Evaluation of Peanut Cake Replacement with Soybean Curd Meal for Growth Performance and Haematological analysis in the Diet of Weaner Rabbit

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Received: 28 April 2022
Accepted: 28 November 2022

Abstract

Six weeks-old heterogeneous hybrids (Chinchilla × New Zealand White breeds crosses) weaner rabbits (n= 40) were used for the feeding trials to evaluate the replacement value of peanut cake with soybean curd meal (SCM) in the diets of weaner rabbits. Eight rabbits each were randomly allotted to five dietary treatments with SCM meal replacing peanut cake at 0, 25, 50, 75 and 100% (T_1, T_2, T_3, T_4 and T_5 respectively). Eight rabbits were randomly assigned to each of the five treatments in a completely randomized design which lasted eight weeks. The rabbits in T_4 recorded a significantly higher ($P<0.05$) weight at 1384.28g compared to the lowest value of 1367.41g in T_1 group. The feed conversion ratio showed that treatment T_4 had a significantly better feed conversion ratio value of 6.41 compared to 6.79, 6.57, 6.49 and 6.46 in T_1, T_5, T_3 and T_2 in that order respectively. The apparent nutrient digestibility of dry matter, crude protein and crude fibre in the treatment groups were comparable to those in control in all the groups, however, the ether extract digestibility was significantly highest in T_1 and T_4 (90.42% and 90.31%) while T_5, T_2 and T_3 groups recorded lower digestibility values (87.77%, 86.34% and 86.06% respectively). There were significant differences ($P<0.05$) among the treatments for serum glucose with T_4 having a significantly highest ($P<0.05$) value of 6.35mmol/L while 4.75mmol/L was recorded in T_2. The creatinine and red blood cell values showed that T_4 had significantly higher values compared to other treatments. The white blood cells ranged between 4.89 in T_3 and 6.89 in T_5. It was concluded that SCM is well accepted by the animal, it is readily digested and T_4 treatment represents the best replacement level of peanut cake in the diet.

Keywords: Growth performance, Rabbit, Soybean-curd meal, Haematological, Peanut.

Introduction

The problem posed by malnutrition in third-world countries which included Nigeria is serious and this arose from the shortage in the intake of protein, especially of animal origin. There are many animal species including rabbits which are the main sources of animal protein (Njidda and Isidahomen, 2009). To ameliorate this condition, it is therefore essential that animals with a very fast growth rate and efficient reproductive ability with short generation intervals be taken into consideration for intensive production. Rabbit is therefore an animal of choice that produces fine-grained low fat and lean delicious meat (Irlbeck, 2001; Bamikole *et al*., 2005).

Rabbits belong to the kingdom A*nimalia*, order *lagomorpha*; genus *oryctolagus*; and species *cunniculus*. They find various uses as meat, fur/wool and pets. The meat has the advantages of being low in cholesterol, high in protein, low in fat, very low in sodium and very palatable (Houndonougbo *et al*., 2012). Rabbit meat is a white meat that is very fine in texture with very low fibre content, making it easily digestible compared to cow meat (Olabanji *et al*., 2007; Jian-Min *et al*., 2009).

Feeding cost in animal production is responsible for about 70- 75% of the total cost of production processes, and as such good feeding for ultimate production will involve combining various feed ingredients (Ijaiya and Awonusi, 2005; Ladokun *et al*., 2006). Soybean curd meal (SCM) also called Okara is a by-product of soybean processing for tofu (soybean curd). It is the solid residue remaining after making soymilk (Abel *et al*., 2014). The soybean-curd meal is an alternative feed ingredient which contains shell, husk or hull of ground soybean. It is beige in colour and has a light, crumbly, fine-grained texture, which makes it look like a moist sawdust or grated coconut (Sinha *et al.*, 2013). SCM will add value to soybean value chain processing thus proving jobs as a form of waste to wealth initiative and also preventing any form of environmental pollution and degradation as a result of heaps of wastes of soybean waste in the environment (Abel *et al*., 2015). SCM is both an energy and protein ingredient source, and as a dietary constituent, it has measurable effects on the blood constituents. There is a paucity of information on the use of soybean-curd meal in rabbit feeding as few authors had used it in broiler chickens, so this research will evaluate the replacement value of SCM for peanut cake in the diet of weaner rabbits in the south humid tropics in a post-Covid lockdown period.

Material and methods

Experimental site

The experiment was carried out in the rabbitry pen section of the Brown Rabbitry Farm, Epe, Lagos State, Nigeria. It has a good, well-ventilated environment and neat hutches (cages) with a dimension of 52 × 67cm. Wet cages and the environment was avoided to prevent snuffles and other respiratory problem and coccidia organisms from the rabbit environment which can predispose them to sickness and diseases. A compounded rabbit diet was given (Table 1). The biosecurity measures were strictly adhered to and health issues were seriously guarded. Water and feed were given twice daily in the morning and evening.

Sourcing and processing of the soybean curd meal (SCM)

The SCM is a by-product of the soybean processing industry and other cottage industries. It is creamy or brownish in colour resembling a grated coconut residue. It has a very high moisture content and is rich in crude protein and crude fibre, however, it has a very short shelf life and is treated as industrial waste with little or no market value, therefore processing methodology must be in place to harness its positive potential. The SCM was collected in wet form as waste from the soymilk industry very early in the morning in jute sacks and processed removing the effluent.

The wet soybean-curd meal was processed by placing a bag containing the wet curd meal under the mechanical screw pressing machine for 120 minutes. They were removed from the screw press for air and sun-drying by spreading them thinly on flat tables $1.9 \times 2.4m^2$ for 2 hrs to avoid fungal infection and proper drying. They were turned at 20 minutes intervals. They were later oven dried at 150^0C for 75 minutes in a cabinet tray drier and turned at intervals for proper even homogenous particulate drying. The dried meal was crunchy after drying, it was cooled and the dried soybean curd cake was milled using the Apex® Hammer Mill. The SCM meal was later stored in dry clean polythene bags for later use in rabbit feed compounding with other ingredients.

Animal Management and Housing of Experimental Stock

The cages (hutches) were washed with clean water and disinfected two weeks before stocking; it was rewashed to avoid any residue of any disinfectant for three days to stocking and air-dried properly. The acclimatization period after stocking was seven (7) days. Ivermectin drug was injected parenterally into all the rabbits treated against both ecto and endo-parasites, after which the experiment commenced and the data collected.
The rabbits used were six weeks old heterogeneous hybrid (Chinchilla × New Zealand White breeds) crosses obtained from a reputable rabbitry with a good record in Abeokuta, Ogun State of Nigeria. The rabbits were balanced for weight equalization and allocated to the five dietary treatment combinations comprising five okara meal levels of 0, 25, 50, 75 and 100% inclusions (T_1, T_2, T_3, T_4 and T_5 respectively). These were eight animals per treatment with each rabbit serving as a replicate. The cages were cleaned daily.

The digestibility cage was cleaned with each unit and rabbits were housed individually in each unit measuring a dimension of 60 × 50 × 55cm with a double-layered iron mesh floor to permit faeces and urine to fall out into the collecting tray for easy waste(s) collection. The cages were raised to a height of 95 cm from the concrete floor. Feed was supplied *ad-libitum* with an allowance of 115g per animal per day. Feeding was however done twice daily at 08:00 and 17:00 hrs respectively. Clean, cool drinking water was made available at all times, as the research lasted 8 weeks. Mortality records were taken by recording the rabbits that died and their corresponding dates and time.

Data Collection

Data were obtained and calculated for the daily weight gain, feed intake and feed conversion ratio using the following formulas (Uko *et al*., 2000):

Daily weight gain per rabbit/ day (g)

$$= \frac{\text{Final live weight – Initial weight}}{\text{Number of rabbits} \times \text{no. of days}}$$

Feed Intake/rabbit/day (g)

$$= \frac{\text{Quantity of feed given- Leftover (refusals)}}{\text{Number of rabbits} \times \text{No. of days}}$$

Feed Conversion Ratio (FCR)

$$= \frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$$

Digestibility trial

At the end of the growth trial, three rabbits per treatment with weight equalization close to the mean in each were selected and housed individually in the metabolic cage. The cages were equipped with facilities for separate collection of faeces and urine. Each animal had access to separate feeding and water cups. Record on feed intake was taken daily. Total faeces voided were collected daily for five days. The faeces were weighed daily and oven-dried (Mitchelle®) at 103°C for 22 hrs.

Table 1. Ingredients and composition of experimental diets (g kg^{-1})

Ingredients	Levels of SCM Inclusion (%)				
	0(T_1)	25(T_2)	50(T_3)	75(T_4)	100(T_5)
Maize	470.00	460.00	470.00	465.00	455.00
Peanut cake	135.00	101.25	67.50	33.75	0.00
Soybean meal	90.00	105.00	120.00	125.00	143.00
Wheat Offal	170.00	155.00	140.00	135.00	130.00
Rice bran	70.00	80.00	75.00	75.00	70.00
Okara meal/SCM	0.00	33.75	67.50	101.25	135.00
Fishmeal (72%)	6.00	6.00	6.00	6.00	8.00
Bone meal	20.00	20.00	20.00	20.00	20.00
Oyster shell	28.00	28.00	28.00	28.00	28.00
*Premix	2.50	2.50	2.50	2.50	2.50
Methionine	2.00	2.00	2.00	2.00	2.00
Lysine	2.50	2.50	2.50	2.50	2.50
Coccidiostats	2.00	2.00	2.00	2.00	2.00
Common Salt	2.00	2.00	2.00	2.00	2.00
TOTAL	1000	1000	1000	1000	1000

SCM: Soybean curd meal; *Provided g kg^{-1} of diet- Vitamin A (12,000IU); Vitamin D_3 (2.500IU); Vitamin E (30,000IU); Vitamin K_3 (2,000mg); Vitamin B2-Riboflavin (3mg); Vitamin B3-Nicotinic acid (10mg); VitaminB5(15mcg)-Pantothenicacid(15,000mg); Manganese(80,000mg); Zinc(50mg); Copper(5mg); Iodine(1,000mg); Cobalt (Co) (0.2mg); Selenium (Se) (0.1mg)), Folic acid (1,500mg), Biotin (50 mcg); Choline chloride (300,000mg).

The dried faeces were bulked and milled, and the representative samples for each group were stored in sealed bottles for laboratory analysis. Feed and faecal samples were analysed for dry matter, crude protein, crude fibre, ether extract and ash using the conventional methods of AOAC (1990). Protein was determined by the Macro-Kjedahl technique and fat was determined using Soxhlet ether extractor apparatus. Minerals digested were determined by ashing the samples in a muffle furnace.

Apparent nutrient digestibility was obtained by calculation using the formula:

Nutrient digestibility (%)

= [Nutrient intake (g DM) - Nutrient in faeces (g DM) / Nutrient intake] × 100

Blood and serum profile analysis

Parameters included the packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), glucose, albumin, total protein, globulin, and creatinine. Three rabbits per treatment were randomly selected at the end of the 56 days. Two groups of blood samples (with and without anticoagulant) were collected from each rabbit from the treatment groups using a hypodermic syringe through the pinna vein into a well-labeled sample bottle containing the anticoagulant ethylene diamine tetra-acetic acid (EDTA). The PCV, RBC/WBC and Haemoglobin (Hb) concentrations were analysed and measured using the Wintrobes Microhaematocrit, Neubauer Haemocytometer and cyanomethaemoglobin methods respectively (~~Jain, 1986;~~ Ayo-Ajasa *et al.*, 2015). Blood samples without anticoagulants were used for the serum biochemical components of glucose, total protein, creatinine, albumin and globulin using commercial analytical kits (Ayo-Ajasa *et al.*, 2015).

Statistical Analysis

Data collected were subjected to statistical analysis of variance (ANOVA) in a completely randomized design using the General Linear Model of SAS (2005). The means were separated using Tukey Test in the Statistical Analysis Software.

Results and discussion

The feed compounding and proximate compositions of the experimental diets are presented in Table 2.

The dry matter content was similar for the diets and ranged from 89.82% in T_4 to 91.32% in T_2. The crude protein content of the diets was consistent with the calculated value of 17%. The values ranged from 16.89% in T_4 to 17.11% in T_1. The crude fibre and crude fat also ranged between 11.12% in T_4 to 11.97% in T_3 and 3.89% in T_1 to 4.83% in T_5 respectively. The test ingredient (SCM) analysis showed that it is very rich in crude protein with a value of 26.18%, however, this is low when compared to 34.00% reported by Sinha *et al.* (2013), but higher than 24.27% reported by Abel *et al.* (2014). The difference(s) could probably be due to the different quality of soybean seed used and the different processing methodologies according to Culbertson, (2004). The crude fibre content was 16.63% which was lower than 22.5% reported by Sinha *et al.* (2013). The growth performance analysis showed that the final live weight per rabbit was significantly ($P<0.05$) highest in T_4 with a value of 1384.28g compared to 1367.41, 1368.31, 1371.42, 1374.05g in T_1, T_3, T_5 and T_2 respectively (Table 3).

The daily feed intake per rabbit was not significantly affected ($P>0.05$) as they ranged from 89.33g in T_2 to 95.59g in T_1, this is higher than 8.50g per rabbit reported by Adeniji *et al.* (2010), however, this could be due to their use of *Moringa oleifera* leaf meal replacing groundnut and tannin effect in leaf meal when not properly processed can reduce feed intake in farm monogastric. The daily weight gain was highest ($P<0.05$) in T_4 with a value of 14.05g compared to 13.94g in T_5 which was followed by 13.86g, 13.82g and13.64g in T_3, T_2 and T_1 respectively ($T_4>T_5>T_3>T_2>T_1$). This means that the rabbits in T_4 were more efficient in utilizing the nutrients gathered from the diet and that the diet contains an adequate level of proteins that supports the growth performance of the rabbits though with a comparatively lower feed intake than treatments in T_1 and T_5. The values recorded with the use of SCM were higher than 10.20g reported by Olabanji *et al.* (2007) where blood meal and wild sunflower mixture were used

The feed conversion ratio in T_4 (6.41) was better ($P<0.05$) compared to a significantly poorest value of 6.79 recorded in T_1, this could be a result of higher weight gain and lower feed intake per rabbit in T_4 when compared to other treatments.

Table 2. Proximate composition of experimental diets and soybean-curd meal (SCM)

Constituents (%)	Levels of Inclusion (%)					
	0(T_1)	25(T_2)	50(T_3)	75(T_4)	100(T_5)	SCM
Dry Matter	90.43	91.32	90.84	89.82	90.09	92.04
Crude Protein	17.11	17.08	16.93	16.89	16.91	26.18
Crude Fibre	11.59	11.81	11.97	11.12	11.24	16.63
Crude Fat	3.89	4.17	4.38	4.61	4.83	15.17
Ash	6.51	7.04	7.21	7.41	7.66	3.98
NFE	51.33	51.22	50.35	49.69	49.45	30.09
Energy (MJ/KG)	11.32	11.15	11.27	11.04	11.12	13.22

NFE-Nitrogen Free Extract

Table 3. Effect of feeding treatments (inclusion of SCM) on the growth performance of rabbit

Parameters	0% (T_1)	25% (T_2)	50% (T_3)	75% (T_4)	100% (T_5)	SEM
Initial live weight (g)	603.52^a	599.53^a	591.54^a	597.43^a	589.29^a	31.87
Final live weight (g)	1367.41^b	1374.05^b	1368.31^b	1384.28^a	1371.42^b	162.64
Daily weight gain rabbit^{-1} (g)	13.64^c	13.82^b	13.86^b	14.05^a	13.94^a	2.85
Daily feed intake rabbit^{-1} (g)	92.59^a	89.33^a	90.08^a	90.17^a	91.86^a	1.21
Feed conversion ratio	6.79^a	6.46^b	6.49^b	6.41^c	6.57^b	0.98
Mortality (%)	2.45^a	2.18^b	2.32^b	2.10^{bc}	1.83^c	0.94

$^{a-c}$ Means within the same row with different superscripts differ significantly at P<0.05.
SEM: - Standard Error of Means; SCM: Soybean curd meal.

Table 4. Effects of feeding treatments on nutrient digestibility of rabbits

Parameters	Levels of SCM Inclusion (%)					SEM
	0%(T_1)	25%(T_2)	50%(T_3)	75%(T_4)	100%(T_5)	
Dry matter	76.24^a	78.17^a	79.42^a	77.64^a	78.35^a	1.93
Crude Protein	86.33^a	84.6^a	87.43^a	85.37^a	86.65^a	1.78
Crude Fibre	91.68^a	92.24^a	91.58^a	91.54^a	89.19^a	2.01
Ether Extract	90.31^a	86.34^b	86.06^b	90.42^a	87.77^b	0.21

$^{a-b}$ Means within the same row with different superscripts differ significantly at P<0.05.
SEM-Standard Error of Mean; SCM: Soybean curd meal.

The mortality percentage was significantly higher (P<0.05) in T_1 at 2.45% while T_5 had the lowest mortality percentage of 1.83%. It was observed that treatments T_2 to T_5 where the soybean-curd meal was introduced recorded lower mortality ratios compared to control in T_1, this means that the soybean-curd meal (SCM) was properly processed and could not have been the cause of any mortality recorded though snuffles were implicated by the veterinarians after post mortem examination. However, mortality was within acceptable ranges (Taiwo *et al*., 2006; Olabanji *et al*., 2007).

The effect of soybean-curd meal levels of inclusion on nutrient digestibility in rabbits is presented in Table 4. The dry matter digestibility was not significantly affected (P>005) by the SCM levels of inclusion though there were numerical differences where the control (T_1) was numerically lowest (P>0.05) with a value of 76.24% when compared to the other treatments where the SCM was included with a value of 77.64, 78.17, 78.35 and 79.42 in T_4, T_2, T_5 and T_3 respectively. This showed that the rabbit was able to digest the feed with the addition of the SCM better than the control feed without the soybean-curd meal. The crude fibre digestibility was high in all the treatments with values ranging from 89.19% in T_5 to 92.24% in T_2, this signifies that the rabbits were able to handle the fibre content in the feed better. Houndonougbo *et al*. (2012) reported that grower rabbits can digest feed with high crude fibre content and this is a confirmation of that assertion. The ether extract digestibility was significantly highest (P<0.05) in T_4 with a value of 90.42% compared to the lowest value of 86.06% recorded in T_3. The haematological values as affected by the feeding treatments are presented in Table 5.

Table 5. Effect of feeding treatments on serum profile and haematological values of rabbits

Parameters	Levels of SCM Inclusion (%)					SEM
	0% (T_1)	25% (T_2)	50% (T_3)	75% (T_4)	100% (T_5)	
Glucose (mmol/l)	4.81^b	4.75^b	6.29^a	6.35^a	4.86^b	7.64
Albumin (g/dl)	3.78	3.21	3.69	3.65	3.59	1.11
Total protein (g/dl)	5.60	4.92	5.70	5.63	5.52	1.25
Globulin (g/dl)	1.84	1.73	2.01	1.98	1.93	0.54
Creatinine (mg/dl)	0.92^c	0.87^c	1.23^a	1.42^a	0.97^c	0.11
PCV (%)	35.00	34.00	36.75	36.00	35.00	0.75
RBC (x 10^6/mm^3)	4.62^b	3.74^c	4.65^b	5.09^a	3.68^c	1.53
WBC (x 10^3/mm^3)	6.54^{ab}	6.23^b	4.89^c	6.34^b	6.89^a	0.21
Haemoglobin (g/dl)	11.26	11.13	11.49	11.78	11.18	2.05

$^{a-c}$ Means within the same row with different superscripts differ significantly (P<0.05)
SEM- Standard Error of Mean; SCM: Soybean curd meal; PCV: Packed Cell Volume; RBC: Red Blood Cells; WBC: White Blood Cells.

There were significant differences ($P<0.05$) among the treatment groups for serum glucose, creatinine, red blood cells (RBC) and white blood cells (WBC). Serum glucose values (mmol/l) varied significantly among the treatment groups with T_4 having the highest ($P<0.05$) value of 6.35mmol/l, also, $T_3>T_5>T_1>T_2$ (6.29 > 4.86 > 4.81 > 4.75mmol/l) respectively, though these variations existed, it is pertinent to know that the values are well within the normal range of 4.2- 8.9mmol/l reported by Fudge (1999). A significantly highest creatinine value of 1.42mg/dl recorded in T_4 compared to 1.23, 0.97, 0.92 and 087mg/dl in T_3, T_5, T_1 and T_2 could be due to increased filtration process by the kidneys due to increased muscle metabolism as weight gain increased (Taiwo *et al*., 2006). The RBC value was significant ($P<0.05$). highest in T_4 (5.09 cu/mm^3) compared to a significantly lowest value of 3.68 cu/mm$_3$ recorded in T_5.

Conclusion

It is concluded that soybean-curd meal (SCM) is well processed and tolerated by the subjects-rabbits. It is well accepted and rich in nutrients for growth and development in the rabbits and has good replacement values for groundnut cake with as much as 100% inclusion level, however, 75% inclusion showed the best performance in the research results

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Competing Interest

The authors declare that they have no competing interests.

Author's Contribution

AFAS, AOY and AT designed and carried out the animal experiment and also assisted in data collection and statistical analysis, AFAS and AOY assisted in the animal design and feeding trials. AFAS and OJ assisted in analytical results and interpretation, and also revised the manuscript. All authors read and approve the final manuscript.

Acknowledgements

We want to thank Mr Brown for his support and love for animals in the research. We appreciated all the support.

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