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Growth performance and nutrient intake of West African Dwarf sheep fed selected browse forages

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ABSTRACT: The growth performance and nutrient intake of West African Dwarf sheep were investigated. Five selected forages, *Mangifera indica, Anacardium occidentale, Gmelina aborea, Gliricidia sepium and Panicum maximum,* were used for the study. Twenty West African Dwarf (WAD) male sheep of an average weight of 12.65 kg, between 6 and 7 months old, were subjected to five dietary treatments with four animals per treatment in a completely randomised design in a study that lasted for 84 days. Significantly ($p<0.05$) highest (4.33 kg) weight gain was observed in sheep fed *P. maximum* + *A. occidentale,* while the (2.23 kg) was recorded in sheep fed *P. maximum* only. The same trend was observed in the daily weight gain. The best (5.41) feed conversion ratio was observed in sheep fed *P. maximum* + *A. occidentale.* The highest (249.15 g/day) significant ($p<0.05$) total dry matter intake was observed in animals fed *P. maximum* + *A. occidentale,* while the least (170.32 g/day) was obtained in animals fed *P. maximum* + *G. aborea*. Addition of forages to *P. maximum* fed to WAD sheep significantly ($p< 0.05$) affected crude protein intake, as animals on *P. maximum* + *M. indica* recorded the least value (39.02 DM g/day) while the highest significant value (67.02 DM g/day) was obtained from animals fed *P. maximum* + *A. occidentale*. The study concluded that, in terms of feed conversion ratio and weight gain, sheep fed *P. maximum* supplemented wit*h A. occidentale* gave the best performance.

Keywords: *Anacardium occidentale*, browse forages, *Gmelina aborea, Gliricidia sepium, Mangifera indica, Panicum maximum*, West African Dwarf sheep.

INTRODUCTION

A major constraint to livestock production in developing countries is the scarcity and fluctuating quantity and quality of the year-round feed supply (Olafadehan and Okunade, 2018). Sheep display a unique ability to adapt and survive in areas where they are found, and consequently, their wide geographical distribution in Nigeria (Ahaotu *et al*., 2017). According to Jiwuba *et al.* (2021), sheep production is vital, as it is seen as one of the key factors of food security and the realisation of animal protein adequacy in Nigeria, with approximately 211,400,708 people currently relying on it as a major source of animal protein. Seasonal variations, accompanied by a surplus of forages during the rainy season and a deficit of forage during the dry season, have been seen as one of the major challenges to sheep production (Jiwuba *et al.,* 2016).

Natural pastures and crop residues available during the dry season are usually lignified and deficient in most essential nutrients needed for improved performance of the animals fed such diets. This has resulted in poor nutrient intake, poor digestibility, poor growth rate, weight loss, low birth, weaning and slaughter weights, lowered resistance to disease and overall poor performance of the animal. The relevance of evaluating the nutritional value of indigenous shrubs, trees and browse plants is evident (Okunade *et al.,* 2014) as their foliage can make important contributions to the protein and energy consumption of ruminant animals. This is particularly important during the critical dry season when forage availability and quality are severely limited and affected.

Browse fodders are useful sources of cheap feed for ruminant animals in developing countries, especially during dry seasons when herbaceous pasture grasses and

legumes are senescing. Since they can retain their green leaves and nutrient content during dry seasons, they bridge the gap created by a decline in the nutritive potential of natural pastures. The ability of their foliage to remain green and maintain their protein content makes them potential sources of protein and energy (Olafadehan, 2013).

The objective of the study was to evaluate growth performance and nutrient intake of West African Dwarf sheep fed selected browse forages.

MATERIALS AND METHODS

Location of the experiment

The experiment was carried out at the Teaching and Research Farm of the School of Agricultural Technology, Yaba College of Technology, Epe, Lagos State. The farm is located at longitude 3.58°E and latitude 6.47°N. It is 42 m above sea level along the Epe- Ijebu Ode road. Epe lies in the lowland rain forest, a vegetation zone within the savannah agroecological zones of South Nigeria (Google Earth, 2025).

Collection of forages for chemical analysis

Five forages were harvested during the rainy season around the premises of Yaba College of Technology School of Agriculture, Odoragunshin, Epe campus, Lagos State, Nigeria. The forage plants were *Mangifera indica (Mango), Anacardium occidental (Cashew), Gmelina aborea (Gmelina), Gliricidia sepium (Gliricidia) and Panicum maximum (Guinea grass).* About 500 g samples of each plant's leaves were harvested from different mature plants before flowering from several stands. All the forages were oven dried at 65°C to constant weight to determine the dry matter, crude protein, crude fibre, ether extract and ash contents. The dried samples were milled and sieved to 1.0 mm particles size, bulked on an individual leaf basis and stored in an air-tight container pending analysis.

Experimental design

The animals were randomly allocated to five treatments with four animals per treatment in a completely randomised design (CRD) according to Omoniyi (2014). The treatment diets are:

T_1- control- 100% of *Panicum maximum*
T_2- 40% of *Mangifera indica* leaves with 60% *Panicum maximum*
T_3- 40% of *Gmelina arborea* leaves with 60% *Panicum maximum*
T_4- 40% of *Anacardium occidentale*_leaves with 60% *Panicum maximum*
T_5- 40% of *Gliricidia sepium* leaves with 60% *Panicum maximum*

Feeding and management of animals

Twenty growing West African dwarf male sheep weighing between 11.10 and 14.20 kg were randomly assigned to five dietary treatments, having four replicates per diet in a completely randomised design. The pens were thoroughly washed and disinfected. Animals were dewormed with Albendazole® 2.5% oral suspension (Anthelmintic) at 1ml/10kg body weight and treated against ectoparasites with Cypermethrin® Pour-on at 1ml/10 kg body weight before allotting them to individual pens on the basis of weight equalisation. The weights of the animals were taken before the commencement of the experiment and thereafter weekly to monitor weight changes during the trial. A known quantity (0.4 kg) of selected browse forages with (0.6 kg) *Panicum maximum* was offered to the animals, while (1.0 kg) *Panicum maximum* only was served to the control animals. Clean water was offered daily *ad libitum.* Two weeks adaptation period was allowed before the commencement of the study. During the trial, a known amount of feed was offered daily to each treatment group. The leftover feed was weighed and discarded every morning. Voluntary feed intake was determined as the difference between feed offered and feed refused. The study lasted for 84 days (12 weeks).

Performance characteristics

The daily feed intake and weekly weight gain were monitored and recorded in all phases of the experiment. Feed conversion ratio (FCR) was computed.

Body weight gain (g)

The initial body weights of the sheep were taken upon arrival, and subsequent body weight gains were recorded at the end of every week throughout the study with a hanging scale. Body weight gain was calculated as the difference between the body weight gain for the given week and the previous week.

Feed consumption/intake (g)

A known quantity of fresh feed was given to the sheep, while the leftover was weighed to determine the weekly feed intake of the sheep. Feed intake for each week was obtained from the differences between the feed given per week and leftover.

$$\text{Daily feed intake} = \frac{\text{Total feed intake (g)}}{\text{Total number of days of the experiment}}$$

Table 1. Growth performance of WAD sheep fed browse forages.

Parameters	*P. maximum* only	*P. maximum* + *M. indica*	*P. maximum* + *G. aborea*	*P. maximum* + *A. occidentale*	*P. maximum* + *G. sepium*	P value	SEM
Average Total grass intake (kg)	22.48^{a}	9.03^{b}	8.20^{b}	9.97^{b}	7.33^{b}	0.0001	1.53
Average Total browse intake (kg)	0.00^{d}	9.43^{b}	7.90^{c}	13.43^{a}	12.60^{a}	0.0001	1.29
Average Total feed intake (kg)	22.48^{ab}	18.47^{cd}	16.10^{d}	23.39^{a}	19.93^{bc}	0.0001	0.80
Average Daily grass intake (g/day)	267.66^{a}	107.54^{b}	97.62^{b}	118.65^{b}	87.30^{b}	0.0001	18.27
Average Daily browse intake (g/day)	0.00^{d}	112.30^{b}	94.05^{c}	159.84^{a}	150.00^{a}	0.0001	15.30
Average Total daily feed intake (g/day)	267.66^{ab}	219.84^{cd}	191.66^{d}	278.49^{a}	237.30^{bc}	0.0001	9.56
Average Total weight gain (kg)	2.23^{b}	2.33^{b}	2.77^{b}	4.33^{a}	2.33^{b}	0.0001	0.17
Average Daily weight gain (g/day)	26.59^{b}	33.73^{b}	32.93^{b}	51.59^{a}	27.70^{b}	0.0001	1.98
Feed conversion ratio (FCR)	10.20^{a}	8.09^{a}	5.82^{b}	5.41^{b}	8.62^{a}	0.0001	0.12

^{a,b,c,d} means on the same row with different superscripts are significantly different ($p<0.05$).

Feed conversion ratio (FCR)

The feed conversion ratio of the sheep was determined by calculating the ratio of feed intake to weight gain.

$$\text{FCR} = \frac{\text{Total feed intake (g)}}{\text{Total body weight gain (g)}}$$

Nutrient intake

Ten percent (10%) of the faecal samples were analysed for proximate components using the AOAC (2000) method. The fibre fractions such as neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to the methods of Van Soet *et al.* (1991).

Chemical composition/analysis

Five selected forage plants samples were analysed for proximate constituents according to AOAC (2000), while NDF, ADF and acid detergent lignin (ADL) were determined by the procedures of Van Soest*et al.* (1991). Hemicellulose was calculated as the difference between (NDF) and (ADF. Cellulose was also calculated as the difference between (ADF) and (ADL).

Statistical analysis

Data collected was subjected to one-way analysis of variance, and significant differences among means were compared using Duncan Multiple Range test (SAS, 2005). The statistical model used was:

$Y_{ij} = \mu + T_i + \varepsilon_{ij}$

Where: Y_{ij} =Observed value of dependent variable, μ =Population mean, T_i = Mean effect of treatment feed, and ε_{ij} = Random residual error.

RESULTS

Performance characteristics of WAD sheep fed selected forages

As revealed in Table 1, all the data obtained were significantly ($p<0.05$) varied. Sheep on the control diet had the highest (22.48 kg) total grass intake while those on *P. maximum* + *G. sepium* had the least (7.33 kg). *P. maximum* + *Anacardium occidentale* recorded the highest (13.43kg) plant intake. Diets influenced the total weight gain of the sheep, with a significant ($p<0.05$) highest weight gain (4.33 kg) was observed in sheep fed *P. maximum* + *Anacardium occidentale* while the least value of 2.23 kg was recorded in sheep fed *P. maximum* only. The same trend was observed in the daily weight gain. The best feed conversion ratio (5.41) was observed in sheep fed *P. maximum* + *Anacardium occidentale.*

Nutrient intake (DM g/day) of WAD sheep fed selected forages

Nutrient intake of WAD sheep fed selected forages is presented in Table 2. It was revealed that there were significant ($p<0.05$) variations in all the parameters measured. The highest (249.15 g/day) total dry matter intake was observed in sheep fed *P. maximum* + *Anacardium occidentale* (249.15 g/day), while the least (170.32 g/day) was obtained

Table 2. Nutrient intake of WAD sheep fed browse forages.

Parameters	*P. maximum* only	*P. maximum* + *M. indica*	*P. maximum* + *G. aborea*	*P. maximum* + *A. occidentale*	*P. maximum* + *G. sepium*	P value	SEM
Dry matter browse intake	0.00^{d}	112.30^{b}	94.05^{c}	159.84^{a}	150.00^{a}	0.0001	15.30
Dry matter grass intake	267.66^{a}	107.54^{b}	97.62^{b}	118.65^{b}	87.30^{b}	0.0001	18.27
Total dry matter intake	227.51^{ab}	196.30^{bc}	170.32^{c}	249.15^{a}	213.20^{b}	0.0001	8.16
Organic matter intake	547.69^{a}	383.80^{bc}	290.31^{c}	593.43^{a}	456.71^{ab}	0.0001	33.88
Crude protein intake	49.99^{b}	39.02^{b}	46.24^{b}	67.20^{a}	65.46^{a}	0.0001	3.43
Ether extract intake	78.99^{b}	56.68^{c}	42.67^{c}	112.82^{a}	56.00^{c}	0.0001	7.03
Crude fibre intake	154.43^{a}	94.38^{b}	79.14^{b}	178.39^{a}	112.83^{b}	0.0001	10.96
Ash intake	14.33^{ab}	10.88^{bc}	8.73^{c}	18.05^{a}	13.42^{b}	0.0001	0.97
NDF intake	410.13^{ab}	276.10^{cd}	211.12^{d}	460.56^{a}	326.06^{bc}	0.0001	27.10
ADF intake	306.84^{a}	194.00^{b}	154.55^{b}	339.40^{a}	228.29^{b}	0.0001	20.63
ADL intake	158.92^{a}	93.72^{b}	77.90^{b}	178.80^{d}	112.70^{b}	0.0001	11.31

^{a,b,c,d} means on the same row with different superscripts are significantly different (p<0.05). **Key:** NDF= Neutral Detergent Fibre; ADF= Acid Detergent Fibre; ADL= Acid Detergent Lignin.

Table 3. Chemical composition of the selected plants.

Selected plants	DM	CP	EE	Ash	CF	OM	NFE	NDF	ADF	ADL	Cellulose	Hemicellulose
P. maximum	85.00^{b}	8.13^{d}	10.92^{c}	2.33	21.35^{b}	89.08^{b}	57.26^{a}	56.70^{b}	42.42^{b}	21.97^{b}	20.45	14.28^{c}
Mangifera indica	93.40^{a}	9.80^{c}	12.35^{b}	2.67	17.53^{d}	87.65^{c}	57.65^{a}	56.80^{b}	37.60^{d}	16.67^{d}	20.93	19.20^{a}
Gmelina aborea	92.87^{a}	20.29^{a}	12.21^{b}	3.00	21.50^{b}	87.79^{c}	42.99^{c}	57.60^{b}	41.23^{b}	20.17^{c}	21.07	16.43^{b}
Anacardium occidentale	92.78^{a}	10.83^{c}	17.23^{a}	2.80	24.20^{a}	82.77^{d}	44.93^{c}	61.30^{a}	44.70^{a}	23.83^{a}	20.87	16.60^{b}
Gliricidia sepium	92.66^{a}	15.70^{b}	9.34^{d}	2.83	19.20^{c}	90.66^{a}	52.93^{b}	56.40^{b}	39.30^{c}	18.80^{c}	20.50	19.10^{a}
SEM	1.00	1.20	0.72	0.10	0.63	0.72	1.66	0.50	0.69	0.68	0.17	0.55

^{abcd} Means along the same column with different superscripts are significantly different (P<0.05). **Keys:** DM = Dry matter, NDF = Neutral detergent fibre, CP = Crude protein, ADF = Acid detergent fibre, CF = Crude fibre, ADL = Acid detergent lignin, OM = Organic matter, NFE = Nitrgen free extract, SEM = Standard error of mean.

in sheep fed *P. maximum* + *Gmelina aborea*. The addition of forages to *P. maximum* fed to WAD sheep significantly (p<0.05) affected CP intake, as animals on *P. maximum* + *Mangifera indica* recorded the least (39.02 DM g/day). Total value recorded for CF intake ranged from 79.14 to 178.39 DMg/day in animals fed *P. maximum* + *Gmelina aborea* and *P. maximum* + *Anacardium occidentale,* respectively. The total ash intake was highest (18.05 DMg/day) in animals fed *P. maximum* + *Anacardium occidentale*, while the least (8.73 DMg/day) value was recorded in animals fed *P. maximum* + *Gmelina aborea*. The total fat intake ranged from 42.67 to 112.82 DMg/day in animals fed *P. maximum* + *Gmelina aborea* and *P. maximum* + *Anacardium occidentale,* respectively. The NDF intake was highest (460.56) in sheep fed *P. maximum* + *Anacardium occidentale* while the least (211.12) was obtained in sheep fed *P. maximum* + *Gmelina aborea*. A similar trend was observed in the ADL.

Chemical composition of the forages

Presented in Table 3 are the proximate composition and fibre contents of the selected forages.

Mangifera indica had the highest ($p<0.05$) dry matter (DM) value of 93.40% while the least DM content of 85.00% was obtained in *Panicum maximum.* Crude protein (CP) content ranged from 8.13% in *Panicum maximum* to 20.29% in *Gmelina aborea. Anacardium occidentale* recorded significant ($p<0.05$) highest ether extract content of 17.23% while the least value (9.34%) was obtained in *Gliricidia sepium*. Crude fibre ranged from 17.53% in *Mangifera indica* to 24.20% in *Anacardium occidentale.* Organic matter (90.66%) was higher in *Gliricidia sepium* when compared to other forages.

Anacardium occidentale recorded significant highest value of 61.30% in NDF while the least value (56.70%) was observed in *Panicum maximum*. ADF values ranged from 37.60 to 44.70% in *Mangifera indica* and *Anacardium occidentale* respectively. Cellulose was least ($p>0.05$) in *Panicum maximum* (20.45%) and highest content was obtained in *Gmelina aborea* (21.07%). The least significant ($p<0.05$) hemicellulose value (14.28) was recorded in *Panicum maximum* while the highest value (19.20) was obtained in *Mangifera indica.*

DISCUSSION

The addition of browse forage to the basal diet (*P. maximum*) significantly increased the total feed intake of the sheep. The highest total feed intake was observed in the sheep supplemented *with Anacardium occidentale, which* was lower when compared to the range of total feed intake recorded by Njidda and Ikhimioya (2010) when WAD goats were fed semi-arid browse forages. Similar values of daily feed intake were also reported by Ogungbesan *et al.* (2013) and Fajemisin *et al.* (2013) when WAD goats were fed selected browse plants and cassava peels, and when WAD bucks were fed cassava peels substituted with graded levels of *Cajanus cajan* hay, respectively. Positive correlation was observed between the total feed intake and the total weight gain. High feed intake observed in the sheep fed with *Anacardium occidentale* could be attributed to the texture of the plants, familiarity and palatability of the plants. This assumption on the palatability of the plants was in line with the report of Van (2006) and Daovy *et al.* (2008) that the structure of the leaves, coarse, soft versus hard, smooth versus waxy or hairy, content of substances causing the foliage to taste or smell distinctly or morphology of the plants resulting in different bite sizes.

The result of average weight gain compared favourably with the values reported by Yeshambel and Mekuriaw (2012) when Washera sheep were fed a mixture of lowland bamboo leaves and natural pasture grass hay at different ratios. Daily weight gain of the animals fed with *P. maximum* + *Mangifera indica* compared favourably with the highest value (34.3 g/d) reported by Bamikole *et al*. (2003) when WAD goats were fed with high *Ficus religiosa*.

The best feed conversion ratio (FCR) observed in sheep fed with *P. maximum* + *Anacardium occidentale* was lower compared with the range reported by Wuanor *et al.* (2013) when WAD goats were fed forages and cassava processing by-products. The highest live weight gain and best feed conversion ratio obtained in goats fed with *P. maximum* + *Anacardium occidentale* indicated better performance in terms of weight gain with the addition of browse forages in the present study.

The addition of browse forages to the basal diet of *P. maximum* improved the digestibility of sheep. The least DM digestibility observed in sheep supplemented with *P. maximum* + *Gmelina aborea* could be attributed to the least intake of the plant by sheep. The range of the DM digestibility values recorded in the current study was lower than the values observed by Ilori *et al.* (2013) in WAD goats fed with different dietary inclusion of baobab. However, the CP digestibility values observed in this study compared favourably with the reported range in goats fed with *Moringa oleifera* and some browse forages (Asaolu *et al.,* 2011). Higher organic matter digestibility values were recorded in this finding when compared with the reported values by Aderinboye *et al.* (2012) when WAD goats were fed graded levels of monensin, and when WAD sheep were fed different roughages (Akinbode, 2011). The high digestibility values obtained for the nutrient in all the treatments, including the control, suggest that the plants were highly degraded in the rumen.

The high CP content of browse species is well documented and is one of the main distinctive characteristics of browse compared to most grasses (Omoniyi, 2014). The range of the CP content in the present study fell within the reported range of CP content of semi-arid browse forages (Njidda and Ikhimioya, 2010). The highest CP value observed in *Gmelina aborea* was higher than that reported values in *Balanites aegyptiaca (*174.80g/kg) and *Maerua angolensis (*174.30g/kg) (Njidda and Ikhimioya,, 2010). Disparity observed in the CP content can be explained by inherent characteristics of each species related to the ability to extract and accumulate nutrients from soil and/or to fix atmospheric nitrogen, which is the case for legumes plants as corroborated by Njidda and Ikhimioya (2010). The other factors causing variation in the chemical composition of browse forages include soil type (location), the plant part (leaf, stem, pod), age of leaf and season.

Conclusion

It could be concluded that *P. maximum* supplemented wit*h Anacardium occidentale* best improved the performance characteristics in terms of feed intake and weight gain of West African Dwarf sheep.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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