



UTILIZATION OF ROSELLE SEED CAKE AS PROTEIN SOURCE IN THE DIETS OF GROWER RABBITS AS PARTIAL REPLACEMENT FOR SOYBEAN MEAL (SBM)

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ABSTRACT

The study investigated the utilization of Roselle seed cake (RSC) in the diets of growing rabbits as Partial Replacement for Soybean Meal (SBM). Thirty grower rabbits of mixed breed were used for the six (6) week study. The grower rabbits were randomly assigned to five treatments, with three replicates having two rabbits per replicate in a completely randomized design. The experimental diets contained RSC at levels of 0, 10, 20, 30, and 40%, corresponding to T₁, T₂, T₃, T₄, and T₅, respectively. The performance results showed no significant differences ($P > 0.05$) in most parameters except in feed intake. Initial body weight ranged from 708.33 to 715.00g, final body weight 1235.00 to 1268.33g, total weight gain 525 g (10% RSC) to 553.33 g (40%), and daily weight gain 12.50 g (10%) to 13.17 g (T₅ 40% RSC). The feed conversion ratio ranged from 5.33 (40%) to 6.38 (10%). Significant differences ($P < 0.05$) were found in total feed intake. The highest TFI was in T₂ (10%) at 3346.67g and T₄ (30%) at 3285.78 g, while T₅ (40%) had the lowest at 2925.56g. Nutrient digestibility results revealed that the highest dry matter digestibility was in rabbits fed 30% RSC, while the crude protein digestibility ranges from 54.99-68.15% at 0 and 10% RSC. Crude fiber ranges from 57.37-60.24% at 40 and 10% and ether extract digestibility were significantly different ($p < 0.05$). In conclusion, the inclusion of 40% RSC did not significantly affect the growth performance and nutrient digestibility. It is recommended to include RSC at levels up to 30% to optimize growth performance and nutrient digestibility.

Keywords: Carcass, Characteristics, Digestibility, Grower and Performance

INTRODUCTION

Global rabbit meat production remains relatively low, with approximately 980 million rabbits slaughtered globally in 2016, yielding about 1.4 million tons of meat, a fraction of the 329.9 million tons of global meat production (Trocino *et al.*, 2019). Asia dominates rabbit meat production, contributing around 73% of the global market, followed by Europe, Africa, and the Americas (Chisoro and Nkukwana, 2020a). While rabbit meat production has risen in recent years, the growth is uneven across regions, with Asia seeing the most significant increase (Szendro *et al.*, 2020). In Europe, Spain, France, and Italy are the primary producers, where commercial and backyard farming co-exist (European Commission, 2017). Rabbit meat is highly valued for its nutritional benefits, containing high protein content, essential amino acids, and beneficial fatty acids, making it a recommended choice by dietitians (Dalle-Zotte, 2014). Rabbits are also well-suited for both commercial and subsistence farming, offering a solution to protein malnutrition in developing regions due to their efficient feed conversion, rapid growth, and adaptability (Abdullahi *et al.*, 2024).

In sub-Saharan Africa, protein malnutrition is a critical issue, driven by inadequate animal protein intake (Chisoro *et al.*, 2023). The livestock sector in Africa faces challenges, including limited access to quality feed, high feed costs, and environmental degradation (Asmare and Meheret, 2018). Climate change exacerbates these challenges by impacting feed availability and



quality (Jalal *et al.*, 2023). To address these issues, there is a growing interest in using locally available, affordable, and sustainable feed alternatives, such as agricultural by-products and invasive plant species (Chisoro and Nkukwana, 2020a.). Research has shown that unconventional feed resources, like Roselle seed cake, could serve as viable alternatives to traditional feed ingredients like soybean meal (Igoche, 2015). Roselle seed cake, a by-product of the hibiscus flower industry, is rich in protein, fiber, and antioxidants, offering a cost-effective and readily available protein source for poultry diets (Aletor *et al.*, 2019; El-Sayed, 2019). Although not widely explored, its potential as a substitute for conventional protein sources could reduce reliance on scarce and expensive feed ingredients, providing economic benefits for farmers and supporting the growth of the livestock sector in Africa (Onunkwo *et al.*, 2019). The study aimed to investigate the utilization of Roselle seed cake as protein source in the diets of grower rabbits as partial replacement for soybeans.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Teaching and Research Farm, Abubakar. Tafawa Balewa University, ATBU, Bauchi. The area is located within the Southern Guinea Savannah on latitude 10° 18'37.2 N and longitude 9° 50'38.0 E. The average annual rainfall of Bauchi is about 1009 mm, highest relative humidity 94% (August) and the lowest 35% (February). Temperatures are between 13 – 17°C (December – February) and 36 – 37°C (March – April) (World Atlas, 2015).

Sources of Roselle seed cake

Roselle seeds were obtained at Muda-Lawal market, Bauchi State. The seeds were first cleaned and then transported to oil extraction factory where they were subjected to mechanical pressing to remove the oil. After the oil was extracted, the remaining solid material, known as seed cake or meal, was collected for the research study.

Experimental Rabbits and Their Management

A total of thirty mixed breed Rabbits, 6-7 weeks old were used for the study which lasted for six weeks. The animals were allowed a week adjustment for period for acclimatization and rendered or given prophylactic medication before they were randomly allotted to the five treatments diets, each treatment replicated three times with two rabbits per replicate in a completely randomized design (CRD). The rabbits were housed in a well-constructed cage with provision of feeding trough and drinkers. Feed and water were provided *ad-libitum*. Routine sanitary operations were also carried out.

Experimental Diets

Five (5) experimental diets (16 CP%) were formulated to contained graded levels of Roselle seed meal at 0, 10, 20, 30, and 40% as designated diets 1, 2, 3, 4 and 5 respectively. Ingredients and percentage composition of dietary levels of Roselle seed cake fed to weaner rabbits is shown in Table 1.



Table 1: Composition of Experimental Diets Containing Varied Levels of Roselle seed cake

Parameters	Diets				
	1(0%) RSC	2(10%) RSC	3(20%) RSC	4(30%) RSC	5(40%) RSC
Maize	27.00	27.00	29.00	30.00	30.00
Soybean meal	15.00	13.50	12.00	10.50	9.00
Roselle seed cake	0.00	1.50	3.00	4.50	6.00
Maize offal	11.00	11.00	11.00	11.00	10.00
Wheat offal	21.80	21.80	21.80	21.80	22.80
Groundnut hay	22.00	22.00	20.00	19.00	19.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated analysis					
Crude protein	16.04	16.12	15.98	16.10	16.33
ME kcal/kg	2469.40	2429.65	2409.90	2380.15	2328.40

ME= Metabolisable energy

Table 2: Proximate Composition of Experimental Diets Containing Varying Levels of Roselle Seed Cake Meal (RSC) as Partial Replacement for Soybean Meal (SBM)

PARAMETERS (%)	T1 (0%) RSC	T2 (10%) RSC	T3 (20%) RSC	T4 (30%) RSC	T5 (40%) RSC
	RSC	RSC	RSC	RSC	RSC
Dry matter	90.54	89.88	90.91	90.90	90.55
Crude protein	16.04	16.12	15.98	16.10	16.33
Crude fiber	13.76	14.91	14.10	14.66	12.88
Ether extract	5.11	6.02	5.67	4.98	5.13
Ash	7.51	7.28	8.44	8.52	7.60
Nitrogen free extract	57.58	56.67	55.81	56.74	58.06

RSC: Roselle Seed Cake Meal

Experimental Design

The experiment was conducted in a completely randomized design (CRD) (Steel and Torrie, 1990). Rabbits were randomly assigned to five treatments with three replicates having two rabbits per replicate.

Data Collection

Feed Intake (g)

Feed was served in the morning and evening using a balance weighing scale.

Feed intake: The total quantity of feed given per day minus the leftover, as shown below.

$$\text{Feed intake} = \text{Total quantity of feed given} - \text{Leftover} \quad \dots(1)$$

Weight gain (g)

This is calculated as final weight minus initial weight as shown below.

$$\text{Weight gain} = \text{Final weight} - \text{Initial weight} \quad \dots(2)$$

Feed conversion ratio

Feed conversion ratios were calculated by.

$$\text{Feed Conversion Ratio} = \frac{\text{Quantity of feed consumed}}{\text{Weight gain}} \quad \dots(3)$$



Carcass evaluation

At the end of the six (6) weeks study, three (3) Rabbits from each treatment were randomly selected individually weighed, slaughtered, skinned and eviscerated. Weight of carcass and organs were also measured. Dressing percentage (DP) was obtained by weighing the carcass relative to the live weight of each rabbits and expressed in percentage (%) as shown below.

$$\text{Dressing Percentage (DP)} = \frac{\text{Carcass weight}}{\text{Live Weight}} \times 100 \quad \dots(4)$$

Nutrients digestibility

Digestibility study was conducted during the last week of feeding. Fecal samples were collected daily for 5 days to determine nutrient digestibility. Pieces of nylon net were tied under individual cages to collect feces. Fecal output from each rabbit was collected daily, dried and stored in an air tight container. At the end of the 5 days collection period, the feces from each rabbit was bulked, weighed and thoroughly mixed and sampled for proximate analysis according to AOAC (1990). Determination of apparent nutrients was calculated using this equation.

$$\text{Apparent digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient voided}}{\text{Nutrient intake}} \times 100 \quad \dots(5)$$

Chemical Analysis

The proximate composition of experimental diets samples was determined according to the methods of AOAC (1990). For each nutrient, the sample was analyzed thrice, and an average was recorded as the representative value.

Data Analysis

Data collected were subjected to one way analysis of variance (ANOVA) using the general linear model of SPSS (2007) and where differences exist among the means separated at 5% level of significance ($P < 0.05$) using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Growth Performance of Grower Rabbits Fed Varied Levels of Roselle Seed Cake Meal (RSC) as Partial Replacement for Soybean Meal (SBM)

The growth performance of rabbits fed Roselle seed cake (RSC) as presented in Table 3. Most parameters, including initial body weight, final body weight, total weight gain, daily weight gain, and feed conversion ratio (FCR), showed no significant differences ($P > 0.05$), except for total feed intake (TFI) and daily feed intake (DFI), which showed significant differences ($P < 0.05$). The initial body weight of the rabbits across the treatments ranged from 708.33 g to 715.00 g, while the final body weight varied between 1235.00g and 1268.33g. These results indicate that the rabbits across all treatment groups maintained a consistent growth trajectory, unaffected by the varying levels of RSC in their diets. The lack of significant difference in initial and final body weights suggests that RSC provided an adequate nutrient profile (Table 3), enabling steady growth in the rabbits, similar to findings by El-Sayed. (2019), who noted that Roselle seed by-products can support growth when included in animal feed.

Total weight gain ranged from 525g in T₂ (10% RSC) to 553.33g in T₅ (40% RSC), and daily weight gain ranged from 12.50g in T₂ to 13.17g in T₅ (Table 3). The absence of significant differences in weight gain parameters indicates that RSC did not negatively impact the growth rates of the rabbits across different inclusion levels. This could be due to the reduction of anti-nutritional factors through heat treatment during the oil extraction process, a method noted by Igoche (2015) for its effectiveness in improving feed quality by reducing harmful components in



Roselle seeds. The feed conversion ratio (FCR), which measures the efficiency of the rabbits in converting feed into body mass, ranged from 5.33 in T₅ to 6.38 in T₂. The absence of significant differences in FCR across the treatments further underscores the suitability of RSC as a feed ingredient, indicating that rabbits could efficiently convert the RSC-inclusive diets into body weight, consistent with findings by Onunkwo *et al.* (2019), who also reported positive FCR values in poultry fed with Roselle seed cake meal.

Significant differences were observed in Total Feed Intake (TFI) and Daily Feed Intake (DFI) TFI and DFI, with T₂ (10% RSC) recording the highest total feed intake at 3,346.67g, while T₅ (40% RSC) had the lowest at 2,925.56g. These results suggest that higher inclusion levels of RSC may lead to reduced feed intake, as observed in T₅ (Table 3). This trend aligns with the observations of Awodola-Peters *et al.* (2019), who found that increasing levels of certain feed ingredients could lead to lower feed intake, potentially due to reduced palatability or increased fiber content. For daily feed intake, T₂ and T₄ (30% RSC) had the highest DFI at 79.68g, while T₅ recorded the lowest at 69.66g (Table 3). This is in contrast to higher DFI values of 100.56 g to 102.56 g reported by Wafar *et al.* (2020) for rabbits fed processed fermented sorrel seed meal. The lower feed intake in the present study might be due to differences in processing methods or the specific composition of the RSC used.

Table 3: Growth Performance of Grower Rabbits Fed Varied Levels of Roselle Seed Cake Meal (RSC) as Partial Replacement for Soybean Meal (SBM)

PARAMETERS	T ₁ (0%) RSC	T ₂ (10%) RSC	T ₃ (20%) RSC	T ₄ (30%) RSC	T ₅ (40%) RSC	SEM
INTIAL	708.33	710.00	708.33	711.67	715.00	1.07 ^{NS}
FWG	1251.67	1235.00	1240.00	1251.67	1268.33	11.07 ^{NS}
TWG	543.33	525.00	531.67	540.00	553.33	11.08 ^{NS}
DWG	12.93	12.50	12.66	12.86	13.17	0.26 ^{NS}
TFI	3086.67 ^{ab}	3346.67 ^a	3054.89 ^{ab}	3285.78 ^a	2925.56 ^b	54.25 [*]
DFI	73.49 ^{ab}	79.68 ^a	72.74 ^{ab}	78.23 ^a	69.66 ^b	1.29 [*]
FCR	5.75	6.38	5.77	6.14	5.33	0.18 ^{NS}

^{a,b,c,d} on the same row shows significant difference ($p < 0.05$), RSC: Roselle Seed Cake Meal, FWG: final weight gain, TWG: total weight gain, DWG: daily weight gain, TFI: total feed intake, DFI: daily feed intake, FCR: feed conversion ratio

Nutrient Digestibility of Rabbits Fed Varying Levels of Roselle Seed Cake (RSC) as Partial Replacement for Soybean Meal (SBM)

The dry matter digestibility in the current study ranged from 87.45% in T₅ (40% RSC) to 89.88% in T₄ (30% RSC), with significant differences observed among the treatments. This indicates that T₄ had the highest dry matter digestibility, suggesting that a 30% inclusion of RSC might provide an optimal balance for nutrient absorption (Table 4). These values are comparable to those reported by Malik *et al.* (2020) in weaner rabbits fed cowpea milling waste, where dry matter digestibility ranged from 86.40% to 87.97%. Similarly, Azi and Alu (2022) found that Acha offal inclusion resulted in dry matter digestibility between 83.75% and 87.03%, indicating that RSC at certain levels can achieve similar or better digestibility.

Crude protein digestibility in the current study (Table 4) showed values ranging from 54.99% in T₁ (0% RSC) to 68.15% in T₂ (10% RSC). Although no significant differences were observed across the treatments, the higher values in T₂ and T₃ (20% RSC) suggest that moderate inclusion levels of RSC could enhance protein digestibility. In contrast, the study by Evans *et al.* (2024) reported higher crude protein digestibility values ranging from 87.68% to 90.97% with



Delonix regia seed meal, suggesting that RSC may have lower protein digestibility potential compared to other seed meals. On the other hand, Mohammed *et al.* (2020) found similar trends in crude protein digestibility when using African locust bean pulp, with values ranging from 69.46% to 73.73%, indicating that RSC's protein digestibility falls within a reasonable range for alternative feed ingredients.

The crude fiber digestibility in this study (Table 4) ranged from 57.37% in T5 (40% RSC) to 60.23% in T2 (10% RSC). These values are slightly lower than those reported by Malik *et al.* (2020) for rabbits fed cowpea milling waste, where crude fiber digestibility ranged from 72.64% to 84.04%. However, they align more closely with the results from Mohammed *et al.* (2020), where crude fiber digestibility ranged from 42.20% to 58.12% when using African locust bean pulp. This suggests that RSC's crude fiber digestibility is comparable to other alternative feed ingredients, though it may be slightly less effective than more fibrous alternatives.

Ether extract digestibility in the current study (Table 4) showed significant differences, with values ranging from 63.86% in T1 (0% RSC) to 77.71% in T4 (30% RSC). This indicates that higher inclusion levels of RSC (particularly 40%) significantly enhance ether extract digestibility. These values are consistent with those reported by Evans *et al.* (2024), where ether extract digestibility ranged from 24.38% to 32.15%, and higher than the ether extract digestibility reported by Azi and Alu (2022), which ranged from 61.00% to 65.23% in rabbits fed Acha offal. Similarly, Mohammed *et al.* (2020) reported higher ether extract digestibility with African locust bean pulp, ranging from 58.99% to 83.36%, aligning with the current findings where higher RSC inclusion resulted in better fat utilization.

Ash digestibility in this study (Table 4) varied significantly, with T1 (0% RSC) and T4 (30% RSC) showing the highest values at 65.07% and 65.91%, respectively, while T5 (40% RSC) had the lowest at 53.72%. These values are lower than those reported by Malik *et al.* (2020), where ash digestibility ranged from 43.74% to 63.54%, but comparable to Mohammed *et al.* (2020), who found ash digestibility values between 45.43% and 56.35%. The significant differences in ash digestibility observed here suggest that optimal RSC inclusion levels may vary, with too high and inclusion potentially reducing mineral absorption.

The nitrogen-free extract digestibility showed (Table 4) no significant differences, with values ranging from 71.43% to 72.88%. These findings are consistent with the results reported by Malik *et al.* (2020) for weaner rabbits fed cowpea milling waste, where NFE digestibility ranged from 93.58% to 96.04%. Mohammed *et al.* (2020) also reported similar trends in NFE digestibility with African locust bean pulp, ranging from 65.20% to 76.52%. The consistent NFE digestibility across treatments suggests that RSC inclusion does not adversely affect carbohydrate utilization, maintaining energy provision across all level.

Table 4: Nutrient Digestibility of Rabbits Fed Varying Levels of Roselle Seed Cake (RSC) as Partial Replacement for Soybean Meal (SBM)

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	SEM
Dry Matter	88.48 ^d	89.07 ^b	88.95 ^c	89.88 ^a	87.45 ^e	0.11*
Crude Protein	54.99	68.15	68.00	64.24	66.15	6.73 ^{ns}
Crude Fiber	59.54	60.23	57.59	58.59	57.37	2.84 ^{ns}
Ether Extract	63.86 ^b	74.19 ^a	66.66 ^b	77.71 ^a	76.21 ^a	2.57*
Ash	65.07 ^a	51.00 ^b	54.50 ^b	65.91 ^a	53.72 ^c	4.51*
Nitrogen free extract	72.88	72.45	71.43	72.45	72.88	0.71 ^{ns}

^{a,b} on the same row shows significant difference ($p < 0.05$), SEM: standard error of the means



CONCLUSION AND RECOMMENDATIONS

The study concluded that roselle seed cake (RSC) can be included in rabbit diets up to 40% without significantly affecting growth performance parameters such as final weight gain, total weight gain, daily weight gain, and feed conversion ratio. Carcass characteristics remain unaffected by RSC levels, but hematological parameters indicate potential health impacts, particularly at higher inclusion levels. It is recommended to include RSC at levels up to 30% level to optimize growth performance while maintaining healthy hematological parameters. Further studies should be conducted to understand the long-term effects of varying RSC levels on rabbit health and productivity.

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