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Effect of bovine rumen content meal on growth, carcass, and gut parameters in rabbits

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Abstract

The rising cost and competition for conventional feedstuffs between humans and livestock necessitate the exploration of non-conventional alternatives to improve economic efficiency in animal feeding. This study evaluated the use of bovine rumen content (BRC) as a feed ingredient in rabbit diets. A total of 36 weaned crossbred rabbits, aged five weeks, were randomly assigned to four dietary treatments (T1–T4) with 0%, 20%, 30%, and 40% BRC inclusion levels, respectively. Each treatment had three replicates in a completely randomized design. The experiment assessed growth performance, carcass traits, and gut characteristics. Results showed that daily feed intake increased significantly ($P < 0.001$) with higher BRC levels, indicating improved palatability or nutrient drive. However, weight gain and feed conversion ratio were not significantly affected ($P > 0.05$), suggesting that BRC inclusion did not negatively impact growth efficiency. Significant differences ($P < 0.001$) were observed in live weight, carcass weight, and dressing percentage, with higher values recorded at increased BRC levels. Among the carcass components, thigh, skin, head, loin, rack, and shoulder weights varied significantly across treatments. Internal organ weights revealed significant differences ($P < 0.001$) in kidney weight and large intestine length, while lung weight also differed ($P < 0.05$). No significant differences were found in small intestine length, abdominal fat, heart, liver, tail, or feet weights. Importantly, no mortality was recorded during the trial. In conclusion, BRC can be included in rabbit diets up to 40% without adverse effects on performance or carcass characteristics, making it a promising alternative feed resource. Further research is recommended to explore other rumen content sources for broader application in rabbit nutrition.

Keywords: Rabbit; Bovine rumen content; Performance; Carcass and gut characteristics

1. Introduction

Rabbits (*Oryctolagus cuniculus*) are fast-growing and highly prolific animals with a short generation interval [1] making them potential for improving animal protein supply in developing countries, particularly in Nigeria. The increasing demand for affordable animal protein, coupled with the rising costs of conventional meats such as chicken, pork, and beef, has intensified interest in rabbit production as a viable alternative [2]. Rabbits offer numerous advantages including high reproductive efficiency, rapid growth rates, efficient feed conversion ratios, minimal competition with humans for food resources, and the ability to thrive under diverse management systems [3] [1].

Rabbit meat is characterized by its low fat content, favourable flavour profile, and nutritional benefits, offering a palatable alternative to poultry and red meats [4] [5]. Moreover, it is nutritionally beneficial for human health due to its low cholesterol and sodium content, making it especially suitable for individuals with cardiovascular concerns or those following low-sodium diets [6] [7]. Additionally, rabbit meat does not carry religious restrictions in major faiths practiced in Nigeria, further enhancing its acceptability and potential for widespread consumption.

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Therefore, diversifying into large-scale rabbit production offers a promising strategy for increasing the supply of high-quality animal protein at more affordable prices. This can be further enhanced by incorporating unconventional feed resources such as rumen content (RC), which is an abattoir by-product consisting of partially digested feed materials found in the rumen of slaughtered ruminants. If not properly managed, RC poses environmental challenges due to its significant volume and potential for pollution [8]. It constitutes approximately 80% of the total stomach capacity in adult ruminants and has been identified as a viable feed ingredient for monogastric animals due to its nutrient composition [9].

Studies have shown that rumen content meal contains moderate levels of crude protein, typically ranging between 17–20%, making it a potential alternative to conventional protein sources in livestock diets [10] [11]. According to [9], the proximate composition of rumen content includes: 92.83% dry matter, 17.13% crude protein, 7.49% ash, 2.81% ether extract, 24.58% crude fibre, 40.82% nitrogen-free extract, and an estimated metabolisable energy value of 2278.50 kcal/kg. Importantly, [11] reported that rumen content does not contain anti-physiological or toxic factors, enhancing its safety for inclusion in animal feeds.

Rumen content is relatively inexpensive, widely available in Nigerian abattoirs and slaughterhouses, and currently poses a disposal challenge rather than being utilized [12]. Its incorporation into rabbit diets when properly processed and balanced can contribute to sustainable livestock feeding systems while reducing feed costs. Researchers such as [13] [14] have recommended the use of rumen content-based feed mixtures as partial or full replacements for traditional feedstuffs in livestock nutrition.

Animal nutritionists and related professionals have long sought cost-effective alternative feed ingredients capable of replacing conventional cereal and legume grains, which are not only expensive but also subject to high demand for direct human consumption. The search for such alternatives is driven by the need to reduce production costs and alleviate competition between humans and livestock for limited food resources [15] [16]. Non-conventional feedstuffs must ideally be abundant, affordable, and amenable to simple processing methods for safe and effective utilization in animal diets.

Rumen content (RC), a by-product of the abattoir industry, represents one such unconventional feed ingredient with potential utility in rabbit nutrition. When properly processed, RC can serve as a locally available and low-cost protein supplement, contributing to sustainable feeding systems while simultaneously addressing environmental concerns associated with its disposal. The rising costs of traditional feedstuffs such as maize, fishmeal, groundnut cake, and soybean meal further underscore the necessity for alternative ingredients that can maintain nutritional value while enhancing economic efficiency in livestock production.

Therefore, with the increasing pressure on feed resources and the growing interest in sustainable livestock systems, this study was designed to evaluate the effects of incorporating bovine rumen content into rabbit diets. Specifically, it aims to assess the impact on growth performance and carcass characteristics, providing insights into the feasibility of using this underutilized resource in practical rabbit feeding programs.

2. Material and methods

2.1. Experimental Animals (Rabbits) and their Management

The experimental animals consist of twelve (36) cross-bred rabbits weaned at 5 weeks of age; which were randomly divided into four treatment groups replicated thrice each, in a completely randomized design. The rabbits were intensively managed and housed individually in cages and were provided with drinking and feeding facilities that can prevent tipping over of feed. The feed were supplied to each rabbit *ad libitum* in two installments per day to reduce wastage. Feed offered and the left over were weighed to determine feed intake of the animals. After the initial weight, weekly weights were taken. These records were used to monitor and determine the performance parameters in terms of mean feed intake, weight gain and feed conversion ratio. Also, water was provided *ad libitum*.

2.2. Sources of Rumen Content Meal

The rumen contents were collected from Gombe municipal abattoir for Bovine only. After slaughtering, the rumen was split open with aid of sharp butcher's knife and the contents emptied into a polythene bags. It was allowed to drain in a sack. After draining, the rumen contents were spread on a clean cemented floor and allowed to sundry while turning was done between 3-4 hours interval until the moisture content was below 15% after 4 -5 days of sun drying. The dried rumen content was then grounded and incorporated into the diets.

2.3. Experimental Diet

Four experimental diets were formulated using the following ingredients; maize, rice bran, bone meal, groundnut cake, soybean meal, common salt, premixes and bovine rumen content meal (BRCM) as shown in Table 1. Rumen content was serves as a test ingredient at different levels of inclusion as 0% BRC, 20% BRC, 30% BRC and 40% BRC as diets 1, 2, 3 and 4 respectively. The experimental diets were formulated to contain 18% crude protein (CP).

Table 1 Ingredient composition of the rabbit diets containing varying levels of bovine rumen content

Level of inclusion				
Ingredient	**T_1**	**T_2**	**T_3**	**T_4**
Maize	56.00	44.50	33.00	21.50
Rice bran	20.00	15.00	10.00	8.00
BRCM	0.00	20.00	30.00	40.00
Groundnut cake	9.00	7.00	5.00	3.00
Soybean meal	11.50	9.00	6.50	4.00
Bone meal	3.50	3.50	3.50	3.50
Salt	0.30	0.30	0.30	0.30
Premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
CP (%)	18.00	18.00	18.00	18.00
Ash (%)	5.40	6.30	7.20	8.10
EE (%)	4.90	5.10	5.30	5.50
CF (%)	5.60	8.80	12.00	15.20
NFE (%)	61.1	53.80	47.50	41.20

T1 – control diet (0% RCM), T2 - 20% RCM, T3 - 30% RCM, T4- 40% RCM, BRCM – bovine rumen content meal, CP – crude protein, EE – ether extracts, CF – crude fibre, NFE – nitrogen free extracts

2.4. Data Collection

2.4.1. Feed Intake

The rabbits were provided with ration twice daily in the morning and evening. The amount of feed that were provided in each cage was weighed and allowance of about 20% above the expected daily requirements was given. The refusal were weighed the next day, just before provision of another ration. The difference between feed given and left over was used to evaluate feed intake, then calculated daily intake in each dietary treatment was obtained as follows:

Total feed supplied – Total feed left over = Total feed consumed.

2.4.2. Measurement of live weight

The rabbits were weighed individually at the beginning of the experiment as the initial body weight. Thereafter, they were weighed individually every week by using weighing balance before morning feeding to determine the live weight.

2.4.3. Weight Gain

The difference between the final weight and the initial weight of the rabbits for every week was determined as the weekly weight gain.

Weight gain = final weight – initial weight.

2.4.4. Feed Conversion Ratio

The Feed Conversion Ratio (FCR) was calculated by dividing total feed intake (g) by total weight gain (g) as shown from the expression below:

$$\text{F.C.R (Rabbits)} = \frac{daily\ feed\ intake\ (g)}{daily\ weight\ gain\ (g)}$$

2.4.5. Determination of the Rate of Mortality

The rate of mortality is the ratio between the number of the rabbits died and the initial total number of rabbits in the batch multiplied by 100.

$$\text{Mortality (\%)} = \frac{Number\ of\ subjects\ dead}{Total\ number\ of\ initial\ subjects} \text{ x } \frac{100}{1}$$

2.4.6. Carcass Measurement for Rabbits

At the end of the experiment, two rabbits from each replicate i.e six rabbits from each treatment were randomly selected for slaughter. They were deprived of feed for 12 hours as recommended by [17] but drinking water was provided. Withholding feed for 12 hours before slaughter reduced the volume of gut contents and hence bacteria, and therefore reduced the risk of contamination of the carcass during dressing without adversely affecting meat yield and quality [17]. The rabbits were weighed in the morning and slaughtered by cutting transversely across the trachea, oesophagus, large carotid arteries and jugular veins to ensure maximum bleeding [18]. This slaughter method is in line with the accepted local practices. They were later dissected and dressed as described by [19]. The dressed carcass is the portion of the rabbit remaining after the removal of the head, feet, skin (pelt), tail and viscera organs. The dressed carcasses were split into retail cuts such as shoulder/foreleg, thigh/hindleg, rack and loin as described by [19]. The dressed carcass and the retail cuts were weighed.

2.4.7. Carcass weight

Carcass weight were determined after all the internal organs and the head, feet, skin (pelt), tail were removed.

2.4.8. Dressing Percentage

This were determined by dividing carcass weight by the live weight and multiply by 100.

$$\text{Dressing \%} = \frac{carcass\ weight}{live\ weight} \text{ x } \frac{100}{1}$$

2.4.9. Intestinal Determination

The intestinal parts; the small intestine, and large intestine were measured with measuring tape, and weights were taken using electronic digital weighing scale.

2.4.10. Organs determination

Other organs of the rabbits include liver, heart, kidney, and intestines were removed and each cut-up parts and organs were separately weighted using a sensitive electronic scale.

2.5. Method of Data Analysis

The research designed used for this experiment is Completely Randomized Design (CRD). Data collected during the experiment were analyzed using Analysis of Variance (ANOVA) and where differences exist among the treatment means Least Significance Difference (LSD) was used to separate the means.

3. Results

3.1. Performance of Rabbit Fed with Different Levels of the Bovine Rumen Content

The results of daily feed intake, weight gain, and feed conversion ratio of rabbits fed with different levels of bovine rumen content (BRC) were presented in table 2. The results for daily feed intake revealed that there was high significant difference ($P < 0.001$) among the treatment means, where higher mean value of (94.90g) was obtained in rabbit fed

30% BRC diet and diet 40% BRC (94.73g) followed by diet 20% BRC (91.42g) while the least value was obtained in control diet (89.29g).

The daily weight gain (DWG) result revealed no significant difference (P > 0.05) among the dietary treatment means but the highest numerical value (23.22g) was obtained in rabbit fed control diet, follows by diets 20% BRC (21.43) then, 30%BRC diet (20.69g) and the lowest value (16.97g) was obtained in 40% BRC.

The feed conversion ratio (FCR) for the rabbit fed with different levels of the bovine rumen shows no significant difference (P > 0.05) among the dietary treatment means. However, the highest gain was obtained in control diet (3.85), follows by 20% BRC (4.27) then 30% BRC (4.59) and 40% BRC (5.58). The results also indicates no mortality rate among the dietary treatments.

Table 2 Growth performance of rabbit fed with different levels of the bovine rumen content

Parameters	T_1	T_2	T_3	T_4	SEM	p-value
DFI (g)	89.29	91.42	94.90	94.73	1.284	0.0001
DWG (g)	23.22	21.43	20.69	16.97	8.363	0.1453
FCR	3.85	4.27	4.59	5.58	2.045	0.1126
Mortality (%)	0	0	0	0	-	

[abcd] Means ± SEM. Means with different superscripts in the same row differ significantly (*P*< 0.05DFC=Daily Feed Intake, DWG=Daily Weight Gain, FC =Feed Conversion Ratio, T_1= Control Group (0% BRC), T_2 =20% Bovine Rumen Content, T_3 =30% Bovine Rumen Content, T_4 = 40% Bovine Rumen Content

3.2. Carcass and Organs Characteristics of Rabbits Fed with a Mixture of Bovine Rumen Content

The results of Carcass characteristics of rabbit fed with different levels of the bovine rumen content are presented in Table 3. The result of the body weight revealed that there was highly significant difference (P>0.001) among the treatment means for live weight and carcass weight where diet T2 had the highest mean (2130g) follows by diet T3 (2070g) and T4 (1900g) while diet T1 recorded the least mean (1700g); the result for dressing percentages revealed a highly significant difference (P<0.001) where diet T2 having the highest mean (57%), followed by diet T3 (53.21%) whereas diet T4 was similar to diet T1 with a mean value of 45.67% and 39.78% respectively. The diet T2 had the highest (P<0.001) mean value in the thigh, skin, and head, a high significant difference (P<0.01) in loin weight, and a significant difference (P<0.05) in rack and shoulder weight follows by diet T3 while diets T4 and T1 were the least.

The weight of Viscera organs are shown in Table 3. The results revealed that there was highly significant difference (P>0.001) among the treatment means for kidney weight where diet T1 had the highest mean value follows by diet T4 while the least was recorded in diet T3, in the lungs weight diet T3 recorded the highest mean value follows by diet T2 and the least value was obtained in diet T1. The large intestine length was highly significantly different (P>0.001) where diet T2 (90.33cm) had the highest and the T1 diet had the lowest means (85.00cm). There was no significant difference (P>0.05) among the treatment means for small intestine length, abdominal fat, heart, liver, tail and feet.

Table 3 Carcass and organs characteristics of rabbits fed with different levels of bovine rumen content

Parameter	T_1	T_2	T_3	T_4	SEM p-value
Weight of Body					
Live weight (g)	1700 [d]	2130 [a]	2070 [b]	1900 [c]	45.36 0.0001
Carcass/dressing weight (g)	676.26 [d]	1226.06 [a]	1101.54 [b]	867.66 [c]	52.31 0.0001
Dressing percentage (%)	39.78 [c]	57.56 [a]	53.21 [ab]	45.67 [c]	4.14 0.0001
Weight of Viscera Organs					
Heart (g)	3.83	3.57	2.63	2.90	1.25 0.1324
Kidney (g)	7.87 [a]	4.53 [c]	4.67 [bc]	7.73 [ab]	0. 24 0.0001
Liver (g)	31.87	33.60	33.70	31.80	2.54 8.643

Lungs (g)	7.00 c	8.17 b	9.00 a	8.03 bc	0.16 0.0135
Abdominal fat (g)	2.37	3.13	2.77	3.30	2.12 0.1632
Large intestine (cm) Weight of body parts	85.00 c	90.33 a	86.00 b	85.67 bc	0.34 0.0001
Head (g)	88.87 c	108.07 a	89.40 c	90.23 b	1.08 0.0001
Skin (g)	57.67 c	90.53 a	61.10 b	56.93 bc	3.43 0.0001
Feet (g)	8.97	8.30	8.57	8.53	1.14 0.3256
Shoulder (g)	30.80c	38.10 a	32.07 b	27.03 c	1.43 0.0273
Rack (g)	26.80 b	38.07 a	25.73 b	23.10 c	2.13 0.0321
Loin (g)	14.67 c	30.40 a	17.77 b	10.33 d	2.78 0.0011
Thigh (g)	145.53 bc	201.40 a	134.43 c	151.47 b	11.56 0.0001

abcd Means ± SEM. Means with different superscripts in the same row differ significantly ($P< 0.05$). T_1 = Control Group, T_2 = 20% Bovine Rumen Content, T_3 = 30% Bovine Rumen Content, T_4= 40% Bovine Rumen Content

4. Discussion of Results

The highly significant difference ($P < 0.001$) in the feed intake of rabbit fed with different levels of the bovine rumen content indicates palatability of the diet as well as the need to meet the energy requirement of the rabbits [20] as shown from the results there was increased in feed consumption as the level of the rumen content increases, compared to the control diet. The daily feed intake values obtained were similar to those reported by [21][22].

The non-significant difference ($P > 0.05$) in the daily weight gain corroborate with the findings of [10] who fed bovine blood-rumen content mixture (BBRCM) and reported that increasing the BBRCM level in the diets significantly increased feed consumption but with a non-significant difference in growth rate. [14] and [10] similarly reported a non-significant effect on the rate of daily weight gain when rabbits were fed rumen content. However, the results disagreed with the results of [11] who observed a general increment in growth rate as dietary inclusion of dried rumen content increased. The absence of mortality indicates that the inclusion of bovine rumen content in the diet of rabbits is safe with no adverse effects on performance.

The high ($P<0.001$) carcass characteristics among the treatment means for live weight, carcass, thigh, loin, head, skin weights and dressing percentages as well as the significant difference ($P<0.05$) for shoulder, and rack weights in diets containing bovine rumen content indicates that bovine rumen content had positive effect in increasing body weight of rabbit. This result is in agreement with the findings of [23][24] who observed similar trend. However, the dressing percentages obtained in this study especially for 20%BRC was higher than the average of 56.50% for ready-to-cook carcass of different European breeds reported by [25].

The weight of viscera organs for kidney, lungs and large intestine length are higher than the values reported by [26] but lower than the values reported by [27]. The liver weight recorded in this study is higher than the value reported by [27] and the lower abdominal fat recorded in this study indicates good quality of the rabbit meat as leaned.

5. Conclusion

Based on the results obtained in this study, it can be concluded that, rabbit fed with different levels of bovine rumen content had positive significant effect on the growth performance, carcass traits and gut characteristics of rabbits and it can be included in the diets up to 40% level of inclusion without any adverse effect. Therefore, the used of bovine rumen content as feed for rabbit production should be harnessed.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The experiment was carried out based on ethical approval by the Research and development unit (R & D), Federal college of Education (Tech), Gombe (FCE (T) G/R and D/AUP-R07/2024).

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