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Feed intake, nutrient utilisation and growth performance of West African dwarf rams fed silage combinations of maize forage and *Mucuna pruriens* foliage

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Abstract

Crude protein is essentially needed for ruminants but expensive to supply. Mucuna puriens is a high yielding domesticated legume. When the legume is strategically combined with a fibre source, it will make a good diet for ruminants. Thus, a study was carried out to assess the effect of ensiling mucuna with maize forage on performance of rams. In the study, rams were fed silage combinations of Maize Forage (MF) and Mucuna pruriens foliage (MPF). Downy mildew and streak resistant (DMR-SR) yellow variety maize was planted and harvested as MF at six weeks of growth and ensiled with MPF at four levels : 1:0, 3:1, 1:1 and 1:3 for 21 days. All the four silages were fed to 20 WAD rams (12.00±0.25 Kg) in a completely randomised design for 105 days. Proximate composition of the silages, apparent nutrient digestibility of silages in WAD rams, feed intake and weight changes were determined using standard procedures, while feed conversion ratio was computed using standard procedures. Data obtained were analysed using descriptive statistics and ANOVA at $\alpha_{0.05}$. The dry matter (DM) was significantly higher in T1 (25.65±0.62) and T2 (23.48±0.47) than T3 (21.80±0.41) and T4 (21.57±0.40). The crude protein (CP) was highest in T4 (13.0±0.6) and least in T1 (8.0±0.2). The crude fibre was significantly higher in T1 (26.4±2.6) and T2 (26.2±2.0) than T3 (24.0±1.8) and T4 (21.6±0.9). Apparent digestibility of neutral detergent fibre (NDF) was highest in T2 (59.2±1.7) and least in T4 (37.7±1.9), while percentage nitrogen retention was significantly higher in T2 (43.2±3.8) and lower in T1 (20.0±4.3). The FCR for rams fed T2 was significantly lower (8.84±1.2) than T1 (9.76±0.80), T3 (9.60 ±0.60) and T4 (11.50±0.90) Ensiling maize forage with Mucuna pruriens foliage at 3:1 enhanced nutrient digestibility and growth performance in West African dwarf rams without any deleterious effect.

Keywords: *Mucuna pruriens* foliage, Maize–*Mucuna* silage, Ram performance, Silage digestibility

Introduction

One of the problems facing livestock production in the tropics is poor nutrition and productivity arising from inadequate feed supplies. Forages produced in this part of the world are of low quality. They grow and become lignified fast during the raining season (Williams *et al*., 1995) and become scarce during the dry season (Bamikole and Babayemi, 2004).This results in staggered growth pattern as animals gain weight slowly in the rainy season and lose it rapidly in the dry season (Babayemi and Bamikole, 2006).

Forages, crop residues and by-products are usually consumed fresh by domestic animals during the rainy season but become dried and lignified or scarce in the dry season. Hence the need for conservation in form of silage which is less weather dependent unlike hay, during the rainy season, when they are in abundant supply and of high nutritive value (t'Mannatje, 1999).

Ensiling is an efficient method of forage preservation and serves as a means of salvaging the underutilised pasture for better acceptability and degradability. *Mucuna pruriens* (Velvet beans) is a tropical legume belonging to the family *Fabaceae* of the sub-division *Palpilionoideae.* The plant is a vigorously growing, climbing shrub with long vines that can **reach over** 15 m in length. *Mucuna pruriens* has been widely promoted as a superior green manure crop in Honduras, Guinea and elsewhere (Diallo *et al.*, 2000). Many experiments had been carried out on *Mucuna pruriens* seed as feed for monogastric animals (Olaboro *et al.*, 1995, Onwneka, 1997; Iyayi and Egherevba, 1998; Iyayi *et al.*, 2006). However, results of these experiments revealed that *Mucuna pruriens* have anti nutritional factors that inhibit the growth of the animals.

Maize, Guinea corn, etc. constitute the bulk of the components of livestock rations as sources of dietary energy. They constitute part of staple food for man; they are among the major arable crops produced in Nigeria especially in the savanna region (Makkar, 1994). Unlike monogastrics, feeding maize grains to ruminants as a source of dietary energy might be unrealistic because of its cost implications. However, huge tonnages of maize forage are lost during their milking stage especially due to poor soil condition and draught. Hence, there is need to convert them to the form that can be utilised by livestock such as maize forage. However, there is paucity of information on the use of maize forage as ruminant feed in Nigeria. Therefore, the present study assessed the weight changes and nutrient digestibility in WAD rams fed ensiled maize forage and *Mucuna pruriens* foliage.

Materials and methods

Study location

The study was carried out at the Teaching and Research Farm of University of Ibadan, Ibadan, Nigeria.

Planting of Mucuna and maize

Two acres of land were used for the planting of *mucuna* and maize seeds. The land was adequately ploughed twice, harrowed once and fenced before planting to prevent accidental grazing. The plot was divided into 1 acre each for separate planting of maize and *mucuna* seeds. Seeds of both downy mildew/streak resistance (DMR-SR) yellow variety maize and *mucuna* were purchased from IITA, Ibadan. *Mucuna pruriens* seeds were planted at 2 seeds per hole two weeks before the planting of DMR-SR yellow variety maize at 2-3 seeds per hole. Weeding was done manually once respectively, for the *Mucuna pruriens* and maize at four weeks after planting during this period. Thinning was done on maize plot to 2 stands at 3 weeks after planting, while re- supplying of seeds was done on *Mucuna pruriens* plot at two weeks after planting.

Harvesting and silage making

Mucuna pruriens foliage was harvested at eight weeks after planting (onset of flowering) while maize was harvested at dough stage as maize forage (including maize stalks, leaves, immature cobs and tassels excluding the roots) at six weeks after planting. Harvested *Mucuna pruriens* foliage and maize forage were chopped into 2-3 cm pieces (for easy compaction) as recommended by t'Mannetje (1999). Chopping of forages was done by using chopping machine fabricated for the purpose of silage production located at the dairy unit of Teaching and Research Farm, University of Ibadan, Nigeria (Olorunnisomo, 2011). Thereafter, the chopped materials were wilted under shade for 24 hours on polyethene sheets spread on concrete floor. That was followed by ensiling the maize forage and *Mucuna pruriens* foliage in different proportions to form five dietary treatments as follow;

- T1 = 1 MF: 0 MPF
- T2 = 3MF: 1MPF
- T3 = 1MF: 1MPF
- T4 = 1MF: 3MPF

Dry matter determination and chemical analysis of the silage

In triplicates, 100g of each silage sample was wrapped in foil paper and oven dried at 65 °C until a constant weight was obtained for dry matter determination. Oven dried samples were then milled in the laboratory with hammer mill of 1mm sieve and subjected to chemical analysis for determination of dry matter, crude protein, ash, ether extract and nitrogen free extract as described by AOAC, (1995). Neutral detergent fibre ((NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assayed by the methods of Van Soest *et al.* (1991). Hemicellulose was calculated as the difference between NDF and ADF and cellulose as the difference between ADL and ADF (Rinne *et al.*, 1997)

Digestibility study

Twelve post weaned West African dwarf rams (12±0.25 kg) aged 6-8 months were used for the experiment. They were purchased from Ikire, Osun State and Akinyele village in Oyo State. On arrival, the rams were given prophylactic intramuscular treatment of oxytetracycline and vitamin B complex at the dosage of 1ml/10kg body weight of the animal. They were also drenched with albendazole to control endo parasites and treated for mange and other ecto parasites using Ivomec.

The rams were allowed two weeks (2wks) of acclimitisation to their new environrment and the effect of the administered drugs to wear out. The design of the experiment was a completely randomized design (CRD). The rams were randomly allotted to the four dietary treatments at three rams per treatment and each ram was a replicate. Each ram was individually housed in metabolic cage with fitted facilities for separate collection of faeces and urine (Akinsoyinu, 1974). The study lasted for 14 days including 7 days of adjusted period. During the first 7 days of the experiment, the rams were introduced to the experimental silage diets and clean water were supplied *ad libitum*. During the last 7 days of the experiment, silage was given to each of the rams and 5 % body weight, the remnants were measured and recorded in the morning of the following day to determine the daily feed intake for each ram. Also the faecal sample and urine output for each ram was measured and recorded for each of the last seven days. The urine output for each of the rams was measured using measuring cylinder and later transferred into plastic bottle and two drops of concentrated HCl was added to trap the air inside the plastic bottles. Also at the end of the experiment, all the faecal samples and reminants of fresh silage for each ram were bulked together, respectively. About 100 g each of the faecal sample and remnants of silage for each ram from the bulked samples was taken and put inside the foil paper and then oven dried at 105°Cuntil a constant weight was obtained for dry matter determination. The oven dried faecal samples and remnants were later milled and stored in air tight container for proximate analysis using standard procedure of AOAC, (1995).

Intake and growth performance study

The animals' pens were made of low walls of 1.90m (height) by 7.10m by 13.94m in size. Each pen was about 1.83m long and 1.54m wide. The floor of the pen was made of concrete and the roof of the sheep unit which housed the pens was made of corruagated iron sheets. The pens were washed thoroughly with detergent and were further disinfected with broad spectrum insecticide, acaricide and larvicide (Diazintol). The feeding and drinking troughs were washed and disinfected and the whole house was left to rest for two weeks before usage. Wood shavings were spread on the floor of the pens up to a depth of 5cm as bedding materials and also to enhance prompt removal of urine and faeces and were replaced fortnightly.

Twenty post weaned West African dwarf rams with average initial body weight of 12±0.25Kg and 6-8months old were used for the experiment. They were purchased from Ikire in Osun State, Nigeria. On arrival, animals were given a prophylactic treatment which consisted of oxytetracyline long acting antibiotic (1ml/10kg body weight of the animal) and vitamin B complex. They were also drenched with albendazole to control endoparasites and treated for mange and other ectoparasites using ivomec. During the acclimatisation period for four weeks, rams were offered local diets from where they were purchased for the first two weeks and were introduced to the experimental diets for the remaining part of the acclimatisation period. At the end of the feeding trial, animals were weighed and allotted to four dietary treatments on weight equalization basis such that the average initial weight per treatment was not statistically different. Silages were offered at 0800 hr and 1500 hr at 5% body weight. Ration offered was frequently adjusted to ensure that ram received 10% of feed above its previous week's consumption. For the determination of daily feed intake, the orts were deducted from total amounts served the previous day. Samples from orts were taken for proximate composition. Fresh water and feed were served *ad libitum* each for the 105 days duration of the experiment. Salt licks were placed permanently in each pen.

Weights of rams were taken on a weekly basis using weighing scale before the morning feeding.

Experimental Design

The design of this experiment was a completely randomised design (CRD).

Data collection

Data collected were proximate composition of the silages, daily feed intake and orts. Weekly weight changes was computed as the difference between the present and previous body weight, while feed conversion ratios were computed as daily feed intake divided by daily body weight gain.

Statistical analysis

All data collected were analysed using analysis of variance (ANOVA) with the procedure of SAS (2003).Statistically significant observed means were compared using LSD of the same package at 5 % level of probability.

Results

Results obtained from the proximate composition (%) of silage combinations of maize forage and *Mucuna pruriens* foliage are shown in Table 1. There were significant ($P<0.05$) differences in the values of DM, CP, CF, EE, ash and NFE of the silage combinations. The dry matter (DM) content ranged from 21.5±0.4% in T4 (1 MF: 3 MPF) to 25.6±0.6% in T1 (1 MF: 0 MPF). Crude protein (CP) was lowest 8.0±0.2% in T1 (1 MF: 0 MPF) and significantly higher 13.0±0.6% in T4 (1 MF: 3 MPF). Crude fibre (%) ranged from 21.6±0.9 in T4 (1 MF: 3 MPF) to 26.4±2.6 in T1 (1 MF: 0 MPF). Ether extract (EE) was lowest 2.3±1.2% in T1 (1MF: 0 MPF) and highest 6.6±1.6% in T4 (1 MF: 3MPF). Ash content ranged from 6.5±0.7% in T1(1 MF: 0 MPF) to 14.3±1.8% in T4 (1 MF: 3 MPF), while Nitrogen free extract (NFE) ranged from 44.3±2.3% in T4 (1 MF: 3MPF) to 56.7±4.3% in T1 (1 MF: 0 MPF).

Table 1: Proximate Composition of silage combinations of maize forage and *Mucuna pruriens* foliage

	Treatments			
Parameters	**T1**	**T2**	**T3**	**T4**
Dry Matter (%)	25.6[a]±0.6	23.4[a]±0.4	21.8[b]±0.4	21.5[b]±0.4
Crude Protein (%)	8.0[c]±0.2	8.9[c]±0.2	11.7[b]±1.3	13.0[a]±0.6
Crude Fibre (%)	26.4[a]±2.6	26.2[a]±2.0	24.0[ab]±1.8	21.6[b]±0.9
Ether Extract (%)	2.3[c]±1.2	3.6[b]±0.8	4.6[b]±1.3	6.6[a]±1.6
Ash(%)	6.5[c]±0.7	8.3[b]±2.3	10.3[b]±2.2	14.3[a]±1.8
Nitrogen Free Extract(%)	56.7[a]±4.3	52.7[b]±0.9	49.1[b]±1.7	44.3[c]±2.3

[a, b, c] Means in the same row with different superscript are significantly different (P< 0.05).
VFI: Voluntary Feed intake; T1 = 1 MF: 0 MPF; T2 = 3 MF: 1 MPF; T3 = 1MF: 1 MPF; T4 = 1 MF: 3 MPF; MF – Maize Forage; MPF –*Mucuna pruriens* Foliage

Results in Table 2 shows apparent digestibility (%) of dry matter (ADDM), crude protein (ADCP), crude fibre (ADCF), ether extract (ADEE) and Nitrogen free extract (ADNFE). There were significant (P<0.05) differences in apparent digestibility of crude protein (ADCP) and crude fibre (ADCF) among the treatment means of WAD rams fed silage combinations of maize forage and *Mucuna pruriens* foliage. The values of ADDM ranged between 62.5±1.8% in T1 (1 MF: 0 MPF) and 66.2±0.7% in T2 (3 MF: 1 MPF). The ADCP ranged from 64.3±2.6% in T1 (1 MF: 0 MPF) to 76.4±2.7% in T3 (1 MF: 1 MPF). ADCF were 45.6±2.6% in T1(1 MF: 0 MPF), 48.1±2.6% in T2 (3 MF: 1 MPF), 48.6±2.1 % in T3 (1 MF: 1 MPF) and 47.6±1.4% in T4 (1 MF: 3 MPF), while ADEE were 66.7±4.3%, 66.6±3.3%, 65.4±4.6% and 65.0±3.8% in T1 (1 MF: 0 MPF), T2 (3 MF:1 MPF), T3 (1 MF:1 MPF) and T4 (1 MF: 3 MPF), respectively. ADNFE ranged from 53.2±3.0% in T4 (1 MF: 3 MPF) to 57.6±3.8% in T1 (1MF: 0 MPF). There were significant (P<0.05) differences in the apparently digestibility of all fibre fractions across the treatments as shown in Table 2. Apparent digestibility of Neutral detergent fibre (ADNDF) was significantly higher 59.2±1.7% in rams on T2 (3 MF: 1 MPF) and lowest 37.7±2.2% in rams on T4 (1 MF: 3 MPF). Apparent digestibility of acid detergent fibre (ADADF) ranged from 35.9±0.6% in rams on T4 (1 MF: 3 MPF) to 56.0±1.1% in T2 (3 MF: 1 MPF), while the values for apparent digestibility of acid detergent lignin (ADADL) ranged from 32.0±0.8% in rams on T4 (1MF: 3MPF) to 35.6±0.7% in rams on T2 (3 MF: 1 MPF).

Results obtained on the nitrogen utilisation in WAD rams fed the silage combinations of maize forage and *Mucuna pruriens* foliage is shown in Table 3. Significant differences (p>0.05) were observed in all the silage treatments in nitrogen utilisation. Voluntary feed intake (VFI), Nitrogen-intake, faecal-nitrogen, urinary-nitrogen, nitrogen-balance and Nitrogen-retention ranged from 690.62±13.33 (T1) to 798.54±15.01 (T3)g/day,7.24±1.24 (T1) to 12.18±1.89 (T4)g/day, 1.67±0.92 and 1.67±1.01 (T1 and T2) to 2.79±0.89 (T4)g/day, 4.02±1.22 (T1) to 6.09±0.79 (T4)g/day, 1.55±0.72 (T1) to 4.34±1.84 (T2)/day, and 20.2±4.3 (T1) to 43.23±3.2% (T4), respectively. The N-intake had the higher value of 12.18±1.89g/day in rams on T4 (1 MF: 3 MPF) and lowest 7.24±1.24g/day in rams on

Table 2: Apparent digestibility Coefficients (%) in West African dwarf rams fed silage combinations of maize forage and *Mucuna pruriens* foliages

Parameters	Treatments			
	T1	T2	T3	T4
Dry Matter	62.5±1.8	66.2±0.7	66.0±1.3	63.6±1.5
Crude Protein	64.3[c]±2.6	76.0[a]±2.3	76.4[a]±2.7	69.6[b]±2.2
Crude Fibre	45.6[c]±2.6	48.1[a]±2.6	48.6[a]±2.1	47.6[b]±1.4
Ether Extract	66.7±4.3	66.6±3.3	65.4±4.6	65.0±3.8
Nitrogen Free Extract	57.6±3.8	56.8±2.7	56.2±3.4	53.2±3.0
Neutra ldetergent fibre	54.6[b]±2.8	59.2[a]±1.7	41.1[c]±1.9	37.7[d]±2.2
Acid detergent fibre	51.2[b]±0.4	56.0[a]±1.1	42.6[c]±0.6	35.9[d]±0.6
Acid detergent ligin	34.2[a]±0.6	35.6[a]±0.7	32.3[b]±1.0	32.0[b]±0.8

[a,b,c] Means in the same row with different superscript are significantly different (P<0.05).
T1 = 1 MF: 0 MPF; T2 = 3 MF: 1 MPF; T3 = 1MF: 1 MPF; T4 = 1 MF: 3 MPF; MF – Maize Forage; MPF –*Mucuna pruriens* Foliage

T1 (1 MF: 0 MPF). The N-balance was significantly higher 4.34±1.84g/day in WAD rams on T2 (3 MF: 1 MPF) and lowest 1.55±0.72g/day in WAD rams on T1 (1 MF: 0 MPF), also the same trend was observed for the N- retention (%)

Results in Table 4 showed the intake and weight changes in WAD rams fed the silage combinations of maize forage and *Mucuna pruriens* foliage. Significant differences (p<0.05) were observed for Final body weight (FBW), body weight gain (BWG), daily body weight gain (DBWG), dry matter intake (DMI) and feed conversion ratio (FCR) among the treatment means. The BWG of WAD rams on T2 (3 MF: 1 MPF) was significantly higher 11.63±1.83 Kg compared to 8.67±2.22 Kg in T1 (1 MF: 0 MPF), 10.67±2.04 Kg in T3 (1 MF: 1 MPF) and 7.25±2.67 Kg in T4 (1 MF: 3 MPF), respectively. The FCR was highest 11.50±0.90 for rams on T4 (1 MF: 3MPF), while it was lowest 8.48±1.20 for rams on T2 (3 MF: 1 MPF).

Discussion

The dry matter (DM) values obtained in the present study were similar to the range of values of 20 – 27% reported by Moran (2005) for tropical forages but lower than 30 - 35% reported by FAO (2000). The differences could be as a result of certain factors such as age of harvesting the forage materials, additives used, ensiling technique, and silo materials.

The crude protein (CP) and ether extract (EE) increased with increasing inclusion of *Mucuna pruriens* foliage in the silage, while the DM, Crude fibre (CF) and nitrogen free extract (NFE) decreased with increasing level of *Mucuna pruriens* foliage in the silage. The CP in T1 (1 MF: 0 MPF) and T2 (3 MF: 1 MPF) were within the critical value of 7% recommended for small ruminants (ARC, 1980). The silage of T3 (1 MF: 1MPF) was within the minimum protein requirement of 10 - 12% recommended by ARC (1984) for ruminants, while the CP contents of T4 (1 MF: 3 MPF) was slightly above the minimum recommended value by ARC (1984). The ash content represents the inorganic mineral matter in a feed. Its value is mainly the contents of phosphorous, calcium and potassium and amounts of silica

Table 3: Nitrogen utilisation by WAD rams fed silage combinations of maize forage and *Mucuna pruriens* foliage

Parameters	Treatments			
	T1	T2	T3	T4
VFI (g/day)	690.62^{c}±13..22	784.07^{a}±14.04	798.54^{a}±15.01	693.28^{c}±11.11
N- Intake (g/day)	7.24^{b}±1.24	10.04^{a}±1.02	10.82^{a}±1.66	12.18^{a}±1.89
N – Urine (g/day)	4.02^{c}±0.92	4.03^{c}±1.01	5.38^{b}±0.98	6.09^{a}±0.89
N – faeces (g/day)	1.67^{b}±1.22	1.67^{b}±1.46	2.08^{a}±0.88	2.79^{a}±0.79
N–total excreted (g/day)	5.69^{b}±1.02	5.70^{b}±0.64	7.46^{a}±2.13	8.88^{a}±1.47
N – balance (g/day)	1.55^{c}±0.72	4.34^{a}±1.84	3.36^{b}±1.36	3.30^{b}±0.88
N– retention (%)	20.0^{d}±4.3	43.2^{a}±3.8	31.0^{b}±2.3	27.0^{c}±3.2

a, b, c: Means in the same row with different superscript are significantly different (P< 0.05).
VFI: Voluntary Feed intake; T1 = 1 MF: 0 MPF; T2 = 3 MF: 1 MPF; T3 = 1MF: 1 MPF; T4 = 1 MF: 3 MPF; MF – Maize Forage; MPF –*Mucuna pruriens* Foliage

Table 4: Feed intake and growth performance in WAD rams fed silage combinations of maize forage and *Mucuna pruriens* foliage

Parameters	Treatments			
	T1	T2	T3	T4
IBW (kg)	12.00±0.25	11.75±0.37	12.00±0.25	12.00±0.24
FBW (kg)	20.67^{b}±1.65	23.38^{a}±1.82	22.67^{ab}±1.02	19.25^{c}±2.02
BWG (kg)	8.67^{ab}±2.22	11.63^{a}±1.83	10.67^{b}±2.04	7.25^{c}±2.67
DBWG (g/day)	82.57^{c}±7.28	110.76^{a}±6.44	101.62^{b}±10.03	69.05^{d}±8.42
DMI (g/day)	806.38^{c}±11.12	869.39^{a}±12.08	872.41^{b}±19.04	794.76±15.44^{d}
FCR	9.76^{b}±0.80	8.48^{c}±1.20	9.60^{b}±0,60	11.50^{a}±0.90

a, b c: Means in the same row with different superscript are significantly different (P<0.05)
IBM- Initial body weight (Kg), FBW - Final body weight (Kg), BWG - Body weight gain (Kg), DBWG –Daily body weight gain (g/day), DMI - Dry matter intake(g/day), FCR - Feed conversion ratio
T1 = 1 MF: 0 MPF; T2 = 3 MF: 1 MPF; T3 = 1MF: 1 MPF; T4 = 1 MF: 3 MPF; MF – Maize Forage; MPF –*Mucuna pruriens* Foliage

(Bogdan, 1977). The ether extract of the silages ranged from 2.2% in T1 (1 MF: 0 MPF) to 6.6% in T4 (1 MF: 3 MPF). Ether extract is the lipid fraction, which is a major form of energy storage in plant. The energy derivable from the plant is what animal uses for its body maintenance and production. The results from the present study showed that the silages had sufficient energy. The crude fibre (CF) contents of the silages (21.6 - 26.42) revealed that the silage would produce effective rumination in which rumen microbes can degrade to produce sources of energy for the rams. Decrease in NFE percentage across the treatments was a good indication that maize forage has high soluble carbohydrates needed for effective fermentation of forage combinations during ensiling.

Digestibility of feed is classified as high (> 60%), medium (40-60%) and low (<40%) (FAO, 2000). According to FAO (2000), the apparent digestibility was high for all the nutrients except medium values recorded for nitrogen free extract (NFE), neutral detergent fibre (NDF) and acid detergent fibre (ADF), respectively. However, low values were obtained for acid detergent lignin (ADL) across the dietary treatments. The apparent dry matter digestibility (ADDM) for all the silages was similar statistically. Non-significant values obtained in this present study for ADDM indicated that silage dry matter digestibility by WAD rams was similar and this was similar to the study conducted by Morris *et al.* (2005).

The apparent digestibility of dry matter did not follow any particular trend across the treatments in this study. However, T2 (3 MF: 1 MPF) had the highest ADDM followed by T3 (1 MF: 1 MPF) and followed by T4 (1 MF: 3MPF), while T1 (1MF: 0 MPF) had the least. These results obtained were in line with the work of Nour *et al.* (1987) and Elkholy *et al.* (2009) who reported higher values of ADDM, respectively. Similar result was also observed by Babayemi (2009) who obtained a higher digestibility value in study conducted using Guinea grass silage to feed WAD sheep. The higher values of ADDM obtained in this study revealed that, dry matter is not a limiting factor for silage intake and digestibility when ensiled maize forage and *Mucuna pruriens* is used in feeding ruminants, which could be of great benefits to the animals.

The apparent digestibility of crude protein (ADCP) increased with increased level of *Mucuna pruriens* foliage in the silage from T1 (1 MF: 0 MPF) to T3 (1 MF: 1 MPF) and later decreased in T4 (1 MF: 3MPF). High crude protein digestibility has been considered an important factor that enables high intake of the silage. However, apparent crude protein digestibility values in the present study were higher than what was reported by Taiwo *et al.* (1995). This may be due to the *Mucuna pruriens* foliage having higher crude protein content.

The Crude fibre digestibility in this study was similar to those reported by Nour *et al.* (1987) and Elkholy *et al.* (2009), respectively. The factors responsible might be level of silage intake and stages of harvest of ensiled forage materials which may affect the fibre digestion (Scholljegerdes *et al.*, 2004). Nour *et al.* (1987) also reported that decreasing fibre digestibility is correlated with decreased forage intake. However, the higher crude fibre digestibility for WAD rams in all the silages in this study might be due to proliferation of fibrolytic microorganisms or increased activities of fibre digesting fungi and fibrolytic bacteria in the rumen of the rams on the feed due to adaptation and nature of the diet. The apparent digestibility of ether extract (ADEE) obtained in the present study was higher than those obtained (44.79 - 59.61%) by Nour *et al.* (1987) but lower than 81.83 - 85.68% for maize stover treated with yeast and urea fed to lamb in the studies conducted by Sabbah *et al.* (2006) and Elkholy *et al.* (2009).

The apparent digestibility of nitrogen free extract (ADNFE) decreased with an increased level of *Mucuna pruriens* foliage in the silage. The values obtained in the present study were lower than the values obtained by Sabbah *et al.* (2006) and Elkholy *et al.* (2009). They reported that the NFE digestibility (%) of cross bred Rahmany male lambs fed on rations containing corn stover silage with 5 g yeast/head/day was 80.34%. The non-significant differences on the apparent digestibility of neutral detergent fibre (ADNDF) in the dietary treatments in this study showed that the fibre fractions were relatively digested by WAD rams which was the expectation since rams are ruminants and have the ability to digest cellulose (Elkholy *et al.*, 2009).

The nitrogen (N) as a precursor of protein is also one of the most limiting nutrients for ruminant animal production apart from energy. Therefore, it is very important to incorporate this nutrient in a feeding system based on low nitrogen fibrous diet. The nitrogen balance (g/day) of WAD rams on the silages was in the order of T2> T3>T4> T1, all with positive N-balance. The N-retention followed a similar trend from 20.0

to 43.2%. The level of N-retention may be as a result of the high digestibility of nutrients in all the diets containing ensiled maize forage and *Mucuna pruriens* foliage. The positive N-balance and retention obtained in the present study were indices of weight gain in WAD rams or nitrogen conservation during the period of this study. This therefore suggests that the diets (all the silages) could be deemed adequate. The superiority of N-retention in a specific ratio is usually affected by several factors which include possible production of microbial protein synthesis and increased presence of fermentable energy (Hagemeister *et al.*, 1981). Also, differences in availability of fermentable energy (Tagari *et al.*, 1976) coupled with variability in nitrogen which might escape fermentation from the rumen and increased utilisation of ammonia in the rumen influence nitrogen retention in animals (Holzer *et al.*, 1986). All these may explain the reasons for variation in nitrogen retention as affected by silage treatments in this study.

The dry matter intake (DMI) is known to be a primary limiting factor in the efficient feed utilisation since it determines or controls the quality of intake of every other nutrient in the feed and consequently the overall performance of the farm animals. Plant physical structure and chemical composition are some of the important factors influencing intake (Babayemi *et al.*, 2009). Dry matter intake (DMI) by WAD rams fed the dietary treatments increased with increased level of *Mucuna pruriens* foliage in the silage. However, there was reduction in DMI for T4 (1 MF: 3MPF). The values obtained in this study are slightly higher than values of 617.2 - 759.1g/day obtained by Babayemi (2009) on a group of WAD sheep fed Guinea grass silage. Although, all the silage treatments met the 3-5% DMI per body weight recommended by ARC (1980). The high dry matter intake (DMI) of rams on the ensiled maize forage and *Mucuna pruriens* foliage in this study could be as a result of the succulent nature of the silages coupled with the high crude protein (CP) content. However, it has been reported by the earlier researchers that DMI could be favourably influenced by dietary CP level (Karim *et al.*, 2001; Karim and Santra, 2003). The results from this study showed that the silage treatments have sufficient crude protein contents to have influenced high dry matter intake in WAD rams.

The final weight and daily body weight gain of WAD rams fed T2 (3 MF: 1 MPF) was higher than the weights of WAD rams on other dietary treatments. Variations in the final weight and daily body weight gain of the WAD rams might be due to differences in nutrients supplied in the silage (Oddy and Sainz, 2002).

The feed conversion ratio (FCR) is a measure of animal efficiency in converting feed mass into increased body mass. Animals that have low FCR are considered efficient users of feed. The higher FCR was recorded for T4 (1 MF: 3 MPF) which implies that the rams utilised the supplied feed with least efficiency. However, the best efficiency was obtained for WAD rams on T2 (3 MF: 1MPF) followed by T3 (1 MF: 1 MPF) and T1 (1 MF: 0 MPF) in that order. This reflects a better utilisation of nutrients which led to higher weight gain by rams on the silage. The FCR for WAD rams in this study were within the values of 5 to 6 reported by Fahmy *et al.* (1992) for sheep on some forages of high quality.

Conclusion

Ensiling maize forage with *Mucuna pruriens* foliage at 3:1 improved growth, enhanced feed utilization, nutrient digestibility and positive nitrogen retention

West African dwarf rams.

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