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Full Length Research

Carcass characteristics and organ weights of grower rabbits fed graded levels of soybean cheese waste as a replacement for full-fat soybean

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ABSTRACT: This study evaluated the carcass characteristics and organ weights of grower rabbits fed full-fat soybean cheese waste meal as a replacement for full-fat soybean meal. Thirty (30) mongrel rabbits with an initial body weight of 1160.00-1206.67g were randomly assigned to five dietary treatments of six rabbits per treatment with two rabbits per replicate in a Completely Randomised Design (CRD). The study lasted for forty-two (42) days. The experimental diets were: T1 with 0% soybean cheese waste as the control, while T2, T3, T4 and T5 contained 25, 50, 75 and 100% soybean cheese waste, respectively. Feed and water were provided ad libitum during the period of the research. The results showed significant ($p<0.05$) differences in all carcass parameters measured, except fasted live weight and shank length, and also significant ($p<0.05$) differences in the weights of different organs across the treatment groups. Findings from the study showed that full fat soybean can be replaced with soybean cheese waste up to 100 per cent without any adverse effect on the animals, which can cut down the cost of feed. The study recommended the dietary inclusion of 100 per cent soybean cheese waste as a replacement of full fat soybean. The objective of this research was to evaluate the carcass characteristics and organ weights of rabbits fed graded levels of soybean cheese waste-based diet as a replacement of full fat soybean.

Keywords: Carcass, cheese, rabbit, soybean, waste, protein.

INTRODUCTION

Rabbit production has gained considerable interest recently in Nigeria because of the exorbitant prices of conventional sources of beef, chevon, mutton, pork and poultry (Adeyemi and Akanji, 2012). Rabbit meat is high-quality meat that is often considered a delicacy. It is high in protein and low in fat, cholesterol, sodium and calories (Damron, 2006). Rabbit meat contains all essential amino acids, minerals and all required vitamins except vitamin C needed by humans (Partridge *et al*., 1989).

The major indicators in maximizing performance of rabbit species are growth performance and meat yield being the primary purpose for any specie of animal is achieved by the plane of nutrition given and the ability of the animal to utilize the feed provided at the higher level such that maximum output of growth and body development is achieved with the least quantity of feed with other management factors being provided to support the task (Mandal *et al*., 2004). The growing demand for soybean as a protein source for both human, industrial and livestock consumption has pushed its market price to an alarming rate that has directly affected the production cost of farm animals, particularly the non-ruminants (Gulukun *et al.*, 2022). Research into the use of cheaper industrial by-products and waste has been intensified in the last few years to determine the efficiency of their utilisation in terms of growth and production (Adeniji and Balogun, 2002). According to Fadepe (1996) the search for cheaper sources of feed ingredients for livestock feeding in Nigeria

and many developing countries will continue as long as the protein requirement in the human diet is not met.

Feeding by-products of crops and food processing waste to livestock has two important advantages: these are to limit dependency of livestock on grains that can be consumed by humans and eliminates the need for costly waste management programs, which have become very important in recent years as the world's human population increased, particularly in developed countries (USDA, 2013). Thus, the need for utilising alternative feed ingredients removed from human and industrial uses have been stressed by several researchers (Durunna *et al.,* 1999; Attia *et al.,* 2001; Attia *et al.,* 2003; Famino *et al.,* 2007; Nsa *et al.,* 2007).

Soybean cheese waste (SCW) is an agro-industrial by-product that has potential in monogastric feeding due to an increase in the production of soybeans in Nigeria, which has resulted in a concomitant increase in the consumption of soybeans and their products, such as soy milk, soy flour, and soy cheese. Soybean cheese waste (residue) is a by-product of soy cheese production. It is used in feeding animals such as cattle, sheep, goats, pigs, etc., and it is readily available and cheap in towns and villages where the cheese is widely produced and consumed. It has the potential for reducing the cost of concentrate intake in rabbits due to its high nutrient values of soybean and its products (Aduku, 1992).

Soybean cheese can be a valuable resource in animal feed, providing essential nutrients like protein and fibre. Incorporating soybean cheese residue into animal diets can have positive effects on growth performance, egg quality and overall health. (Osigbodi*,* 2022*).* Some studies have explored the use of soybean by-products, including soybean cheese waste, as a sustainable alternative to traditional feed ingredients study on layers found that dietary inclusion of soybean cheese residues improved egg quality and reduced production costs (Osigbodi, 2022).

Animal protein supply and consumption are low in Nigeria, especially among the low-income earners and non-wage earners (Iyangbe and Orewa, 2009). The decline in animal protein production is caused by the high cost of livestock production resulting from the high cost of feed due to over-dependence on conventional feed ingredients for animals, which are scarce and expensive due to high competition between humans and livestock (Esonu *et al*., 2004)

The use of locally available by-products as a substitution alternative of raw material in rabbit production would be an asset to consider. Despite the presence and availability of soyabean cheese waste, not much study has been devoted to its use in rabbit production. Using soyabean cheese waste in livestock feed can help farmers reduce feed cost and waste, reducing disposal expenses. Therefore, the basis of this study is to determine the carcass and organ weights of rabbits fed graded levels of soyabean cheese waste.

MATERIALS AND METHODS

Experimental site

This study was conducted at the Rabbitry Unit of the Teaching and Demonstration Farm, Animal Science Department of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia campus. The experimental site lies in the Guinea Savannah zone of the middle belt of Nigeria on Latitude 8°35'N and a longitude of 8°33'E. The average minimum temperature is 23°C, and the average maximum temperature is 36.9°C; the mean monthly relative humidity is 74%. The mean annual rainfall is 823 mm; the mean monthly temperature is 35.06°C (NIMET, 2008). At the time of the experiment, temperature, relative humidity and rainfall were obtained from the Meteorological Station of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia campus.

Experimental animals and management

Thirty (30) grower rabbits of mixed breeds and sexes aged 5-6 weeks with initial group mean weight ranging between 776.67 and 853.33g were procured from National Animal Production Research Institute (NAPRI), Shika-Zaria. They were housed according to the five treatments in a well-ventilated house in open-sided wire mesh hutches with facilities for drinking and feeding. The house and hutches were washed and disinfected before the animals arrived. The rabbits were made to undergo one week adaptation period in their hutches. They were served their respective experimental diets with clean water supplied *ad-libitum* but no records were taken on feed intake and weight changes. The essence of this was to allow the animals adjust to the diets and their new environment. Prior to the commencement of the experiment, the rabbits were treated against internal and external parasites by subcutaneous injection of Ivermectin at 0.2ml/rabbit. A broad-spectrum antibiotic (oxytetracycline) was also administered at the rate of 0.2 ml/ rabbit, and other routine management practices were carried out regularly. At the end of the 6 weeks, two rabbits from each treatment group were sacrificed for carcass analysis and organ weights.

Sources of experimental feed ingredients

The soybean cheese waste (SCW) was sourced from local soybean processors into cheese known as awara within the Mangu Local Government Area of Plateau State. The soybean cheese waste (residue) was collected, sun-dried for 2-3 days (during the dry season) to reduce the moisture content and also to avoid the growth of mold and rancidity. Other feed ingredients such as maize, maize offal, rice offal, groundnut cake, full-fat soybean, bone meal, fish meal, palm oil, methionine, lysine, salt, premix, and toxin binder were procured from feed suppliers in Lafia metropolis of Nasarawa State, Nigeria.

Table 1. Gross composition of experimental grower rabbit's diets/100kg.

Ingredients (%)	T1(0%SCW)	T2(25%SCW)	T3(50%SCW)	T4(75%SCW)	T5(100%SCW)
Maize	37.00	37.00	37.00	37.00	37.00
Maize offal	12.00	12.00	12.00	12.00	12.00
GNC	5.00	5.00	5.00	5.00	5.00
Rice offal	25.75	25.75	25.75	25.75	25.75
Bone meal	2.00	2.00	2.00	2.00	2.00
Soya bean	12.00	9.00	6.00	3.00	0.00
SCW	0.00	3.00	6.00	9.00	12.00
Palm oil	2.00	2.00	2.00	2.00	2.00
Fish meal	3.00	3.00	3.00	3.00	3.00
salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Binder	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME Kcal/Kg	2550.49	2568.22	2585.96	2603.70	2621.44
CP (%)	15.82	15.27	15.03	14.78	14.39
Lys (%)	0.98	0.91	0.84	0.76	0.69
Meth (%)	0.54	0.53	0.53	0.52	0.51
EE (%)	8.75	8.28	7.80	7.33	6.35
CF (%)	8.01	8.29	8.31	8.43	8.54
Ca (%)	0.73	0.73	0.72	0.72	0.72
P (%)	0.91	0.81	0.84	0.80	0.86

SCW* Soyabean cheese waste inclusion levels. The vitamin- mineral premix supplied the following per 100kg of diet: vitamin A15,000 I.U, vitamin D3 300,000 I.U. vitamin E 3,000 I.U., vitamin K 2.50mg, vitamin B_1 (thiamin) 200mg, Riboflavin (B_2) 600mg, pyridoxine (B_6), Niacin 40.0mg, vitamin B_{12} 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, anti-oxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14mg, Selenium 24mg, cobalt 214mg. Using Feedwin software version 1.01.

Experimental diets and feeding

Five (5) experimental diets were formulated to provide approximately 2500 kcal/kg and 15% CP for all the experimental groups for the grower diets with five (5) levels of inclusion of soybean cheese waste at 0%, 25%, 50%, 75%, and 100% representing T1, T2, T3, T4 and T5, respectively. T1 contain 0% soybean cheese waste and served as the control (Table 1).

Experimental design

The thirty rabbits were randomly assigned to the five dietary treatments, and each treatment was replicated three (3) times, with each replicate having two rabbits in a Completely Randomised Design (CRD).

Carcass Analysis and organs evaluation

At the end of the feeding trial, two rabbits of similar weight per treatment were selected for carcass evaluation. The rabbits were fasted for 12 hours preceding the slaughtering of the animals, but allowed access to water so as to empty the gut and allow excretion of undigested feed residue. Each rabbit was tagged accordingly and weighed before and after slaughtering to determine the live and slaughtered weights, respectively. The slaughtered animals were deferred using hot water and then eviscerated. Individual internal organs (liver, heart, lungs, and kidneys) were weighed and expressed as a percentage of live weight. The dressed carcasses were weighed and subsequently cut into different parts, viz.: head, neck, fore limbs. Hind limbs, thorax, shanks and each were weighed and expressed as a percentage of carcass weight. The dressing percentage was calculated as:

$$\text{Dressing } \% = \frac{\text{Dresses weight (g)}}{\text{Live weight (g)}} \text{x } \frac{100}{1}$$

Data analysis

Data collected were subjected to one-way analysis of variance using SPSS version 22, while significant means were separated using Duncan's multiple range test at 5% level of significance.

Feed conversion ratio

The feed conversion ratio was determined by dividing the average feed intake by the average body weight gain.

$$\text{FCR} = \frac{\text{Average feed intake (g)}}{\text{Average weight gain (g)}}$$

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) for a Completely Randomised Design (CRD) using SPSS (2007) model. Significance difference means at were separated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Carcass characteristics and organ weights of grower rabbits fed soybean cheese waste

The results of the effect of replacing the value of full-fat soyabean with soya bean cheese waste (SCW) on carcass characteristics and organs weights of grower rabbits are shown in Table 2. The results showed a significant ($p<0.05$) difference in all the parameters measured except the fasted live weight and shank length. The slaughter weight of the rabbits in T4 (75% SCW) with a value of 859.30g and T5 (100% SCW) with the value of 1204.25g had significantly ($p<0.05$) higher values than others. The dressed weight of the rabbits in T4 (75% SCW) with the value of 859.30 g was significantly ($p>0.05$) higher than other treatment groups, but statistically similar to those in T5 (100%) with the value of 855.50 g. Rabbits fed diets T1 (0% SCW) and T5 (100% SCW) had significantly higher ($p<0.05$) head weights than other but were statistically similar to all the treatment groups in their head weights. The neck weights of the rabbits fed diets T2 (25% SCW), T3 (50% SCW) and T4 (75% SCW), with the values of 5.15, 5.08, and 5.34 g, respectively had statistically similar weights and are significantly ($p>0.05$) higher than the control (T1 (0%SCW) with the value of 14.14g. Rabbits fed diets T4 (75% SCW) with the value of 15.34g had the highest value for forelimb weight, similar to those in diet T5 (100%SCW) with the value of 14.78g, while those in T1 (0% SCW) with the value of 13.58 g had the lowest forelimb weight. The shank weight of the rabbits in all the treatments (T1 0%SCW, T2 25%SCW, T4 75%SCW and T5 100%SCW) with the values of 9.65, 10.00, 9.50 and 9.75 g, respectively, is similar except for those in T3 (50% SCW) with the value of 9.30 g. The thigh weight of the animals in T2 (25% SCW) and T4 (75%SCW) had significantly ($p<0.05$) higher with the values of 20.66 g and 20.92 g respectively and are statistically similar to those in T1(0%SCW) and T5 (75%SCW) with the values 20.12 g and 20.53 g respectively while T1 (0%SCW) had the least value of 20.12 g Thorax weight was highest in rabbits fed diet T2 (50%SCW) with a value of 14.32 g had a significant ($p<0.05$) value than other and similar to those in T5 (75%SCW) with the value of 14.15 g, while those in T3 (50%SCW) had the least weight.

The values obtained for the carcass parameters measured across the treatment groups are a true reflection of the body weight performance indices and that of body development. The result of the carcass indicates that rabbits fed 75% soybean cheese waste had significantly ($p<0.05$) higher dressed weight compared to other treatment groups. The dressing percentage obtained in this study was higher than the 47.17 – 63.45% reported by other researchers (Fatufe *et al.,* 2010; Ogunsipe *et al.,* 2014; 2022; Maidala *et al.,* 2016; Idowu *et al.*, 2022). It was, however, lower than the 69.66 – 79.71% report of Makinde *et al*. (2017). It was also lower than the finding of Apata *et al*. (2021 The result showed that rabbits fed 75% were able to utilise the feed efficiently to produce better dressing percentage than others, though statistically similar with and 100% SCW inclusion.

Organs weight evaluation

The internal organs proportion of rabbits fed various experimental diets showed a significant ($p<0.05$) difference in all the parameters measured. The liver and kidney weights of the rabbits fed T5 (100%SCW) with the value of 2.75 g are significantly ($p<0.05$) higher than those of other treatment groups and those in T1 (0%SCW) with the least value of 2.14 g. The intestine weight and length of the rabbits fed diet T5 (100% SCW) are significantly ($p<0.05$) higher than those of the other treatment group. The heart weight of the animals in T1 (0%SCW) with the value of 0.19g was significantly ($p<0.05$) higher but has statistical similar values with those in T4 (75%SCW) and T5 (100%SCW) with the values of 0.23 g and 0.22 g, respectively. Those in T2 (50%SCW) with the value of 0.18g had the least heart weight. The lung weight of all the treatment groups is similar except T1 (0%SCW), which had a significant ($p<0.05$) difference. The caecum weights of the animals fed diets T1 (0%SCW), T2 (50%SCW) and T3 (75%SCW), with the values of 7.60, 7.46 and 7.49 g, respectively, are statistically similar but are significantly ($p<0.05$) lower than T5 (100%SCW). Those in T5 (100%SCW) are significantly $p<0.05$) higher than other treatment groups.

The cut-up parts, such as head, neck, forelimbs, hind limbs, thorax and shanks (as expressed as percentage of carcass weight), rabbits fed the various diets did not follow the performance pattern of the body development. The observed differences might have emanated partly from the differences in diets and partly from manual cutting.

The result also revealed significant ($p<0.05$) differences in the weights of different organs across the treatment groups. The weights of liver and kidneys increased as the inclusion level of soybean cheese waste increased in the diets, with 100% having the highest weight. The higher weights of some organs (liver, kidneys) have been attributed to effects of residual anti-nutritional factors

Table 2. Effect of replacement value of full-fat soybeans with soybean cheese waste (SCW) on Carcass characteristics and organ weights of grower rabbits.

Parameters	Dietary levels of SCW (%)					SEM	LOS
	T1(0)	T2(25)	T3(50)	T4(75)	T5(100)		
Carcass cuts							
Fasted Live weight (g/rabbit)	1277.95	1267.70	1249.55	1258.25	1235.80	6.28	NS
Slaughtered weight (g/rabbit)	1217.50^{c}	1157.95^{e}	1180.00^{d}	1205.80^{a}	1204.25^{ab}	8.26	*
Dressed weight (g/rabbit)	852.40^{c}	755.45^{e}	826.35^{d}	859.30^{a}	857.50^{ab}	12.98	*
Head weight (g/rabbit)	14.21^{a}	13.42^{ab}	12.64^{b}	12.72^{b}	14.06^{a}	0.23	*
Neck weight (g/rabbit)	4.14^{b}	5.15^{a}	5.08^{a}	5.34^{a}	3.99^{b}	0.19	*
Forelimbs weight (g/rabbit)	13.59^{cd}	14.16^{bc}	13.33^{d}	15.34^{a}	14.78^{ab}	0.25	*
Shank weight (g/rabbit)	3.49^{a}	3.57^{a}	2.99^{b}	3.95^{a}	3.67^{a}	0.11	*
Shank length (cm/rabbit)	9.65	10.00	9.30	9.50	9.75	0.16	NS
Thighs weight (g/rabbit)	20.12^{b}	20.66^{a}	19.94^{c}	20.92^{a}	20.53^{ab}	0.12	*
Thorax weight (g/rabbit)	13.21^{c}	14.32^{a}	12.45^{d}	13.57^{bc}	14.15^{ab}	0.23	*
Organs weights							
Liver weight (g/rabbit)	2.14^{e}	2.23^{d}	2.41^{c}	2.65^{b}	2.78^{a}	0.08	*
Kidneys weight (g/rabbit)	0.66^{e}	0.67^{d}	0.76^{c}	0.89^{b}	1.07^{a}	0.05	*
Intestine weight (g/rabbit)	17.89^{d}	18.00^{d}	19.43^{c}	22.36^{b}	24.04^{a}	0.82	*
Heart weight (g/rabbit)	0.27^{a}	0.18^{c}	0.21^{bc}	0.23^{ab}	0.22^{abc}	0.01	*
Lungs weight (g/rabbit)	0.91^{a}	0.75^{b}	0.81^{b}	0.78^{b}	0.76^{b}	0.02	*
Intestinal length (cm/rabbit)	343.55^{c}	334.45^{d}	373.15^{b}	347.65^{c}	401.10^{a}	8.11	*
Caecum content weight (g/rabbit)	7.66^{c}	7.46^{c}	7.49^{c}	9.89^{b}	10.63^{a}	0.45	*

SEM= Standard error means, LOS= Level of significant, a, b, c = Means on the same row bearing different superscript differ significantly (P<0.05); NS= No significant (P>0.05), SCW= soybean cheese waste.

(trypsin inhibitors, tannin, saponin, phytates) present in some agro-industrial by-products. The higher weights of liver and kidneys obtained in this study at a higher inclusion level of the test ingredient could be a result of an attempt by these organs to detoxify the possible anti-nutrients in the diet. The assertion is in agreement with the findings of Ogunsipe*et et al.* (2014), who reported an increase in the weights of liver and kidneys as the level of inclusion of sorghum offal increased in sorghum offal-based diets. The significant (p<0.05) increase reported in these organs also conforms to the findings of previous researchers that dietary treatments exert some influence on certain organ weights (Agbede and Aletor, 2003; Ogunsipe and Agbede, 2010). Ahamefule *et al* (2006) reported that the weight of some internal organs, like the liver and kidneys of animals, may be used in animal feeding as evidence of toxicity. The quality of protein of soybean is dependent on the variety and processing method. Under-processing may lead to deleterious levels of anti-nutritional factors, which may negatively affect the growth and performance in animals. The values obtained in this study for liver weight were higher than the 1.54 – 2.55g reported by Makinde *et al.* (2017) and lower than the 1.20 – 2.97g of Maidala *et al*. (2016a) and Ogunsipe *et al*. (2014). The significant weights of most organs did not show any definite trend.

Conclusion

Carcass evaluation revealed that 100% had the lowest dressed weight, while 75% had better dressing percentage. Also, kidney and liver weights increased linearly with the increased level of the test ingredient up to 100%. The results of this finding showed that full-fat soyabean can be replaced with 75% and 100% soyabean cheese waste, respectively, for carcass development and organs growth without any effect on the animals, which can cut down the cost of feed.

CONFLICT OF INTEREST

The authors declare no competing interests.

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