



SENSORY EVALUATION AND BLOOD PROFILES OF WEANER RABBITS FED VARYING LEVELS OF DIETARY PROBIOTIC (*SACCHAROMYCES CEREVISIAE*)

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ABSTRACT

This study evaluated the effects of graded dietary levels of *Saccharomyces cerevisiae* on the haematological, serum biochemical and sensory characteristics of weaner rabbits. A total of thirty (30) mongrel weaner rabbits were randomly assigned to five dietary treatments containing 0, 0.25, 0.50, 0.75, and 1.0% *S. cerevisiae* in a completely randomized design, with six rabbits per treatment, over a seven-week feeding trial. At the end of the feeding trial, blood samples were collected for haematological and serum biochemical analyses, while meat samples were subjected to sensory evaluation using a nine-point hedonic scale. Data were subjected to one-way ANOVA and means separated by Duncan's Multiple Range Test. Dietary *S. cerevisiae* significantly ($p < 0.05$) influenced packed cell volume, haemoglobin concentration, red blood cell count, white blood cell count, platelet count, mean corpuscular volume, serum albumin, and total cholesterol. Rabbits fed 0.50–1.0% yeast recorded the highest packed cell volume of 35.0–38.5%, haemoglobin of 11.6–12.8 g/dL, red blood cell count of $4.65\text{--}5.10 \times 10^6/\mu\text{L}$, white blood cell count of $8.5\text{--}10.6 \times 10^3/\mu\text{L}$, and platelet count of $338\text{--}360 \times 10^3/\mu\text{L}$ than the control group. Serum albumin increased significantly from 3.55 g/dL in the control to 5.00 g/dL at 1.0% inclusion, whereas glucose, total protein, and total bilirubin remained unaffected. Total cholesterol was lowest at 0.25% with a value of 2.35 mmol/L but increased to 5.06 mmol/L at 1.0% inclusion. Sensory attributes, including tenderness, flavour, colour, juiciness, palatability, and overall acceptability, were not significantly affected ($p > 0.05$), with all treatments receiving high hedonic scores of 7.60–8.35. It was concluded that dietary *S. cerevisiae* improved the hematological profile of weaner rabbits without compromising meat sensory quality. Based on the overall physiological and sensory responses, dietary inclusion of 0.75% *S. cerevisiae* is recommended for optimum health and meat quality in weaner rabbits.

Keywords: *Saccharomyces cerevisiae*, Weaner, Rabbits, Haematology, Serum-biochemistry

INTRODUCTION

The growing global demand for animal protein has intensified interest in sustainable alternative livestock species. Rabbits are increasingly recognized for their rapid growth, short generation interval, high reproductive capacity, efficient feed conversion, and ability to utilize forages and agro-industrial by-products, making them particularly suitable for smallholder production systems and food security initiatives (Siddiqui *et al.*, 2024). According to the Food and Agriculture Organization (FAO, 2025), global rabbit meat production is concentrated mainly in Asia and Europe, with China remaining the leading producer. In Sub-Saharan Africa, rabbit production is increasingly promoted as a low-input enterprise capable of improving household income and animal protein availability (Oguche *et al.*, 2025; Sergon, 2024). Rabbit meat is highly valued for its high-quality protein, low fat and cholesterol contents, favourable fatty acid profile, and rich vitamin and mineral composition, making it a healthier alternative to many conventional red meats (Kumar *et al.*, 2023; Goswami *et al.*, 2025). Furthermore, rabbits have a short gestation period of approximately 31 days, high prolificacy, and excellent feed efficiency, enhancing their potential for sustainable meat production (De Blas, 2013). Despite these advantages, the post-weaning period remains a critical stage characterized by intestinal dysbiosis, reduced nutrient utilization, and increased susceptibility to digestive disorders and mortality due to the immature digestive and immune systems of young rabbits (De Blas, 2013; Beorlegui, 2012). The global restriction



on antibiotic growth promoters because of antimicrobial resistance has therefore stimulated the search for natural alternatives that improve gut health and animal performance.

Among these alternatives, yeast as a probiotic *Saccharomyces cerevisiae* has received considerable attention because it enhances gut microbial balance, stimulates digestive enzyme activity, improves nutrient utilization, modulates immune responses through β -glucans and mannan-oligosaccharides, and provides antioxidant benefits (Elghandour *et al.*, 2020; Liu *et al.*, 2021). Consequently, supplementation with *S. cerevisiae* has been associated with improved growth performance, health status, and meat quality in rabbits (Mancini and Paci, 2021; Helal *et al.*, 2021). Previous studies have shown that dietary *S. cerevisiae* improves growth performance, haematopoiesis, and serum biochemical indices in rabbits (Osita *et al.*, 2024), while probiotic supplementation also enhances meat quality and beneficial caecal microbiota (Elbaz *et al.*, 2025). Moreover, probiotics generally maintain desirable sensory attributes, including tenderness, flavour, juiciness, and overall acceptability, at recommended inclusion levels (Rotolo *et al.*, 2014; Fathi *et al.*, 2025; Mancini and Paci, 2021). Therefore, this study evaluated the effects of graded dietary levels of *S. cerevisiae* on the hematological, serum biochemical, and sensory characteristics of rabbits to determine an optimum inclusion level that enhances physiological health without compromising meat quality.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Rabbit Unit of Bauchi State College of Agriculture, situated along the Bauchi–Dass Road in Bauchi metropolis. Bauchi State lies within the Sudan–Sahel ecological zone of northeastern Nigeria, between latitudes 9°03' and 12°03' N and longitudes 8°50' and 11°00' E, covering approximately 49,259 km² of predominantly savannah vegetation (Bauchi State Government, 2024).

Experimental Animals and Management

Thirty (30) mixed-sex rabbits aged 4–6 weeks, with initial body weights of 704.85–707.45g, were sourced from a reputable commercial rabbitry to ensure genetic and health uniformity. Animals were acclimatized for two weeks prior to the commencement of data collection, during which standard veterinary prophylaxis, including anthelmintic and ectoparasiticide treatment, was administered. Rabbits were housed two (2) per replicate in wire-mesh cages (50 × 40 × 38 cm) fitted with feeders and drinkers, with feed and water offered *ad libitum* for the duration of the seven-week trial.

Experimental Design and Dietary Treatments

A Completely Randomized Design (CRD) was used, with the thirty rabbits allocated to five dietary treatments of six replicates (rabbits) each. The treatments comprised graded inclusion levels of *S. cerevisiae* in an iso-nitrogenous (~16% crude protein) basal diet formulated according to NRC (1977) recommendations: T1 = 0% (control), T2 = 0.25%, T3 = 0.50%, T4 = 0.75%, and T5 = 1.0%. Sorghum served as the principal energy source, with soybean meal and groundnut cake supplying plant protein, and groundnut haulm and wheat offal meeting the fibre requirements. Bone meal, salt, a vitamin–mineral premix, lysine, and methionine were included to balance micronutrient and amino acid supply (Table 1).



Table 1: Gross Composition of the Experimental Diets

Ingredient (%)	Diets				
	Inclusion levels of probiotics				
	D1 (0%)	D2 (0.25%)	D3 (0.50%)	D4 (0.75%)	D5 (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

Slaughter, Sample Collection, and Hematological Analysis

At the end of the seven-week feeding trial, three rabbits per treatment were randomly selected, fasted for 12 h, and slaughtered by cervical dislocation followed by exsanguination. Hind-limb (thigh) muscles were collected for sensory evaluation. Blood samples were collected from the jugular vein of two rabbits per treatment into EDTA tubes for hematological analysis and plain tubes for serum biochemical analysis. Packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell (RBC) count, white blood cell (WBC) count, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and platelet count were determined using standard veterinary hematological procedures described by Stockham and Scott (2008) and Thrall *et al.* (2022). Serum glucose, total protein, albumin, total bilirubin, and total cholesterol were determined using standard veterinary clinical chemistry procedures according to Thrall *et al.* (2022).

Sensory Evaluation

Sensory Evaluation: Hind thigh meat was immersed in 0.5% sodium chloride solution for 15 min and deep-fried in vegetable oil at approximately 180°C for 15–20 min until fully cooked. The cooked samples were cut into uniform portions, coded with random three-digit numbers, and served warm (approximately 60°C) to a trained sensory panel under controlled conditions. Panelists evaluated tenderness, flavour, colour, juiciness, palatability, and overall acceptability using a nine-point hedonic scale (1 = dislike extremely, 9 = like extremely) following the standard sensory evaluation procedures described by Lawless and Heymann (2010) and Stone *et al.* (2012). The selection of sensory attributes was consistent with those commonly assessed in rabbit meat quality studies (Kumar *et al.*, 2023; Yarali, 2023).

Statistical Analysis

All data were subjected to one-way analysis of variance (ANOVA) using the Statistical Analysis System (SAS Institute, 2013). Significant treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955) at a 5% probability level ($p < 0.05$).

RESULTS AND DISCUSSION

Haematological Parameters

Table 2 shows that dietary *Saccharomyces cerevisiae* significantly ($p < 0.05$) affected packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), platelet count,

and mean corpuscular volume (MCV), whereas mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were not influenced ($p > 0.05$). Rabbits fed 0.50–1.0% yeast (T3–T5) recorded higher PCV (35.0–38.5%), Hb (11.6–12.8 g/dL), RBC ($4.65\text{--}5.10 \times 10^6/\mu\text{L}$), WBC ($8.5\text{--}10.6 \times 10^3/\mu\text{L}$), and platelet counts ($338\text{--}360 \times 10^3/\mu\text{L}$) than those fed the control and 0.25% diets. Mean corpuscular volume declined slightly from 78.9 fL at 0.25% to 75.3–75.8 fL at higher inclusion levels, while MCH (25.0–25.8 pg) and MCHC (32.7–33.2 g/dL) remained unchanged. All values were within the normal physiological ranges for rabbits.

The increases in PCV, Hb, and RBC indicate enhanced erythropoiesis and improved oxygen-carrying capacity in rabbits supplemented with *S. cerevisiae*. These findings agree with Onifade *et al.* (1999), who reported higher haematocrit, haemoglobin, and erythrocyte counts in rabbits fed 1.5–3.0 g/kg dietary yeast, and attributed these improvements to enhanced nutrient utilization and better physiological status. Similarly, Osita *et al.* (2024) observed significantly higher PCV, Hb, RBC, and WBC values in weaner rabbits supplemented with up to 2 g/kg *S. cerevisiae*, recommending this level for improved hematological performance. The higher WBC ($10.6 \times 10^3/\mu\text{L}$) and platelet ($360 \times 10^3/\mu\text{L}$) counts observed at 1.0% yeast inclusion suggest enhanced immune competence. This response is consistent with the immunomodulatory properties of yeast cell-wall components, particularly β -glucans and mannan-oligosaccharides, which stimulate leukocyte activity and improve innate immune responses (Elghandour *et al.*, 2020; Attia *et al.*, 2023). Similar improvements in immune-related blood indices following yeast supplementation have been reported in rabbit studies by Istifanus (2024), where *S. cerevisiae* maintained normal hematological values while improving the physiological condition of rabbit bucks.

The lack of significant differences in MCH and MCHC indicates that yeast supplementation increased the number of erythrocytes without altering haemoglobin concentration per cell, reflecting normal erythrocyte maturation. This finding corroborates the report of Osita *et al.* (2024), who found no significant changes in erythrocyte indices despite improvements in PCV, Hb, RBC, and WBC following dietary *S. cerevisiae* supplementation. Overall, the results demonstrate that dietary *S. cerevisiae*, particularly at 0.50–1.0%, improved hematological status and immune response without causing pathological alterations, as all measured values remained within the established physiological reference ranges for healthy rabbits. These findings support earlier reports that yeast probiotics enhance haematopoiesis, nutrient utilization, and immune function while maintaining normal blood homeostasis in rabbits.

Table 2: Haematological Parameters of Weaner Rabbits Fed Varying Levels of *Saccharomyces cerevisiae*

Parameter	Diets					SEM	Sig.	*Ref. Range
	Inclusion levels of probiotics							
	0%	0.25%	0.50%	0.75%	1.0%			
PCV (%)	32.5 ^b	30.0 ^c	35.0 ^a	35.8 ^a	38.5 ^a	1.05	*	30–50
Hb (g/dL)	10.8 ^b	9.8 ^c	11.6 ^a	11.8 ^a	12.8 ^a	0.40	*	10–17
WBC (×10 ³ /μL)	8.8 ^b	7.6 ^c	8.5 ^b	8.9 ^b	10.6 ^a	0.35	*	5–12
RBC (×10 ⁶ /μL)	4.20 ^b	3.80 ^c	4.65 ^a	4.72 ^a	5.10 ^a	0.18	*	4.0–7.0
MCV (fL)	77.4 ^b	78.9 ^b	75.3 ^c	75.8 ^c	75.5 ^c	1.79	*	58–79
MCH (pg)	25.70	25.80	25.00	25.00	25.10	0.42	NS	20–27
MCHC (g/dL)	33.20	32.70	33.10	33.00	33.20	0.18	NS	30–36
Platelets (×10 ³ /μL)	315 ^b	280 ^c	338 ^a	345 ^a	360 ^a	17.10	*	250–600

Note: ^{a, b, c} Means within a row bearing different superscripts differ significantly ($p < 0.05$); PCV = Packed Cell Volume; Hb = Haemoglobin; WBC = White Blood Cell count; RBC = Red Blood Cell count; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration; SEM = Standard Error of Mean; NS = not significant.
Sources: *Thrall *et al.* (2022)

Serum Biochemical Parameters

Table 3 shows that dietary *Saccharomyces cerevisiae* significantly ($p < 0.05$) affected serum albumin and total cholesterol, whereas glucose, total protein, and total bilirubin were not influenced ($p > 0.05$). Glucose ranged from 5.85 to 6.40 mmol/L, total protein from 5.90 to 6.51 g/dL, and total bilirubin from 9.80 to 11.16 μ mol/L, with no significant treatment differences. Serum albumin increased from 3.55 g/dL in the control to 5.00 g/dL at 1.0% yeast inclusion, while total cholesterol declined to 2.35 mmol/L at 0.25% inclusion before increasing to 5.06 mmol/L at 1.0% inclusion. The progressive increase in serum albumin suggests enhanced protein synthesis and improved hepatic function in rabbits fed *S. cerevisiae*. Albumin is a sensitive indicator of nutritional status and liver synthetic capacity, and its increase may be attributed to improved nutrient digestibility, amino acid availability, and intestinal microbial balance associated with yeast supplementation (Elghandour *et al.*, 2020). Similar improvements in serum protein metabolism have been reported by Onifade *et al.* (1999), who observed enhanced blood biochemical indices and improved physiological status in rabbits supplemented with *S. cerevisiae*. Likewise, Istifanus (2024) reported that dietary yeast supplementation maintained normal serum biochemical indices while improving the physiological condition of rabbit bucks, confirming the safety of *S. cerevisiae* as a feed additive.

The absence of significant differences in serum glucose, total protein, and total bilirubin indicates that dietary yeast did not adversely affect carbohydrate and protein metabolism, or liver integrity. These findings agree with Istifanus (2024), who reported no significant changes in serum glucose and total protein of rabbit bucks supplemented with *S. cerevisiae*, and with Adebisi (2024), who identified similar ranges of serum biochemical parameters as indicators of normal physiological status in healthy rabbits. The cholesterol response, however, was dose-dependent. Rabbits receiving 0.25% yeast had the lowest cholesterol concentration (2.35 mmol/L), whereas cholesterol increased to 5.06 mmol/L at 1.0% inclusion. The reduction at the lower inclusion level disagrees with Onifade *et al.* (1999), who reported that *S. cerevisiae* reduced serum cholesterol through improved lipid metabolism and enhanced gut microbial activity. In contrast, the elevated cholesterol at the highest inclusion level also differs from the findings of Elbaz *et al.* (2025), Abdelsalam *et al.* (2025), and Shaheen *et al.* (2025), who observed reduced serum cholesterol and improved lipid metabolism in rabbits receiving probiotic supplementation. These differences may be attributed to variations in probiotic strain, dietary composition, inclusion level, feeding duration, and environmental conditions, all of which influence lipid metabolism and probiotic efficacy. Overall, the results indicate that dietary *S. cerevisiae* improved serum albumin while maintaining normal glucose, total protein, and bilirubin concentrations, suggesting that yeast supplementation enhanced protein metabolism without impairing liver or metabolic function. However, the increase in cholesterol at 1.0% inclusion indicates that excessive yeast supplementation may alter lipid metabolism, supporting the recommendation that moderate inclusion levels (0.25–0.75%) may provide greater physiological benefits than higher (1.0%) supplementation rates.

Table 3: Serum Biochemical Parameters of Weaner Rabbits Fed Varying Levels of *Saccharomyces cerevisiae*

Parameter	Diets					SEM	Sig.	**Ref. Range
	Inclusion levels of probiotics							
	0%	0.25%	0.50%	0.75%	1.0%			
Glucose (mmol/L)	6.25	6.40	6.05	6.15	5.85	0.71	NS	4.2–8.3
Total Protein (g/dL)	5.90	6.05	6.10	6.35	6.51	0.88	NS	5.4–7.5
Total Bilirubin (μmol/L)	9.95	10.60	9.80	10.25	11.16	0.85	NS	0–17
Albumin (g/dL)	3.55 ^c	4.35 ^b	4.35 ^b	4.35 ^b	5.00 ^a	0.39	*	2.7–4.6
Total Cholesterol (mmol/L)	4.20 ^b	2.35 ^c	3.80 ^b	4.20 ^b	5.06 ^a	0.35	*	1.2–3.5

Note: ^{a, b, c} Means within a row bearing different superscripts differ significantly ($p < 0.05$); SEM = Standard Error of Mean; NS = not significant ($P > 0.05$). **Sources:** **Fielder (2024)

Sensory Evaluation

Table 4 shows that dietary *Saccharomyces cerevisiae* had no significant ($p > 0.05$) effect on the sensory characteristics of fried rabbit meat. Tenderness ranged from 7.75 to 8.15, flavour from 7.75 to 8.30, colour from 7.65 to 8.25, overall acceptability from 7.70 to 8.25, palatability from 7.60 to 8.35, and juiciness from 7.65 to 8.15 on the 9-point hedonic scale. Although palatability approached significance ($p < 0.05$), all treatments received high scores, indicating good consumer acceptability irrespective of yeast inclusion level. The absence of significant differences indicates that supplementation with *S. cerevisiae* up to 1.0% did not adversely affect the eating quality of rabbit meat. This agrees with the review of Mancini and Paci (2021), which concluded that probiotic supplementation generally exerts little or no detrimental effect on rabbit meat quality, with most studies reporting inconsistent or minimal changes in sensory and carcass characteristics despite improvements in animal health and productivity. Likewise, Rotolo *et al.* (2014) reported that dietary *Saccharomyces cerevisiae* var. *boulardii* did not significantly influence meat pH, colour, cooking loss, or proximate composition, demonstrating that live yeast supplementation preserves meat quality. This observation is further supported by Elbaz *et al.* (2025), who found that probiotic supplementation improved growth performance and physiological status while maintaining desirable meat quality characteristics. Similarly, Fathi *et al.* (2025) reported that probiotic supplementation under hot climatic conditions enhanced carcass characteristics and antioxidant status with minimal effects on sensory quality, suggesting that probiotics can improve animal performance without compromising consumer preference. Overall, the consistently high sensory scores (7.60–8.35) demonstrate that dietary *S. cerevisiae* can be included up to 1.0% without compromising tenderness, flavour, colour, juiciness, or overall acceptability, indicating that its physiological benefits can be achieved without a sensory trade-off.

Table 4: Sensory evaluation of Meat (fried) of rabbit fed varying levels of probiotic *Saccharomyces cerevisiae*

Parameter	Diets					SEM	P-value
	Inclusion levels of probiotics						
	0%	0.25%	0.50%	0.75%	1.0%		
Tenderness	8.05	7.90	8.05	8.15	7.75	0.16	0.45 NS
Flavour	8.05	7.90	8.20	8.30	7.75	0.21	0.35 NS
Colour	8.05	7.65	7.85	7.75	8.25	0.17	0.10 NS
Acceptability	8.20	7.70	8.25	8.00	7.85	0.18	0.18 NS
Palatability	7.95	7.90	8.35	8.30	7.60	0.20	0.05 NS
Juiciness	7.70	7.85	8.00	8.15	7.65	0.21	0.41 NS

Note: SEM = Standard Error of Mean; NS = not significant ($p > 0.05$).

CONCLUSION AND RECOMMENDATION

Dietary supplementation of *Saccharomyces cerevisiae* positively influenced the physiological status of weaner rabbits without compromising meat sensory quality. Rabbits fed 0.50–1.0% yeast exhibited significantly higher packed cell volume, haemoglobin concentration, red and white blood cell counts, and platelet counts, indicating enhanced erythropoiesis and immune competence, while all hematological values remained within normal physiological ranges. Serum biochemical analysis showed that *S. cerevisiae* improved albumin concentration, suggesting enhanced protein metabolism and liver function, whereas glucose, total protein, and total bilirubin were unaffected. Although total cholesterol increased at the highest inclusion level (1.0%), lower inclusion levels (0.25–0.75%) maintained cholesterol concentrations closer to the normal physiological range. Furthermore, dietary yeast supplementation had no significant effect on tenderness, flavour, colour, juiciness, palatability, or overall acceptability of rabbit meat, demonstrating that meat quality was preserved across all treatments. Overall, dietary *S. cerevisiae* can be safely incorporated into weaner rabbit diets to improve hematological health and protein metabolism without adversely affecting consumer acceptability. Based on the combined hematological, serum biochemical, and sensory responses, 0.75% dietary



Saccharomyces cerevisiae is recommended as the optimum inclusion level, as it provided substantial physiological benefits while maintaining favourable serum biochemical indices and desirable meat sensory characteristics.

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