



EFFECTS OF DIETARY SUPPLEMENTATION WITH PROBIOTIC (*Saccharomyces cerevisiae*) ON THE GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND COST EFFICIENCY OF RABBITS

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ABSTRACT

The study was carried out to evaluate the effect of dietary supplementation of *Saccharomyces cerevisiae* on growth performance, carcass characteristics and economic efficiency of growing rabbits. Thirty mongrel rabbits were randomly assigned to five dietary treatments containing 0.00, 0.25, 0.50, 0.75, and 1.00% *S. cerevisiae* in a Completely Randomized Design for seven weeks. Data on growth performance, carcass traits, and production economics were analyzed using one-way ANOVA, with Duncan's Multiple Range Test used to separate means at $P < 0.05$. Supplementation of *Saccharomyces cerevisiae* in the diet of rabbits, significantly improved final body weight, weight gain, average daily gain, feed conversion ratio, slaughter weight, dressed weight, and dressing percentage while feed intake and internal organ weights were not significantly affected. Rabbits fed the 0.50% probiotic diet recorded the highest final body weight (1828.75 g), total weight gain (1122.65 g), average daily gain (22.91 g/day), slaughter weight (1804.25 g), dressed weight (1102.30 g), dressing percentage (61.09%), and the best feed conversion ratio (4.17). Although feed cost increased with probiotic inclusion (₦365.00–379.00/kg), the 0.50% diet produced the lowest feed cost per kilogram of weight gain (₦1,551.24) and highest cost savings of ₦204.41. It was concluded that dietary supplementation with 0.50% *Saccharomyces cerevisiae* optimizes growth performance, carcass yield, feed efficiency, and profitability without adversely affecting internal organ development in growing rabbits.

Keywords: Probiotics, Rabbits, Growth, Performance, Carcass, Characteristics

INTRODUCTION

Rabbit production is an important component of sustainable livestock farming because it provides high-quality animal protein, enhances food security, and generates income for smallholder farmers (Trocino *et al.*, 2022). Rabbits are known for rapid growth, high reproductive efficiency, efficient feed conversion, and the ability to utilize fibrous feed resources unsuitable for human consumption (Dionisio *et al.*, 2023; Birolo, 2023; Siddiqui *et al.*, 2024). Rabbit meat is also valued for its high protein content, low fat and cholesterol levels, and a favorable fatty acid profile (Dalle Zotte and Szendrő, 2021; El-Sabrou *et al.*, 2023). However, feed accounts for about 60–70% of production costs, and concerns over antimicrobial resistance have increased the need for safe alternatives to antibiotic growth promoters (Dionisio *et al.*, 2023; Abd El-Aziz *et al.*, 2025). Among natural feed additives, *Saccharomyces cerevisiae* has attracted considerable attention for its ability to improve gut microbial balance, nutrient utilization, immune response, and overall productivity (Helal *et al.*, 2021; Elghandour *et al.*, 2024; Chowdhury *et al.*, 2025; Yue *et al.*, 2025). Previous studies have reported improvements in growth performance, feed efficiency, carcass yield, and meat quality following dietary supplementation with *S. cerevisiae* (Rotolo *et al.*, 2014; Istifanus, 2024; Osita *et al.*, 2024; Abdelsalam *et al.*, 2025; Elbaz *et al.*, 2025; Fathi *et al.*, 2025). Although probiotics may slightly increase feed costs, improved feed conversion and weight gain can enhance production profitability (Elghandour *et al.*, 2024; Abd El-Aziz *et al.*, 2025). However, information on the optimal dietary inclusion level of *S. cerevisiae* under Nigerian production conditions remains limited. Therefore, this study evaluated the effects of graded dietary levels of *S. cerevisiae* on the growth performance, carcass characteristics, and economic efficiency of growing rabbits.



MATERIALS AND METHODS

Study Area

The experiment was conducted at the Rabbit Unit of the Bauchi State College of Agriculture, Bauchi, Nigeria, within the Sudan–Sahel savannah zone (9°03'–12°03' N and 8°50'–11°00' E). The area experiences a tropical savannah climate with distinct wet and dry seasons, and annual rainfall ranges from 700 to 1,300 mm (Bauchi State Government, 2025).

Experimental Animals and Management

Thirty (30) mongrel growing rabbits were used in a seven-week feeding trial. Before the experiment, the rabbits were acclimatized for one week and given routine prophylactic treatments. Animals were housed individually in well-ventilated cages equipped with feeders and drinkers. Feed and clean drinking water were provided ad libitum, and standard sanitary and management practices were maintained throughout the study.

Experimental Diets

Five experimental diets were formulated to contain approximately 16% crude protein, in accordance with NRC (1977) recommendations for growing rabbits. The basal diet consisted mainly of sorghum, soybean meal, groundnut cake, groundnut haulm, and wheat offal. *Saccharomyces cerevisiae* (Schromys®) was incorporated at dietary inclusion levels of 0.00, 0.25, 0.50, 0.75, and 1.00% to produce treatments D1, D2, D3, D4, and D5, respectively (Table 1). All ingredients were thoroughly mixed to ensure uniform distribution of the probiotic before feeding.

Table 1: Gross Composition of the Experimental Diets

Ingredient (%)	Diets				
	Inclusion levels of probiotics				
	D1	D2	D3	D4	D5
	(0%)	(0.25%)	(0.50%)	(0.75%)	(1.00%)
Sorghum	46.00	45.75	45.50	45.25	45.00
Soybean meal	22.00	22.00	22.00	22.00	22.00
Groundnut cake	8.00	8.00	8.00	8.00	8.00
Groundnut haulm	10.00	10.00	10.00	10.00	10.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
<i>Saccharomyces cerevisiae</i>	0.00	0.25	0.50	0.75	1.00
Bonemeal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated analysis					
Crude Protein (%)	16.00	16.03	16.06	16.09	16.12
Crude Fibre (%)	10.50	10.54	10.58	10.62	10.66
Metabolizable Energy (kcal/kg)	2412	2408	2404	2400	2396

Experimental Design

The experiment was arranged in a Completely Randomized Design (CRD) with five dietary treatments and six rabbits per treatment.

Data Collection

Growth Performance

Initial and final body weights were recorded, while feed intake was measured daily by subtracting feed refusals from feed offered. Total and average daily weight gains were calculated from body weight changes over the experimental period. Feed conversion ratio (FCR) was determined as:

$$\text{FCR} = \text{Total feed intake (kg)} / \text{Total weight gain (kg)}$$



Carcass Evaluation

At the end of the feeding trial, three rabbits were randomly selected from each treatment, fasted overnight, weighed, slaughtered, dressed, and eviscerated. Slaughter weight, dressed weight, dressing percentage, carcass cuts, and internal organs were recorded. Dressing percentage was calculated as:

Dressing percentage (%) = (Dressed carcass weight / Live weight) × 100

Organs weight (%) = (Organs weight / Live weight) × 100

Economic Analysis

The economic efficiency of the experimental diets was evaluated using feed cost per kilogram of diet, total feed intake, total feed cost per rabbit, feed conversion ratio (FCR), feed cost per kilogram of weight gain, and feed cost savings relative to the control treatment.

The total feed cost per rabbit was calculated by multiplying the total feed intake (kg) by the cost of feed per kilogram, as shown below:

Total feed cost (₦/rabbit) = Feed intake (kg/rabbit) × Cost of feed (₦/kg)

The feed cost per kilogram of weight gain was determined by dividing the total feed cost per rabbit by the corresponding total body weight gain:

Feed cost per kilogram of weight gain (₦/kg gain) = Feed cost (₦/rabbit) × Feed conversion ratio per rabbits (FCR)

The economic advantage of dietary *Saccharomyces cerevisiae* supplementation was assessed by determining the feed cost savings relative to the control diet (0% *Saccharomyces cerevisiae*). Feed cost savings per kilogram of weight gain and the corresponding percentage feed cost savings were calculated using the following equations:

Feed cost savings (₦/kg gain) = Feed cost/kg weight gain (Control) – Feed cost/kg weight gain (Treatment)

Feed cost savings (%) = [Feed cost savings (₦/kg gain) ÷ Feed cost/kg weight gain (Control)] × 100

Statistical Analysis

Data were subjected to one-way analysis of variance (ANOVA) using a Completely Randomized Design. Treatment means were separated using Duncan's Multiple Range Test, and differences were considered significant at $P < 0.05$.

RESULTS AND DISCUSSIONS

Growth Performance of Weaner Rabbits Fed Diets Supplemented with Different Levels of Probiotics (*Saccharomyces cerevisiae*)

Table 2, shows the results of the growth performance rabbits fed supplemented of probiotic. Dietary supplementation with *Saccharomyces cerevisiae* significantly ($P < 0.05$) improved the growth performance of weaner rabbits. Initial body weight did not differ ($P > 0.05$) among treatments, confirming uniformity of the experimental animals at the start of the trial. Rabbits fed 0.50% *S. cerevisiae* recorded the highest final body weight (1828.75 g), total weight gain (1122.65 g), average daily weight gain (22.91 g/day), and the most efficient feed conversion ratio (4.17). Although these values were statistically similar to those obtained with 0.75% supplementation. Total feed intake and average daily feed intake were not significantly affected, indicating that the improved growth performance resulted from enhanced feed utilization rather than increased feed consumption. These findings suggest that 0.50% dietary *S. cerevisiae* is the optimum inclusion level for maximizing growth performance in weaner rabbits. The present findings agree with previous reports demonstrating the growth-promoting effects of *Saccharomyces cerevisiae* in rabbits. Abdalhakim *et al.* (2018), Ezema and Eze (2012), El-Badawi (2017), Shehu *et al.* (2014), Khan *et al.* (2021), and Istifanus (2024) all reported significant improvements in final body weight, weight gain, average daily gain, and feed conversion ratio following yeast supplementation, with little or no effect on feed intake. Similar observations were reported by Abdelsalam *et al.* (2025) and Fathi *et al.* (2025), who found that probiotic supplementation enhanced body weight gain and feed efficiency without significantly affecting feed consumption, while Elbaz *et al.* (2025) demonstrated improved feed conversion ratio and overall performance index following probiotic supplementation. Collectively, these studies indicate that probiotics enhance productive performance primarily through improved nutrient digestibility and

utilization rather than increased voluntary feed intake. The slight decline in growth performance observed at the highest supplementation level (1.00%) agrees with the findings of Ezema and Eze (2012) and Tag El Din (2019), who reported that excessive yeast inclusion reduced productive performance, suggesting that the response to probiotic supplementation is dose-dependent. Similarly, Belhassen *et al.* (2016) reported increased daily weight gain following early *S. cerevisiae* supplementation, attributing the response to improved intestinal development and nutrient absorption during the post-weaning period. In contrast, Rotolo *et al.* (2014) reported no significant effects of *Saccharomyces cerevisiae* var. *boulardii* on body weight, feed intake, or feed conversion ratio, although supplemented rabbits showed numerically higher body weight and better feed efficiency than the control. These differences may be associated with variations in yeast strain, probiotic dosage, diet composition, rabbit genotype, feeding duration, and environmental conditions.

Table 2: Growth Performance of Rabbits Fed Diets Containing Different Levels of Probiotic (*Saccharomyces cerevisiae*)

Parameters	Treatments					SEM	P-value
	Inclusion levels of probiotics						
	0%	0.25%	0.50%	0.75%	1.00%		
Initial Weight (g)	705.20	706.80	705.95	706.10	705.60	4.12	0.98NS
Final Weight (g)	1650.40 ^c	1738.25 ^b	1818.60 ^a	1806.40 ^a	1768.55 ^b	27.86	0.03*
TWG (g)	945.20 ^c	1031.45 ^b	1112.65 ^a	1100.30 ^a	1062.95 ^b	25.94	0.02*
ADWG (g/day)	19.29 ^c	21.05 ^b	22.71 ^a	22.46 ^a	21.69 ^b	0.51	0.01*
TFI (g)	4550.60	4615.40	4672.30	4688.15	4678.20	34.88	0.43NS
ADFI (g/day)	92.87	94.19	95.35	95.68	95.47	0.71	0.41NS
FCR	4.81 ^c	4.48 ^b	4.20 ^a	4.26 ^a	4.40 ^b	0.08	0.02*

Note: ^{a, b, c} Means within a row bearing different superscripts differ significantly ($p < 0.05$); SEM = Standard Error of Mean; NS = not significant ($P > 0.05$). TWG=Total weight gain (g); ADWG= Average daily weight gains; TFI= Total feed intake; ADFI= Average daily feed intake (g/day); FCR=Feed conversion ratio

Carcass Characteristics of Weaner Rabbits Fed Diets Supplemented with Different Levels of Probiotics (*Saccharomyces cerevisiae*)

Probiotic dietary supplementation had a highly significant effect ($P < 0.05$) on carcass parameters in weaner rabbits (Table 3). The slaughter weight, dressed weight and dressing percentage were highest in weaner rabbits supplemented with 0.50% probiotics (1804.25 g, 1102.30 g and 61.09%, respectively), but the values were statistically comparable to those supplemented with 0.75% probiotics (1768.40 g, 1072.80 g and 60.66%). Weaner rabbits supplemented with 0.75% (1.02%) and 0.50% probiotics (0.98%) had significantly high forelimb percentage, while the control group had highest hindlimb percentage (1.79%). Contrarily, head, pelt, tail, fat and weight of lungs, liver, kidney, heart, spleen, stomach, small intestine, large intestine and cecum were not significantly ($P > 0.05$) affected by probiotic supplementation, suggesting an increase in carcass yield without affecting visceral organs development.

The greater slaughter weight, dressed weight, and dressing percentage recorded with 0.50% supplementation are consistent with the findings of Abdelsalam *et al.* (2025). Their study reported a higher carcass weight in probiotic-supplemented rabbits than in the control group (774.2 vs. 747.2 g), along with better tissue development and minimal effects on the visceral organs. Fathi *et al.* (2025) likewise found an improved dressed carcass percentage (52.0%) and front cut yield after probiotic supplementation, while the relative weights of the liver, lungs, and heart did not change. Elbaz *et al.* (2025) reported similar outcomes, including higher dressing percentage (52.54 vs. 50.68%), forequarter yield, and hindquarter yield in probiotic-fed rabbits, with no significant differences in liver or heart weights. The non-significant differences found in the relative weights of internal organs in the present study are in agreement with Rotolo *et al.* (2014), who reported no significant effect of *Saccharomyces cerevisiae* var. *boulardii* supplementation on dressing percentage or the weights of liver, kidneys, heart,

lungs and gastrointestinal tract. Differences in probiotic strain, level of inclusion, diet composition, rabbit genotype and environmental conditions could explain small differences in between studies.

The results indicated that the *S. cerevisiae* supplement had the most important impact on the rabbits' carcass yield. The supplement led to an increase in the lean tissue of the rabbits but did not impact the size of their visceral organs. So, the supplement was determined to be safe for the rabbits. inclusion of *S. cerevisiae* was found to be 0.50%, which resulted in the greatest carcass yield for the rabbits.

Table 3: Carcass Characteristics of Rabbits Fed Diets Supplemented with Different Levels of Probiotics

Parameters	Treatments Inclusion levels of probiotics					SEM	P-value
	(0%)	(0.25%)	(0.50%)	(0.75%)	(1.00%)		
Slaughter Weight (g)	1598.35 ^c	1695.80 ^b	1804.25 ^a	1768.40 ^a	1718.65 ^b	23.84	0.03*
Dressed Weight (g)	914.70 ^c	1008.55 ^b	1102.30 ^a	1072.80 ^a	1026.15 ^b	17.96	0.02*
Dressing Percentage (%)	57.23 ^c	59.48 ^b	61.09 ^a	60.66 ^a	59.70 ^b	0.71	0.01*
Head (%)	9.14	9.47	9.82	10.06	9.95	0.15	0.74 ^{NS}
Pelt (%)	8.31	8.65	8.24	8.52	8.43	0.17	0.69 ^{NS}
Forelimb (%)	0.86 ^b	0.92 ^{ab}	0.98 ^a	1.02 ^a	0.96 ^a	0.04	0.04*
Hindlimb (%)	1.79 ^a	1.61 ^b	1.20 ^c	1.48 ^b	1.52 ^b	0.08	0.03*
Tail (%)	0.40	0.46	0.43	0.49	0.45	0.03	0.66 ^{NS}
Fat (%)	0.34	0.38	0.41	0.44	0.39	0.03	0.69 ^{NS}
Lungs (%)	0.55	0.58	0.60	0.59	0.57	0.02	0.71 ^{NS}
Liver (%)	2.95	3.10	3.25	3.18	3.05	0.05	0.67 ^{NS}
Kidney (%)	0.78	0.80	0.82	0.81	0.79	0.02	0.73 ^{NS}
Heart (%)	0.88	0.81	0.93	0.85	0.84	0.03	0.76 ^{NS}
Spleen (%)	0.39	0.37	0.43	0.45	0.40	0.02	0.84 ^{NS}
Stomach (%)	3.08	3.16	2.91	2.87	2.95	0.07	0.63 ^{NS}
Small Intestine (%)	1.64	1.60	1.71	1.82	1.76	0.06	0.72 ^{NS}
Large Intestine (%)	0.24	0.31	0.35	0.28	0.32	0.02	0.80 ^{NS}
Cecum (%)	5.03	5.18	5.36	5.11	5.24	0.09	0.70 ^{NS}

Note: ^{a, b, c} Means within a row bearing different superscripts differ significantly ($p < 0.05$); SEM = Standard Error of Mean; NS = not significant ($P > 0.05$).

Economic Evaluation of Weaner Rabbits Fed Diets Supplemented with Different Levels of Probiotics (*Saccharomyces cerevisiae*)

Table 4, shows the results of the economy of rabbits fed supplemented of probiotic. The economic evaluation of weaner rabbits fed diets supplemented with different levels of *Saccharomyces cerevisiae* is presented in Table 4. Dietary supplementation with probiotics increased the cost of feed per kilogram from ₦365.00 in the control diet to ₦379.00 at the 1.00% inclusion level. Consequently, total feed cost per rabbit increased progressively from ₦1,660.75 in the control group to ₦1,777.51 in rabbits fed the highest probiotic level. Total feed intake varied only slightly among the treatments, ranging from 4.55 kg/rabbit in the control group to 4.68 kg/rabbit in rabbits fed 0.75 and 1.00% probiotics.

Despite the increased cost of feed, probiotic supplementation improved feed utilization. Rabbits fed 0.50% *Saccharomyces cerevisiae* recorded the lowest feed conversion ratio (4.20), followed closely by those fed 0.75% probiotics (4.26), whereas the control group recorded the poorest feed conversion ratio (4.81). Consequently, rabbits fed 0.50% probiotics achieved the lowest feed cost per kilogram of weight gain (₦1,562.40), followed by rabbits fed 0.75% probiotics (₦1,599.63), while the control treatment recorded the highest production cost (₦1,755.65/kg weight gain). Rabbits fed 0.25% and



1.00% probiotics recorded intermediate feed costs of ₦1,650.88 and ₦1,667.60/kg weight gain, respectively.

The inclusion of probiotics also resulted in measurable feed cost savings compared with the control diet. Rabbits fed 0.50% probiotics achieved the greatest economic advantage, with a feed cost saving of ₦204.41 per kilogram of weight gain, representing an 11.64% reduction in production cost relative to the control. Rabbits fed 0.75% probiotics recorded a saving of ₦167.29/kg weight gain (9.53%), while those fed 0.25% probiotics and 1.00% probiotics recorded savings of ₦112.14 (6.39%) and ₦72.89 (4.15%), respectively. These results demonstrate that although probiotic supplementation increased feed formulation costs, the improvement in feed efficiency substantially reduced the cost of producing one kilogram of live weight gain.

The improved economic efficiency observed in the present study agrees with the findings of Abdalhakim *et al.* (2018), who reported that dietary supplementation with *Saccharomyces cerevisiae* improved feed conversion efficiency and enhanced growth performance, thereby reducing the overall cost of production despite the additional cost of probiotic inclusion. Similarly, Ezema and Eze (2012) and Shehu *et al.* (2014) observed that rabbits receiving optimum levels of dietary yeast exhibited superior feed utilization and growth performance, resulting in improved economic returns compared with rabbits fed unsupplemented diets. More recently, Istifanus (2024) reported that yeast supplementation enhanced feed efficiency and reduced production costs through improved nutrient utilization.

The present findings are also supported by Abdelsalam *et al.* (2025), Fathi *et al.* (2025), and Elbaz *et al.* (2025), who attributed the improved economic performance of probiotic-supplemented rabbits to enhanced nutrient digestibility, improved intestinal microbial balance, greater digestive enzyme activity, and more efficient conversion of feed into body tissue. These physiological improvements enabled rabbits to achieve higher weight gains without a corresponding increase in feed consumption, thereby lowering the cost of producing each kilogram of live weight.

Overall, although dietary supplementation with *Saccharomyces cerevisiae* increased feed cost per kilogram of diet, the improvement in feed conversion efficiency generated appreciable economic benefits. The 0.50% inclusion level proved to be the most economical treatment, producing the lowest feed conversion ratio (4.20), the lowest feed cost per kilogram of weight gain (₦1,562.40), and the highest feed cost saving over the control (₦204.41/kg weight gain; 11.64%). These findings indicate that supplementation with 0.50% *Saccharomyces cerevisiae* offers the optimum balance between biological performance and economic efficiency in weaner rabbit production.

Table 4: Cost Benefit of Weaner Rabbits Fed Diets Supplemented with Different Levels of Probiotics

Parameters	Treatments				
	Inclusion levels of probiotics				
	(0%)	(0.25%)	(0.50%)	(0.75%)	(1.00%)
Cost of feed/kg (₦)	365.00	368.50	372.00	375.50	379.00
Total feed intake (kg/rabbit)	4.55	4.62	4.67	4.68	4.68
Total feed cost/rabbit (₦)	1660.75	1705.16	1744.68	1764.85	1777.51
Feed Conversion Ratio	4.81	4.48	4.20	4.26	4.40
Feed cost per kg weight gain (₦)	1,755.65	1,650.88	1,562.40	1,599.63	1,667.60
Feed cost savings over control (₦/kg gain)	0.00	112.14	204.41	167.29	72.89
Feed cost savings over control (%)	0.00	6.39	11.64	9.53	4.15

CONCLUSION AND RECOMMENDATION

The inclusion of *Saccharomyces cerevisiae* to the diets of weaner rabbits has been shown to improve growth performance, carcass characteristics and economic efficiency. The treatment group that was supplemented with 0.50% *Saccharomyces cerevisiae* had the highest values for the final body weight of 1818.60 g, total weight gain of 1112.65 g, average daily weight gain of 22.71 g/day and the most efficient feed conversion ratio of 4.20. There were no important differences in the amount of feed consumed by these animals compared to those that did not receive the probiotic supplement. Also, these



animals exhibited the best carcass characteristics, as indicated by the highest values for the parameters of slaughter weight (1804.25 g), dressed weight (1102.30 g) and dressing percentage (61.09%), although there were no important differences in the relative weights of the internal organs of these animals compared to those that did not receive the probiotic supplement.

The inclusion of probiotics to the diet of rabbits resulted in an increase in the cost of their feed from ₦365.00/kg in the control diet to ₦379.00/kg at the highest level of supplementation. However, the rabbits that were fed 0.50% *Saccharomyces cerevisiae* had the lowest cost of feed per kilogram of weight gain (₦1,562.40) and the greatest cost saving compared to the control diet (₦204.41/kg weight gain; 11.64%). Therefore, the inclusion of 0.50% *Saccharomyces cerevisiae* to the diet of weaner rabbits is recommended as the optimum level of supplementation to achieve the best balance between growth performance, carcass yield, feed efficiency and cost of production.

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