Nutritional Evaluation of Cattle Rumen Epithelial Tissue Scrapings Meal for Growing Rabbits

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Abstract

An eight week study was conducted in which cattle rumen epithelial tissue scrapings meal (CRETSM) was substituted for fishmeal in growing rabbit diets to reduce feed formulation cost and environmental pollution. One hundred and twenty growing rabbits were divided into six groups of twenty rabbits each which was assigned to six diets that had 0, 20, 40, 60 80 and 100 percent fishmeal in it replaced with CRETSM in a Completely Randomized Design. Data collected were feed intake, weight gain, feed : gain ratio, production cost, carcass characteristics and nutrient digestibility. Data were analyzed by ANOVA. Weight gained by the rabbits fed 0, 20, 40, 60 and 80 percent fishmeal in their diets replaced were similar but were higher ($p<0.05$) than that fed only CRETSM. Similar trend was observed in carcass weight and protein digestibility. Feed cost decreased with increase level of CRETSM in the diets while production cost was lower for the rabbits fed diets that contained CRETSM. Poor feed utilization was observed in the rabbits fed only CRETSM. Feed intake, organ weights and nutrient digestibility were unaffected. It was concluded that CRETSM can replace 80% fishmeal in growing rabbit diet.

Key words: Carcass characteristics, feed:gain ratio, feed intake, nutrient digestibility, weight gain, rabbits

Introduction

Recent increases in the price and demand of fishmeal, the primary protein source in livestock and fish feed call for a search for alternative protein sources (Duangrat *et al.,* 2010). The search for unconventional animal feed protein sources is not a recent issue and many studies have been carried out. These include the use of meat meal, hatchery waste (Sathishkumar and Prabakaran, 2008), earthworm meal and maggot meal (Adeniji, 2007), Shrimp meal (Aktar *et al.* 2011) and cattle rumen epithelial tissue scrapings (Bawala *et al.*, 2007 and Ogunwole, 2011). The most suitable solution to the problem of high cost of conventional animal protein sources may be the exploitation of vast, cheap and available and underutilized slaughterhouse wastes and animal by products which often constitute environmental pollutants (Ogunwole, 2011).

Cattle rumen epithelial scraping is an abattoir by product that results from cleaning rumen for human consumption in most African countries including Nigeria and it consists mainly of papillae layer. Rumen epithelial scrapings is readily available in Nigeria since over 1 million heads of cattle are slaughtered annually excluding sheep and goat which yield related products. It has been estimated that an average of 0.6kg of this product can be

obtained from an adult slaughtered beef cattle when processed. Studies have shown that rumen epithelial tissue scraping meal has some benefits in the nutrition of ruminant animals (Ogunwole, 2011). However, there is a dearth of information on its use as a protein source for rabbits. The use of cattle rumen epithelial tissue scrapings which is a waste as protein source for rabbit could be a way of reducing the cost of producing rabbit pellets which is often needed to achieve maximum production potential for the breeding stock without creating food and feed crises that are associated with poultry and pig production. This study was therefore designed to study the effect of substituting cattle rumen epithelial tissue scrapings for fishmeal a conventional protein source on the production performance of the growing rabbits.

Materials and Methods

The study was carried out at the Rabbitary Unit of the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Oyo State , Nigeria. The location of the study falls between latitudes $8^0$07'N and $8^0$12'N and longitudes $4^0$04'E and $4^0$15'E. The mean annual rainfall is 1247mm with relative humidity of between 75 and 95%. It is situated at about 500mm above the sea level with a mean annual temperature of 26.2^0C.

The cattle rumen epithelial tissue scraping that was used in this study was collected from Bodija abattoir, Ibadan and Ogbomoso township slaughter slab all in Oyo State , Nigeria. The wet material was pressed free of water and poured into a pot containing boiling water (100^0C) where it remained for 30 minutes to kill the pathogenic organisms that may be present. The boiled material was then drained of water, dried in the sun for 7 days and milled to obtain what was referred to as Cattle Rumen Epithelial Tissue Scrapings Meal (CRETSM). A sample of CRETSM was collected and stored in a sealed bottle for laboratory analysis.

Control diet was formulated to contain 2% fishmeal as animal protein source. Cattle rumen epithelial tissue scraping was used to replace 20% (Diet 2), 40% (Diet 3), 60% (Diet 4), 80% (Diet 5) and 100% (Diet 6) of fishmeal in the control (Diet 1). All diets were iso-nitrogenous and iso-caloric. The gross composition of the diets is shown in Table 1. The formulated diets were processed into pellet form using 4mm pelleting machine to ensure adequate feed intake and avoid wastage.

Table 1: Gross composition of experimental diets

Ingredients (%)	Level of CRETSM[1] substitution in diets					
	0 (control)	20	40	60	80	100
Maize	15.0	15.0	15.0	15.0	15.0	15.0
Maize bran	10.0	10.0	10.0	10.0	10.0	10.0
Wheat offal	28.2	28.2	28.2	28.2	28.2	28.2
Palm kernel cake	20.5	20.5	20.5	20.5	20.5	20.5
Soy bean meal	6.0	6.0	6.0	6.0	6.0	6.0
Fishmeal	2.0	1.6	1.2	0.8	0.4	0.0
CRETSM[1]	0.0	0.4	0.8	1.2	1.6	2.0
Rice bran	14.0	14.0	14.0	14.0	14.0	14.0
NaCl	0.3	0.3	0.3	0.3	0.3	0.3
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0
Palm kernel oil	1.0	1.0	1.0	1.0	1.0	1.0
Total	100	100	100	100	100	100
Crude protein (%)	16.8	16.7	16.6	16.8	16.7	16.7
Digestible energy (MJ/kg)	9.4	9.4	9.4	9.4	9.3	9.3
Crude fiber (%)	8.2	8.3	8.4	8.5	8.7	9.0

[1]CRETSM = Cattle rumen epithelial tissue scrapings meal

One hundred and twenty mixed sex crossbreds of New Zealand and Flemish Giant growing rabbits with average body weight of 0.94±8g were used for the study. The rabbits were divided into six groups of 20 rabbits each on equal weight basis. The six groups were randomly assigned to the six diets in a Completely Randomized Design (CRD). Each rabbit in a treatment was a replicate and was housed individually in a wooden hutch of 60×50×45cm with the floor and sides covered with wire netting. Each hutch was equipped with earthen vessels for water and feed and collecting tray at the base to avoid feed wastage and ease faecal collection. Feed and water were supplied *ad libitum* twice a day (8am and 4pm). The rabbits were treated for lice, mange and intestinal worms using ivomectin and allowed to acclimatize prior to the commencement of the experiment. The study lasted for 56 days.

Record of feed intake was collected by measuring the feed offered and the left over after 24-hour period using a weighing scale. Feed consumed for the day was therefore calculated as weight of feed offered minus weight of feed left over the following day. Weights of the rabbits were taken at the beginning of the experiment and weekly thereafter using an electronic weighing scale. The difference in the weights of the rabbits in two successive weeks was taken as the weight gain or change for that week. Feed to gain ratio was determined as feed consumed per unit of weight gain.

$$\text{Feed to gain ratio} = \frac{\text{Feed Intake}}{\text{Weight Gain}}$$

Feed cost was calculated from the prices of the ingredients used in feed preparation. The price of CRETSM was estimated from the costs of transportation, labour and energy for boiling. Feed cost per kilogram weight gain was determined from the price of feed per kilogram and of body weight gain.

Twelve rabbits that had their weights close to the mean for the treatment group were selected for carcass evaluation. The rabbits were fasted for 24 h, properly tagged, weighed, stunned and bled by neck slit using sharp knife. The rabbits were skinned, eviscerated, dressed and the dressed weight taken using an electronic

weighing scale. Carcass yield was calculated by expressing the dressed weight as the percentage of the live weight of the rabbit. Internal organs (liver, kidneys, heart, lungs and spleen) were carefully excised, clean of blood, weighed and the weights also expressed as the percentage of the live weight of the rabbits. Abdominal fat was also carefully scraped, weighed and the weight expressed as the percentage of the live weight of the rabbit.

Digestibility trial was conducted at the end of the study using 12 rabbits per treatment. Rabbits were housed individually in hutches equipped with collecting trays to avoid feed wastage and ease in faecal collection. The rabbits were allowed 5 days of adjustment period followed by another 5 days of collection period. Faeces voided was collected, weighed and dried in the oven at 60^0C for 72 h. Faeces from each treatment was bulked, milled and representative samples collected in sealed bottles for laboratory analysis.

Feed, faecal samples, CRETSM and fishmeal were analyzed for moisture, crude protein, crude fiber and ether extract using AOAC methods (AOAC, 1990). Methionine and lysine contents of CRETSM and fishmeal were determined using high performance liquid chromatography technique as described by Ijarotimi and Olapade (2009) after the hydrolysis of the samples. Phosphorus was determined using a spectrophotometric phosphoammonium vanadate reaction as described by Ravindra and Sivakanesan (1995). Calcium, magnesium, manganese, iron and zinc were determined using Perkin-Elmer Model 2380 atomic absorption spectro-photometer after wet digestion of the samples. Sodium and potassium were determined in the ash solution by emission spectroscopy at acetylene gas flame (AOAC, 1995).

Data were analyzed by one-way analysis of variance using the General Linear Model procedure of SAS (SAS 1998). Significance was determined at $p<0.05$ and where significance were indicated, Least Significance Difference (LSD) was used to separate the means.

Results and Discussion

The composition of CRETSM and fishmeal used in this study is shown in Table 2. The crude protein content of fishmeal (65.72%) was slightly higher than that of CRETSM (64.61%). Fishmeal also had higher fat (14.63% vs 8.20%), ash (11.84% vs 5.60%), methionine (1.12% vs 0.98%), calcium (7.12% vs 3.07%), phosphorus (3.16% vs 2.20%) sodium (0.38% vs 0.22%), Zinc (63.32ppm vs 23.21ppm) and manganese (12.96 vs 8.24ppm) than CRETSM. However, CRETSM had higher crude fiber (3.58% vs 0.51%), nitrogen free extract (18.01% vs 7.30%), lysine (3.80 vs 3.51%) and iron (398ppm vs 190ppm) than fishmeal.

Table 2: Chemical composition of cattle rumen epithelial tissue scrapings meal (CRETSM)

Component	CRETSM[1]	Fishmeal
Dry matter (%)	88.71	89.46
Crude protein (%)	64.61	65.72
Crude fiber (%)	3.58	0.51
Ether extract (%)	8.20	14.63
Ash (%)	5.60	11.84
Nitrogen free extract (%)	18.01	7.30
Methionine (%)	0.98	1.12
Lysine (%)	3.80	3.51
Calcium (%)	3.07	7.12
Phosphorus (%)	2.20	3.16
Sodium (%)	0.22	0.38
Magnesium (%)	0.27	0.21
Potassium (%)	0.20	0.45
Iron (ppm)	398	190
Copper (ppm)	8.4	8.9
Zinc (ppm)	23.21	63.32
Manganese (ppm)	8.24	12.96

[1]CRETSM = Cattle rumen epithelial tissue scrapings meal

The performance characteristics and economic implication of substituting CRETSM for fishmeal in growing rabbits is presented in Table 3. No significant effect of dietary treatments was observed in the weight gain of the rabbits that had 20% (14.7g), 40% (15.0g), 60% (15.1g) and 80% (15.4g) of fishmeal in their diets replaced with CRETSM and those that were fed control diet (14.4g). However, significant ($p<0.05$) depression was observed in the weight gain of those that had 100% fishmeal (13.2g) in their diets when compared with those that were fed 20, 40, 60 and 80 percent CRETSM. The amount of feed consumed by the rabbits were not significantly ($p>0.05$) different across the treatments. Feed to gain ratio of the rabbits that were fed control diet, 20%, 40%, 60%, and 80% CRETSM were similar but were lower ($p<0.05$) than those fed CRETSM as the sole animal protein source (100%CRETSM).

Table 3: Performance and economic implication of substituting CRETSM for fishmeal in the diets of growing rabbits

Parameter	Level of CRETSM[1] substitution in the diets (%)						SEM
	0 (control)	20	40	60	80	100	
Initial weight (kg)	0.94	0.94	0.94	0.93	0.94	0.94	0.01
Final weight (kg)	1.75[a]	1.77[a]	1.78[a]	1.77[a]	1.80[a]	1.68[b]	0.06
Total weight gain (kg)	0.81[a]	0.83[a]	0.84[a]	0.85[a]	0.86[a]	0.74[b]	0.07
Daily weight gain (g)	14.4[a]	14.7[a]	15.0[a]	15.1[a]	15.4[a]	13.2[b]	1.1
Total feed intake (kg)	4.64	4.81	4.94	4.98	4.85	4.96	0.38
Daily feed intake (g)	82.1	85.9	88.2	88.9	86.6	88.6	9.0
Feed to gain ratio	5.73[b]	5.80[b]	5.88[b]	5.93[b]	5.64[b]	6.74[a]	0.5
Feed cost/kg (N[2])	55.8[a]	54.5[b]	51.2[c]	50.9[c]	49.3[d]	47.2[e]	0.9
Feed cost/kg gain (N[2])	320[a]	316[c]	301[d]	298[e]	278[f]	318[b]	1.5

[abcdef]Means bearing different superscripts in the same row are significantly different ($p<0.05$)
[1]CRETSM = Cattle rumen epithelial tissue scrapings meal

Feed cost in Nigerian naira decreased with increased level of CRETSM substitution in the diets. Values obtained were 55.8, 54.5, 51.2, 50.9 and 47.2 naira for the control, 20%, 40%, 60%, 80% and 100% CRETSM diets, respectively. Feed cost per kilogram live weight gain of the rabbits that received diets that contained CRETSM were significantly ($p<0.05$) lower than that of the rabbits that were fed control diet. The values were 320, 316, 301, 298, 278 and 318 naira for the control, 20%, 40%, 60% 80% and 100% CRETSM diets, respectively.

The nutrient digestibility of the rabbits is presented in Table 4. No significant ($p>0.05$) difference was observed in the digestibility of dry matter, crude fiber, ether extract and nitrogen free extract. However, digestibility of crude protein was significantly ($p<0.05$) depressed at 100% substitution level.

Table 4: Nutrient digestibility (%) of growing rabbits fed CRETSM in replacement for fishmeal

Parameter	Level of CRETSM[1] substitution in the diets (%)						SEM
	0 (control)	20	40	60	80	100	
Dry matter	70.9	71.2	71.0	72.8	72.8	72.4	2.5
Crude protein	74.2[a]	75.1[a]	74.2[a]	75.2[a]	75.3[a]	71.3[b]	1.5
Crude fiber	32.4	32.2	32.0	32.1	32.3	32.4	0.8
Ether extract	72.8	72.3	71.9	72.1	71.8	71.8	2.0
Nitrogen free extract	67.2	68.1	67.8	68.6	69.1	68.5	2.3

[ab]Means bearing different superscripts along the same row are significantly different ($p<0.05$)
[1]CRETSM = Cattle rumen epithelial tissue scrapings meal

The organ and carcass characteristics of the rabbits fed varying proportion of CRETSM in replacement for fishmeal are shown in Table 5. Live weight, eviscerated weight, and carcass weight of the rabbits that had 0, 20, 40, 60 and 80 percent fishmeal in their diets replaced with CRETSM were comparable but were significantly ($p<0.05$) higher than the value obtained for those fed only fishmeal as animal protein source. No significant ($p>0.05$) difference was observed in the

carcass yield and the weights of liver, kidneys, hearts, lung, spleen and abdominal fat.

Table 5: Organ and carcass characteristics of rabbits fed varying levels of CRETSM in substitution for fishmeal

Parameter	Level of CRETSM[2] substitution in the diets (%)						SEM
	0 (control)	20	40	60	80	100	
Live weight (kg)	1.84[a]	1.88[a]	1.83[a]	1.87[a]	1.86[a]	1.75[b]	0.07
Eviscerated weight (kg)	1.36[a]	1.35[a]	1.34[a]	1.38[a]	1.37[a]	1.20[b]	0.08
Carcass weight (kg)	1.03[a]	1.06[a]	1.05[a]	1.06[a]	1.07[a]	1.00[b]	0.03
Carcass yield (%)[1]	58.6	59.5	57.8	57.2	57.5	58.5	3.0
Liver (%)[1]	2.02	2.26	2.07	2.11	2.21	2.18	0.4
Kidneys (%)[1]	0.51	0.56	0.60	0.54	0.61	0.54	0.3
Heart (%)[1]	0.21	0.23	0.24	0.23	0.21	0.22	0.05
Lung (%)[1]	0.52	0.56	0.47	0.46	0.44	0.46	0.2
Spleen (%)[1]	0.04	0.05	0.04	0.05	0.04	0.03	0.03
Abdominal fat (%)[1]	1.65	1.33	1.59	1.32	1.67	1.37	0.8

[ab]Means bearing different superscripts in the same row are significantly different ($p<0.05$)
[1]Percentage of live weight
[2]CRETSM = Cattle rumen epithelial tissue scrapings meal

The protein content of CRETSM used in this study is close to that of fishmeal. This implies that CRETSM is a potential animal protein source for livestock animals and fish. The protein content of the CRETSM used in this study was lower than that of Alikwe *et al*. (2005). This could be due to scraping method or the age of the animals from which the scraping was collected. The value was however comparable to that reported by Bawala *et al.* (2007) and Isah and Babayemi (2010).

The fact that there was no difference in the weight gain of the rabbits fed up to 80% CRETSM and the control diet suggests that CRETSM can replace up to 80% fishmeal in growing rabbit diet. Earlier report by Isa and Babayemi (2010) showed that goats fed rumen epithelial tissue scrapings had similar performance with those fed groundnut cake as a source of protein. Depression that was observed in the weight gain when fishmeal was completely replaced with CRETSM could be attributed to the slight difference observed in protein content compared with that of fishmeal and lower digestibility of CRETSM protein compared to that of fishmeal. Meat meal and meat and bone meal are known to be inferior to fishmeal (FAO, 2012). Furthermore, rumen epithelial scrapings consist mainly of papillae layer which consists of a central core of densely packed collagen fibres surrounded by stratified epithelium similar to the papillary bodies in skin. However, this observation contradicted the findings of Handa *et al.* (1996) who observed no significant difference in the weight gain of rabbits fed extruded hatchery waste in replacement for fishmeal. The difference could however be due to better amino acid profile of hatchery waste being an egg byproduct. The result also contradicted the finding of Isah and Babayemi (2010) who observed that groundnut cake and soybean meal could be completely replaced with CRETSM in the diet of West African Dwarf goat. This difference is however expected

since CRETSM is an animal byproduct with better amino acid profile than groundnut cake and soybean meal which are plant protein sources.

This study showed that feed intake of the rabbits was not affected by substituting CRETSM for fishmeal in the diets which indicated that the palatability of the feed was not adversely affected. The poor feed utilization observed in the rabbits fed 100% CRETSM could be attributed to poor protein digestibility observed in the same group which in turn could be due to poor quality of protein in CRETSM compared to fishmeal. Also lower value observed in the live weight, eviscerated weight and carcass weight of the rabbits that received diet 6 (100% CRETSM) could be attributed to poor growth occasioned by poor protein digestibility and feed utilization. The non significant effect of the diets on the weights of internal organs indicates that CRETSM does not contain toxic substance.

Conclusions

The results of this study revealed that CRETSM can be used to replace up to 80% fishmeal in the diet of growing rabbits without any adverse effect on growth and with lower cost of feeding. However, total replacement of fishmeal with CRETSM reduces growth even though it is still economical in terms of cost of production.

Acknowledgement

The authors wish to appreciate Dr Togun V.A., the Farm Director, and the entire staff of Teaching and Research Farm Ladoke Akintola University of Technology, Ogbomoso for their technical support during the period of the study.

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