IMPACT OF MICROBIAL-TREATED RICE HUSK-BASED DIET ON RUMEN FERMENTATION IN WEST AFRICAN DWARF GOATS

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Abstract
This study evaluated microbial-treated rice husk (MTRH) effects on rumen fermentation in West African Dwarf (WAD) goats. Forty (40) goats were randomized into four (4) dietary treatments containing 25% maize (control), bacteria-treated rice husk, fungi-treated rice husk, and a bacterial-fungal cocktail-treated rice husk. The MTRH significantly (P<0.05) increased acetate, butyrate, and ammonia nitrogen concentrations, especially in the cocktail group, indicating enhanced microbial activity and fiber degradation. Nutritional analysis showed increased crude protein and reduced crude fiber in treated rice husks. These results suggest MTRH is a promising sustainable alternative feed for smallholder goat production.

Keywords: Rice husk, microbial fermentation, WAD goats, rumen fermentation, agro-industrial waste.

Description of Problem
The growing demand for animal protein in Sub-Saharan Africa pressures smallholder livestock systems, where West African Dwarf goats are vital due to their hardiness on low-quality forages. However, feed scarcity and high costs limit productivity. Rice husk, an abundant agro-industrial byproduct, has limited nutritional value because of high lignin, silica and low crude protein. Conventional chemical treatments to improve its digestibility are costly and environmentally concerning. Microbial fermentation is an eco-friendly alternative that breaks down lignocellulosic materials (Subburaj *et al,* 2025), improving nutritional quality and digestibility. This study investigates the impact of microbial treatment of rice husk on rumen fermentation in WAD goats, aiming to develop cost-effective, sustainable feeding strategies for smallholder producers.

Material and Methods
Experimental Site and Design
The experiment took place at Afolayan Farms, Nigeria. Rice husk was sterilized and inoculated with *Alcaligenes faecalis* (bacteria), *Aspergillus flavus* (fungus), or a bacterial-fungal cocktail, fermented for 10 days. The rumen was collected at the end of the feeding trial. Forty healthy weaned WAD goats (7 ± 0.5 kg) were randomly assigned to four diets containing 25% of the respective treated rice husk or maize (control).

Diet Composition
- T1: 25% maize (control)
- T2: 25% bacteria-treated rice husk
- T3: 25% fungi-treated rice husk
- T4: 25% bacterial + fungal-treated rice husk (cocktail)

Common ingredients included cassava waste, soybean meal, palm kernel cake, groundnut cake, wheat bran, bone meal, salt, and vitamin-mineral premix as shown in Table 1.

Chemical Composition
Chemical composition was determined by AOAC methods, including proximate analysis, NDF, ADF, and ADL. Rumen liquor samples were collected pre-feeding for volatile fatty acids (VFAs), ammonia nitrogen (NH_3-N), and microbial counts. Data underwent two-way ANOVA and least significant difference (LSD) tests.

Table 1: Experimental Diets Fed to West African Dwarf Goats

Ingredients (%)	T1	T2	T3	T4
Maize	25.00	0.00	0.00	0.00
Cassava Wastes	20.00	20.00	20.00	20.00
Soya Bean Meal	15.00	15.00	15.00	15.00
Palm Kernel Cake	10.00	10.00	10.00	10.00
Groundnut Cake	10.00	10.00	10.00	10.00
Wheat Bran	15.00	15.00	15.00	15.00
Bacteria treated Rice husk	0.00	25.00	0.00	0.00
Fungi treated Rice husk	0.00	0.00	25.00	0.00
Cocktail of treated Rice husk	0.00	0.000	0.00	25.00
Bone meal	2.50	2.50	2.50	2.50
Salt	1.00	1.00	1.00	1.00
Vitamin-mineral premix	1.50	1.50	1.50	1.50
Total	100	100	100	100
Crude protein	15.97	15.85	15.00	15.79
ME (kcal/kg)	2807.86	2839.60	2825.85	2823.71

T1-25% Maize, T2- 25%Bacteria-treated rice husk, T3-25% Fungi-treated rice husk and T4-25% Bacteria + Fungi treated rice husk (curtail)

RESULTS AND DISCUSSIONS

The inclusion of microbial-treated rice husk significantly influenced rumen fermentation parameters. Acetate concentrations increased significantly ($P<0.05$), with the highest value observed in goats fed the cocktail of bacterial and fungal-treated rice husk (T4: 27.62 mM/100ml) compared to the control (T1: 21.08 mM/100ml). Butyric acid levels were significantly higher ($P<0.05$) in T3 (8.12 mM/100ml) and T4 (8.18 mM/100ml) than in T1 (5.58 mM/100ml). Ammonia nitrogen (NH_3-N) also significantly increased across treatments, peaking in T4 (6.53 mg/100ml), suggesting improved microbial protein synthesis. Propionate and total VFA levels showed no significant differences ($P>0.05$), though a numerical increase was observed in T4. Protozoan population, total bacterial count, and fungal load did not significantly differ among the treatment groups.

Table 2: Proximate composition and Crude fibre fraction of the experimental diets

Parameters (%)	**T1 (control)**	**T2 (BTRH)**	**T3 (FTRH)**	**T4 (B+FTRH)**	**SEM**	**p-Value**
Moisture	10.38^{d}	11.17^{a}	10.97^{b}	10.69^{c}	1.12	0.01
ASH	13.92^{a}	9.89^{b}	12.97^{a}	11.30^{b}	0.60	0.01
Crude fibre	8.43^{d}	24.59^{a}	24.28^{c}	23.39^{b}	0.25	0.01
Crude fat	5.16^{a}	4.27^{b}	4.89^{a}	4.45^{b}	0.14	0.01
Crude protein	15.97^{a}	15.85^{a}	15.00^{b}	15.79^{a}	0.15	0.02
Carbohydrate	50.56^{c}	53.63^{a}	52.70^{b}	52.83^{b}	0.43	0.01
Neutral detergent soluble	23.01^{a}	21.57^{b}	22.25^{ab}	21.40^{b}	0.26	0.04
Neutral detergent fibre	76.99^{b}	78.43^{a}	77.76^{ab}	78.60^{a}	0.26	0.04
Acid detergent fibre	52.83^{c}	54.13^{ab}	53.91^{b}	54.79^{a}	0.27	0.01
Acid detergent Lignin	10.24^{c}	11.46^{a}	10.97^{b}	11.38^{a}	0.27	0.01
Silica	8.71^{a}	8.44^{c}	8.62^{b}	8.50^{c}	0.04	0.01
Cellulose	24.16	24.30	23.85	23.81	0.09	0.12
Hemicellulose	42.59	42.67	42.95	43.31	0.15	0.18

^{abc}: means along the same row with different superscripts, differ significantly ($P<0.05$), T1-25% Maize, T2-25%Bacteria-treated rice husk, T3-25% Fungi-treated rice husk and T4-25% Bacteria + Fungi treated rice husk (curtail)

The significant increases in acetate and butyrate concentrations observed in goats fed microbial-treated rice husk (particularly in T3 and T4) mirror findings from Cheng et al. (2024), who demonstrated that fermented rice husk powder improved digestibility and elevated butyrate levels in the rumen promoting rumen epithelial development and fermentation efficiency. The elevated ammonia-N (NH_3-N) levels in T4 suggest enhanced protein degradation and microbial protein synthesis, consistent with improved nitrogen utilization documented in several microbial-treated roughage studies (Akinfemi et al., 2024; Omotosho et al., 2019). The stable protozoan population across treatments implies that microbial treatments modified fermentation pathways without disrupting the microbial ecosystem.

Table 3: Nutritional Analysis of Rice Husk Treated Samples

Parameters (%)	(RRH)	(BTRH)	(FTRH)	(B+FTRH)	SEM	p-Value
Moisture	6.806[a]	4.754[c]	5.614[b]	5.602[b]	0.1633	0.000161**
ASH	18.459	18.552	18.913	14.479	3.006	0.70275
Crude fibre	66.789[a]	66.854[a]	65.618[ab]	62.043[b]	1.198	0.06701
Crude fat	4.585[a]	4.098[b]	4.186[b]	4.141[b]	0.106	0.03947*
Crude protein	9.897[b]	10.710[ab]	10.678[ab]	11.139[a]	0.267	0.05981
Carbohydrate	57.299[ab]	58.080[a]	56.368[bc]	55.245[c]	0.395	0.00502**

BTRH: Bacteria treated rice husk, FTRH: fungi-treated rice husk, RRH: raw rice husk, B+FRH: Bacteria + Fungi treated rice husk (cocktail)

Table 4: Rumen Liquor (Protozoan and Microbial Load)

Parameters	T1	T2	T3	T4	SEM	p-values
Total bacterial count ($x10^{-4}$ cfu/ml)	91.67	81.33	61.67	58.33	11.483	0.2042
Total fungal count (sfu/ml)	3.00	2.33	2.00	3.33	1.404	0.9018
Protozoan ($x10^{-2}$ /ml)	24.33	14.00	17.33	19.67	4.761	0.5129
Acetate (mM/100ml)	21.08[b]	25.33[ab]	26.46[a]	27.62[a]	1.372	0.0435*
Propionate (mM/100ml)	11.79	8.48	7.75	8.75	1.375	0.2477
Ammonia nitrogen (mg/100ml)	5.45[b]	5.95[b]	5.96[b]	6.53[b]	0.159[a]	0.00967**
Butyric acid (mM/100ml)	5.58[b]	6.29[b]	8.12[a]	8.18[a]	0.546	0.02119*
Total volatile fatty acid (mM/100ml)	59.24[b]	60.33[ab]	60.85[ab]	61.70[a]	0.704	0.1722

CONCLUSION AND APPLICATION

Rumen fermentation assessment revealed that MTRH diets significantly improved acetate and butyrate concentrations and ammonia nitrogen (NH_3-N), indicating enhanced fermentation efficiency and microbial protein synthesis. However, total bacterial and protozoan counts were not significantly affected. The treated rice husk showed elevated crude protein and reduced crude fibre content, confirming the efficacy of microbial treatment in breaking down lignocellulosic bonds and enriching protein fractions, thus making it suitable for ruminant feeding.

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