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ORIGINAL RESEARCH ARTICLE

Effect of Graded Levels and Different Forms of *Gliricidia sepium* Leaves Supplement on Nutrient Intake, Digestibility and Nitrogen Retention of West African Dwarf Sheep

Akinlade, J.A, *Ojoawo, O.T and Oyewole, S.T
Department of Animal Production and Health,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria.
*Corresponding author: otojoawo47@lautech.edu.ng

ABSTRACT

Nutrition remains the bedrock of ruminant production, however, scarcity and poor quality of available forage characterized the tropics especially in dry season. Use of browse plants and agricultural by products will perhaps ameliorate the challenges. Therefore, this study investigated the effect of graded levels and different forms of G. sepium leaves on nutrient intake, digestibility and nitrogen retention of West African Dwarf (WAD) sheep for 10 weeks. Thirty six (36) WAD sheep were randomly allocated to three graded levels (0%, 10% and 20% G. sepium) and three forms (Fresh, Wilted and Air-dried) laid in 3 x 3 factorial arrangement using completely randomized design. Dried cassava peel was included appropriately to graded levels of G. sepium to make 100% diet composition. Data collected were daily weight gain (DWG), crude protein intake (CPI), dry matter digestibility (DMD) and nitrogen retained (NR). Sheep on 20% G. sepium had higher DWG (123.81g/d) while animals on 10 and 20% G. sepium recorded similar values for CPI (38.32 and 41.87g/d), DMD (67.06 and 66.31%) and NR (24.94 and 25.75g/d), respectively. Sheep fed on fresh and on wilted forms of G. sepium had similar higher values (120.64 and 132.65g/d; 67.83 and 68.67%) for DWG and DMD, respectively. Animals on wilted and on air-dried forms recorded similar (P>0.05) CPI (38.78 and 39.89g/g) while no significance (P>0.05) was observed for NR. Interaction of graded levels and forms of G. sepium had significant effects (P<0.05) on DWG, CPI, DMD and NR. Therefore, feeding 20% G. sepium in wilted form and 80% dried cassava peel to West African dwarf sheep is recommended for better performance.

Keyword: browse plants, Gliricidia sepium, supplementation, nitrogen retention, weight change

INTRODUCTION

Livestock productivity in the tropics has suffered major setbacks due to inadequate quantity and quality feeds for the animals especially during dry season (Duguma, 2021). In wet season, forage is relatively available and small ruminants may easily gain weight and remain thrifty (Babayemi *et al.*, 2003). Akinlade *et al.* (2005) reported that a major problem facing small ruminants' producer is how to feed the animals adequately during the dry season. Meanwhile, Leng (2008) proposed that ruminant feeding systems based on poor quality tropical forages, crop residues or agro-industrial waste and by-products, in which protein is one of the major limiting factors, may require supplementation with protein-rich feeds. This is to maintain an efficient rumen ecosystem that will stimulate nutrient intake and improve animal performance. Foliage of some browse trees and shrubs have been identified as having the potential to serve as supplementary feeds in small ruminant feeding systems. This is because they grow all year round and their nutritive values do not fluctuate as much as that of grasses in different seasons. The potentials of trees and shrubs as alternative fodder resources in livestock nutrition have thus attracted the attention of researchers worldwide (Okoli *et al.*, 2001; Asaolu *et al.*, 2012; Aye, 2013; Adegun *et al.*, 2014; Aye, 2016 and Fadiyimu, 2016). Browse plants with high nutritive value have been successfully fed to ruminant animals in alley farming system (Fasae and Alokan, 2006).

Gliricidia sepium is one of the browse multipurpose plants which was promoted as a nitrogen source due to its biological ability to fix soil nitrogen and produces high biomass yield during dry season (Nygren *et al.*, 2000. It has been well studied for its potentials as supplement in sheep and goats diets and especially during the dry season (Asaolu *et al.*, 2012; Aye, 2013;

Adegun *et al.*, 2014; Aye, 2016 and Marsetyo *et al.*, 2021). Marsetyo *et al.* (2021) recommended *Gliricidia sepium* as a suitable feed for ruminants which can be consumed in large quantities without deleterious effects on animal performance. Heuzé and Trans (2015) reported that *Gliricidia sepium* can be offered to ruminants in fresh, wilted and air dried forms. Meanwhile, the best acceptable form and inclusion level of *Gliricidia sepium* by West African Dwarf (WAD) sheep especially when offered alongside with cassava peel is lacking in literature. This study therefore assessed the nutrient intake, digestibility coefficient and nitrogen retention of West African Dwarf sheep when offered fresh, air-dried and wilted *Gliricidia sepium* leaves at graded levels as supplement to cassava peel basal diet during the dry season.

MATERIALS AND METHODS

***Experimental Site*:** The experiment was carried out at the Small Ruminants Unit of the Teaching and Research Farm Ogbomosho, Ladoke Akintola University of Technology, for a period of 10 weeks.

Pre Experimental Preparation and Experimental Feed Procurement: Before the arrival of the experimental animal (sheep), the pen was renovated and fumigated with potassium permanganate to destroy any microorganisms and pathogens. The surroundings of the pen house were also disinfected. After washing, the pens were allowed to dry and wood shavings (bedding material) were poured on the floor.

Experimental Animals and Management: Thirty-six (36) West African Dwarf Sheep weighing 18-20 Kg was procured from a local market in Ogbomosho. The animals were quarantined for two weeks and they were observed. The sick ones were treated accordingly based on observable symptoms. Acclimatization period of two weeks was also observed during which feeds like Cassava Peel, *Panicum maximum* were offered and they were allowed to graze. At the end of the acclimatization period, the animals were gradually exposed to the experimental diets for 7 days at 8:00am and 4:00pm daily and water was provided *ad-libitum*. Salt lick was also given to them which served as mineral supplement. The animals were then randomly assigned to the experimental diets with ten animals in each treatment. The experimental diets were three graded levels (0, 10 and 20% *Gliricidia sepium*) and three forms (Fresh, Wilted and Air-dried) in a factorial arrangement. Dried cassava peel was included appropriately to the graded levels of *G. sepium* to make 100% diet composition.

Collection of Data:

Feed Intake and weight change: The feed offered and left over for each of the animals were weighed and recorded. Feed intake was estimated as difference between feed offered and the left over. The weight of the animals were measured with weighing balance and recorded before and after the experiment as the animals' initial and final weight.

Nutrient Digestibility and Nitrogen Retention: Animals were allowed to acclimatize for fourteen days in individual metabolic cages which were constructed to allow for separation of faeces and urine. During the experimental period of fourteen days, feed offered were weighed, left overs, urine and faecal samples were collected and weighed (Osuji *et al*., 1993). The feaces and urine for each of the animals were sub-sampled, dried and kept for analysis. The nutrient digestibility coefficient was estimated as:

$$\text{Nutrient digestibility coefficient} = \frac{\text{Nutrients in feed} - \text{nutrients in faeces} \times 100}{\text{Nutrients in feed}}$$

Urine samples were collected and kept in bottles pretreated with diluted H_2SO_4 to prevent precipitation. Nitrogen retained was estimated as: Nitrogen in feed – (Urinary Nitrogen + Faecal Nitrogen)

Laboratory Analysis: The samples of *Gliricidia sepium* herbage, (air-dried, fresh and wilted) cassava peel, and at the varying levels with the faeces from each of the animals were sub-sampled, weighed, oven-dried @ 60^0c, milled into particles to pass through 0.5mm sieve and kept in cellophanes until analysis. The samples were analyzed for proximate contents (Dry Matter, Crude Fibre, Crude Protein, Ash, Ether

Extract) using the AOAC (2005) procedure. The Nitrogen Free Extract was estimated as 100% - (%EE + %CP + %Ash + %CF). The fibre fractions (Acid Detergent Fibre, Acid Detergent Lignin, and Neutral Detergent Fibre) were also done using the procedure of Van Soest *et al.* (1991). The nitrogen in the urine was also determined using kjeldahl procedure of AOAC (2005).

Experimental Design and Statistical Analysis: The experimental design was complete randomized design of a 3 x 3 factorial arrangement. Data collected were subjected to analysis of variance of General Linear Model procedure of SAS Version 9.3 statistical package (SAS, 2000). Treatment means were separated using Duncan's Multiple Range Test of the same package (5% significant level).

RESULTS AND DISCUSSION

***Chemical Composition of the Experimental diets*:** The chemical composition of the cassava peel, *Gliricidia sepium* (GS) and the experimental diets are shown in Table 1. The crude protein content (CP) of the three forms of GS- fresh, wilted and air-dried offered to the animals ranged from 17.88 - 26.25 % with the air-dried GS having higher value. The dry matter content (DM) was between 70.00 and 89.90%. Air-dried GS at 20% graded supplementation level (GSL) had higher values for CP (13.04%), DM (94.90%) and neutral detergent fibre (NDF) (333.96%). Meanwhile, 0% GSL had lower values for CP and CF while the DM compares favourably with other GSL. The NDF which predicts intake ranged between 19.32 and 33.96%. Table 1 revealed that all the animals had access to balanced ration during the experimental period.

The crude protein content (CP) of GS (17.88-26.25%) reported in this study is similar to the 24.59% reported by Adegun (2014) but higher than that of Devendra (1992) and Asaolu *et al.* (2012). The CP and CF values of the experimental diets were within the range recommended by NRC (2007) for growth of sheep. The CF values in this study are however low and this corroborates the report of Adegun (2014), that browse plants have low CF. Also, the NDF recorded in this study is below the 35% reported by Adegun (2014) at which digestibility reduces.

Table 1: Chemical composition of the cassava peel, forms of *Gliricidia sepium*, and the experimental diets

Parameters (%)		Crude protein	Crude fibre	Dry matter	NDF	ADF	ADL
	Forms						
CAP		7.00	8.60	89.10	22.10	15.60	10.10
G.s	Fresh	17.88	17.50	70.00	24.33	22.40	17.68
	Wilted	19.63	19.00	79.00	16.40	13.70	10.20
	Air-dried	26.25	12.20	89.90	26.41	24.32	19.10
Calculated Nutrients (%)							
0% G.s + 100% CAP		7.00	8.60	89.90	22.10	15.60	10.10
10% G.s+ 90% CAP	Fresh	6.38	9.49	87.91	22.50	16.28	9.09
	Wilted	7.26	9.64	88.81	19.32	15.41	10.11
	Air-dried	8.92	8.96	91.95	22.96	16.47	11.03
20% G.s + 80% CAP	Fresh	7.18	10.38	85.92	22.32	37.80	11.62
	Wilted	7.53	13.20	87.72	22.53	17.34	11.96
	Air-dried	13.04	9.32	94.90	33.96	15.22	2.92

CAP-cassava peel; G.s- *Gliricidia sepium*; NDF- neutral detergent fibre; ADF- acid detergent fibre; ADL- acid detergent lignin

Performance Characteristics of the West African Dwarf sheep: The graded supplementation levels (GLS) and the different forms of *Gliricidia sepium* offered to the West African Dwarf sheep

were significantly (P<0.05) different for feed intake (FI), average daily gain (ADG) and feed conversion ratio (FCR) except for weight change which was only significant for GLS (Table 2). Animals offered 20% GSL of *G. sepium* had higher (P<0.05) values of weight change (2.02kg), FI (519.96 g/day DM) and ADG (123.81g/day). It was observed that as the supplementation level increased from 0 to 20%, the weight change, FI, ADG also increased in value (Table 2). The lower FCR which was the desired, was observed among animals offered *G. sepium* at 20 % supplementation level.

Animals offered wilted *G. sepium* were significantly (P<0.05) different from those offered fresh and air-dried *G. sepium* for FI, ADG and FCR with 526.94 g/day DM, 132.65 g/day and 4.51 (the least FCR) respectively. The order of significance was from wilted, followed by fresh and then air-dried. Animals offered air-dried *G. sepium* had the lower (P<0.05) values for the parameters.

The interaction effects of the graded supplementation levels (GLS) and the different forms of *Gliricidia sepium* (GSL x DFOG) were significant (P<0.05) for all the parameters except for FCR. This implies that there was combined effect of the GSL and the DFOG offered to the WAD sheep for weight change, FI and ADG and it was significantly (P<0.05) higher at 20% GSL of wilted *G. sepium*.

The FI range in this study, 418.25-519.96 g/day DM and 434.62- 526.94 g/day DM was higher when compared with the 303.22 ±20.5 g/day DM of Adegun (2014) and 172.93 g/day DM of Fadiyimu (2016) in which *Panicum maximum* was the basal diet in both study. Meanwhile the FI values observed in this study was lower when compared with the 588.12 – 621.44 g/day DM reported by Aderinola *et al*. (2008). This variation could be attributed to the basal diet used in the study which was vetver grass as against the cassava peel used in this study. Another source of variation could be the season in which the study was conducted which was rainy season. Meanwhile, this study focused on dry season feeding for WAD sheep.

Table 2: Performance Characteristics of the West African Dwarf sheep offered different forms of *Gliricidia sepium* and at the graded supplementation levels

Factors	Weight change (kg)	Feed intake g/day DM	daily weight gain(g/d)	Feed conversion ratio
Graded Supplementation level of *G. sepium*				
0%	1.61^{b}	455.13^{b}	101.85^{b}	4.51^{a}
10%	1.81^{ab}	478.25^{ab}	104.68^{b}	4.57^{a}
20%	2.02^{a}	519.96^{a}	123.81^{a}	4.20^{b}
SEM	0.14	29.67	9.33	0.59
Form of *G. sepium*				
Fresh	1.86	451.84^{ab}	120.64^{a}	5.11^{a}
Wilted	1.89	526.94^{a}	132.65^{a}	4.57^{b}
Air-dried	1.69	434.62^{b}	89.95^{b}	6.00^{a}
SEM	0.14	28.25	9.32	0.47
Interaction	0.003	0.019	0.002	0.067

Means with different superscripts are significantly different at 5% α-level,

Nutrient Intake, Digestibility and Nitrogen Retention of the West African Dwarf sheep: The nutrient intake, nutrient digestibility and nitrogen utilization of the feed by the WAD sheep at the three graded supplementation level (GSL) – (0%, 10% and 20%) and the different forms of GS (DFOG)-(fresh, wilted and air-dried) are shown in Table 3. The GSL main effect revealed that all parameters were different (P<0.05) except neutral detergent fibre intake (NDFI) and neutral detergent fibre digestibility (NDFD).

Significantly (P<0.05) higher values for all the parameters were recorded at 20% GSL except for DMD which was at 10% GSL. It was observed that as the GSL increased the nutrients intake increased. The performance of the animals when offered the different forms of GS (DFOG) (Table III) differed significantly (P<0.05) except for crude fibre intake (CFI), NDFI and nitrogen retention (NR). The CPI and NR of air-dried GS differed significantly. The nutrient composition (Table 1) confirmed this finding. Meanwhile, in terms of digestibility coefficient, there were no significant (P>0.05) difference between the fresh and wilted GS and they showed higher performance than air-dried GS. The interactive effect of the GSL and DFOG revealed significant effect (P<0.05) for all the parameters. This implies that the GSL and the DFOG combined effectively when offered to the animals. Optimum performance for protein was evident at air-dried GS while for digestibility it was wilted GS and all at 20% supplementation level. Thus, offering either wilted or air-dried *Gliricidia sepium* at 20% as supplement to 80% cassava peel will improve the performance of WAD sheep during the dry season.

Browse leaf supplementation increased the nutrient intake and the digestibility of the diets by the animals. This finding corroborates the report of Okoruwa and Ikhiomaya (2020). The leaves of the browse plants provided more nitrogen for high growth rate. High NR implies low nitrogen loss either through faeces or urine. This is so because browse plants reduce the quantity of ammonia excreted in urine into the environment through the reduction of rumen protein degradation (Hariadi and Santoso, 2010).

Table 3: Nutrient Intake, Digestibility and Nitrogen Retention of West African Dwarf sheep offered different forms of *Gliricidia sepium* and at different supplementation levels

Factors	CPI (g/day)	CFI (g/day)	NDFI (g/day)	DMD (%)	CPD (%)	CFD (%)	NDFD (%)	NI (g/day)	DN (g/day)	NR (%)
Supplementation level of *G. sepium*										
0%	30.53^{b}	38.97^{b}	100.14	59.56^{b}	16.69^{b}	10.31^{b}	51.63	6.19^{b}	2.06^{b}	18.44^{b}
10%	38.32^{a}	47.54^{a}	112.84	67.06^{a}	38.38^{a}	27.13^{a}	58.69	7.13^{a}	3.19^{a}	24.94^{a}
20%	41.87^{a}	50.85^{a}	112.75	66.31^{ab}	38.56^{a}	26.25^{a}	56.69	7.00^{a}	2.81^{a}	25.75^{a}
SEM	1.31	2.07	6.92	2.20	4.00	4.82	2.63	0.15	0.18	1.98
Form of *G. sepium*										
Fresh	32.06^{b}	43.24	100.95	67.83^{a}	34.33^{a}	30.83^{a}	56.00^{a}	5.67^{c}	1.83^{b}	20.00
Wilted	38.78^{a}	50.83	120.64	68.67^{a}	37.67^{a}	28.33^{a}	61.00^{a}	6.17^{b}	2.33^{b}	25.67
Air-dried	39.89^{a}	43.28	104.14	52.50^{b}	16.83^{b}	13.83^{b}	47.17^{b}	9.33^{a}	4.50^{a}	23.67
SEM	2.31	3.01	7.29	2.19	4.80	4.80	2.60	1.00	0.99	2.05
Interaction	0.004	0.002	0.002	<0.0001	0.001	0.001	<0.0001	0.001	<0.0001	<0.0001

CPI-Crude protein intake, CFI-Crude fibre intake, NDFI-Neutral detergent fibre intake, DMD-Dry matter digestibility coefficient, CPD-Crude protein digestibility coefficient, CFD-Crude fibre , digestibility coefficient, NDFD- Neutral detergent fibre digestibility coefficient, NI- Nitrogen intake, DN- Digested Nitrogen and NR- Nitrogen retained. Means with different superscripts are significantly different at 5% α-level.

Conclusions and Recommendations

For high feed intake, average daily gain, weight change and lower feed conversion ratio, West African Dwarf sheep could be offered 20% wilted *G. sepium* in combination with cassava pee for optimum performance during the early dry season. Wilted and air-dried *Gliricidia sepium* could be offered at 20% supplementation level to cassava peel during the dry season as it increased growth rate, nutrient intake, nutrient digestibility and nitrogen utilization and even reduced cost of production. There was significant effect of interaction of supplementation level and form of *G. sepium* on growth, intake, digestibility and nitrogen retention except for feed conversion ratio.

Conflict of Interest

The authors declare that there are no conflict of interest during the conduct of the study.

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