



RESPONSE OF WEANER RABBITS TO GRADED LEVELS OF SUN-DRIED BOVINE RUMEN CONTENT

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ABSTRACT

The study was carried out to determine the response of weaner rabbits to graded levels of sun-dried bovine rumen content (SDBRC). A total of forty (40) weaner rabbits were randomly allotted to five dietary treatments, replicated four times in a Completely Randomized Design, in which sun-dried bovine rumen content partially replaced wheat offal at 0, 30, 35, 40 and 45%, and designated as diet 1, 2, 3, 4 and 5 respectively. The results of the study revealed that, performance parameters such as the total weight gain (659.63 to 787.38g), total feed intake (3450.40 to 3672.80g), feed conversion ratio (4.73 to 5.32) and feed efficiency (0.19 to 0.22) were not significantly affected by the dietary treatments. Similarly carcass parameters showed no significant difference except for abdominal fat which was significantly ($P<0.01$) affected, with the highest (1.02%) on diet 1 and the lowest (0.34%) on diet 3. Faecal sample analysis indicated a significant ($P<0.01$) difference for crude protein (89.34 to 91.40%), crude fibre (83.65 to 86.13%), ash (93.00 to 94.92%) and ether extract (98.28 to 98.94%), while dry matter and nitrogen free extract were not significantly influenced by the dietary treatments. Haematological and serum biochemical indices showed no significant effect across the dietary treatments except for urea (3.52 to 8.64mmol/l) which showed a significant ($P<0.01$) response to dietary treatments. Total feed cost reduced as the level of sun-dried bovine rumen content increased, and the least total feed cost (₦1782.37) was recorded for rabbits fed diet 5 (45% SDBRC). Feed cost per kg gain ranged from ₦2475.51 to ₦2758.74 on diets 5 and 4 respectively. In terms of cost saving, diet 5 had the highest (₦137.63) with a percent cost saving of 5.27%. Based on the results obtained from this study, it can be concluded that sun-dried bovine rumen content can best replace wheat offal at 45% level in the diets of weaner rabbits with comparative performance, carcass characteristics, haematological and serum biochemical indices to the control. Diet 5 (45% SDBRC) also had the cost benefit (₦137.63) and is therefore recommended for rabbit production.

Keywords: Weaner, Rabbits, Rumen, Content, Performance

INTRODUCTION

Rabbits are farm animals with strong reproduction rates and capacity to use fodder. Rabbit husbandry is presently of great importance because of its possible support to sustain the increasing need of the human population for protein from animal origin (Cherfaoui, 2015). Rabbits meat is valued for its nutritional properties because is lean, rich in proteins of high biological value, low in cholesterol and sodium content, and high in linolenic acid (Nistor *et al.*, 2013). Rabbit production has gained significant importance in meeting the growing demand for animal protein, particularly in developing countries (Lukefahr, 2004). The need to improve rabbit's production in Nigeria for guaranteed increase in supply of animal protein is no longer in doubt due to the high cost of chicken meat, pork, mutton, beef and bush meat. Developing countries are suffering from a shortage of animal feed ingredients, daily increase in price and competition for this feedstuff between humans and livestock. The economic viability of rabbit farming is heavily influenced by feed costs, which constitute up to 70% of total production expenses. This economic pressure has led to increased interest in identifying alternative feed ingredients that can reduce production costs without compromising animal health and performance (Makkar *et al.*, 2014). In recent years, alternative feed resources have garnered increasing attention as potential components of livestock diets, aiming to enhance animal growth and carcass quality while optimizing resource utilization (Ndudzo *et al.*, 2023). Therefore, there is an urgent need for alternative locally available and cheap sources of feed



ingredients particularly those that do not attract competition in consumption between human and livestock in order to boost rabbit production in a way of providing the required protein to the Nigerian populace. Sun-dried bovine rumen content (SDBRC) is among the locally available unconventional feed material use for feeding livestock animals. SDBRC is an animal by-product which is found mostly in abattoirs when the rumen of the animal is split open after slaughter and retrieved (Okpanachi *et al.*, 2010). The rumen content contains partially digested feed materials at different stage of degradation. Bovine rumen content is a good source of energy, protein (feed and microbial protein), minerals and vitamins especially vitamin B complex (Elfaki and Abdelatti, 2016). The nutrient composition of rumen content is largely dependent on the types of ration fed prior to slaughter. Elfaki and Abdelatti (2015) reported that the samples of rumen contents taken from cattle had high level of crude protein (ranged between 18.52-19.56%). Whyte and Wadak (2002) reported that there is 10.69% moisture, 10.82% crude protein, 5% ether extract, 20% ash, and 20% fibre in bovine rumen content or digester. Additionally, dried rumen content was shown by Esonu *et al.* (2006) to contain 18.20% moisture, 15.30% crude fibre, 18.52% crude protein, 7.60% ash, 8.79% ether extract, and 38.39% carbohydrate. Wheat offal, a by-product of wheat processing, is commonly used as a fiber source in rabbit diets (De Blas and Mateos, 2010). However, its availability and cost can fluctuate due to competition with other livestock sectors and human food production (Oloruntola *et al.*, 2016). Consequently, researchers have been exploring unconventional feed ingredients as potential replacements for wheat offal in rabbit diets. Sun-dried cattle rumen contents (SDCRC) have emerged as a promising alternative feed ingredient. Rumen contents, typically considered waste from cattle slaughter, possess potential nutritional value for livestock (Adeniji and Rumak, 2017). The utilization of SDCRC in animal feed not only provides a cost-effective alternative to conventional feed ingredients but also contributes to waste reduction and environmental sustainability in the meat industry (Elghandour *et al.*, 2017). While previous studies have investigated various unconventional feed ingredients in rabbit diets (Ogunsipe *et al.*, 2014), the potential of SDCRC as a replacement for wheat offal has not been thoroughly explored, particularly regarding its effects on the hematological and biochemical parameters of weaner rabbits. These parameters are crucial indicators of animal health and can provide insights into the physiological impact of dietary changes (Etim *et al.*, 2014). The objectives of this study are to determine the performance, evaluate the carcass characteristics, examine the blood chemistry and assess the cost benefit of weaner rabbits fed graded levels of sun-dried bovine rumen content.

MATERIALS AND METHODS

Experimental Site

The study was carried out at Abubakar Tafawa Balewa University, Bauchi, teaching and research farm Yelwa campus. The university is located at Yelwa along Tafawa Balewa road, Bauchi. Bauchi lies between latitude of 10°, 17°N, longitude 9° 49'E and at attitude of 902 meters above the sea level. There are two distinct season in the area; rainy season, which usually starts in May and end in October, and dry season which starts from November to April. The mean annual rainfall is 1091mm (World Atlas, 2015).

Collection and Processing of Bovine Rumen Content

Fresh bovine rumen content was collected from eviscerated cattle after slaughter, into clean containers from Bauchi State Abattoir. The rumen was incised with the aid of a sharp knife and the contents emptied into the container. The bovine rumen content was sun-dried for 3 days by spreading on clean plastic sheets. While drying, it was turned four times daily to facilitate even drying. The sun-dried bovine rumen content was hand-crushed and then stored in sack bags.

Experimental Diets

Five experimental diets (16%CP) were formulated, where SDBRC was incorporated to replace wheat offal at 0, 30, 35, 40 and 45% as diets 1, 2, 3, 4 and 5 respectively. The percentage composition of the experimental diets is shown in Table 1.

Table 1: Percentage Composition of the Experimental Diets

Ingredients	Diets				
	1(0%)	2(30%)	3(35%)	4(40%)	5(45%)
Maize	40.00	40.20	40.24	40.27	40.30
SBM	16.00	15.80	15.76	15.73	15.70
Wheat offal	20.00	14.00	13.00	12.00	11.00
SDBRC	0.00	6.00	7.00	8.00	9.00
G/nut haulms	20.00	20.00	20.00	20.00	20.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Premix	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis (%)					
Crude protein	16.00	16.00	16.00	16.00	16.00
ME (Kcal/kg)	2566.68	2590.54	2595.27	2599.34	2603.41
Crude fibre	10.05	11.00	11.17	11.34	11.50
Ether Extract	5.78	5.71	5.71	5.68	5.68
Calcium	1.31	1.34	1.35	1.35	1.36
Phosphorus	0.82	0.84	0.85	0.85	0.86
Lysine	0.86	0.81	0.80	0.79	0.78
Methionine	0.41	0.39	0.39	0.39	0.39

SBM = Soya Bean Meal; SDBRC = Sun-Dried Bovine Rumens Content

Experimental Rabbits and their Management

A total of forty (40) weaner rabbits of 6-8 weeks of age was purchased from a reliable rabbit keeper for this study. The weaner rabbits were allowed to acclimatize with the environment for a week, during which feed and water were given *ad libitum*. The rabbits were also administered multivitamins, antibiotics and ivermectin (against both internal and external parasites). After the acclimatization period, the rabbits were randomly allotted to five dietary treatments, replicated four times with two rabbits per replicate in a Completely Randomized Design (CRD). At the commencement of the experiment, each rabbit was weighed to determine its initial weight using EK3250 digital weighing scale. The initial weight was balanced for treatments, and feed and water were offered *ad libitum*. Each rabbit was weighed on weekly basis to obtain the weekly and daily body weight gain throughout the experiment. Mortalities were recorded as they occur during the period of feeding trial.

Data Collection

Performance of weaner rabbits

Daily feed intake and daily weight gain were recorded throughout the experimental period. Feed conversion ratio (FCR) was calculated using the relationship:

$$FCR = \frac{\text{Feed intake}}{\text{Weight gain}}$$

While feed efficiency (FE) was calculated as;

$$FE = \frac{\text{Weight gain}}{\text{Feed intake}}$$

Carcass characteristics of weaner rabbits

At the end of the experiment, one rabbit was selected from each replicate, weighed and slaughtered after 12 hours without feed. The parameters measured include live weight, carcass weight, dressing %, head, lungs, pelt, heart, kidney, liver, small intestine, large intestine, caecal, stomach, abdominal fat, spleen, tail, fore limb and hind limb weights. The dressing percentage was determined using the formula:

$$\text{Dressing \%} = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100$$



Nutrient digestibility of rabbits

During the last week of the feeding trial, the digestibility study was carried out. The faeces were collected daily from each replicate for five (5) days and were air-dried in order to remove the moisture content. Fifty (50) grams of the total dried faeces for the five (5) days and for each replicate was taken to serve as representative sample for proximate analysis. The proximate analysis for the faecal sample was carried out according to the method of the Association of Official's Analytical Chemists, AOAC (2006). The apparent Nutrient digestibility of dry matter, crude protein, crude fibre, ash, ether extract and nitrogen free extract was calculated using the formula of Isikenuet *et al.* (2010).

$$\text{Nutrient Digestibility} = \frac{\text{Nutrient in feed intake} - \text{Nutrient voided in faeces}}{\text{Nutrient in feed intake}} \times 100$$

Blood collection

At the end of the study period, blood was collected through the jugular vein of slaughtered rabbit from each replicate were put into bottles containing Ethylene Diaminetetra-acetic Acid (EDTA) for haematological studies. Similarly, blood samples meant for serum biochemical studies were collected into plain bottles (without anticoagulant) to enhance serum separation. All the blood samples collected were taken to the laboratory for analyses.

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2010) and mean differences were separated using Duncan's Multiple Range Test (Duncan, 1955).

Cost Benefit Analysis

Costs of feed were calculated using the prevailing market prices of ingredients at the time of the experiment for the economic appraisal of the feeds.

RESULTS AND DISCUSSION

Growth Performance of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content

The growth performance of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 2. The result indicated no significant difference in the mean values across dietary treatments for all parameters observed. The result further showed that, total weight gain ranged from 659.63 to 787.38g on diets 4 and 1 respectively. Also, total feed intake ranged from 3450.40 to 3672.80g on diets 5 and 1. Feed conversion ratio was lowest (4.73) on dietary treatment 5 and highest (5.32) on dietary treatment 4. Feed efficiency ranged from 0.19 on diet 4 to 0.22 on the control diet. Two mortalities (one each) were recorded for diets 2 and 3. This is an indication that dietary treatments supplied adequate nutrients which supported and had no adverse effect on the growth performance of the rabbits. This result is in conformity with the findings of Saidu *et al.* (2024) who observed no significant difference in all the growth parameters across the diets. It is also similar to the report of Mohammed *et al.* (2005). The similarity in the performance among the dietary treatments may also be as a result of the similarities in nutrient utilization, which is a function of nutrient quality, since all the diets met the nutrient requirement.



Table 2: Performance of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content (SDBRC)

Parameters	Diets					SEM
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)	
Initial weight (g)	819.75	828.13	838.63	824.88	814.13	8.09 ^{NS}
Final weight (g)	1607.10	1515.00	1581.10	1484.50	1536.90	58.26 ^{NS}
Total weight gain (g)	787.38	686.88	742.50	659.63	722.75	59.19 ^{NS}
Total feed intake (g)	3672.80	3497.10	3526.50	3494.10	3450.40	99.92 ^{NS}
Daily feed intake (g)	65.59	62.45	62.98	62.40	61.61	1.78 ^{NS}
Daily weight gain (g)	14.06	12.26	13.26	11.78	12.91	1.06 ^{NS}
Feed conversion ratio	4.73	5.16	4.85	5.32	4.99	0.42 ^{NS}
Feed efficiency	0.22	0.20	0.22	0.19	0.21	0.02 ^{NS}
Mortality (number)	0.00	1.00	1.00	0.00	0.00	-

SEM: Standard Error of the Means; NS: Not Significant.

Carcass Characteristics of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content

The carcass characteristics of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 3. The result in Table 3 showed no significant difference in all the carcass parameters measured across the dietary treatments except for abdominal fat (0.34 to 1.02%) which has significant ($P < 0.01$) difference. The highest value for abdominal fat was recorded for diet 1, followed by diet 4 (0.68%). Diet 3 recorded the lowest value (0.34%) which is similar to the values obtained for diets 2 (0.43%) and 5 (0.42%). This can be attributed to the high fat content in the control diet compared to diets containing graded levels of sun-dried bovine rumen content. Live weight values varied between 1240.00 and 1600.70g on diets 2 and 1 respectively. Carcass weight values ranged from 696.33 to 792.67g on diets 5 and 1 respectively. The lowest (46.20%) dressing percent was found on diet 2 while the highest (50.85%) was on diet 4. The lowest mean value of head weight was observed in diet 5 (8.68%) while the highest was in diet 2 (10.00%). Lungs weight varied between 0.53 and 0.72% on diets 4 and 3 respectively. The highest mean value of pelt weight was recorded for diet 3 (9.19%) and the lowest on diet 5 (8.19%). Heart weight ranged from 0.23 to 0.37% on diets 3 and 1 respectively. Also, kidney weight ranged from 0.67 to 0.86% on diets 1 and 2 respectively. Liver weight was lowest in diet 4 (3.36%) and highest in diet 2 (4.03%). Small intestine weight varied between 3.95 and 4.85% on diets 4 and 1 respectively. The highest mean value of the large intestine weight was observed in diet 5 (2.74%) while the lowest was on diet 1 (1.87%). Caecal weight was lowest in diet 1 (5.41%) and highest in diet 2 (7.28%). Stomach weight varied between 4.70 and 6.16% on diets 4 and 5 respectively. Spleen weight ranged from 0.07 to 0.12% on diets 4 and 1, 5 respectively. Tail weight was lowest in diet 3 (0.14%) and highest in diet 2 (0.30%). Fore limb weight ranged from 0.58 to 0.67% on diets 5 and 2 respectively. Also, hind limb weight varied between 1.19 and 1.57% on diets 5 and 2 respectively. This finding was contrary to the report of Sibanda *et al.* (2024) who had significant ($P < 0.05$) difference in the carcass weight. It also disagreed with Osita *et al.* (2023) who had significant ($P < 0.05$) difference in the liver, heart, kidney, spleen, small intestine and large intestine.

Table 3: Carcass Characteristics of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content (SDBRC)

Parameters	Diets					SEM
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)	
Live weight (g)	1600.70	1240.00	1476.70	1460.00	1433.00	98.23 ^{NS}
Carcass weight (g)	792.67	576.33	709.00	741.67	696.33	46.96 ^{NS}
Dressing %	49.75	46.20	48.20	50.85	48.48	1.31 ^{NS}
Head weight (%)	9.39	10.00	9.32	8.97	8.68	6.00 ^{NS}
Lungs weight (%)	0.56	0.56	0.72	0.53	0.58	1.20 ^{NS}
Pelt weight (%)	8.91	9.14	9.19	8.81	8.19	14.01 ^{NS}
Heart weight (%)	0.37	0.30	0.23	0.32	0.30	0.75 ^{NS}
Kidney weight (%)	0.67	0.86	0.70	0.73	0.77	1.13 ^{NS}
Liver weight (%)	3.89	4.03	3.61	3.36	3.72	3.84 ^{NS}
Small intestine weight (%)	4.85	4.17	4.27	3.95	4.51	5.69 ^{NS}
Large intestine weight (%)	1.87	2.53	2.21	2.19	2.74	4.71 ^{NS}
Caecal weight (%)	5.41	7.28	7.00	6.73	6.75	10.26 ^{NS}
Stomach weight (%)	4.71	5.86	5.89	4.70	6.16	9.53 ^{NS}
Abdominal fat (%)	1.02 ^a	0.43 ^b	0.34 ^b	0.68 ^{ab}	0.42 ^b	1.78 ^{**}
Spleen weight (%)	0.12	0.11	0.09	0.07	0.12	0.22 ^{NS}
Tail weight (%)	0.23	0.30	0.14	0.21	0.26	1.30 ^{NS}
Fore limb weight (%)	0.62	0.67	0.63	0.62	0.58	0.50 ^{NS}
Hind limb weight (%)	1.40	1.57	1.47	1.35	1.19	1.31 ^{NS}

^{a,b}: Means on the same row with different superscripts are significantly ($P < 0.01$) different; SEM: Standard Error of the Means; NS: Not Significant.

Nutrient Digestibility of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content

The nutrient digestibility of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 4. The result obtained in Table 4 showed that the faecal sample indicated a significant ($P < 0.001$) difference across the dietary treatments for crude protein, crude fibre, ash and ether extract while dry matter and nitrogen free extract were not significantly influenced. The dry matter mean values ranged from 83.62 to 84.47% on diets 5 and 1 respectively. Crude protein had the highest mean value (91.40%) on diet 1, which was similar to the mean values obtained on diets 2, 3 and 4 while the lowest (89.34%) was found on diet 5. Crude fibre was highest (86.13%) on diet 2 which was statistically the same with values obtained for diets 3 and 4, while the lowest (83.65%) was found on the control diet, similar to the value recorded for diet 5. Ash recorded lowest (93.00%) on diet 4 with similar value on diet 5 while diet 2 had the highest (94.92%) which was similar to the values obtained on diets 1 and 3. Ether extract obtained the highest mean value (98.94%) on diet 1, which was statistically the same with values recorded for diets 2 and 3 while diet 5 had the lowest (98.28%) with similar values obtained on diets 3 and 4. Nitrogen free extract ranged from 78.98 to 80.76% on diets 2 and 1 respectively. The result of this study disagreed with that of Osita *et al.* (2023) who reported a significant ($P < 0.05$) difference in crude protein, crude fibre, ash, ether extract and nitrogen free extract. However, the quantity and quality of dietary fibre have an impact on the digestive health (mortality and morbidity) of the weaner rabbit. The digestive health of growing rabbits is expressly weakened by a diet lacking in fibre. When enough digestible fibres are added to the meal, digestive problems are somewhat reduced. The fermentative activity in rabbits' stomach is positively impacted by adequate fibre in their diet (Gidenne and Bellier, 2000). Higher percentage values of nutrient digestibility in favour of the dietary treatments may be connected to their high dietary fibre content. This range can be ideal for effective nutrient usage (Osita *et al.*, 2023).

Table 4: Nutrient Digestibility of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content (SDBRC)

Parameters (%)	Diets					SEM
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)	
Dry Matter	84.47	83.92	83.87	83.94	83.62	0.45 ^{NS}
Crude Protein	91.40 ^a	90.54 ^a	90.73 ^a	90.39 ^a	89.34 ^b	0.27 ^{***}
Crude Fibre	83.65 ^b	86.13 ^a	85.62 ^a	85.64 ^a	84.18 ^b	0.41 ^{**}
Ash	94.61 ^a	94.92 ^a	94.87 ^a	93.00 ^b	93.03 ^b	0.17 ^{***}
Ether Extract	98.94 ^a	98.60 ^b	98.46 ^{bc}	98.30 ^c	98.28 ^c	0.07 ^{***}
Nitrogen Free Extract	80.76	78.93	79.22	79.34	79.50	0.32 ^{NS}

a,b,c: Means on the same row with different superscripts are significantly ($P < 0.001$) different SEM: Standard Error of the Means; NS: Not Significant.

Haematological Indices of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content

The haematological indices of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 5. The result indicated that there was no significant difference in all the parameters observed across the dietary treatments. The Packed Cell Volume ranged from 34.00 to 37.33% on diets 2 and 4 respectively. Haemoglobin varied between 11.30 and 12.40g/dl on diets 2 and 4 respectively. Red blood cell observed the highest ($4.07 \times 10^{12}/l$) on diet 4 and lowest ($2.81 \times 10^{12}/l$) was found on diet 5. White blood cell indicated lowest value ($4.63 \times 10^9/l$) on diet 3 while the control diet had the highest ($10.07 \times 10^9/l$). Mean Corpuscular Volume (MCV) ranged from 40.43 to 48.83fl on diets 2 and 4 respectively. Mean Corpuscular Haemoglobin (MCH) varied between 29.93 to 42.13pg on diets 1 and 3 respectively. Mean Corpuscular Haemoglobin Concentration (MCHC) ranged from 68.43 to 79.50g/dl on diets 4 and 2 respectively. Haematocrit indicated highest value (9.27%) on diet 5 while the lowest (14.13%) was observed on diet 4. Neutrophils was lowest in diet 1 (53.00%) and highest in diet 2 (64.33%). Lymphocytes ranged from 29.00 to 43.67% on diets 2 and 1 respectively. The highest mean value of monocytes was recorded for rabbits fed diet 4 (8.33%) while the lowest was recorded for diet 1 (2.00%). Eosinophils recorded highest value in diet 3 (2.00%) while diet 2 (0.67%) had the lowest. Also, basophils was lowest in diet 1 (0.00%) and highest in diet 4 (1.33%). Platelets varied between 210.00 and $340.00 \times 10^9/l$ on diets 3 and 1 respectively. This means that diets containing graded levels of sun-dried bovine rumen content had no adverse effect on the haematological indices of the weaner rabbits. This result is not in agreement with the findings of Maina *et al.* (2022) who reported significant ($P < 0.01$) difference in red blood cell, mean corpuscular volume and mean corpuscular haemoglobin. This could be attributed to nutrition which has a strong influence on the haematological traits, and values of these traits are indicators of the nutritional status of the animals (Adeyeye *et al.*, 2017; Oloruntola *et al.*, 2018). Haematological constituents also reflect the responsiveness of the animal to its environment, including feed and feeding (Akanbi, 2019). Reports also stated that Packed Cell Volume, Haemoglobin and Mean Corpuscular Haemoglobin (MCH) were major indices for evaluating circulating erythrocytes and were very significant in the diagnosis of anemia and also served as useful indices of bone marrow capacity to produce red blood cells as in mammals (Chineke *et al.*, 2006).

Table 5: Haematological Indices of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content (SDBRC)

Parameters	Diets					SEM
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)	
Packed Cell Volume (%)	34.33	34.00	34.67	37.33	34.67	1.01 ^{NS}
Haemoglobin (g/dl)	11.43	11.30	11.53	12.40	11.53	0.34 ^{NS}
Red Blood Cells ($\times 10^{12}/l$)	3.07	2.87	3.31	4.07	2.81	0.44 ^{NS}
White Blood Cells ($\times 10^9/l$)	10.07	6.10	4.63	8.17	4.80	1.20 ^{NS}
MCV (fl)	41.10	40.43	44.60	48.83	42.77	2.55 ^{NS}
MCH (pg)	29.93	40.37	42.13	40.07	37.70	3.16 ^{NS}
MCHC (g/dl)	69.27	79.50	76.04	68.43	68.70	2.79 ^{NS}
Haematocrit (%)	11.67	10.00	9.83	14.13	9.27	1.40 ^{NS}
Neutrophils (%)	53.00	64.33	55.00	54.67	55.67	5.71 ^{NS}
Lymphocytes (%)	43.67	29.00	38.00	34.00	37.00	6.57 ^{NS}
Monocytes (%)	2.00	5.67	4.67	8.33	5.33	2.09 ^{NS}
Eosinophils (%)	1.33	0.67	2.00	1.67	1.67	0.65 ^{NS}
Basophils (%)	0.00	0.33	0.33	1.33	0.33	0.34 ^{NS}
Platelets ($\times 10^9/l$)	340.00	334.67	210.00	262.33	225.00	44.45 ^{NS}

SEM: Standard Error of the Means; NS: Not Significant; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Haemoglobin; MCHC: Mean Corpuscular Haemoglobin Concentration.

Serum Biochemical Indices of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumen Content

The serum biochemical indices of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 6. The result showed no significant difference in all the parameters measured across the dietary treatments except for urea (3.52 to 8.64mmol/l) which showed significance ($P < 0.01$). The highest value was observed on diet 3 while the lowest was found on diet 4. Glucose ranged from 4.18 to 5.23 mmol/l on diets 5 and 3 respectively. Total cholesterol varied between 3.84 and 5.15mmol/l on diets 4 and 3 respectively. Total protein indicated lowest value (6.59g/dl) on diet 4 and highest (7.44g/dl) on the control diet. Total bilirubin had highest value of 14.08 μ mol/l on diet 3 and lowest (9.86 μ mol/l) recorded for diet 5. Conjugated bilirubin ranged from 3.14 to 4.21 μ mol/l on diets 5 and 2 respectively. Albumin mean values varied between 2.72 and 3.91g/dl on diets 4 and 1 respectively. All the serum biochemical parameters were within the normal range values. This showed that diets containing graded levels of sun-dried bovine rumen content had no adverse effect on serum biochemical indices of the weaner rabbits fed. This result was not in agreement with the findings of Maina *et al.* (2022) who reported no significant difference in all the serum biochemical indices measured. However, cholesterol, a high molecular weight sterol, is used in the body as raw material for the therapeutic process which is useful in the normal role of the brain, and it is an essential constituent of the cell membrane including organelles inside the cell (Oloruntola *et al.*, 2018). Also, Sekine *et al.* (2013) reported that albumin concentration in serum is predicated on factors that are independent of nutrition such as infections, liver function, kidney disease, trauma and hydration status of which the result of this study clearly shows that none of these nutritional factors had considerable effects on the rabbits. The normal serum values obtained also showed nutritional adequacy of dietary protein. Abnormal serum albumin usually reveals an alteration in the normal systematic protein utilization.

Table 6: Serum Biochemical Indices of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumens Content (SDBRC)

Parameters	Diets					Normal value	SEM
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)		
Glucose (mmol/l)	4.92	4.57	5.23	4.50	4.18	4.00 - 10.00	0.26 ^{NS}
Total cholesterol (mmol/l)	4.48	4.64	5.15	3.84	4.44	Up to 5.17	0.32 ^{NS}
Total protein (g/dl)	7.44	6.63	7.38	6.59	7.12	6.20 - 8.00	0.39 ^{NS}
Total bilirubin (μmol/l)	13.79	12.12	14.08	11.07	9.86	Up to 17.00	1.44 ^{NS}
CB (μmol/l)	3.49	4.21	4.06	3.37	3.14	Up to 4.60	0.27 ^{NS}
Albumin (g/dl)	3.91	3.19	3.78	2.72	3.44	2.80 - 4.00	0.24 ^{NS}
Urea (mmol/l)	7.48 ^{ab}	5.80 ^{ab}	8.64 ^a	3.52 ^b	4.71 ^b	1.70 - 9.10	0.62 ^{**}

^{a,b}: Means on the same row with different superscripts are significantly ($P < 0.01$) different; SEM: Standard Error of the Means; NS: Not Significant; CB: Conjugated Bilirubin.

Cost Benefit of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumens Content

The cost benefit of weaner rabbits fed graded levels of sun-dried bovine rumen content is presented in Table 7. The total feed intake ranged from 3.45 to 3.67 kg on diets 5 and 1 respectively. Feed cost varied between ₦516.63/kg to ₦562.50/kg on diets 5 and 1 respectively. Total feed cost ranged from ₦1782.37 to ₦2064.38 on diets 5 and 1 respectively. Total weight gain recorded lowest (0.66 kg) on diet 4 while highest (0.79 kg) was recorded for the control diet. Feed cost per kg gain had the highest value (₦2613.14) on diet 1 while the lowest (₦2475.51) was recorded for diet 5. Cost saving varied between -₦145.60 and ₦137.63 on diets 4 and 5 respectively. Percent cost saving recorded the highest (5.27%) for diet 5, followed by diet 3 (3.83%). The result showed that feed cost (₦/kg) and total feed cost (₦) decreased as the levels of sun-dried bovine rumen content increased progressively in the diets. This is attributed to the cost price of sun-dried bovine rumen content which is lower compared to wheat offal. Feed cost per kg gain for the control diet was found to be cheaper than diets 2 and 4, but higher than diets 3 and 5, with diet 5 having the lowest value (₦2475.51). Also, the highest value of cost saving was observed on diet 5, thereby saving 5.27% of the cost of feed while diet 3 had ₦100.17, with 3.83% cost saving. This showed that the utilization of sun-dried bovine rumen content in the diets of rabbit had led to cost reduction in feed. This finding is in conformity with the report of Saidu *et al.* (2024).

Table 7: Cost Benefit of Weaner Rabbits Fed Graded Levels of Sun-Dried Bovine Rumens Content (SDBRC)

Parameters	Diets				
	1 (0%)	2 (30%)	3 (35%)	4 (40%)	5 (45%)
Total feed intake (kg)	3.67	3.50	3.53	3.49	3.45
Feed cost (₦/kg)	562.50	531.92	526.80	521.71	516.63
Total feed cost (₦)	2064.38	1861.72	1859.60	1820.77	1782.37
Total weight gain (kg)	0.79	0.69	0.74	0.66	0.72
Feed Cost/ kg gain (₦)	2613.14	2698.14	2512.97	2758.74	2475.51
Cost saving (₦)	0.00	-85.00	100.17	-145.60	137.63
Cost saving (%)	0.00	-3.25	3.83	-5.57	5.27

CONCLUSION AND RECOMMENDATION

Based on the results obtained from this study, it can be concluded that sun-dried bovine rumen content can best replace wheat offal at 45% level in the diets of weaner rabbits with comparative performance, carcass characteristics, haematological and serum biochemical indices to the control. Diet 5 (45% SDBRC) had a cost benefit of (₦137.63) with percent cost saving of 5.27% and is therefore recommended for rabbit production.



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