heart and pancreas were not influenced ($p>0.05$) by the test diets while those of liver, lung and kidney were significantly higher ($p<0.05$) than the control diet. The result of the cost analysis showed a decline in feed cost per kilogram from 2.60 to 10.72% as the level of CLPC increased from 2.99 to 11.96% in diets 2 to 5. The implication is that, it is most economical to raise rabbits on CLPC substituted for GNC at 11.96% CLPC supplementation.

Key words: equi-protein, leaf protein concentrate, carcass characteristics, organ growth, cost implications

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INTRODUCTION

The realization that feeding alone currently account for over 75% of intensive non-ruminants (poultry, swine and rabbits) (Ikani *et al.,* 2001; Agbede and Agbede, 2009) production in the third world countries has stimulated and necessitated research work and studies aimed at exploiting the locally available feed resources as alternatives to the expensive conventional ones, which a times are not readily available due to their seasonality. A notable feed resource often used in rabbit feed formulation, which requires an urgent research attention is groundnut cake. The call for alternative use to groundnut cake in non-ruminant feed formulation is not unconnected with its high cost, in addition to its contamination with a toxic substance (aflatoxin) which limits its utilization for maximum meat production. The high cost of groundnut cake comes largely from the competition between man and animal. As a result of the ever increasing demand for groundnut to satisfy human needs, nutritionists have in recent times attempt to replace it with locally available protein sources. An ingredient with high nutrient density deserving evaluation in this regard is the leaf protein concentrate of *Centrosema pubescens*.

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(*C. pubescens*) abound in Nigeria and other West African countries, and they are rich in protein (11-22%) (Agbede, 2006), minerals (Nworgu *et al.,* 2001; Agbede, 2006) and vitamins. On extraction, the juice known as leaf protein concentrate contains appreciable level of protein (20-30%) (Agbede, 2006; Isaac *et al.,* 2008) which can be compared with most conventional feed sources used in livestock feed formulation. Apart from the relatively high protein and mineral contents, it has an amino acid profile which in most cases compared and even surpassed those of the conventional feed sources such as, groundnut cake and soybeans meal (Aletor *et al.*, 1989; Ajayi *et al.*, 2005; Agbede, 2006). Centrosema leaf meal and concentrate have been reported to enhance good growth in rabbit at 2.5% inclusion level (Nworgu *et al.,* 2001). It is therefore hoped that a successful use of centrosema leaf protein at higher levels as alternative protein source to groundnut cake in rabbit diet could lead to better rabbit performance and consequently reduce the cost of rabbit production in Nigeria, and possibly other tropical regions. This study was therefore carried out to assess the effect of centrosema leaf protein concentrate on the body weight, feed intake, feed conversion efficiency, carcass traits, organ weights and the cost implications when substituted for groundnut cake in rabbit's diet.

MATERIALS AND METHODS

Materials and the production of leaf protein concentrate

Leaves from *Centrosema pubescens* were harvested within Adeyemi College of Education campus, weighed and washed prior to pulping using a village-scale fractionation method (Fellows, 1987). The pulping helped to rupture the plant cell walls for easy extraction of the juice. The juice, which contains most of the proteins, was squeezed from the leaf residue by using a press. The separated leaf juice was heated in batches to 80-90^{0}C for 10min. This procedure helped to coagulate the leaf proteins from the whey. Hot whey was siphoned using rubber hose while the protein coagulum was separated from other fractions by filtering through a muslin bag, followed by pressing with screw-press (Aletor, 1993). The centrosema leaf protein concentrate (CLPC) was thereafter rinsed, pulverized, sun-dried and milled. The CLPC was used to formulate diets alongside other ingredients purchased from a reputable feed mill in Akure, Ondo State, Nigeria.

Experimental diets

Five iso-nitrogenous and iso-caloric diets were formulated. The basal and proximate compositions are shown in Tables 1 and 2, respectively. Diet 1 was the control with 27% groundnut cake (GNC). GNC was substituted at 5, 10, 15 and 20% with CLPC in diets 2, 3, 4 and 5, respectively. The five diets were analyzed for their chemical composition (AOAC, 1990).

Management of rabbits and experimental layout

Thirty-five rabbits of mixed sexes, aged 5-6 weeks were weighed individually and randomly assigned to the five dietary treatments with 7 rabbits per treatment. Each rabbit was treated as a replicate. The rabbits were housed individually in cages in two rows of hutches. Each cage measured approximately 75x60x56 cm with facilities for feeding, drinking and feacal dropping. The hutches were raised approximately 85 cm from the floor in a house with 1.2 m high walls, which permitted adequate ventilation. The rabbits were fed commercial diets in their individual cages for the first week to ensure uniform growth, and to acclimatize to their new environment and the cage facilities. Completely randomized design (CRD) was adopted for the trial. At the end of the acclimation period, the rabbits were weighed and 7 rabbits of mixed sexes were assigned to each of the five dietary treatments. The rabbits were fed their respective experimental diets *ad-libitum* for a period of 56 days during which the daily feed consumed and weekly weight changes were taken. Drinking water was provided *ad-libitum* throughout the experimental period.

Table 1: Composition of experimental diet (g/100g) for growing rabbits

	Levels of cenrosema leaf protein concentrate (%)				
	0	5	10	15	20
	Diets				
Ingredients (kg)	1	2	3	4	5
Maize	62.57	60.25	57.94	55.62	52.34
CLPC	-	2.99	5.98	8.97	11.96
Groundnut cake	27.00	25.65	24.30	22.95	21.60
Wheat bran	5.78	6.46	7.13	7.81	9.45
Bone meal	2.00	2.00	2.00	2.00	2.00
Blood meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Calculated composition					
Energy (kal ME/kg)	2303.10	2315.80	2323.70	2331.50	2334.30
Crude protein (g/kg)	19.00	19.00	19.00	20.00	20.00
Crude fibre (g/kg)	10.63	11.49	12.31	12.82	12.93

Table 2: Proximate composition of test ingredient and experimental diets

Constituents (g/100g dry matter)	DM	CP	CF	EE	Ash	NFE	GE
CLPC	90.90	34.50	8.01	7.53	3.84	46.22	23.44MJ/kg
Experimental diets (g/kg)							
0	91.30	18.63	10.81	7.10	9.20	54.22	
5	91.50	18.59	11.62	7.18	9.52	53.09	
10	91.70	18.72	12.17	7.21	9.59	52.31	
15	90.90	18.68	12.69	7.23	9.48	51.92	
20	90.85	18.95	12.83	7.19	9.63	51.40	

Carcass characteristics and organ measurement

Before slaughtering, the rabbits were starved overnight to determine the rabbit live-shrunk weight in addition to avoid soiling the carcasses and organs during dissection. Five rabbits were selected from each treatment and slaughtered. Slaughtering was done in accordance with the guidelines of the World Rabbit Science Association (WRSA). After slaughtering and bleeding, the rabbits' pelts were removed, after which the carcasses were cut/dissected with surgical knife and subsequently weighed. Organs such as lungs, liver, heart and kidneys were separately removed and weighed. Both the carcasses and organs were expressed in g/kg body weight.

Chemical analysis

The proximate composition of the test ingredient and test diets were determined by the method of AOAC (1990).

Data collection and statistical analysis

Data were collected on body weight, feed intake, feed efficiency, carcass traits, organ weights and the cost effectiveness of raising rabbits on CLPC-based diets. Data collected were analyzed by

one-way analysis of variance procedure using the SPSS version 10 Software Package. Where significant differences exist, the means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate composition and energy content

The proximate composition of *Centrosema pubescens* leaf protein concentrate was presented in Table 2. The crude protein value was 345 g/kg dry matter (DM) and this fell within the range of nutrients for the conventional plant protein sources used in feed formulation (NRC, 1984). Data on proximate composition and energy value of *Centrosema pubescens* leaf protein concentrate revealed the potential of the legume leaf concentrate as a good source of feed for rabbits. For instance, the crude protein content of the CLPC compared favourably with, and in some cases surpassed some conventional plant protein sources used in feed formulation (FAO, 1972; Igene *et al.,* 2001; Aletor *et al.,* 2002; Agbede and Aletor, 2004; Agbede, 2006). The protein content was higher than those reported for its leaf (115±0.5 g/kg) (Agbede 2006) but lower than the protein contentrate of *Glyricidia sepium, Mucuna pruriens, Leucaena leucocephala* (Agbede, 2006). The gross energy of centrosema leaf protein concentrate was 23.4MJ/Kg. This compares favourably with the values obtained by Agbede (2006), for *Mucuna pruriens* 23.3MJ/Kg, *Leucaena leucocephela* 21.4MJ/Kg, *Delonix regia* 20.4MJ/Kg and *Centrosema pubescens* 22.8MJ/Kg, but lower than 34.6MJ/Kg for *Glyricidia sepium (*Amata and Bratte, 2008).

General observation

Throughout the period of the experiment, the rabbits were alert, though one of the rabbits placed on diet 1 was sick and showed watery faeces on the third week (3rd week) of the experiment. However, there was no mortality recorded throughout the experimental period.

Performance of rabbits

Table 3 shows that the live-shrunk weight, average weight gain and feed efficiency were not significantly ($p>0.05$) influenced by the dietary treatments. While this result showed that the experimental diets were well digested and utilized by the animals as evidenced by their comparable growth, the study conducted by Fasuyi (2005) on the use of cassava leaf protein concentrate in rats diet, showed that growth rate was significantly lower than that of rats placed on casein-based diets. Similarly, Agbede and Aletor (2003a) and Agbede *et al.* (2007 and 2008) showed that the protein quality indices of rats fed Glyricidia, Leucaena, Telfairia and Vernonia leaf protein concentrates were consistently lower than those fed with casein-based diets. However, various studies by Agbede (2003), Agbede and Aletor (2003b) showed that leaf protein concentrates could be included at 25% in place of fish meal in broiler-chicks diet. Adeparusi *et al*. (2007) reported that the response of *Oreochromis niloticus* fed either cooked or toasted bambara groundnut supplemented with leaf protein concentrate as either or partial replacement of groundnut cake had superior growth, nutrient utilization and digestibility and better feed conversion ratio than those not substituted. The body weight gain and feed efficiency in this study is in agreement with the reports by Amata and Bratte (2008) and Agbede *et al.* (2007 and 2008) that leaf protein concentrate promote tissue synthesis and are as digestible as legume seeds like soybean and groundnut cake.

Table 3: Performance of rabbits fed different levels of centrosema leaf protein concentrate as replacement for groundnut cake

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
	Levels of centrosema leaf protein concentrate				
Parameters	0%	5%	10%	15%	20%
Initial weight (g)	483.33± 83.29	466.67±81.53	716.67±108.31	733.33±113.51	546.67±100.17
Final weight (g)	1233.33±175.59^{a}	1216.67±76.38^{a}	1683.33±125.46^{b}	1583.33±202.07^{b}	1450.00±150.00^{ab}
Live-shrunk weight (g)	1167.33±171.35	1160.33±71.29	1481.67± 104.73	1518.67±198.75	1388.00±91.10
Total weight gain/rabbit(g)	750.00±50.00	750.00±73.21	966.67±89.30	850.00±71.29	903.33±50.33
Weekly weight gain/rabbit(g)	93.75±12.50	93.75±21.65	120.92±23.72	106.25±16.54	112.91±6.29
Daily wt. gain/rabbit(g)	13.39±1.79	13.39±3.09	17.26±3.38	15.18±2.36	16.13±0.89
Total feed consumed/ rabbit(g)	1675.13±102.54^{a}	1975.13±107.50^{a}	2472.03±121.80^{b}	1906.90±125.82^{a}	1940.27±133.73^{a}
Weekly feed consumed/ rabbit(g)	209.39±12.82^{a}	264.89±21.19^{a}	309.01±32.73^{b}	238.37±15.73^{a}	242.53±29.22^{a}
Daily feed consumed/ rabbit(g)	29.91±1.83^{a}	35.27±3.03^{a}	44.14±4.68^{b}	34.05±2.25^{a}	34.68±4.12^{a}
Feed efficiency	0.45±0.06	0.38±0.11	0.39±0.10	0.44±0.07	0.47±0.03
Mortality	0	0	0	0	0

^{ab}Means with different superscripts along the same row are significant (P<0.05)

Table 4: Carcass traits (g/kg body weight) of weaned rabbit fed diets containing different levels of centrosema leaf protein concentrate as replacement for groundnut cake

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
	Levels of centrosema leaf protein concentrate				
Parameters	0%	5%	10%	15%	20%
Dressed carcass weight (g)	325.69±20.42^{a}	312.20±21.36^{a}	507.70±58.27^{b}	533.17±17.97^{b}	538.48±21.16^{b}
Eviscerated wt (g)	248.18±18.48^{a}	245.57±6.81^{a}	304.07±36.81^{b}	336.64±35.08^{b}	351.87±28.15^{b}
Live weight (g)	1233.33±175.59^{a}	1216.67±76.38^{a}	1683.33±125.56^{b}	1583.33±202.07^{b}	1450.00±150.00^{ab}
Head (g)	10.18±1.84	9.88±1.31	7.27±1.15	8.46±1.52	8.98±1.24
Neck (g)	0.77±0.18^{a}	0.70±0.21^{a}	1.25±0.13^{b}	1.36±025^{b}	1.39±0.17^{b}
Loin (g)	5.54±0.71^{a}	4.80±0.53^{a}	6.42±0.69^{ab}	8.06±0.43^{b}	8.21±1.03^{b}
Limbs (g)	2.82±0.11^{c}	1.98±0.09^{a}	1.90±0.08^{a}	2.06±0.07^{b}	2.79±0.10^{c}
Tail (g)	0.21±0.02^{a}	0.32±0.02^{b}	0.19±0.01^{a}	0.35±0.01^{b}	0.32±0.01^{b}
Pelt (g)	5.28±0.64^{a}	4.67±0.59^{a}	7.88±0.83^{b}	8.48±1.02^{b}	9.41±0.73^{c}
Shoulder (g)	6.40±0.55^{a}	6.58±0.58^{a}	7.30±0.25^{b}	7.65±0.38^{b}	8.94±0.51^{c}
Thigh (g)	11.20±1.03^{a}	10.56±1.00^{a}	12.38±0.97^{b}	13.08±1.11^{b}	13.31±0.97^{b}
Rib (g)	2.22±0.15^{a}	2.82±0.31^{c}	2.48±0.19^{b}	2.84±0.29^{c}	2.87±0.27^{c}
Carcass length (cm)	20.02±0.33	27.90±0.35	28.60±0.33	29.00±1.00	29.42±1.38

^{abc}Means with different superscripts along the same row are significant (P<0.05)

Carcass characteristics and organ weights

Among all the carcass traits measured, only the head weight was not influenced ($p>0.05$) by the dietary treatments. Other carcass traits measured were significantly influenced ($p<0.05$) by the test diets as presented in Table 4. The dressed, eviscerated, neck, shoulder, thigh, pelt and loin weights were significantly higher ($p<0.05$) at 10% CLPC-based diet and above. The significantly higher carcass traits over the control diet might be attributed to the dietary effect of the test ingredient on the rabbits. Other parameters such as the limbs, tail and rib weights showed various significant differences ($p<0.05$) among the experimental diets. In general, CLPC inclusion promoted better carcass cuts than the control diet in this study. This report supports that of Adeparusi *et al.* (2007) that groundnut cake when substituted with leaf protein concentrate promoted good carcass development.

Table 5 shows that the heart and pancreas weights were not significantly influenced ($p>0.05$) by the dietary treatments. The relative organ weights of liver, intestine, lungs and kidney did not show any particular trend across the dietary treatments. Although, it was observed that there was a significant difference ($p>0.05$) in the liver, lungs and kidney weights of rabbits placed on 20% CLPC-based diets over the control diet. The increase in the weights of these internal organs could be as a result of the increased metabolic rate of the organs particularly liver, kidney and lungs to reduce the toxic or anti-nutritional factors such as tannins, phytin, oxalate, phytate, cyanide and P-phytin present in forage crop (Aletor, 1993 and 1999; Agbede and Aletor, 2003b; Agbede and Aletor, 2004; Fasuyi *et al.,* 2005). The cost analysis of the study as presented in Table 6 showed that the feed cost per kilogram of feed progressively declined by 2.60% and 10.72% as the level of CLPC increased by 2.99 and 11.96% in diets 2 and 5 as shown in Table 6.

The cost of feed to produce a kilogram of rabbit was highest (N197.1) on 2.99% CLPC-based and lowest (N147.50) on 11.96%-based CLPC (Table 6). Cost reduction per kilogram weight gain showed improved savings by 13.58% on rabbits placed on 20%CLPC-based diet as against the control diet.

The implication therefore is that it is most economical to raise rabbits on CLPC substituted for GNC at 11.96% CLPC supplementation than the control diet. The reduction in feed cost/kg weight gain when CLPC were supplemented at 8.97 and 11.96%-based CLPC diet is in agreement with Dairo (1999) that recorded the highest relative cost advantage in 20%-based water hyacinth leaf meal-based diet for rabbit.

Table 5: Relative organ weights (g/kg body weight) of weaned rabbits fed diets containing different levels of centrosema leaf protein concentrate as replacement for groundnut cake

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
	Levels of centrosema leaf protein concentrate				
Parameters	0%	5%	10%	15%	20%
Heart	0.24±0.02	0.17±0.01	0.16±0.01	0.21±0.01	0.22±0.01
Intestine+content	16.32±1.83^{c}	7.60±0.58^{a}	14.21±1.07^{b}	17.21±0.98^{c}	13.69±0.79^{b}
Pancreas	0.10±0.01	0.10±0.01	0.07±0.01	0.07±0.01	0.08±0.01
Liver	2.11±0.11^{a}	2.45±0.09^{b}	2.06±0.05^{a}	2.16±0.13^{a}	2.40±0.23^{b}
Lungs	0.69±0.03^{a}	0.98±0.03^{d}	0.76±0.02^{b}	0.79±0.02^{b}	0.88±0.03^{c}
Kidney	0.68±0.02^{a}	0.85±0.02^{c}	0.62±0.01^{a}	0.74±0.01^{b}	0.82±0.02^{c}

^{abcd} Means with different superscripts along the same row are significant ($P<0.05$)

CONCLUSION

The study showed that CLPC could replace up to 20% for GNC on equi-protein basis in rabbit diets without any adverse effects on the weight gain, carcass characteristics and internal organs. Consequently, the use of CLPC in the diets of rabbits in the developing countries hold tremendous promise for making rabbit meat and animal protein intake affordable.

Table 6: Cost implications of rabbits fed different levels of centrosema leaf protein concentrate as replacement for groundnut cake

Diets	%GNCreplaced with CLPC	Levels of substitution of GNC with CLPC(g/kg)	Total no. of rabbits	Average with gain/ rabbit (kg)	Average feed consumed/ rabbit (kg)	Cost of feed (N)/kg	Cost of feed N/kg weight gain	%cost reduction	%cost reduction/ kg weight gain
1	0	-	7	0.75	1.67	76.65	170.67	-	-
2	5	2.99	7	0.75	1.98	74.66	197.10	2.60	-15.49
3	10	5.98	7	0.97	2.47	72.70	185.12	5.15	-8.47
4	15	8.97	7	0.85	1.91	70.67	158.80	7.80	6.95
5	20	11.96	7	0.90	1.94	68.43	147.50	10.72	13.58

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