©Kashere J. Anim. Sci. Volume 1 Issue 1 229-236 ISSN: 3115-6479
Date received: 26th November 2025
Date accepted: 6th December 2025
Date published: 28th December 2025

GROWTH PERFORMANCE AND COST BENEFITS ANALYSIS OF WEANER RABBITS FED TOASTED ROSELLE (*Hibiscus sandariffa*) SEED MEAL BASED DIETS

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ABSTRACT
This study was conducted at the Teaching and Research Animal Farm, Faculty of Agriculture, Federal University of Kashere, Gombe State, to evaluate the effect of roselle seed meal (RSM) as a partial replacement for full-fat soybean on the growth performance and economics of production of weaner rabbits. A total of twenty-four (24) weaner rabbits of mixed sexes were randomly allotted to three dietary treatments in a Completely Randomized Design (CRD) experiment. Each treatment was replicated four times with two rabbits per replicate. The experiment lasted for a period of eight weeks. The experimental diets contained 0% (T1), 20% (T2), and 40% (T3) levels of RSM replacing soybean 'full fat'. Data were collected on initial weight, final weight, total weight gain, daily weight gain, daily feed intake, feed conversion ratio, and mortality. A cost–benefit analysis was also carried out. Results of daily feed intake (84.63-95.49g), daily weight gain (13.28-15.07g) and feed conversion ratio (6.25-6.63) measured were all similar. Feed intake and weight gain decrease as RSM inclusion level increases, but feed conversion ratio remained similar across treatments although, the best FCR was in treatment 2 (6.25). Mortality was not recorded, indicating that RSM is safe for rabbit feeding. Cost benefits analysis revealed reduced feed cost in Naira per kilogram gain with increasing RSM inclusion levels, the highest value was the control, and the lowest treatment 2. Therefore, from this study it can be concluded that roselle seed meal can be included in weaner rabbit diets up to 20% replacement level for soya bean 'full-fat' without negative effects on growth performance and with corresponding reduction in feed costs.

Keywords: Economics, Feed cost, Performance, Roselle seed meal, Weaner rabbits

1.0 INTRODUCTION
Livestock production is a crucial component of global food security, providing essential animal proteins in the form of meat, milk, and eggs. However, the productivity of these sectors largely depends on the availability of affordable and nutritionally balanced feed resources. Feed constitutes about 60–80% of the total cost of animal production, and the increasing cost of conventional feed ingredients, particularly soybean meal and fish meal, poses a significant challenge to sustainable livestock production (Olukosi and Akinyemi, 2021). The dependence on these expensive feedstuffs has resulted in reduced profitability for farmers and limited expansion of the livestock industry, thereby threatening food security and income generation (Esonu *et al*., 2020). In light of these challenges, the search for alternative, underutilized, and locally available feed resources have become imperative. Roselle (*Hibiscus sabdariffa*) seed meal, which is often discarded as waste after calyx harvesting, presents a potential substitute for conventional protein sources due to its appreciable crude protein and essential amino acid content (Sridhar and Bhat, 2021). The roselle seeds are rich in proteins, essential fatty acids, and minerals, making them a potential candidate for partial replacement of conventional protein sources in animal feed (Ali *et al*., 2020). The utilization of these seeds can help reduce feed costs and simultaneously minimize agricultural waste. Nutritionally, roselle seeds contain approximately 18–25% crude protein, with appreciable levels of lysine and other essential amino acids (Morrison *et al*., 2022). In addition, the seeds contain oil rich in linoleic acid, which

could provide energy and support metabolic functions in livestock. The presence of bioactive compounds in roselle seeds has also been reported to have antioxidant and antimicrobial properties, which may contribute to improved health and performance of animals (Abbas *et al*., 2021). This makes roselle seed meal an attractive supplement in animal nutrition programs. Roselle (*Hibiscus sabdariffa*) seed meal is abundant in many parts of Nigeria and has been reported to possess appreciable levels of crude protein, essential amino acids, and minerals that could make it a viable substitute for conventional protein sources in animal nutrition (Ogunlade *et al*., 2021). Utilizing Roselle seed meal in feed formulation would not only reduce feed cost but also minimize competition between humans and livestock for staple protein sources like soybean. Integrating Roselle seed meal into livestock feed can promote sustainable agricultural practices and enhance food security. Previous studies have shown that incorporating underutilized legume and oilseed by-products in livestock feed improves growth performance while lowering production costs (Idowu *et al*., 2020; Bello *et al*., 2022). The objectives of this study therefore, is to evaluate the growth performance and cost effectiveness of feeding weaner rabbits roselle seed meal-based diets.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was conducted at Teaching and Research Animal Farm Faculty of Agriculture, Federal University of Kashere Gombe State Nigeria. The Rabbits were sourced from farms and villages within Gombe State. The Roselle Seed Meal was sourced from Kashere market. The seeds were collected and toasted to reduce the anti-nutritional factors and moisture content.

2.2 Experimental Animals and their Management

A total of 24 weaner rabbits, both male and female, were selected for the study. The rabbits were of similar age, weight, and breed to minimize variation. The rabbits were housed in well-ventilated cages with 1x2x3 feet, to allow free movement. Each cage was equipped with a feeder, drinker, and a resting area. The rabbits were fed their respective diets *ad libitum,* ensuring that they had constant access to feed, water and proper hygiene.

2.3 Experimental Design

Twenty-four weaner rabbits (both sexes) were randomly allotted to three treatments diets that were replicated four times of two weaner rabbits per replicate in a Completely Randomized Design (CRD) experiment. The experiment lasted for a period of eight weeks.

2.4 Experimental Diets

Three experimental diets were formulated to meet the nutritional requirements of weaner rabbits, with the varying inclusion levels of roselle seed meal as partial replacement of soyabean 'full fat' at 0, 20 and 40% designated as treatments 1 (control), 2 and 3 respectively, as shown in Table 1 below.

2.5 Data Collection

Data on the growth performance were recorded such as feed intake on daily basis, weight changes on weekly basis. Data obtained on daily feed intake (DFI) and daily weight gain (DWG) were used to determine the feed conversion ratio (FCR). Body weight, feed consumption and feed conversion ratio were measured as the performance indices and cost per kilogram of feed and feed cost per kilogram weight gain were calculated to show the cost effectiveness of using roselle seed meal to partly replacing "full-fat' soyabean.

Table 1: Percentage composition of the experimental diets fed to weaner rabbits

Ingredients	Diets		
	1 (0%)	2 (20%)	3 (40%)
Maize	46.94	46.94	46.94
TRSM	0.00	7.85	15.70
Soya bean (FF)	39.26	31.41	23.56
Wheat Bran	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00
+Premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Methionine	0.20	0.20	0.20
Lysine	0.10	0.10	0.10
Total	100.00	100.00	100.00
Calculated Analysis			
Crude protein (%)	20.35	19.70	19.10
ME (Kcal/kg)	2940.00	2890.00	2840.00
Crude fibre (%)	3.95	4.85	5.75
Calcium (%)	1.22	1.23	1.25
Phosphorus (%)	0.70	0.70	0.69

TRSM = Toasted Roselle Seed Meal; ME = Metabolizable Energy

2.6 Data Analysis

All data obtained were subjected to Analysis of Variance (ANOVA) using SAS statistical software. Where significant differences occurred among treatment means, Duncan's Multiple Range Test (DMRT) was used to separate the means at a 5% probability level ($p<0.05$).

3.0 RESULTS AND DISCUSSION

3.1 Results

The results of the proximate composition of toasted roselle seed meal as in Table 2, showed a dry matter content of 93.00%, Crude protein content of 30.00%, Ether extract value of 21.00%, Crude fiber value of 16.00%, Ash content of 6.00% and Nitrogen Free Extract estimated to be 27.00%.

The effect of incorporating roselle seed meal (RSM) into the diets of weaner rabbits on growth performance is presented in Table 2. Parameters measured include initial body weight, final body weight, weight gain, daily feed intake, feed conversion ratio, and mortality rate. Overall performance indicators did not differ significantly ($P > 0.05$) among diets, indicating that including RSM up to 40% did not impair growth or survivability of weaner rabbits. Numerically, final weight and total gain declined with higher RSM: T1 had the highest final weight (1425 g), while T3 was about 10.1% lower (1281.25 g). Daily weight gain showed a similar pattern (15.07 vs. 13.28 g/day; 11.9% lower in T3). Daily feed intake decreased progressively with RSM level (95.49 → 84.63 g/day; 11.4% lower in T3). Feed conversion ratios were comparable (6.63–6.39), with T2 showing the lowest (best) FCR numerically (6.25), but differences were not significant. Zero mortality across all treatments suggests good dietary safety.

The slight numerical reductions at higher inclusion likely reflect modest effects of RSM on palatability or nutrient availability (e.g., fiber or residual anti-nutritional components), but the lack of statistical significance and the stable FCR indicate overall comparable efficiency of nutrient use across diets. Note that T3 started slightly lighter (initial weight ~7.5% below T1), which may partly explain its lower final weight independent of diet effects. Taken together, the data support the practical conclusion that RSM can replace conventional ingredients in weaner rabbit diets up to 40% without significant loss in performance or health. The results of the cost benefits analysis of weaner rabbits that were fed graded levels of roselle seeds meal diets is presented in Table 3. The cost–benefit analysis shows that feed cost per kilogram reduced as the inclusion of roselle seed meal (RSM) increased. The control diet (T1) had the highest feed cost (₦1114.91/kg), while T3 recorded the lowest (₦1075.66/kg). Consequently, the total feed cost incurred per rabbit was lowest in T3 (₦5098.63) and highest in T1 (₦5964.77). This reduction reflects the lower market price of RSM compared to conventional protein sources such as soybean meal, making diets with higher RSM inclusion more economical in terms of feed formulation. However, when efficiency is considered (feed cost per kilogram of body weight gain), T2 (₦6845.56/kg gain) was the most cost-effective, followed by T3 (₦6890.04/kg gain), while T1 was the least economical (₦7100.92/kg gain). Cost savings relative to the control were positive for T2 (₦255.36) and T3 (₦210.88), implying that feed formulation was cheaper with RSM, giving potential cost advantage. Overall, the results suggest that incorporating RSM up to 40% reduces feed cost per unit weight and improves economic returns due to the positive cost savings.

Table 2: Proximate Composition of Toasted Roselle seed meal

Nutrients	**Composition (%)**
Dry Matter	93.00
Crude Protein	30.00
Ether extract	21.00
Crude fiber	16.00
Ash	6.00
Nitrogen Free Extract	27.00

Table 3: Growth performance of weaner rabbits fed roselle seed meal (RSM)–based diets

Parameter	**T1 (0% RSM)**	**T2 (20% RSM)**	**T3 (40% RSM)**	**SEM**	**Sig.**
Initial weight (g)	581.25	575.00	537.50	34.88	NS
Final weight (g)	1425.00	1375.00	1281.25	30.69	NS
Total weight gain (g)	843.75	800.00	743.75	33.55	NS
Daily weight gain (g)	15.07	14.29	13.28	0.60	NS
Daily feed intake (g)	95.49	89.35	84.63	2.29	NS
Feed conversion ratio	6.64	6.25	6.37	0.30	NS
Total feed intake (g)	5347.50	5003.75	4739.25	128.14	NS
Mortality (number)	0.00	0.00	0.00	0.00	NS

SEM = Standard Error of Mean, NS = Not Significant

Table 4: Cost–benefit analysis of weaner rabbits fed roselle seed meal (RSM)–based diets

Parameter	**T1 (0% RSM)**	**T2 (20% RSM)**	**T3 (40% RSM)**
Feed cost (₦/kg)	1114.91	1095.29	1075.66
Total feed intake (kg)	5.35	5.00	4.74
Total feed cost (₦)	5964.77	5476.45	5098.63
Total weight gain (kg)	0.84	0.80	0.74
Feed cost per kg gain (₦)	7100.92	6845.56	6890.04
Cost savings (₦)	0.00	255.36	210.88

3.2 Discussion

The growth performance results showed no significant (P>0.05) differences among treatments, indicating that inclusion of roselle seed meal up to 40% did not adversely affect weight gain, feed intake, or survivability of weaner rabbits. Numerically, the control group (T1) performed better in terms of final weight (1425 g) and daily weight gain (15.07 g/day), while T3 (40% RSM) recorded slightly lower values (1281.25 g and 13.28 g/day, respectively). Feed intake decreased progressively with increasing RSM level, from 95.49 g/day in T1 to 84.63 g/day in T3, suggesting possible effects of dietary fiber or palatability at higher inclusion levels. There is no significant difference (P>0.05) in the total weight gain and feed conversion ratio. The reported values are lower than the values of 1212.75 to 1228.61 reported by Wafar *et al.,* (2020), who fed fermented sorrel seed meals to weaner rabbits, however the values are higher than the value ranges of 553.98 to 578.51 reported by Yusuf *et al.,* (2024) who fed rabbits graded levels of fermented Sunflower seed meals. Despite this, feed conversion ratios (6.25–6.63) were comparable across diets, and mortality was zero in all groups, confirming that RSM can safely be used as a dietary ingredient for rabbits. The FCR values are higher than the values of 4.62 to 4.74 reported by Wafar *et al.,* (2020), who fed fermented sorrel seed meals to weaner rabbits, while the values reported by Wafar *et al.,* (2020) are similar to the value ranges of 4.46 to 4.60 reported by Yusuf *et al.,* (2024) who fed rabbits with graded levels of fermented Sunflower seed meals. The cost–benefit analysis revealed that feed cost per kilogram decreased with higher levels of RSM, reflecting the cheaper cost of RSM compared to conventional protein sources. Total feed cost per rabbit reduced from ₦5964.77 in treatment 1 to ₦5098.63 in treatment 3. However, when expressed as feed cost per kilogram of weight gain, treatment 2 (20% RSM) was the most economical (₦6845.56), while treatment had the highest value of (₦7100.92). Higher cost savings in treatment 2 of (₦255.36) and treatment 3 (₦210.88) revealed that partly replacing costly "full-fat" soyabean causes the reduction in the feed cost. This results also indicated that although RSM can reduce feed cost, but its inclusion beyond moderate levels of (20%) may not necessarily translate into better economic returns. Therefore, partial inclusion (20%) appears to balance both performance and cost-effectiveness in rabbit production.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The findings of this study demonstrated that roselle seed meal can be safely included in the diets of weaner rabbits up to 20% without adverse effects on growth performance with reduction in feed cost. Although growth performance decreased slightly at higher inclusion levels, feed efficiency and feed conversion ratios were not affected. Economic analysis showed that diets containing 20% RSM provided the best balance between growth performance and cost-effectiveness. Therefore, roselle seed meal represents a promising alternative protein source to partially replace soybean full fat in rabbit diets, contributing to lower feed costs and reducing dependence on conventional protein sources.

4.2 Recommendations

1. Roselle seed meal should be included at moderate levels (around 20%) in rabbit diets to optimize growth performance at reduced cost of production.
2. Further processing techniques such as other heat treatments e.g. boiling or fermentation should be explored to reduce anti-nutritional factors in roselle seed meal and enhance nutrient utilization.
3. Farmers should adopt roselle seed meal as a locally and affordable alternative protein source to reduce reliance on expensive soybean meal.

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