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PERFORMANCE, DIGESTIBILITY AND NITROGEN UTILIZATION OF WEST AFRICAN DWARF SHEEP FED *PANICUM MAXIMUM* WITH SUPPLEMENTAL LEGUME PELLETS

D. K. OYANIRAN[1*], V. O. A. OJO[1], R. Y. ADERINBOYE[2], O. O. ADELUSI[2], A. O. OGUNSAKIN[1], J. A. OLANITE[1]

[1]Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[2]Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria

ABSTRACT

This study was conducted to evaluate the effect of supplementing legume pellets in the diets of West African dwarf (WAD) rams. Twenty West Africa dwarf (WAD) rams of the average body weight of 12.43 ± 0.5 kg were allocated to four treatment: sole *Panicum maximum* (diet 1), *P. maximum* supplemented with *Lablab purpureus* pellets (diet 2), *P. maximum* supplemented with *Calopogonium mucunoides* pellets (diet 3) and *P. maximum* supplemented with *Mucuna pruriens* pellets (diet 4) arranged in a completely randomized design. *Panicum maximum* was offered to the animals *ad libitum* and legume pellets were fed at 5 % of their body weight. The feeding trial lasted 12 weeks and metabolic trial for two weeks. Nutrient intake, weight gain, nutrient digestibility and nitrogen utilization of the experimental animals were assessed. Obtained data were subjected to one-way analysis of variance. Among the rams supplemented with legume pellets, rams fed *M. pruriens* pellets had the highest ($P < 0.05$) nutrient intake (963.97 g). The highest ($P < 0.05$) weight gain was recorded for rams fed *L. purpureus* pellets (7.03 kg). Rams fed *L. purpureus* pellets had the highest ($P < 0.05$) dry matter (76.79 %) and crude protein digestibility (82.61 %) while the lowest ($P < 0.05$) was recorded for rams fed sole *P. maximum*. Nitrogen retention ranged from 38.90 % for rams fed sole *P. maximum* to 60.77 % for rams fed supplemented *L. purpureus* pellets. It can be concluded from this study that rams fed supplemented *L. purpureus* pellets gave the highest performance in weight gain, nutrient digestibility and nitrogen utilization.

Key words: legume pellets; *Lablab purpureus*; *Calopogonium mucunoides*; *Mucuna pruriens*

INTRODUCTION

Forage is the most widely available as low cost feed for ruminant animals during the wet season in the tropics and they rely on them almost exclusively for nutrition since it sustains their production (Aderinola *et al.*, 2008). Grasses are the most abundant forage species due to their aggressive growth and as they mature especially during the dry season, their productivity declines sharply as they tend to lose their nutrients (Aderinola, 2007). Their crude protein usually drop as low as 3 % which is below the critical level of 7 % recommended by Minson (1982) and this affects the productivity of the animals. However, efforts have been made in the past to augment low quality feeds for ruminant animals by supplementing grasses with concentrate feeds and agro industrial by-products, unfortunately, they are unavailable or in short supply and are expensive (Adjolohoun *et al.*, 2008; Ososanya *et al.*, 2013). Herbaceous legumes could be included in animal feed when the nutritive value of grasses is low so as to sustain and improve the performance of the animals. The use of forage legumes in livestock production systems has increased in the tropics

***Correspondence:** Email: oyanirandammy4real@yahoo.com
Oyaniran Damilola Kola, Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta, P. M. B. 2240, Abeokuta, Ogun State, Nigeria
Tel.: +2348165082609

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in recent years since they are cheap feeds that are used as supplement to ruminant animal. However, seasonal fluctuations results in their low quality and unavailability, which poses a threat to livestock survival. To alleviate this problem, it becomes imperative to conserve and process during period of abundance for use during the period of scarcity. Legumes such as *Lablab purpureus*, *Calopogonium mucunoides* and *Mucuna pruriens* can be conserved as silage, hay and pellets to meet the nutritional needs of animals when there is low availability (Amole *et al.*, 2013). The major constraint in large scale hay production in the tropics is unreliable weather conditions and poor herbage quality for most of the year (Crowder and Chedda, 1982). Conservation of legumes as silage is not extensively practiced worldwide because of their high buffering capacity and low concentration of fermentable carbohydrates, which limits the quality of their silage (Tauqir *et al.*, 2009).

Pelletizing of forages is an alternative technology to solve the problem of decreasing dry matter consumption, total digestible nutrient content and energy inefficiency problem in ruminant productivity (Widiyanto *et al.*, 2011). Legumes pellets are also reported to be consumed much faster than long stemmed forages and this can increase the feed intake of animals and, hence their productivity. The present study was designed to assess the feed intake, digestibility and nitrogen utilization of WAD rams fed *P. maximum* grass supplemented with pellets of *L. purpureus*, *C. mucunoides* and *M. pruriens* at dry season.

MATERIALS AND METHODS

Location and climate of the study area

The experiment was carried out at the Directorate of University Farms, Federal University of Agriculture, Abeokuta (FUNAAB), located in the derived savannah zone of the South-Western Nigeria on latitude 7°13' 49.46'' N and longitude 3°25' 11.98'' E (Google Earth, 2015). It has an average annual rainfall of 1037 mm and temperature of about 34.7 °C and an average relative humidity of 82 %.

Legume pellets preparation

Lablab purpureus, *C. mucunoides* and *M. pruriens* were harvested at 12 weeks and sun dried. The dried legumes were milled and pelletized using a 6 mm die size to produce pelleted forage of average length of 40 mm. Cassava flour was used as binder (proportion of 1 kg of cassava flour to 100 kg of the milled sample) with addition of water to moisten. The pellets were warm and moist, when they came out of the mill. They were then cooled down to harden up so as to hold their form. The experimental diets were Sole *Panicum maximum*, *Panicum maximum* supplemented with *L. purpureus* pellet, *Panicum maximum* supplemented with *C. mucunoides* pellet, *Panicum maximum* supplemented with *M. pruriens* pellet. Table 1 shows the chemical composition of *P. maximum* and herbaceous forage legumes pellets.

Table 1. Chemical composition (g.kg^{-1}) of *P. maximum* and herbaceous forage legume pellets

Treatment	*Panicum maximum*	*Lablab purpureus* pellets	*Calopogonium mucunoides* pellets	*Mucuna pruriens* pellets	Standard Error of Means
Dry matter	256.00^{d}	855.20^{c}	902.07^{b}	915.23^{a}	1.13
Crude protein	94.50^{d}	120.80^{b}	105.00^{c}	126.00^{a}	3.79
Ether extract	40.00^{c}	50.00^{b}	50.00^{b}	70.00^{a}	3.30
Ash	120.00^{a}	95.00^{b}	70.00^{c}	70.00^{c}	6.26
Neutral detergent fibre	560.00^{b}	480.00^{d}	580.00^{a}	500.00^{c}	12.43
Acid detergent fibre	360.00^{a}	240.00^{c}	300.00^{b}	300.00^{b}	12.79
Acid detergent lignin	140.00^{a}	60.00^{d}	100.00^{b}	80.00^{c}	8.92

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

Experimental animals and their management

A total number of twenty (20) West African dwarf (WAD) rams with average body weight of 12.43 ± 0.5 kg aged 10-12 months were used for the experiment. On arrival of the animals, they were acclimatized for 28 days during which they were given prophylactic treatment to ensure good health conditions. All the animals were fed *Panicum maximum* with groundnut haulms. Clean water was provided *ad libitum* to the animals on daily basis. After acclimatization, the animals were weighed and randomized into four treatment groups of five animals per treatment each balancing for body weight. A basal diet of fresh *Panicum maximum* grass was fed daily to the animals. The grass was harvested at 6 weeks of re-growth, wilted, chopped and offered to the animals *ad libitum* daily. The legume pellets were fed as supplements to the animals at 5 % of their body weight. The feeds were fed once daily at 8:00 am, with legume pellets served first with *Panicum maximum* after thirty (30) minutes in separate feeding troughs.

Feed intake and weight change

Feed refusal were estimated the following morning. The weight of individual animal was measured at the onset of the trial and subsequently on weekly basis. The difference between the initial and final weight was used to compute weight change (gain/loss) for rams in each dietary treatment.

$$\text{Feed conversion ratio} = \frac{\text{Feed consumed (Feed intake)}}{\text{Weight change}}$$

Digestibility and nitrogen balance studies

At the end of the feeding trial which lasted for 84 days, the animals were transferred to individual metabolic cages with provision for separate collection of faeces and urine. Three rams per treatment were used for digestibility and nitrogen balance study. Animals were allowed for an adaptation period of seven days, followed by a seven-day of total faeces and urine collection period. The total voided faeces per animal were collected and weighed daily. Urine was collected daily into bottle fitted with plastic funnel containing two drops of 10 % H_2SO_4 to prevent loss of nitrogen from the urine. The total volume of urine of each animal was recorded daily and 10 % of the measured urine was stored in the refrigerator at 4 °C for nitrogen determination.

$$\text{Nutrient digestibility \%} = \frac{\text{Nutrient in feed consumed-Nutrient in faeces voided x 100}}{\text{Nutrient in feed consumed}}$$

Chemical analyses

Sub- samples of the grass, legume pellets and faeces were oven dried at 65 °C to constant weight. Proximate composition (dry matter, crude protein, ether extract and ash) were determined according to AOAC (2000) while determination of neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) was carried out according to the procedure of Van Soest *et al.* (1991).

Statistical analyses

All data obtained were arranged in a completely randomized design and subjected to one-way analysis of variance (ANOVA). Significant means were separated using Duncan's Multiple Range Test of SAS (2001).

RESULTS AND DISCUSSION

The performance characteristics of West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legume pellets are given in Table 2. The total dry matter intake ranged from 758.84 g for rams fed sole *P. maximum* to 963.97 g for those fed supplemented *M. pruriens* pellets. Rams fed *M. pruriens* pellets had the highest ($P < 0.05$) legume pellet intake (466.80 g), while rams fed *C. mucunoides* pellets had the lowest (235.83 g). High nutrients intake were observed for rams fed *M. pruriens* pellet and *L. purpureus* pellet supplemented diets. The lowest dry matter intake for rams fed supplemented *C. mucunoides* pellets could be due to high fibre content. Rams fed *M. pruriens* pellets had the highest ($P < 0.05$) crude protein intake (105.80 g), which could be due to high protein content in the feed of the animals. Protein supplement brings about increase in protein content of the feed of the animal and this usually lead to increase in protein intake (Arigbede *et al.*, 2006). Neutral detergent fiber and ADF intakes were significantly higher for rams fed supplemented *M. pruriens* pellets (511.82 and 319.02 g) than others. Mtenga and Kitaly, (1990) reported a positive correlation between crude protein intake and dry

Table 2. Performance characteristics of West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legume pellets

Parameters	Dietary treatments				Standard Error of Means
	Panicum maximum	*Lablab purpureus* + *Panicum maximum*	*Calopogonium mucunoides* + *Panicum maximum*	*Mucuna pruriens* + *Panicum maximum*	
Grass (g)	758.84^{a}	598.67^{b}	558.68^{bc}	497.17^{c}	31.34
Legume pellet (g)	265.25^{b}	235.83^{b}	466.80^{a}	37.80	
Total dry matter intake (g)	758.84^{c}	863.92^{b}	794.51^{c}	963.97^{a}	25.19
Crude protein intake(g)	71.71^{c}	88.67^{b}	77.65^{c}	105.80^{a}	4.00
Ether extract intake(g)	30.35^{d}	37.21^{b}	34.14^{c}	52.56^{a}	2.57
Ash intake (g)	91.06^{ab}	97.04^{a}	83.55^{b}	92.34^{a}	1.80
Neutral detergent fibre intake (g)	424.95^{b}	462.58^{b}	449.65^{b}	511.82^{a}	10.88
Acid detergent fibre intake (g)	273.18^{b}	279.18^{b}	271.88^{b}	319.02^{a}	6.71
Acid detergent lignin intake (g)	106.24	99.73	101.80	106.95	1.64
Total voided faeces (g)	369.67^{c}	537.44^{ab}	484.33^{b}	623.33^{a}	31.19
Initial weight (kg)	12.20	12.43	11.91	13.17	0.50
Final weight (kg)	15.72^{b}	19.46^{a}	17.14^{ab}	16.98^{ab}	0.58
Weight gain (kg)	3.52^{c}	7.03^{a}	5.23^{b}	3.81^{bc}	0.47
Feed conversion ratio	20.09^{a}	10.33^{b}	13.19^{ab}	21.28^{a}	1.78

$^{a, b, c}$ Means on the same row with different superscripts are significantly different (P < 0.05)

matter intake. Arigbede *et al.* (2006) stated that an increase in protein intake will enhance the intake of other nutrients, since high protein content will improve the rumen environment. Supplementing a low to medium quality forage with degradable protein in the form of forage legumes often results in improved growth performance of ruminants (Mupangwa *et al.*, 2000). Highest (P < 0.05) weight gain (7.03 kg) was recorded for rams fed supplemented *L. purpureus* pellets. This is reflected by high dry matter and crude protein digestibility recorded for the animals. Rams fed supplemented *M. pruriens* pellets had the highest feed conversion ratio (FCR) and this indicates that the feeds were not efficiently converted by the animals. This could be due to low digestibility in rams fed supplemented *M. pruriens* pellets compared to rams fed *L. purpureus* and *C. mucunoides* pellets.

Table 3 gives the nutrient digestibility of West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legume pellets. The digestibility of DM was highest (P < 0.05) for rams fed supplemented *L. purpureus* pellets (76.79 %). The CP digestibility increased from 62.46 % for rams fed sole *P. maximum* to 82.61 % for rams fed supplemented *L. purpureus* pellets. Rams fed *L. purpureus* pellets had the highest NDF and ADF digestibility (81.14 and 70.61 %). Digestion in the rumen is dependent on the activity of micro-organisms. Processing of feeds such as pelletizing is conducted in an attempt to enhance digestibility (Faichney, 1986; Sarwar *et al.*, 1992). Rams fed legume pellets supplemented diets had improved dry matter digestibility compared to those fed sole *P. maximum*. This was in accordance with the findings reported by Abdel-Ghani *et al.* (2011) that dietary protein improves digestibility coefficient of many nutrients in sheep and lamb rations. Lower digestibility of CP, NDF and ADL were observed in rams fed sole P. maximum grass. Previous studies shows that addition of protein source to the diet of the animals enhanced digestibility (Oladotun *et al.*, 2003). Rams fed supplemented *L. purpureus* pellets had higher CP digestibility than rams fed supplemented *M. pruriens* pellets, which had higher crude protein intake. Rams fed legume pellets supplemented diets had higher NDF digestibility. The lower NDF digestion in rams fed sole grass could be due to insufficient protein for rumen microorganisms to improve the digestion of the feed. Rams fed *M. pruriens* pellets had the lowest NDF digestibility among supplemented diet feed.

Table 3. Nutrient digestibility of West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legumes pellet

Nutrient (%)	Dietary treatments				Standard Error of Means
	Panicum maximum	*Lablab purpureus* + *Panicum maximum*	*Calopogonium mucunoides* + *Panicum maximum*	*Mucuna pruriens* + *Panicum maximum*	
Dry matter	60.58[c]	76.79[a]	70.11[b]	67.68[b]	1.84
Crude protein	62.46[c]	82.61[a]	73.49[b]	72.63[b]	2.38
Ether extract	54.27[c]	72.15[a]	64.13[b]	69.99[a]	2.20
Ash	43.34[b]	62.74[a]	42.35[b]	43.44[b]	2.73
Neutral detergent fibre	61.73[c]	81.14[a]	79.00[a]	72.20[b]	2.34
Acid detergent fibre	64.25[b]	78.72[a]	70.61[b]	65.52[b]	2.01
Acid detergent lignin	50.42[b]	66.55[a]	66.35[a]	62.35[a]	2.27

[a, b, c] Means on the same row with different superscripts are significantly different (P < 0.05)

The nitrogen utilization of West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legume pellets are presented in Table 4. Among the rams fed supplemental diets, rams fed *L. purpureus* pellets (10.15 $g.d^{-1}$) had highest nitrogen balance and rams fed *C. mucunoides* pellets (6.84 $g.d^{-1}$) had the least. The nitrogen retention ranged from 38.90 % for rams fed *P. maximum* only to 60.77 % for rams supplemented *L. purpureus* pellets. The lower nitrogen intake observed in rams fed supplemented *C. mucunoides* pellets and sole *P. maximum* could be due to low level of protein intake and low crude protein content. The lower faecal N-output in rams fed supplemented *L. purpureus* pellets compared to those fed *M. pruriens* pellet supplemented diet could largely be a reflection of *L. purpureus* pellets that was well utilized. Nitrogen balance and retention were best in rams fed *L. purpureus* pellet supplemented diet. Higher nitrogen retention in rams supplemented *L. purpureus* pellets, indicated that protein requirements for maintenance were adequately met by the diets (Fadiyimu *et al.*, 2010).

CONCLUSION

Supplementing the legume pellets with *P. maximum* improved the nutrient intake, nutrient digestibility and growth performance of the experimental rams. *Lablab purpureus* pellets enhanced the performance of WAD rams better than *Mucuna pruriens* and *Calopogonium mucunoides* pellets.

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Table 4. Nitrogen utilization by the West African dwarf rams fed *P. maximum* supplemented with herbaceous forage legume pellets

Parameters (g.d^{-1})	Dietary treatments				Standard Error of Means
	Panicum maximum	*Lablab purpureus* + *Panicum maximum*	*Calopogonium mucunoides* + *Panicum maximum*	*Mucuna pruriens* + *Panicum maximum*	
Nitrogen intake	11.47^{c}	14.19^{b}	12.41^{c}	16.93^{a}	0.64
Faecal nitrogen	4.67^{b}	2.99^{c}	4.31^{bc}	7.52^{b}	0.53
Urinary nitrogen	2.32^{a}	1.05^{b}	1.25^{b}	1.68^{ab}	0.19
Total nitrogen output	6.99^{b}	4.04^{d}	5.56^{c}	9.20^{a}	0.58
Nitrogen balance	4.48^{c}	10.15^{a}	6.84^{b}	7.73^{b}	0.63
Nitrogen retention (%)	38.90^{c}	60.77^{a}	51.23^{b}	39.78^{c}	2.86

$^{a, b, c}$ Means on the same row with different superscripts are significantly different ($P < 0.05$)

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