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Full Length Research

Evaluation of *Gliricidia sepium* leaf meal on digestibility and nitrogen retention in Yankasa rams fed D*igitaria smutsii* hay basal diet

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ABSTRACT: The study was conducted to evaluate the effect of *Gliricidia sepium* leaf meal (GSLM) supplementation on digestibility and Nitrogen retention in Yankasa rams fed graded levels of *Gliricidia sepium* leaf meal. The study involved twelve (12) growing Yankasa rams, weighing 14.69±2kg averagely. The experimental Yankasa rams were assigned randomly to four dietary treatment levels at 0, 10, 20 and 30% inclusion of *Gliricidia sepium* leaf meal. Each treatment consisted of three rams as replicates. They were adequately fed and provided with fresh and clean water. The dietary treatments were fed to the experimental rams in a feeding trough in the morning once daily, and *Digitaria smutsii* hay was fed *ad libitum* for the 21-day trial. The data collected were subjected to analysis of variance of SPSS software. Means were separated using Duncan's multiple range tests. Results of total dry matter digestibility (DMD) showed a significant difference (p<0.001) in rams fed 10% and 20% GSLM (68.0% and 67.0%) compared to the control (60.5%) and 30% (63.0%) treatments. GSLM supplementation had a significant improvement (p<0.05) in nutrient digestibility, digestibility coefficient at 10-20%, nitrogen intake and nitrogen retention at 10-20%. Nitrogen retained was high at 0-20% (54.55-52.88%), decreasing sharply at 30% (42.85%, p<0.05%), potentially due to fibre diluting available Nitrogen. In conclusion, the *in vivo* assay showed 10% GSLM as optimal in dry matter digestibility Percentage Nitrogen retained, and this underscores *Gliricidia sepium* Leaf Meal's value up to 20% for sustainable protein use in hay-based systems and effective improvement in Ram production.

Keywords: Digestibility and Retention, *Digitaria smutsii*, *Gliricidia sepium*, Yankasa Rams.

INTRODUCTION

Small ruminant production in Sub-Saharan African countries has consistently remained at a subsistence level, with over 90% of women and youth engaged in it rarely possessing a steady income (Yusuf*, 2*017). In Nigeria, the sheep population was estimated to be 64.93 million, which makes the sheep the second most important livestock species in the country (FAO, 2023). Sheep are reared primarily for meat production, and they require adequate nutrients for growth and productivity.

Currently, high cost, irregular supply (Akinmutimi, 2004) and competition from conventional feedstuffs such as maize, fish meal, groundnut cake, soybean meal and others, with humans and monogastric animals (Adama, 2008; Ajayi *et al*., 2008) as supplements to low-quality feed, make it usage uneconomically feasible. It was also reported that escalating prices of commercial concentrates render their supplementation to livestock production on low-quality grasses financially prohibitive for smallholder livestock producers (Nepali, 2025).

The green forages that serve as major nutrients to ruminants during the rainy season are scarce in the dry season. This makes the dry matter and nutrient consumption by animals reduce drastically. However, several unconventional feed resources are available for utilisation. In the tropics, browse plants have shown significant promise for ruminant production due to their high adaptability, productivity, and acceptability by animals. These attributes help alleviate the persistent problem of feed shortages during the dry season (Abraham *et al*., 2022).

This has necessitated the need to look inwards and lay more emphasis on the use of quality forages like *Gliricidia sepium* in livestock production systems. *Gliricidia sepium* leaves contain 18–28% crude protein and improve nutrient digestibility and growth performance in sheep (Akinlade *et al*., 2022). The study therefore aimed at evaluating the digestibility and Nitrogen retention potential in Yankasa rams fed *Gliricidia sepium* leaf meal supplement.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria. The farm is situated at an elevation of 671 m above sea level, at latitude 11.100°N and longitude 07.380°E (Ovismaps, 2023). The climate of the area is characterised by distinct wet and dry seasons. The wet season typically begins between April and early May and ends in late September to early October, while the dry season extends from October to April. Annual rainfall ranges from 748.6 to 1156.7 mm, with a long-term average of 1058.6 mm. Maximum air temperatures of 37 °C are recorded in May, and minimum temperatures of 11.5°C occur in December–January. Relative humidity averages approximately 70% during the rainy season (IAR, 2023).

Sources of experimental materials

Gliricidia sepium leaves were harvested from stems of 0.5–0.8 cm diameter at the National Animal Production Research Institute (NAPRI) Farm, Shika, and its environs at the onset of the rainy season in April. The leaves were air-dried for 30 days in the pasture drying shed of the NAPRI Forage Production Unit to approximately 90% dry matter (DM). *Digitaria smutsii* (finger grass or crab grass) hay was obtained from the Forage Production Unit of the National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State.

Experimental treatment, design and feeding of animals

The rams were weighed and randomly allotted to four isonitrogenous diets containing graded inclusion levels (0, 10, 20 and 30%) of *Gliricidia sepium* leaf mixture, with three animals per treatment, in a completely randomised design (Table 1).

Metabolism trial

The experimental animals were housed in disinfected individual metabolism cages. Three rams per treatment were allocated to four dietary treatments containing 0, 10, 20 and 30% *Gliricidia sepium* leaf meal (GSLM) in a completely randomised design. The trial lasted 21 days, comprising a 14-day adaptation period to the metabolic cages followed by a 7-day collection period.

Animals were fed at 1.5% of body weight, and daily feed intake was recorded. Total faeces and urine were collected during the final 7 days for the determination of nutrient digestibility and nitrogen retention.

Daily faecal output was weighed, and a 50 g subsample from each day's collection was oven-dried at 60 °C, bulked by animal, milled and retained for dry matter determination and subsequent chemical analysis.

Total daily urine volume from each animal was collected in plastic containers placed beneath the cages. Containers were acidified with 10 mL of 10% H_2SO_4 to trap ammonia. A 10% aliquot of the total urine was transferred to labelled plastic bottles and stored at −4 °C pending nitrogen determination (AOAC, 2023).

Chemical analysis

- Milled samples of the experimental diets and faeces were analysed in triplicate for dry matter (DM), organic matter (OM), NDF, ADF and total nitrogen (N) according to the official methods of AOAC International (2023). Crude protein (CP) was calculated as N × 6.25. Hemicellulose was calculated as NDF − ADF.
- Nitrogen balance components: nitrogen intake (NI), faecal nitrogen (FN), urinary nitrogen (UN), digested nitrogen (DN = NI − FN), retained nitrogen (RN = NI − FN − UN), and nitrogen retention as a percentage of intake (RN/NI × 100).
- Ash content (by incineration) and organic matter by difference. All analyses were performed in accordance with current standard laboratory protocols for ruminant nutrition studies (AOAC International, 2023; Danese *et al*., 2025).
- Metabolisable energy of the diets was calculated using the method of Pauzenga (1985) as: ME (Kcal/Kg) = % CP x 37+ % EE x 81.8+ % NFE x 353.13.

Data analysis

All data collected on digestibility and nitrogen balance were subjected to Analysis of Variance (ANOVA) (using

Table 1. Composition of experimental diet containing *Gliricidia sepium* Leaf meal based diets fed to Yankasa rams.

Parameters (%)	Inclusion level of GSLM (%)			
	0	10	20	30
CSC	18.00	16.00	14.00	12.00
GSLM	0.00	10.00	20.00	30.00
Maize offal	49.75	41.75	33.75	25.75
Rice husk	30.00	30.00	30.00	30.00
Bone meal	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated CP (%)	14.00	14.00	14.00	14.00
ME(Kcal/kg)	2925.05	2818.69	2784.94	2806.86

CSC = Cotton Seed Cake, GSLM = Gliricidia sepium Leaf Meal; CP = Crude Protein; ME = Metabolizable Energy, kg=kilogram.

Table 2. Effects of different inclusion levels of *Gliricidia sepium* leaf meal on nutrient digestibility in Yankasa rams.

Digestibility Coefficient (%)	Inclusion levels of GSLM (%)				SEM
	0	10	20	30	
Dry matter	60.5^{c}	68.0^{a}	67.0^{a}	63.0^{b}	1.75
Organic matter	62.0^{c}	70.0^{a}	69.5^{a}	65.5^{b}	1.88
Crude protein	62.5^{c}	73.0^{a}	74.5^{a}	68.0^{b}	2.72
Crude fibre	58.0^{c}	65.0^{a}	64.5^{a}	60.5^{b}	1.67
Ether Extract	82.0^{b}	87.5^{a}	86.0^{a}	83.5^{b}	1.23
NDF	55.5^{c}	63.0^{a}	64.5^{a}	58.5^{b}	2.07
ADF	52.5^{c}	60.0^{a}	61.5^{a}	56.5^{b}	2.00
Nitrogen Free Extract	67.0	70.8	71.4	68.0	1.07
Lignin	42.0	45.0	46.0	43.5	0.88

^{abc} Means on the same row with different superscripts are significantly (*p<0.05) different, SEM = Standard Error of Means; GSLM = Gliricidia sepium Leaf Meal; NDF = Neutral Detergent Fibre; ADF = Acid Detergent Fibre

the procedure of the Statistical Analysis System (SAS, 2002). Significant differences between means were tested using the Duncan Range Test of the SAS software.

RESULTS AND DISCUSSION

Nutrient digestibility

The inclusion of graded levels of *Gliricidia sepium* leaf meal (GSLM) produced clear quadratic responses in nutrient digestibility among Yankasa rams (Table 2). Dry matter (DM) digestibility increased from 60.5% in the control diet to 68.0% and 67.0% at 10% and 20% GSLM, respectively, before decreasing to 63.0% at 30% inclusion. Organic matter (OM) digestibility followed the same pattern (62.0% → 70.0%/69.5% → 65.5%).

These improvements at moderate inclusion levels are consistent with the high rumen-fermentable protein and energy supplied by *G. sepium*, which stimulate microbial activity when the basal diet contains appreciable fibre. Similar quadratic responses have been reported when *G. sepium* foliage or leaf meal is offered at 10–20% of the diet to small ruminants.

Crude protein (CP) digestibility increased markedly from 62.5% (0% GSLM) to 73.0–74.5% at 10–20% inclusion and then decreased to 68.0% at 30%. Because the experimental diets were formulated to be iso-nitrogenous (≈14.3% CP; Table 3), the gain at moderate levels reflects the highly degradable-protein fraction of *G. sepium*. Mondejar and Bestil (2020) demonstrated that sun-drying *G. sepium* leaves raised CP digestibility from 74.6% to 84.0% in native goats, confirming that processed leaf meal enhances protein utilisation when anti-nutritional factors are reduced.

Crude fibre (CF) digestibility improved from 58.0% in the control to 64.5–65.0% at 10–20% GSLM and remained intermediate (60.5%) at 30%. Rusdy *et al*. (2020) observed significantly higher fibre digestibility when 40% *G. sepium* was added to old *Panicum maximum* offered to goats, attributing the response to increased nitrogen supply for cellulolytic bacteria. The same trial recorded elevated

Table 3. Chemical composition of experimental diets with graded levels of GSLM.

Nutrients (%)	Inclusion levels of GSLM (%)			
	0	10	20	30
Dry Matter	92.51	92.63	92.27	90.83
Organic Matter	86.68	84.28	88.67	81.72
Crude Protein	14.29	14.28	14.28	14.27
Crude fiber	14.45	14.55	14.72	14.92
Ash	5.83	8.35	10.21	9.11
Ether Extract	1.68	2.10	3.60	2.65
NDF	42.50	42.80	46.00	46.62
ADF	17.00	17.12	18.40	18.65
NFE	63.75	58.98	56.73	52.59
Lignin	9.07	9.10	9.97	9.06

NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, NFE = Nitrogen Free Extract, GSLM = Gliricidia sepium Leaf Meal.

Table 4. Levels of anti-nutritional factors in the experimental diets fed to Yankasa Rams.

Parameters Mg/100g)	Inclusion levels of GSL (%)				GSLM	Reference Value
	0	10	20	30		
Phytate	0.37	0.53	0.24	0.35	1.71	1,8-18
Oxalate	0.07	0.09	0.04	0.08	0.33	50-74
Tannin	0.81	0.24	0.56	0.11	0.38	35-270
Saponin	2.36	2.81	2.43	2.03	2.00	106-170

GSLM= Gliricidia sepium leaf meal (Source of Reference values: JECFA, 2012).

neutral detergent fibre (NDF) digestibility under *G. sepium* supplementation, matching the rise from 55.5% (control) to 63.0–64.5% at 10–20% GSLM in the present study.

Acid detergent fibre (ADF) digestibility followed an identical trend (52.5% → 60.0–61.5% → 56.5%). Silva *et al*. (2024), in a systematic review of *G. sepium* across fed forms, noted that moderate leaf-meal inclusion consistently improves ADF utilisation by diluting the relative impact of lignin and structural carbohydrates. Lignin digestibility itself remained statistically similar across treatments (42.0–46.0%), indicating that the absolute lignin content of the diets (Table 3) did not reach levels that impaired fibre fermentation at the inclusion rates tested.

Ether extract (EE) digestibility was high throughout (82.0–87.5%) and significantly greater at 10% and 20% GSLM. In pelleted cassava-peel diets containing graded *G. sepium* leaf meal, West African Dwarf bucks showed a linear increase in EE digestibility with increasing inclusion (highest values at 10–15%), supporting the present findings (Olawoye *et al*, 2024). Nitrogen-free extract (NFE) digestibility displayed a non-significant numerical increase at intermediate levels.

Ikhimioya and Okoruwa (2025) reported NFE digestibility of 67.80% when *G. sepium* reached 30% of the diet (combined with neem leaves) in growing sheep, confirming that the readily available carbohydrate fraction of the legume supports NFE utilisation.

The anti-nutritional factors present in the complete diets (Table 4) remained well below established safety thresholds, limiting any negative impact on digestion at the levels examined. Collectively, the digestibility data indicate that 10–20% GSLM optimises the utilisation of DM, OM, CP, CF, NDF, ADF and EE in Yankasa rams.

Nitrogen balance

Nitrogen metabolism parameters were significantly influenced by GSLM level (Table 5). Nitrogen intake decreased progressively from 76.27 g/d (0% GSLM) to 70.31 g/d (30%), reflecting minor differences in voluntary intake and a slight reduction in dietary dry-matter content at the highest inclusion. In a metabolism trial with ewe-lambs, Okoruwa *et al.* (2018) recorded nitrogen intakes within a comparable range when *G. sepium* was increased from 20% to 30% of the diet, confirming that intake adjustments accompany changes in legume proportion.

Faecal nitrogen remained relatively stable at 0–20% GSLM (26.0–26.7 g/d) but rose significantly at 30% (31.86 g/d). Fadiyimu *et al* (2024) reported significant treatment effects on faecal nitrogen excretion in West African Dwarf rams receiving *G. sepium*-substituted diets, with higher faecal losses appearing when legume inclusion elevated

Table 5. Effects of different inclusion levels of *Gliricidia sepium* leaf meal on Nitrogen balance in Yankasa rams fed *Digitaria smutsii* hay basal diets.

Parameters	Inclusion levels of GSLM (%)				SEM
	0	10	20	30	
Nitrogen intake (g/d)	76.27^{a}	76.92^{b}	74.87^{c}	70.31^{d}	1.49
Faecal Nitrogen (g/d)	26.51^{b}	26.70^{b}	26.04^{b}	31.86^{a}	1.37
Urinary Nitrogen (g/d)	8.15^{d}	9.54^{a}	8.60^{b}	8.32^{c}	0.31
Total Nitrogen outgo (g/d)	34.66^{b}	36.24^{b}	34.64^{b}	40.18^{a}	1.31
Nitrogen retained (g/d)	41.61^{a}	40.68^{a}	40.23^{a}	30.13^{b}	2.69
% N retained	54.55^{a}	52.88^{a}	53.73^{a}	42.85^{b}	2.73

^{abc} Means on the same row with different superscripts are significantly (*p<0.05) different, GSLM = Gliricidia sepium Leaf Meal; SEM = Standard Error of Means.

residual secondary compounds. Urinary nitrogen was lowest in the control (8.15 g/d) and highest at 10% GSLM (9.54 g/d). Rusdy *et al*. (2020) observed that *G. sepium* supplementation of low-quality grass shifted a greater proportion of nitrogen excretion toward faeces rather than urine, a pattern consistent with the intermediate levels in the present study.

Total nitrogen outgo increased at 30% GSLM (40.18 g/d). Despite this increase, nitrogen retained (g/d) and the percentage of nitrogen retained remained highest and statistically similar at 0–20% GSLM (40.2–41.6 g/d; 52.9–54.6%) and decreased only at 30% (30.13 g/d; 42.85%). Positive nitrogen balance was maintained across all treatments. Okoruwa *et al* (2018) recorded nitrogen retention of 81.47% at 30% *G. sepium* (plus neem), while Rusdy *et al*. (2020) obtained 67.9% retention with 40% *G. sepium*, both demonstrating that moderate-to-high inclusion can sustain efficient nitrogen utilisation when anti-nutritional factors remain low.

Conclusion

The present results demonstrate that inclusion of 10–20% *Gliricidia sepium* leaf meal in complete diets for Yankasa rams optimises the digestibility of dry matter, organic matter, crude protein, crude fibre, NDF, ADF and ether extract, while maximising nitrogen retention. At 30% inclusion level, both nutrient digestibility and nitrogen balance decreased relative to the intermediate levels, although absolute values remain positive and nutritionally adequate. The favourable chemical composition of the iso-nitrogenous diets and the low residual concentrations of anti-nutritional factors underpin the observed improvements. Consequently, 10–20% GSLM is recommended as the practical inclusion range for enhancing nutrient utilisation and nitrogen economy in Yankasa rams.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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