

Haematology and Serum Biochemistry of Pregnant West African Dwarf Goats Fed Diets Containing Microbial Treated Rice Husk as a Replacement for Maize

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Abstract

The study was conducted to evaluate the effects of microbial treated rice husk as a replacement for Maize on the haematology and serum biochemical parameters of West African Dwarf (WAD) goats. Raw rice husk was subjected to solid-state fermentation using *Alcaligenes faecalis*, *Aspergillus flavus*, or a mixture of both. Forty West African Dwarf goats were randomly placed on four dietary treatments with ten goats per treatment. The treatments were 0% treated rice husk, 25% bacterial-treated, 25% fungi-treated and 50:50 bacterial + fungi treated rice husk diet. The animals were fed at 5% of their body weight. Blood samples of 10 ml were collected before morning feeding at the end of each trimester of gestation to analyze for haematology and biochemical components. Blood samples were taken before morning feeding via jugular vein puncture into a plain and an anticoagulant bottle. Packed Cell Volume, Haemoglobin, red blood cell and total white Blood Cells were determined. Mean Corpuscular volume, Mean Corpuscular haemoglobin and Mean Corpuscular haemoglobin concentration was calculated from Packed Cell Volume, haemoglobin and Red Blood Cell. Serum biochemical parameters measured include total protein, albumin, blood urea nitrogen aspartate aminotransferase and alanine aminotransferase parameters were determined. Goat fed the cocktail diet had better red blood cell, Packed Cell Volume, hemoglobin, platelet, eosinophil and aspartate aminotransferase but high in cholesterol level. Goat on bacterial-treated diet had the highest Total protein and better hemoglobin, Packed Cell Volume, platelet lymphocytes, aspartate aminotransferase and globulin content. The treated rice husk had positive impact on the blood parameters, the values are within the normal range for healthy goat. Hence, with the results of this study, the cocktail microbial treated rice husk replacement for Maize is suitable for better performance of WAD goats.

Keywords: Haematology, Serum, Rice husk, Microbial, Maize, Pregnant WAD goats

Introduction

Small ruminant production represents a vital segment of livestock agriculture across sub-Saharan Africa, particularly in Nigeria where goats are integral to rural livelihoods, household economy, and food security (Olanrewaju *et al.*, 2025). Among indigenous goat breeds, the West African Dwarf (WAD) goat is highly valued due to its tolerance to trypanosomiasis, adaptability to diverse climatic conditions, resistance to endemic diseases, small body size, and good reproductive performance (Daramola *et al.*, 2005; Ibhaeze *et al.*, 2021). These attributes make WAD goats especially suitable for low-input systems where conventional feeds are not always accessible or affordable. However, the availability and the quality of feed resources for WADGs during pregnancy can significantly impact their haematological and serum biochemical and overall health. Rice husk is one of the most abundant agricultural by-products produced in rice-growing regions around the world. Due to the rising cost and limited availability of conventional feed ingredients, there is growing interest in utilizing rice husk as an alternative feed resource for livestock, particularly ruminants. However, its use is often limited by its high fibre, lignin, and silica contents, which reduce digestibility and restrict the amount of nutrients that animals can obtain from it. To improve its feeding value, microbial treatment has been explored as an effective and environmentally friendly approach. This process involves the use of beneficial microorganisms, such as bacteria and fungi, which ferment the rice husk and break down its complex fibrous structure. As a result, the treated rice husk becomes more digestible, nutrients become more readily available, and the protein content may increase due to microbial growth during fermentation. These improvements can enhance the nutritional quality of rice husk, making it a more suitable, affordable, and sustainable feed ingredient for ruminant production. The haematology and serum biochemical parameters of WAD goats fed diets containing treated rice husk as a replacement for maize have generated interest among researchers and farmers alike. Understanding the effects of these dietary modifications on the health status and metabolic responses of WAD goats is essential for ensuring optimum productivity, physiological well-being, and overall animal welfare. For instance, Afolayan *et al.* (2025) observed that the combined bacteria and fungi-treated rice husk diet (T4) improved economic efficiency by lowering feed cost, although it resulted in a marginal reduction in weight gain compared to the maize-based control diet. This indicates its potential as a cheaper alternative feed ingredient in small ruminant production systems. Similarly, Ibhaeze *et al.* (2021) investigated the blood chemistry of West African Dwarf goats fed microbial-treated maize cob and husk diets and reported that the diets supported normal erythropoiesis and maintained serum electrolyte balance without



adverse effects on liver function, suggesting that they are safe for inclusion in goat diets at levels of up to 30%. However, limited research has been conducted on the effects of microbial treatment of rice husk specifically on WADGs during pregnancy and lactation. Despite the growing interest in the use of treated rice husk as an alternative feed resource, information on its effects on the health and physiological status of West African Dwarf (WAD) goats remains limited. Therefore, there is a need to address this knowledge gap by evaluating the potential advantages and possible limitations associated with the inclusion of treated rice husk in goat diets. This study was designed to assess the effects of diets containing microbially treated rice husk on the haematological and serum biochemical characteristics of WAD goats. The haematological parameters evaluated include red blood cell (RBC) count, white blood cell (WBC) count, haemoglobin (Hb) concentration, and packed cell volume (PCV), while the serum biochemical indices include total protein, albumin, globulin, urea, creatinine, and liver enzymes such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT). Evaluation of these parameters will provide valuable information on the nutritional adequacy, physiological responses, and overall health status of goats fed diets containing treated rice husk, thereby contributing to the development of sustainable and cost-effective feeding strategies for small ruminant production.

Materials and Methods

Experimental Site

The study was conducted at the Small Ruminant Unit of Afolayan Farms, located in Oro, Irepodun Local Government Area of Kwara State, Nigeria. Oro lies within the Southern Guinea Savannah agro-ecological zone of Nigeria, which is characterized by distinct wet and dry seasons. The area receives an average annual rainfall ranging from 1,000 to 1,500 mm and experiences mean ambient temperatures between 27 °C and 33 °C.

Experimental materials and collection

Aspergillus flavus (fungus) and *Alcaligenes faecalis* (bacterium) were obtained from the Microbiology culture laboratory, University of Ilorin, Ilorin, Nigeria. The organisms were cultured on appropriate media and maintained under optimum conditions (25–37°C) through regular sub-culturing to ensure purity and viability.

The culture media were prepared according to standard microbiological procedures and sterilized by autoclaving at 121°C for 15 minutes. After cooling and solidification in sterile Petri dishes, the organisms were inoculated onto the media using the streak plate technique. The inoculated plates were incubated at 37°C for 24–48 hours until distinct colonies were obtained. Pure cultures were subsequently maintained and used for the preparation of inocula for rice husk fermentation.

Inoculation of Rice husk reduce moisture content to a safe storage level. Rice husks samples were sourced, cleaned and sterilized in an autoclave at 121. A microbial suspension was prepared by diluting 1mL of inoculum in 9 mL sterile saline solution and uniformly applied to the sterilized rice husk. The incubation lasted for 10days, after which the fermented substrate was subsequently dried to reduce moisture content to a safe storage level, packaged, labeled and stored prior to diet formulation.

Experimental Animals

Forty (40) clinically healthy pregnant West African Dwarf (WAD) goats with average weight of 15 ± 0.5 kg were purchased from Ajase Local Market, Irepodun Local Government Area, Kwara State, Nigeria for this experiment. The animals were treated against ecto and endo-parasites using Ivomec® and vaccinated against Peste des Petits Ruminants (PPR) using Tissue Culture Rinderpest Vaccine and were fed ad libitum with formulated experimental diets with adequate supply of drinking water.

Experimental Diets

Four experimental diets were formulated for the study as presented in Table 1. The treatments consisted of T1 (diet containing 25% maize, serving as the control), T2 (diet containing 25% bacteria-treated rice husk), T3 (diet containing 25% fungi-treated rice husk), and T4 (diet containing 25% combined bacteria- and fungi-treated rice husk). The experimental animals were randomly assigned to the four dietary treatments using a Completely Randomized Design (CRD), with ten animals allocated to each treatment.

Procedures for blood Profile

Blood samples were collected from the jugular vein before morning feeding into EDTA-treated and plain tubes. The EDTA samples were used for haematological analysis, while serum obtained from the plain tubes was used for biochemical and immunological analyses.

Haematological parameters determined included Packed Cell Volume (PCV), Haemoglobin (Hb), Red Blood Cell (RBC), and White Blood Cell (WBC) counts, Lymphocyte, Eosinophil. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), and Mean Corpuscular Haemoglobin Concentration (MCHC) were calculated from PCV, Hb, and RBC values.

Serum biochemical parameters analyzed were glucose, total protein, albumin, blood urea nitrogen (BUN), aspartate aminotransferase (AST), and alanine aminotransferase (ALT) using standard laboratory procedures.



Antibody and cytokine concentrations were determined using enzyme-linked immunosorbent assay (ELISA) techniques.

Statistical Analysis

Data collected was subjected to Analysis of Variance (ANOVA) and differences between treatment means were separated using Least Significant Difference (LSD) using General Linear Model procedure of Statistical Analysis System (DSAASTAT, 2011).

Table 1: Composition of Treatment Diets

Ingredients	Diets (kg)			
	T1 (Control)	T2 (BTRH)	T3 (FtRH)	T4 (B+F-TRH)
Treated rice husk	-	25	25	25
Maize	25	-	-	-
Soya beans meal	15	15	15	15
Palm kernel cake	10	10	10	10
Groundnut cake	10	10	10	10
Cassava peel	20	20	20	20
Wheat bran	15	15	15	15
Bone meal	2.5	2.5	2.5	2.5
Salt	1	1	1	1
Premix	1.5	1.5	1.5	1.5
Total	100	100	100	100

Keys: Control = maize diet, BTRH=Bacterial treated rice husk, FTRH =Fungi treated rice husk, B+FTRH = Bacterial + Fungi treated rice husk)

Results

The haematological profile of pregnant West African Dwarf goats during the first trimester is presented in Table 2. White blood cell count (WBC) ranged from 13.36 to 16.71 $\times 10^9/L$ across the dietary treatments. Red blood cell count (RBC) varied significantly ($P < 0.05$), with values of 12.27, 11.63, 13.42 and 13.23 $\times 10^{12}/L$ recorded for T1, T2, T3 and T4, respectively. Packed cell volume (PCV) ranged from 31.33 to 33.33%, while haemoglobin concentration (HGB) varied between 10.87 and 11.43 g/dl.

Lymphocyte counts ranged from 7.26 to 8.06 $\times 10^9/L$, whereas neutrophil values ranged from 4.63 to 5.44 $\times 10^9/L$. Monocyte counts varied between 0.26 and 0.42 $\times 10^9/L$, eosinophils ranged from 0.34 to 0.53 $\times 10^9/L$, and basophils ranged from 0.03 to 0.06 $\times 10^9/L$. Mean corpuscular volume (MCV) values were between 18.97 and 20.03 fl, while mean corpuscular haemoglobin concentration (MCHC) ranged from 30.00 to 31.20 g/dl.

Red cell distribution width expressed as coefficient of variation (RDW-CV) ranged from 14.93 to 16.80%, whereas red cell distribution width standard deviation (RDW-SD) ranged from 24.60 to 26.50 fl. Apart from RBC, all measured haematological parameters showed no significant differences ($P > 0.05$) among the dietary treatments during the first trimester of pregnancy.

Table 2: 1st Trimester Haematology Study of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments				SEM	p-Value
	T1	T2	T3	T4		
WBC ($\times 10^9/L$)	16.71	15.07	13.46	13.36	1.368	0.330
RBC ($\times 10^{12}/L$)	12.27 ^{ab}	11.63 ^b	13.42 ^a	13.23 ^a	0.414	0.049*
PCV (%)	31.33	31.67	33.33	33.33	1.607	0.826
HGB (g/dl)	11.43	11.13	10.87	10.97	14.374	0.396
LYM ($\times 10^9/L$)	8.06	7.26	7.62	7.69	0.856	0.929
NEUT ($\times 10^9/L$)	4.63	4.69	4.92	5.44	0.736	0.859
MONOCYTE ($\times 10^9/L$)	0.33	0.26	0.42	0.35	0.117	0.796
EOS ($\times 10^9/L$)	0.53	0.34	0.35	0.39	0.128	0.696
BASO. ($\times 10^9/L$)	0.06	0.05	0.03	0.05	1.384	0.455
MCV (fl)	20.03	18.97	19.26	19.67	1.192	0.925
MCHC (g/dl)	30.23	30.00	30.07	31.20	1.629	0.947
RDW-CV (%)	14.93	16.00	16.80	16.77	1.388	0.758
RDW-SD (FL)	26.43	25.80	26.50	24.60	1.106	0.614

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, WBC = White blood cell, RBC = Red blood cell, PCV = Packed cell volume, HGB = Haemoglobin, Lymphocyte, NEUT = Neutrophil, EOS = Eosinophil, BASO = Basophil, MCV = Mean corpuscular, MCHC = Mean corpuscular haemoglobin concentration, RDW = Red cell distribution width, RDW-CV = Red cell distribution width- coefficient of variation, RDW-SD = Red cell distribution width- standard deviation.



The serum biochemical profile of pregnant West African Dwarf goats during the first trimester is presented in Table 3. Urea concentration ranged from 6.17 to 9.00 mmol/l, with the highest value observed in T2 and the lowest in T1. Cholesterol values varied between 2.10 and 2.61 mmol/l, while high-density lipoprotein cholesterol (HDL-C) ranged from 1.01 to 1.16 mmol/l. Low-density lipoprotein cholesterol (LDL-C) values were similar across treatments, ranging from 0.62 to 0.71 mmol/l. Triglyceride concentrations varied from 0.17 to 0.29 mmol/l. Liver enzyme activities showed values ranging from 23.72 to 26.38 U/L for alanine aminotransferase (ALT), 93.52 to 115.86 U/L for aspartate aminotransferase (AST), 42.63 to 50.98 U/L for gamma-glutamyl transferase (GGT), and 133.67 to 160.67 U/L for alkaline phosphatase (ALP). Total protein concentrations ranged from 67.03 to 69.58 g/l, whereas albumin values ranged from 33.48 to 35.54 g/l. Total bilirubin concentrations varied between 0.19 and 0.34 mg/dl, while direct bilirubin ranged from 0.01 to 0.07 mg/dl. Significant differences ($P < 0.05$) were observed only for direct bilirubin, with T1 and T2 recording the highest values (0.07 mg/dl) and T3 the lowest value (0.01 mg/dl). All other serum biochemical parameters were not significantly affected ($P > 0.05$) by dietary treatments during the first trimester of pregnancy.

Table 3: 1st Trimester Serum Blood Profile of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments					
	T1	T2	T3	T4	SEM	p-Value
Urea (mmol/l)	6.17 ^b	9.00 ^a	8.13 ^{ab}	7.4 ^{ab}	0.622	0.061
Cholesterol (mmol/l)	2.10	2.15	2.61	2.29	0.238	0.475
HDL-C (mmol/l)	1.16	1.01	1.06	1.09	0.186	0.956
LDL-C (mmol/l)	0.62	0.64	0.71	0.67	0.133	0.968
Triglyceride (mmol/l)	0.24	0.29	0.17	0.19	5.228	0.432
ALT (U/L)	26.38	24.43	23.72	26.38	2.195	0.052
AST (U/L)	93.52	115.86	95.38	100.97	8.713	0.325
GGT (U/L)	42.63	43.86	50.98	44.41	5.619	0.723
ALP (U/L)	156.0	149.0	160.67	133.67	31.419	0.933
Total Protein (g/l)	68.15	68.17	67.03	69.58	4.622	0.984
Albumin (g/l)	33.79	33.48	35.54	34.45	2.787	0.954
Total Bilirubin(mg/dl)	0.31	0.34	0.31	0.19	0.119	0.830
Direct Bilirubin(mg/dl)	0.07 ^a	0.07 ^a	0.01 ^b	0.03 ^{ab}	1.453	0.052

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, HDL-C = High density lipoprotein, LDL-C = Low-density lipoprotein cholesterol, ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, GGT = Gamma-glutamyl transferase, ALP = Alkaline phosphatase

The haematological indices of pregnant West African Dwarf (WAD) goats fed microbial-treated rice husk-based diets during the second trimester are presented in Table 4. The results showed that dietary treatments did not significantly ($P > 0.05$) influence most of the haematological parameters evaluated, including WBC, RBC, PCV, lymphocyte, neutrophil, monocyte, eosinophil, basophil, MCV, RDW-CV, and RDW-SD. This suggests that the inclusion of microbial-treated rice husk in the diets did not adversely affect the physiological status or blood-related functions of the animals, as the haematological and biochemical responses remained within normal physiological ranges reported for West African Dwarf goats.

The similar white blood cell (WBC) values observed across dietary treatments suggest that the experimental diets did not induce infections, inflammatory responses, or physiological stress in the animals. Likewise, the comparable lymphocyte and neutrophil counts indicate that immune function remained within normal physiological limits throughout the feeding period. These findings suggest that microbial treatment may improve the nutritive value and safety of rice husk-based diets without compromising the health status of West African Dwarf goats. This result is supported by established haematological reference frameworks for goats, which indicate that stable leukocyte profiles are consistent with normal physiological and immune function (Daramola et al., 2005; Weiss & Wardrop, 2022).

Red blood cell count, packed cell volume, and haemoglobin concentration are important indicators of oxygen transport and general health status. Although haemoglobin values differed numerically among treatments, goats fed T2 and T3 recorded marginally higher values than those fed T4. The maintenance of normal RBC, PCV, and HGB values across treatments suggests that the diets provided adequate nutrients required for erythropoiesis and prevented the occurrence of anaemia during pregnancy (Weiss & Wardrop, 2022).

Among all the parameters measured, mean corpuscular haemoglobin concentration (MCHC) was significantly ($P < 0.05$) affected by dietary treatment. Goats fed T4 recorded a lower MCHC value (29.00 g/dl) compared with those fed T1, T2, and T3. However, the value remained within the normal physiological range reported for healthy goats, indicating that the reduction was not severe enough to impair oxygen-carrying capacity or animal performance. The lower mean corpuscular haemoglobin concentration (MCHC) observed in T4 may indicate slight variation in erythrocytic haemoglobin distribution, which is often influenced by nutritional and physiological factors affecting red cell indices (Thrall et al., 2019).



Table 4: 2nd Trimester Haematology Study of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments				SEM	p-Value
	T1	T2	T3	T4		
WBC ($\times 10^9/L$)	17.55	17.35	15.93	18.65	0.953	0.317
RBC ($\times 10^{12}/L$)	11.23	12.33	12.74	13.30	0.678	0.252
PCV (%)	28.67	30.00	29.67	29.00	0.849	0.926
HGB (g/dl)	10.83 ^{ab}	11.10 ^a	11.07 ^a	10.01 ^b	0.256	0.078
LYM ($\times 10^9/L$)	8.08	8.03	6.89	7.13	0.578	0.397
NEUT ($\times 10^9/L$)	0.37	0.30	0.47	0.38	0.084	0.596
MONOCYTE ($\times 10^9/L$)	0.43	0.3	0.47	0.50	0.13	0.730
EOS ($\times 10^9/L$)	0.02	0.02	0.01	0.02	7.8E-03	0.781
BASO. ($\times 10^9/L$)	0.05	0.07	0.04	0.05	1.9E-02	0.545
MCV (fl)	20.00	22.07	21.80	21.85	0.837	0.335
MCHC (g/dl)	33.27 ^a	31.83 ^a	31.47 ^a	29.00 ^b	0.574	0.005**
RDW-CV (%)	17.53	17.47	17.50	17.90	0.606	0.951
RDW-SD (FL)	27.13	28.23	27.30	27.10	0.995	0.832

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, WBC = White blood cell, RBC = Red blood cell, PCV = Packed cell volume, HGB = Haemoglobin, Lymphocyte, NEUT = Neutrophil, EOS = Eosinophil, BASO = Basophil, MCV = Mean corpuscular, MCHC = Mean corpuscular haemoglobin concentration, RDW = Red cell distribution width, RDW-CV = Red cell distribution width- coefficient of variation, RDW-SD = Red cell distribution width- standard deviation.

The serum biochemical profile of pregnant West African Dwarf (WAD) goats fed microbial-treated rice husk-based diets during the second trimester is presented in Table 11. The results showed that most serum biochemical parameters, including cholesterol, HDL-C, LDL-C, triglycerides, ALT, AST, GGT, ALP, total protein, and total bilirubin, were not significantly ($P > 0.05$) affected by dietary treatments. This indicates that the inclusion of microbial-treated rice husk did not adversely influence lipid metabolism, protein utilization, or liver function of the pregnant goats.

Urea concentration showed significant variation among treatments, with goats fed T2 and T4 recording higher values than those fed T3. The differences in serum urea levels may reflect variations in dietary protein degradation and nitrogen utilization among the treatment groups. However, the values obtained remained within the normal physiological range for goats, suggesting efficient protein metabolism and adequate utilization of dietary nitrogen. This interpretation is consistent with recent findings showing that serum urea levels in goats are influenced by dietary protein intake and rumen nitrogen metabolism, but values within physiological limits indicate effective nitrogen utilization without metabolic stress (Ibhaze et al., 2021; Olanrewaju et al., 2025).

Similarly, albumin concentration differed among treatments, with T2 recording the highest value and T4 the lowest. Albumin is a major indicator of protein nutritional status and liver synthetic activity. The higher albumin concentration observed in T2 may suggest improved protein availability and utilization resulting from microbial treatment of rice husk. Nevertheless, all values remained within normal physiological limits, indicating that liver function was not compromised (Thrall et al., 2019).

Table 5: 2nd Trimester Serum Blood Profile of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments				SEM	p-Value
	T1	T2	T3	T4		
Urea (mmol/l)	7.43 ^{ab}	8.13 ^a	6.67 ^b	8.17 ^a	0.399	0.087
Cholesterol (mmol/l)	1.91	2.05	2.21	1.93	0.179	0.638
HDL-C (mmol/l)	0.99	1.05	1.05	0.67	0.144	0.261
LDL-C (mmol/l)	0.77	0.67	0.65	0.72	6.344	0.581
Triglyceride (mmol/l)	0.39	0.35	0.29	0.42	5.739	0.472
ALT (U/L)	29.12	20.20	21.05	19.36	3.031	0.164
AST (U/L)	76.01	89.44	86.13	80.04	4.16	0.186
GGT (U/L)	34.45	42.92	38.68	39.16	8.56	0.918
ALP (U/L)	180.11	218.49	217.81	187.01	35.565	0.809
Total Protein (g/l)	65.50	67.95	68.08	63.85	3.631	0.813
Albumin (g/l)	29.93 ^{ab}	32.57 ^a	30.61 ^{ab}	28.95 ^b	0.925	0.113
Total Bilirubin(mg/dl)	0.48	0.44	0.31	0.44	5.102	0.172
Direct Bilirubin(mg/dl)	0.08 ^{ab}	0.10 ^a	0.01 ^b	0.03 ^{ab}	5.265	0.131

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, HDL-C = High density lipoprotein, LDL-C = Low-density lipoprotein cholesterol, ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, GGT = Gamma-glutamyl transferase, ALP = Alkaline phosphatase



The absence of significant differences in ALT, AST, GGT, and ALP activities suggests that the experimental diets did not induce hepatic damage or metabolic disorders. Likewise, the similarity in total protein, cholesterol fractions, triglycerides, and bilirubin concentrations among treatments indicates stable metabolic and physiological conditions throughout the feeding period. These findings demonstrate that microbial-treated rice husk can be incorporated into diets of pregnant WAD goats without detrimental effects on serum biochemical characteristics during the second trimester.

The haematological profile of pregnant West African Dwarf (WAD) goats during the third trimester is presented in Table 6. The results revealed that dietary treatments had no significant ($P > 0.05$) effect on all the haematological parameters measured, including WBC, RBC, PCV, HGB, lymphocytes, neutrophils, monocytes, eosinophils, basophils, MCV, MCHC, RDW-CV, and RDW-SD. This indicates that the inclusion of microbial-treated rice husk in the diets did not adversely affect the health status or physiological functions of the pregnant goats.

The similar WBC and differential leukocyte counts across treatments suggest that the experimental diets did not induce stress, infection, or inflammatory responses. The values obtained indicate that the immune system of the animals remained stable throughout the third trimester of pregnancy (Olafadehan, 2011). Likewise, the absence of significant differences in lymphocyte and neutrophil counts further confirms that microbial-treated rice husk did not compromise immune competence.

Red blood cell count, packed cell volume, and haemoglobin concentration were also unaffected by dietary treatments. The maintenance of comparable RBC, PCV, and HGB values across treatments suggests adequate oxygen-carrying capacity and normal erythropoietic activity in the goats. These findings indicate that the experimental diets supplied sufficient nutrients required for blood formation and prevented the occurrence of anaemia during late pregnancy (Daramola et al., 2005).

Similarly, MCV, MCHC, RDW-CV, and RDW-SD values did not differ significantly among treatments, indicating normal red blood cell morphology and uniformity in erythrocyte size distribution. The stability of these indices suggests that microbial treatment improved the utilization of rice husk without causing abnormalities in red blood cell production or function (Weiss & Wardrop, 2022).

This results demonstrate that microbial-treated rice husk-based diets supported normal haematological status during the third trimester of pregnancy. The absence of significant differences among treatments indicates that the diets were safe and capable of maintaining adequate health and physiological functions in pregnant WAD goats.

Table 6: 3rd Trimester Haematology Study of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments				SEM	p-Value
	T1	T2	T3	T4		
WBC ($\times 10^9/L$)	21.48	21.76	21.40	23.01	2.057	0.938
RBC ($\times 10^{12}/L$)	10.40	11.03	10.83	10.63	0.721	0.932
PCV (%)	28.00	27.33	28.00	28.00	2.279	0.996
HGB (g/dl)	9.33	9.10	9.17	10.03	1.029	0.912
LYM ($\times 10^9/L$)	6.00	7.13	6.37	7.13	0.459	0.279
NEUT ($\times 10^9/L$)	9.67	9.36	9.99	8.21	1.261	0.772
MONOCYTE ($\times 10^9/L$)	0.43	0.3	0.47	0.50	0.13	0.730
EOS ($\times 10^9/L$)	0.24	0.20	0.29	0.28	7.7E-02	0.817
BASO. ($\times 10^9/L$)	0.05	0.07	0.04	0.06	1.8E-02	0.627
MCV (fl)	21.96	21.38	23.40	23.07	1.526	0.769
MCHC (g/dl)	34.43	31.9	32.13	32.23	1.246	0.484
RDW-CV (%)	18.77	18.50	18.50	18.80	0.894	0.991
RDW-SD (FL)	29.07	29.37	29.80	30.07	1.563	0.969

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, WBC = White blood cell, RBC = Red blood cell, PCV = Packed cell volume, HGB = Haemoglobin, Lymphocyte, NEUT = Neutrophil, EOS = Eosinophil, BASO = Basophil, MCV = Mean corpuscular, MCHC = Mean corpuscular haemoglobin concentration, RDW = Red cell distribution width, RDW-CV = Red cell distribution width- coefficient of variation, RDW-SD = Red cell distribution width- standard deviation.

The serum biochemical profile of pregnant West African Dwarf (WAD) goats during the third trimester is presented in Table 7. The results showed that most serum metabolites and liver function indices were not significantly ($P > 0.05$) affected by dietary treatments, indicating that the inclusion of microbial-treated rice husk did not adversely influence metabolic activities or organ function in the pregnant goats.

Serum urea concentration showed a treatment effect, with goats fed T4 recording the highest value and those fed T3 the lowest. Variations in serum urea are often associated with differences in dietary protein degradation and nitrogen utilization efficiency. Nevertheless, all values remained within the normal physiological range for goats, suggesting efficient protein metabolism and adequate utilization of dietary nitrogen across treatments. This observation is consistent with recent reports that serum urea levels in goats are influenced by dietary nitrogen intake and rumen microbial activity, while values within physiological limits indicate proper protein utilization without metabolic stress (Ibhaze et al., 2021; Olanrewaju et al., 2025).



Among the liver enzymes evaluated, alanine aminotransferase (ALT) was significantly ($P \leq 0.05$) affected by dietary treatment. Goats fed T4 recorded the highest ALT value (43.43 U/L), while those fed T2 and T3 had lower values. Although elevated ALT activity is commonly associated with increased hepatic cellular activity or mild tissue stress, the values observed remained within acceptable physiological limits for healthy goats and were not accompanied by corresponding increases in AST, GGT, or bilirubin concentrations. This suggests that the diets did not induce hepatic damage or compromise liver integrity (Thrall et al., 2019).

The absence of significant differences in cholesterol, HDL-C, LDL-C, and triglyceride concentrations indicates that lipid metabolism was not altered by the dietary treatments. Similarly, total protein, albumin, total bilirubin, and direct bilirubin values remained comparable among treatments, suggesting adequate protein nutrition and normal liver synthetic function (Kaneko et al., 2008).

Furthermore, the non-significant AST, GGT, and ALP activities across treatments provide additional evidence that microbial-treated rice husk did not exert adverse effects on hepatic function or general metabolic status. These findings agree with reports that serum biochemical indices within normal physiological ranges are indicative of good nutritional status and healthy organ function in goats (Daramola et al., 2005).

Table 7: 3rd Trimester Serum Blood Profile of Pregnant WAD Goats Fed Experimental Diet.

Parameters	Treatments					
	T1	T2	T3	T4	SEM	p-Value
Urea (mmol/l)	8.1 ^{ab}	8.47 ^{ab}	6.67 ^b	9.17 ^a	0.58	0.081
Cholesterol (mmol/l)	1.84	1.88	2.21	1.56	0.222	0.306
HDL-C (mmol/l)	0.83	0.92	0.87	0.76	0.127	0.824
LDL-C (mmol/l)	0.69	0.54	0.71	0.57	9.1E-02	0.468
Triglyceride (mmol/l)	0.46	0.59	0.63	0.53	9.9E-02	0.662
ALT (U/L)	36.45 ^{ab}	27.78 ^b	30.72 ^b	43.43 ^a	3.429	0.050
AST (U/L)	176.49	256.10	219.47	250.58	45.017	0.600
GGT (U/L)	54.51	54.11	51.12	50.65	5.495	0.939
ALP (U/L)	353.11	258.49	407.81	287.60	49.596	0.219
Total Protein (g/l)	62.17	64.81	62.74	63.85	3.994	0.965
Albumin (g/l)	26.41	26.20	26.28	24.95	0.426	0.130
Total Bilirubin(mg/dl)	0.53	0.49	0.48	0.48	8.2E-02	0.973
Direct Bilirubin(mg/dl)	0.11	0.05	0.08	0.14	2.9E-02	0.225

a,b,c = means within the same row with different superscripts are significantly ($P < 0.05$) different, HDL-C = High density lipoprotein, LDL-C = Low-density lipoprotein cholesterol, ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, GGT = Gamma-glutamyl transferase, ALP = Alkaline phosphatase

Conclusion

This study evaluated the effects of microbial-treated rice husk as a partial replacement for maize in the diets of pregnant West African Dwarf (WAD) goats. The findings revealed that inclusion of bacterial-treated, fungal-treated, and combined bacteria–fungi treated rice husk did not negatively affect the haematological and serum biochemical parameters of the experimental animals across the three trimesters of pregnancy.

Most haematological indices, including white blood cells, red blood cells, packed cell volume, haemoglobin, and differential leukocyte counts, remained within normal physiological ranges, indicating stable immune status, adequate oxygen-carrying capacity, and absence of anaemia or physiological stress. Similarly, serum biochemical parameters such as total protein, albumin, cholesterol fractions, liver enzymes (ALT, AST, ALP, GGT), and bilirubin were largely unaffected by dietary treatments, suggesting normal metabolic function, protein utilization, lipid metabolism, and liver integrity.

Among the treatments, the combined bacteria–fungi treated rice husk (T4) generally showed comparable or slightly improved haematological and biochemical performance, indicating its potential superiority in enhancing nutrient utilization. Overall, the results demonstrate that microbial fermentation improves the feeding value of rice husk, making it a safe and effective alternative feed ingredient for replacing maize in diets of pregnant WAD goats without compromising health status.

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