Performance of West African Dwarf Growing Bucks Fed Varying Levels of *Gliricidia Sepium* Leaf Meal Supplement in Pelleted Diets

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ABSTRACT

Insufficient resources and subpar pasture quality during the dry season necessitate a proven supplement to enhance the nutritional status of goats. In this study, *Gliricidia sepium* leaf meal (G-supplement) derived from a leguminous deciduous protein tree was proportionally incorporated into pelleted cassava peel-based diets (concentrate). The study aimed to assess the impact of this supplement addition to the concentrate on the growth performance of West African dwarf (WAD) goat bucks. Twenty bucks were assigned to four groups in a completely randomized design, with varying levels of G-supplement in pelleted concentrate (0%, 5%, 10%, and 15%). Each group comprised five animals. The inclusion of the supplement significantly influenced ($p<0.05$) diet consumption and utilization. Bucks fed with 10% G-supplement exhibited the highest feed intake (24,248g), weight gain (2650g), and a feed conversion efficiency of 9.15%. Parameters such as total feed intake, daily feed intake, final body weight, total weight gain, and average daily weight gain were significantly affected ($p<0.05$) by the diet. The animals on the 10% G-inclusion diet demonstrated higher ($p>0.05$) nutrient digestibility compared to other treatments. In conclusion, this study suggests that incorporating 10% G-supplement in pelleted concentrate enhances the performance of WAD goats in terms of feed intake, live body weight gain, feed conversion ratio, and nutrient digestibility. The efficacy of the G-supplement at the 10% inclusion level notably contributed to improved performance

Key words: *Gliricidia sepium* leaf meal supplement; Pelleted cassava peel based diet; consumption and utilization, Growth performance of West African dwarf bucks

INTRODUCTION

Recently, goats have gained popularity as a valuable livestock option, particularly for those with limited resources [1]. Their production is gaining recognition worldwide, especially in tropical countries. However, a significant challenge to their productivity lies in the insufficient supply of quality native pasture, especially during the dry season [2]. The high cost of available feedstuffs has led to fierce competition between humans and other livestock, exacerbating the irregular supply of high-quality feed for animals and increasing the cost of their products. Similarly, goats in tropical and sub-tropical countries primarily depend on pasture and agricultural by-products with relatively poor nutritional content. Enhancing goat production requires increased efforts to explore ways of upgrading these poor roughages to boost their consumption, digestibility, and utilization. Consequently, feeding strategies are essential to improve goat performance

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using combinations of locally available, affordable feed resources. Cassava peel, a by-product of cassava processing in Nigeria [3], is a rich energy source that promotes high performance in ruminants when supplemented with protein feedstuffs [4]. *Gliricidia sepium* is a novel high-protein feed source that has proven effective in ruminant feeding [5], [6]. To avoid selective feeding and wastage when offering multiple feedstuffs to animals, pelleting of the feedstuffs becomes necessary. Feed pelleting, a preservation technique, combines various feed ingredients into a single ration, enhancing palatability and intake by ruminants [7]. Pellets reduce dustiness, minimize feed waste, and contribute to cost savings in relation to production output [8; 9]. Goats tend to select the most preferred feed, leaving the rest to go to waste. Consequently, this study aimed to assess the impact of graded levels of *Gliricidia sepium* leaf meal supplementation in pelleted cassava peel-based complete diets on the performance characteristics of growing West African Dwarf (WAD) bucks.

MATERIALS AND METHODS

Location of the study

The study was conducted at the goat unit of Teaching and Research Farm of the College of Agriculture, Landmark University, Omu Aran, Kwara State, Nigeria. Omu-Aran is located in Kwara State, Nigeria at an altitude of 564 meters above sea level, at latitudes 8° 8:00 N and 5° 6:00 E [10]. It is approximately 88 kilometers South of Ilorin, the capital of Kwara State and about 16km North-East of Otun Ekiti, in Ekiti state.

Experimental design, diet and Animal management

Twenty-four growing West African Dwarf (WAD) bucks, with an average weight of 5.95±, were randomly allocated into four dietary treatments, each comprising five bucks, in a complete randomized design experiment lasting twelve weeks. The animals, sourced from small ruminant markets in Omu-Aran, were neck-tagged for accurate identification. The four experimental diets (concentrates) consisted of equal proportions of ingredients, except for *Gliricidia sepium* leaf meal (G-supplement), which was incorporated at levels of 0%, 5%, 10%, and 15%, respectively. These ingredients were pelleted together to create Diet 1 (0% G-supplement and 100% concentrate), Diet 2 (5% G-supplement and 100% concentrate), Diet 3 (10% G-supplement and 100% concentrate), and Diet 4 (15% G-supplement and 100% concentrate). Before the commencement of the study, the bucks were isolated for two weeks and acclimated to the experimental conditions over seven days. Each animal received intramuscular long-acting antibiotic (TridoxR), subcutaneous wormer (IvermectinR), and multivitamin injections at rates of 1ml/10kg, 0.25ml/25kg, and 5ml/kg body weight, respectively, ensuring their well-being from the beginning of the experiment. Individual animal housing units were equipped with appropriate feeding and watering facilities. The feed was provided to the experimental animals at 5% of their body weight daily in a single ration for a twelve-week period. Fresh water and a salt lick were freely available in each pen. Daily feed refusals were weighed and recorded before morning feeding to estimate the animals' daily feed intake.

Collection and Processing of Cassava peel and *Gliricidia sepium* into meal

Freshly prepare cassava peels were procured from a Garri processing industry in Omu-Aran, Kwara State, Nigeria, washed and sun-dried at normal sunny day temperature of 32^0C for five days and then mechanically milled using harmer mill grinder. Fresh *Gliricidia sepium* leaves were obtained in the vicinity of Omu-Aran. The gathered *Gliricidia sepium* leaves were laid out in the shade of 32^0C for ten days to avoid direct solar radiation that may affect the protein quality of the leaf. The leaf was subsequently mechanically milled. A diet based on cassava peels was formulated, comprising dry cassava peel, corn bran, bone meal, and a vitamin-mineral premix (Table 1). A measured quantity of the milled *Gliricidia sepium* was incrementally added to each concentrate mixture, thoroughly mixed, and mechanically forced through a

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6 mm die (mesh) in a pelletizer. This process produced pellet diets with an average length of 40 mm. The pelleted diets were sun-dried for 3 hours to prevent spoilage. The formulation of the experimental diet is detailed in Table 1.

Table 1: Composition of Experimental Diets

Ingredients (Kg)	T1 C + (0% G)	T2 C + (5% G)	T3 C+ (10% G)	T4 C + (15% G)
Cassava peel	76.00	76.00	76.00	76.00
Corn bran	20.00	20.00	20.00	20.00
Oyster shell	3.00	3.00	3.00	3.00
Salt	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50
Total	100	100	100	100
G	0	5.00	10.00	15.00

C: concentrate, G: G-supplement, T: Treatment

Assessment of Physio-chemical parameters of pelleted diets

The physico-chemical parameters of the diets were assessed as described by Kilic (1986). The colour was assessed with a color chart. The smell, texture and firmness were adjudged by 6 individuals using sense organs (eye, nose and touch) i.e organoleptic observation.

Table 2: Physico-chemical characteristics of the experimental diets

TREATMENTS

Physico-chemical Parameters	T1 100%C+0%G	T2 100%C+5%G	T3 100%C +5%G	T4 100%C+15%G
Colour	Creamy	Light green	Dull green	Dark green
Firmness	Very firm	Very firm	Firm	Slightly firm
Odour	Odourless	Slightly leafy odour	Leafy odour	Very leafy odour
Texture	Fine	Fine	Slightly coarse	Coarse

G: G-supplement; C: Concentrate

Digestibility studies

The nutrient digestibility trial followed the feeding and growth trial, wherein three goats were randomly chosen from each treatment group and transferred to metabolic crates for fecal collection. The animals underwent a seven-day adjustment period in the crates before the data collection commenced. Each buck was housed individually, and their daily feed intake, feed refused, and fecal output were recorded. During the seven-day collection period, 10% of the total feces voided by each goat were retained. These feces were pooled together, and representative samples were extracted from each pool for subsequent chemical analysis.

Chemical analysis

The chemical composition of dried cassava peel, air-dried *Gliricidia sepium* leaf and the experimental diets and feaces was carried out according to the methods of [12].

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Statistical analysis

Data generated were analysed statistically using analysis of variance (ANOVA) model to establish the degree of significance ($P<0.05$) between different treatments. The analysis was carried out using Genstat (2013 package). The Duncan Multiple Range Test [13] was used to separate the significant means.

RESULTS

Table 3: Composition of *Gliricidia sepium* leaf and Cassava peel used

Parameters	Gliricidia sepium (Gs)	Cassava peel (C)
Dry Matter (%)	92.67	90.4
Moisture (%)	7.33	9.6
CP (%)	20.72	3.55
CF (%)	7.95	14.06
EE (%)	5.67	2.04
Ash (%)	6	7.5
NFE (%)	52.33	63.25
NDF (%)	40.7	18.34
ADF (%)	28.7	17.34
Hemicellulose (%)	12	1
Cellulose (%)	8	6.34
Lignin (%)	7.67	6.34
Silica (%)	13.6	11.67

CP: Crude Protein; CF: Crude Fibre; EE: Ether Extract; NFE: Nitrogen-free Extract; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre

Table 4: Physico-chemical characteristics of the experimental diets

Physico-chemical Parameters	T1. 0%G + 100%C	T2. 5%G +100%C	T3. 10%G +100%C	T4. 15%G +100%C
Colour	Creamy	Light green	Dull green	Dark green
Firmness	Very firm	Very firm	Firm	Slightly firm
Odour	Odourless	Slightly leafy odour	Leafy odour	Very leafy odour
Texture	Fine	Fine	Slightly coarse	Coarse

G: G-supplement*;* C: Concentrate T: Treatment

Table 5: Proximate composition of the experimental diets

Parameters	T1. (0%G + 100%C)	T2. (5%G +100%C)	T3. (10%G + 100%C)	T4. (15%G +100%C)	p-value	SEM±	LSD
Dry Matter (%)	86.31	86.79	86.88	85.70	0.442	0.834	2.709
Moisture (%)	13.69	13.21	13.12	14.30	0.743	0.834	2.719
CP (%)	8.26^{c}	11.60^{b}	13.28^{a}	14.25^{a}	<.001	0.207	0.676

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CF (%)	6.11	6.44	6.45	7.13	0.577	0.509	1.659
EE (%)	1.63^{c}	2.26^{b}	3.15^{a}	3.41^{a}	<.001	0.0266	0.086
Ash (%)	7.17	7.33	7.17	7.00	0.124	0.382	1.245
NFE (%)	63.14^{a}	59.16^{b}	56.83^{bc}	53.91^{c}	0.002	0.830	2.705
NDF (%)	23.33	24.00	25.00	25.20	0.441	0.833	2.718
ADF (%)	13.30	13.7	15.30	16.70	0.826	2.83	9.24
Hemicellulose (%)	10.03	10.30	9.70	8.50	0.909	2.96	9.66
Cellulose (%)	6.67	5.00	7.33	3.67	0.378	1.528	4.982
Lignin (%)	9.70	12.00	10.30	11.30	0.159	2.96	9.65
Silica (%)	3.00	2.33	2.67	3.67	0.452	0.577	1.883
TDN (%)	81.19	82.29	83.65	82.96	<.001	0.005	0.018
Energy Kcal/g	10.16	9.69	10.65	11.15			

abc =The means within the same row with different superscripts are statistically ($p<0.05$) different

G: G–supplement; C: Concentrate; CP: Crude Protein; CF: Crude Fibre; EE: Ether Extract; NFE: Nitrogen-free Extract; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre; TDN: Total Digestible Nutrient; SEM: Standard errors of means; LSD: Least significant differences of means

The composition of *Gliricidia sepium* and cassava peel is detailed in Table 3, while Table 4 displays the physico-chemical characteristics of the diet (Table 3), confirming the influence of G-supplement on the pelleted diets. The color dullness of the diet increased with higher levels of G-supplement, and at 15% inclusion, the firmness slightly diminished. The leafy odor of the diet with 15% G-supplement inclusion was more pronounced. The texture of the 15% *Gliricidia sepium* leaf meal (GLM) was coarse and crumbly with minimal handling, possibly due to the substantial impact of the 15% G-supplement inclusion, which could account for reduced binding force. The proximate composition of the experimental diets is outlined in Table 5. The dry matter (DM) content varied from 86.88% to 85.70% as G-supplement levels increased in the diets. The highest DM value was observed in the diet containing 10% G-supplement, whereas the diet with 15% G-supplement (T4) had the lowest value (85.70%). However, these values were statistically similar ($p>0.05$) for all treatments. Moisture content values for all treatments followed a similar trend as DM values. Crude protein (CP) values increased from 8.26% (T1) to 17.25% (T4) with increasing G-supplement in the diets. The CP value (8.26%) of the diet with 0% GLM was significantly low ($p<0.05$), while the highest value (17.25%) was recorded for T4. Ether extract (EE) values ranged from 3.41% (T4) to 1.63% (T1), with T1 (1.63%) being numerically low among the groups. Despite the numerical increase in G-supplement, the crude fiber value remained comparable ($p>0.05$). The highest ash value (7.33%) was obtained from T2, but values were similar ($p>0.05$) for all treatments. Nitrogen-free extract (NFE) values decreased from T1 to T4 (63.14% to 53.91%). NFE value of T1 (63.14%) was significantly low ($p<0.05$), while values of T2, T3, and T4 (59.16%, 56.83%, and 53.91%) were comparable ($p>0.05$). Similar results ($p>0.05$) were found for NDF, ADF, hemicellulose, cellulose, and lignin. Total Digestibility Nutrient (TDN) values for all diets were similar ($p>0.05$). The growth performance of the WAD bucks is presented in Table 6. The initial live weights of the experimental goats were comparable ($p>0.05$). However, the live weight of each goat fed the experimental diets increased over time. The group fed a diet containing 10% G-supplement exhibited the highest total weight gain (2650g), which was significant ($p<0.05$), while the lowest (733g) was recorded from goats fed diets with 0% G-supplement. The total feed intake of the group fed 10% G-supplement (24248g) was significantly high ($p<0.05$), with the lowest value (19293g) recorded in the group fed 0% G-supplement. However, these values were comparable ($p>0.05$). Daily feed intake exhibited a similar pattern to total feed intake. The feed conversion ratio (FCR) values obtained from goats fed 0% G-supplement (26.32) were significantly high ($p<0.05$), while 9.33% and 9.15% of T2 and T3,

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respectively, were similar (p>0.05).

Table 6: Growth performance of growing WAD bucks fed *Gliricidia sepium* leaf meal supplement in pelleted cassava peel based diets

Parameters	T1 (0%G + 100%C)	T2 (5%G + 100%C)	T3 (10%G + 100%C)	T4 (15%G + 100%C)	p-value	SEM±	LSD
Initial weight (g)	5717^{b}	6250^{a}	5100^{b}	5600^{b}	0.460	498.2	1469.7
Final weight (g)	6450^{b}	8417^{a}	7267^{ab}	6833^{ab}	0.081	528.9	1560.3
T. weight gain(g)	733^{d}	2167^{b}	2650^{a}	1233^{c}	<.001	0.0892	0.2632
D. weight gain(g)	11.63^{d}	34.40^{b}	42.06^{a}	19.57^{c}	<.001	0.0890	0.2630
TFI (g)	19293^{ab}	20218^{ab}	24248^{a}	23498^{b}	<.001	0.0549	0.1619
DFI (g)	306^{b}	314^{b}	388^{a}	372^{a}	<.001	0.0019	0.0056
FCR (%)	26.32^{a}	9.33^{c}	9.15^{c}	19.06^{b}	<.001	1.096	3.232

abcd =The means within the same row with different superscripts are statistically (p<0.05) different

G: *G*-supplement; C: Concentrate; T: Treatment TFI: Total Feed Intake; DFI: Daily Feed Intake; FCR: Feed Conversion Ratio; SEM: Standard errors of means; LSD: Least significant differences of means

Table 7: Apparent Nutrient digestibility of growing WAD goats fed *Gliricidia sepium* in pelleted cassava peel based diets.

Parameters	T1 (0%G + 100%C)	T2 (5%G + 100%C)	T3 (10%G + 100%C)	T4 (15%G + 100%C)	p-value	SEM±	LSD
Dry Matter (%)	87.00	86.86	86.78	85.50	0.441	0.837	2.709
Moisture (%)	13.00	13.14	13.22	14.50	0.643	0.835	2.719
CP (%)	58.55^{b}	62.60^{a}	68.50^{a}	66.44^{a}	<.001	0.209	0.676
CF (%)	49.13^{b}	50.44^{a}	50.45^{a}	50.11^{a}	0.577	0.509	1.659
EE (%)	61.22^{c}	62.22^{b}	63.12^{a}	63.41^{a}	<.001	0.024	0.086
Ash (%)	57.19	57.30	57.11	57.01	0.124	0.382	1.245
NDF (%)	76.00	76.33	78.00	75.00	0.442	0.831	2.712
ADF (%)	33.30	35.30	36.70	33.70	0.825	2.83	9.32

abc =The means within the same row with different superscripts are statistically (p<0.05) different

G: G-supplement; C: Concentrate; CP: Crude Protein; CF: Crude Fibre; EE: Ether Extract; NFE: Nitrogen-free Extract; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre; SEM: Standard errors of means; LSD: Least significant differences of means

Table 7, illustrates the apparent nutrient digestibility. The crude protein value of 66.44% obtained from the animal group with 15% G-supplement (T4) was comparable (p>0.05) to the 68.50% of the group fed 10% G-supplement. The highest crude protein (CP) value (68.50%) was observed in animals from T3. The lowest CP (58.55%) was recorded in T1, which was similar (p>0.05) to the 62.60% of T2. Crude fiber digestibility in T1 (49.13%) was significantly low (p<0.05), while values in T2, T3, and T4 were similar (p>0.05). The lowest and significantly low (p<0.05) ether extract (EE) value (61.22%) was recorded in T1. The highest (63.41%) was observed in T4, which was similar (p>0.05) to the value in T3 (63.12%). However, EE values increased with higher levels of G-supplement. The digestibility values of total ash across the treatments

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were similar ($p>0.05$). Although numerically T2 had the highest value, the estimate of acid detergent fiber (ADF) digestibility increased in T3 (36.70%). T1 had the lowest value (30.30%), but values were similar ($p>0.05$) across the treatments. Neutral detergent fiber (NDF) digestibility showed variation but was similar ($p>0.05$).

DISCUSSIONS

The crude protein (CP) value obtained for cassava peel in this study (3.55%) is relatively low, as indicated in Table 2. This suggests that cassava peel represents a variety of low-protein feed ingredients, consistent with previous reports [14] that cassava peel protein is lower than that of cereal grains. If cassava is to be used as a basal diet, it becomes imperative to address its protein deficiencies. On the contrary, the high CP value (20.72%) obtained for *Gliricidia sepium* indicates its rich protein content, aligning with previous records stating that *Gliricidia sepium* can contain as much as 20-30% CP and 15% CF [15]. The uniformity in dry matter (DM) values across the treatments (diets) suggests that the diets were uniformly dried, indicating consistent texture and dryness in the pelleted diets. This is supported by reports indicating that pelleting aids in binding feed components together [7]. The increase in CP levels as *Gliricidia sepium* increased in the diets may indicate its sufficiency for goat nutrition, more so, as literature has indicated that minimum protein between 6 and 7% will suffice for goat development. This falls within the range of CP concentration recognized to be adequate for microbial activities in the rumen, as mentioned by [16], and surpasses the range of 11.00 to 13.00% considered sufficient for maintenance and moderate development in goats [17]. The observed higher weight gain in animals on the diet containing 10% G-supplement could be attributed to its palatability, evident in the lower intake of animals on the diet with 15% G-supplement. The reduced intake of diet 1 may be linked to its lower CP content. The diminished consumption of the pelleted diet with 15% G-supplement could be attributed to the animals' feeding preferences, in line with the observation that goats often show a preference for certain foods based on taste [18] or due to the perceived apparent odor of the diet containing more G-supplement. However, all goats in the experimental units fed pelleted diets containing G-supplement demonstrated weight gain ranging from 19.57 to 42.06g/day, falling within the range reported for goats fed PKC concentrate in a previous study [19]. The dry matter level of the consumed diets in this study appears to be indicative of the ration's quality, suggesting that goats favored diets containing 10% G-supplement more among the treatments, as evidenced by the observed weight gain. This aligns with the idea that voluntary feed intake is crucial in determining feed quality [20]. The remarkable weight of animals fed the diet containing 10% G-supplement may imply the efficacy of its nutrient content as well as its palatability to goats, consistent with previous reports [21]. The supplementation of diets with G-supplement in this study improved the apparent digestibility of nutrients compared to diets without G-supplement. The differences in DM and nutrient digestibility between diets containing G-supplement and those without could be attributed to the high-fiber nature of added *Gliricidia sepium* leaf meal to cassava peel-based diets. This enhancement in digestibility aligns with the notion that digestibility improves when a ration contains a reasonable proportion of protein to the amount of readily available carbohydrates [22].

CONCLUSION

This study highlights the nutritional value of *Gliricidia sepium* leaf meal as a viable forage option in the diet of West African Dwarf (WAD) bucks. Incorporating *Gliricidia sepium* leaf meal as a supplement at a 10% level in a total mixed dry cassava-based pelleted diet did not adversely affect the performance of the goats. This suggests that *Gliricidia sepium* leaf meal can be effectively utilized as a supplemental resource for intensive ruminant production.

DECLARATION OF COMPETING INTEREST

Authors declare no conflict of interest.

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