

Assessment of Nutrient intake and Nitrogen utilization of Growing West African Dwarf Rams Fed *Panicum maximum* with *Cajanus cajan* Foliage Hay as a dietary supplement

Abstract

The utilization of browse legume fodders, such as *Cajanus cajan*, as hay or silage in combination with pasture grasses has gained considerable attention due to their superior protein content, digestible energy, and total nutrient value. This study investigated the effects of *Cajanus cajan* foliage inclusion in the diet of 30 growing West African Dwarf (WAD) rams aged 6 – 9 months and weighing 10.75 – 11.68 kg. The rams were randomly assigned to five dietary treatments (six per group) in a completely randomized design over 90 days. The experimental diets consisted of varying ratios of *Panicum maximum* (PM) and *Cajanus cajan* (CJ) foliage: T₁ (100% PM), T₂ (70% PM + 30% CJ), T₃ (50% PM + 50% CJ), T₄ (30% PM + 70% CJ), and T₅ (100% CJ). Each diet was fed daily at 3% of body weight. Significant ($P < 0.05$) differences in all parameters determined on nutrient intake and nitrogen utilization parameters across the dietary treatments. Ram maintained on T₃ diet had the highest Dry matter intake (767.31g/d), while the lowest value (683.10g/d) for DMI was recorded on ram fed diet T₅. Results revealed that highest CP intake (67.65g/d) and CF intake (74.13g/d) values was observed in ram fed diet T₅ while the least CP intake (47.72g/d) and CF intake (60.78g/d) was recorded in ram fed diet T₁ respectively. Highest ether extract intake (59.21g/d) and nitrogen free extract intake (70.43g/d) values was observed in ram fed diet T₅ while the least EE intake (51.95g/d) and NFE intake (60.75g/d) was recorded in ram fed diet T₁. Ram maintained on T₅ diet had the highest nitrogen intake of 10.21g/d while T₁ diet had the lowest value of 6.83g/d. Rams fed T₅ diet had the highest faecal nitrogen value of 7.03g/d. However, rams maintained on T₁ diet had the highest value urinary nitrogen of 2.46g/d. Ram maintained on diet T₄ recorded the best nitrogen utilization value of 40.21%. Feeding of fresh *Panicum maximum* (PM) forages at 30% inclusion with *Cajanus cajan* hay (CJ) at 70% for growing rams diet has a good nutrient profile and enhanced nutrient intake and nitrogen utilization of the WAD growing rams.

Keywords: Tropical grass, *Cajanus cajan* hay, WAD rams, Nutrient intake, Nitrogen utilization.

Introduction

The changing climatic conditions in the past years have resulted in persistent droughts, heat waves and shortages in animal feed (FAO, 2014). This has severely affected ruminant animal production leading to a dire need to address feed shortages particularly in small scale farming systems. One of such proposals is the use of forage legumes as protein supplements (Gebregiorgis *et al.*, 2011) in ruminant diets. Forage legumes provide adequate protein (Washaya *et al.*, 2018) and average energy (McDonald *et al.*, 2011) for ruminant livestock production. Ruminant animals constitute a very important part of the livestock sub-sector of the Nigerian agricultural economy. The potential of small ruminant production in alleviating the low animal protein intake by man in developing nations such as in Nigeria has been reported (Fajemisin *et al.*, 2010). Recently, more attention has been paid to small ruminant production in the tropics as their advantages are becoming more understood than ever before, particularly for their ability to produce meat, milk and skin, even in hostile environments (Konlan *et al.*, 2012; Makun *et al.*, 2013; Okoruwa *et al.*, 2013). Sources of cheaper alternative forages of high quality for ruminant

livestock production have been a subject of research in the recent years (Alan *et al.*, 2013), especially for small-scale livestock producers in tropical areas during the dry season. Fodder trees, browse plants and shrub forages are considered to be good and cheap sources of protein and micronutrients that can be used to increase the quality and availability of feeds for ruminants during the dry season (Moyo *et al.*, 2012; Bebeke and Abdalbagi, 2015, Babiker *et al.*, 2017). Therefore, there is a need to look for protein sources that farmers could get from their own farm with minimum cost. One potential way for increasing the availability of feeds for smallholder farmers could be through the use of fodder trees and shrub legumes. Pigeon pea (*Cajanus cajan*) is one of such fodder legumes whose leaves are an important fodder and serves as a valuable source of feed for farm animals (Foster *et al.*, 2009). Pigeon pea (*Cajanus cajan*) is a legume species grown in semi-arid tropical and subtropical areas of the world, such as Asia, Africa, and Brazil. *Panicum maximum* also called guinea grass and tangayika grass (FAO, 2003) is a highly productive, palatable, persistent and acceptable grass by ruminants. It can be fed to livestock solely or with concentrates or legumes. Additionally, fresh feeding of legumes is limited due to the seasonality of rain which reduces the independence from protein-rich feedstuffs during the dry season. By conserving excess forage produced during the wet season to hay or silage, the low production and productivity of livestock during the dry season due to scarcity of forage can be ameliorated (Wong, 2000). This study was designed to assess the Nutrient intake and nitrogen utilization of West African Dwarf growing rams fed different proportions of *Cajanus cajan* foliage hay with *Panicum maximum*.

Literature review

Grass-legume fodder mixtures for improved ruminant production

The use of leguminous forage crops as an alternative supplemental diets is more promising because, in addition being more affordable and easily produced locally, they also have low fibre content and high crude protein and minerals, making them a good option during dry season when pasture is scarce or poor quality (Hailecherkos *et al.*, 2020). The supplementary value of leguminous fodder crops on production and reproduction performance of ruminant animals have been widely explored and published in various literatures (Dida *et al.*, 2023). One potential way for increasing the availability of feeds for smallholder farmers could be through the use of fodder trees and shrub legumes. Pigeon pea (*Cajanus cajan*) is one of such fodder legumes whose leaves are an important fodder and serves as a valuable source of feed for farm animals (Foster *et al.*, 2009). It can be fed to livestock solely or with concentrates or legumes. To preserve for future use and to reduce the effects of some inherent antinutritive factors present in the leaves of some browse species either drying or wilting is employed at the On-farm level of production.

Materials and methods

Experimental site and animals

The experiment was carried out at the Sheep and Goat Unit, Teaching and Research Farm, Oyo State College of Agriculture and Technology, Igboora. Thirty (30) growing West African dwarf rams weighing between 10.75 – 11.68kg and of 6 – 9 months of age were used. Purchased rams were transported to the site, the rams were dewormed with anthelmintics (Albendazole[®]) to control endoparasites; oxytetracycline and multivitamin preparations were administered at rate of 1mL per 10kg body weight through intramuscular route for prophylactic treatment. Homologous *Pesti des petit* ruminant (PPR) vaccine was administered against PPR disease and acclimatized for 28days before the commencement of the experimental dietary treatment. Guinea grass and

cassava peels were offered to the animals during the adaptation period. Fresh and clean water was also made available throughout the experiment.

Harvesting and processing of experimental diets

The forages were harvested from pasture demonstration plot of the college farm. *Cajanus cajan* foliage and *Panicum maximum* were cut at a height of 30cm above the ground level at 50% flowering stage to allow for good re-growth. *Cajanus cajan* foliage including twigs and petioles were harvested and air-dried for 3 to 4 days by spreading on a clean concrete floor and turning thoroughly to facilitate uniform drying for saving storage. Fresh *Panicum maximum* was harvested daily (Zero grazing) and chopped manually into 3-5 cm length before feeding.

Table 1: Gross composition of the experimental diet (%)

Forage	A	B	C	D	E
Fresh <i>P. maximum</i>	100.00	70.00	50.00	30.00	0.00
<i>C. cajan</i> Hay	0.00	30.00	50.00	70.00	100.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
ME (MJ/KgDM)	11.97	11.77	11.57	11.37	11.17
Determined Analysis					
DM	89.67	88.56	88.14	87.50	86.60
OM	77.81	74.83	76.9	80.31	78.35
CP	7.30	12.15	14.62	16.46	19.01
CF	22.20	18.52	17.38	15.70	15.04
EE	2.90	4.26	3.01	5.18	1.70
Ash	3.30	6.20	5.31	4.62	3.90
NFE	66.00	57.35	54.80	56.75	51.20

P. maximum=*Panicum maximum*; *C. cajan*=*Cajanus cajan*; DM=Dry matter, OM=Organic matter, CP=Crude protein, CF=Crude fibre, EE=Ether extract, NFE=Nitrogen free extract

Experimental layout, design and feeding method

The animals were allocated by weight into five treatments of six rams per treatment and each ram served as a replicate in a completely randomized design (CRD). The CJ foliage cut at 8 weeks after planting and air-drying for 3 to 4 days were mixed in varying proportions with fresh PM (*Panicum maximum*) as the experimental diets (ED) and fed for each individual ram per day at 3% body weight. The ED were: T₁ (100%PM), T₂ (70PM30CJ), T₃ (50PM50CJ), T₄ (30PM70CJ) and T₅ (100%CJ). Each group of animals was assigned to an experimental diet and fresh and clean water was provided *ad libitum*.

Data Collection and Analysis

Urine and faeces were collected separately from each animal daily throughout the last seven days of the experiment in metabolic cages. The faeces sample collected were oven-dried at 80 C until a constant weight was reached. The urinary outputs were collected in sample bottles with a plastic cover containing 20 % dilute tetraoxosulphate (IV) acid, and stored at -20⁰C for analysis. The faecal samples were chemically analyzed using A.O.A.C procedure (AOAC, 1995). Data obtained were subjected to one-way analysis of variance (SAS 2002) mean value variance showing significant (P<0.05) difference were separated using Duncan's multiple range test (Duncan 1955).

Statistical Analysis

Data were subjected to one-way Analysis of Variance (ANOVA) procedure of SAS version 9.4 (SAS, 2002). Differences among treatment means were tested using Duncan Multiple Range Test (DMRT).

The statistical model for the experimental design was:

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

Where;

Y_{ij} = response variable, μ = overall mean, T_i = treatment effect, and \sum_{ij} = random error.

Results and Discussion

Table 2: Proximate Composition and Fibre fractions of *Cajanus cajan* foliage and *Panicum maximum* (%) harvested at 8weeks of age fed as experimental diet

Parameters	<i>Cajanus cajan</i> foliage	<i>Panicum maximum</i>
Dry matter	96.00	89.67
Crude protein	21.16	7.30
Ether extract	6.00	2.90
Ash	9.25	3.30
Non- fibre carbohydrate	5.60	22.20
Acid Detergent fibre	35.00	47.30
Neutral Detergent Fibre	58.00	70.12
Acid Detergent Lignin	11.50	23.57
Cellulose	23.50	23.73
Hemicellulose	23.00	22.82

The chemical composition of *Cajanus cajan* foliage and *Panicum maximum* fed as experimental diet are shown in Table 2. The chemical components of forage usually indicate the level at which consumption and utilization would yield a positive or negative effect(s) on animal output. The value (96.00%) for the DM content of *Cajanus cajan* foliage is at variance with that reported for indigenous multipurpose trees in Nigeria (Babayemi, 2006, Anele *et al.*, 2009) which may be attributable to the maturity of the leaves used in this study to feed the growing rams. The crude

protein value recorded by *Panicum maximum* was lower than that reported by Ukanwoko and Igwe (2012) for *Panicum maximum* (8.45%); this disparity might be attributed to the growth stage, maturity of the plants as well as the soil types and constituents. The percentage crude protein (CP) value (21.16%) for *Cajanus cajan* foliage was above 8% required to satisfy the maintenance requirement for ruminants (Norton, 2003) and also above the minimum level necessary to provide sufficient nitrogen required by rumen micro-organisms to support optimum rumen activity (Mc Donald *et al.*, 2002) and adequate intake of forages. Getachew *et al.* (2004) also stated that browse forages are higher in CP than tropical grasses and roughages such as hay, straw and stover. The observed value (21.16%) for CP content of Pigeon pea foliage in the current experiment is within the range (21 to 38%) reported by Cook *et al.*, 2005; Belete *et al.* 2013 and Diriba *et al.*, 2013. The CP content of Pigeon pea foliage in the present study also favourably compared with the values 21.30 and 20.00% reported by Shenkute *et al.* (2013) and Cheva-Isarakul (1992), respectively. According to Maasdorp *et al.* (1999), plant species/variety, soil, climate, grazing, plant fraction and stage of maturity at sampling affect the nutritive value of forages. The high CP content of pigeon pea foliage in the present study, therefore, suggests that it can serve as protein supplement in ruminant rations. The observed value (6.00%) for ether extract content recorded for pigeon pea foliages and 2.90% ether extract recorded for *Panicum maximum* were above the values of 1.40% reported by FAO, (2003) and 1.26% (Adegun, 2014). Ether extract contents of *Cajanus cajan* foliage observed in this current study were above the values of 3.07% reported by Babayemi *et al.* (2006) and 4.10% reported by Alalade *et al.* (2016) for *Psophocarpus tetragonolobus* leaves. However, ether extract contents of *Cajanus cajan* foliage fell within the range of 4 - 10% EE reported by Campbell *et al.*, (2006). The value of ether extract in the *Cajanus cajan* foliage was an indicator of higher energy level in the cultivar for the animal (Babayemi and Bamikole, 2006) which could be utilized for body maintenance and production. The slightly changed in the ash content value (9.25%) for *Cajanus cajan* foliage in this study is not comparable with the report of Dele (2012) and Onyeonagu *et al.* (2012) that reported that with advancement in age, total ash content decreases. This might be due to a major component of the total ash content called silicic acid which reduces with reduction in water uptake with maturity thereby reducing total ash content of the plant (Quigley and Anderson, 2014). The observed Non-fibre carbohydrate value (5.60%) for *Cajanus cajan* foliage was lower than the values range of 17.01 - 33.53% reported by Fadiyimu (2009). The assessed quality value (58.00%) of the Neutral detergent fibre (NDF) for *Cajanus cajan* foliage and 70.12% recorded for *Panicum maximum* in this study were comparable to the values reported by Gomez, (2011) and Minson (1990) for tropical forage. The increase in NDF with age of regrowth is related to physiological changes that occur as plant ages, that lead to a decrease in cell cytoplasm highly soluble components (cell contents), accompanied by an increase in cell wall fibre components (Nogueira *et al.*, 2000). The decrease in digestibility with age of forage is the consequence of the increase in its gut-fill. As the plant ages, its morphological and histological development decrease the amount of cell content, which is soluble, rapidly degraded and almost no gut-fill, and increases the amount of cell walls. Consequently, forage retention time in the rumen increases. In addition, tissue lignification increases the undegradable fraction of the cell walls and decreases the degradation rate of the degradable fraction (Grenet and Demarquilly, 1987). The CP and NDF concentrations of diets are the most important factors affecting DMI. However, forage with high ADF value is classified as low quality roughage (Rusdy, 2016). According to Kellems and Church (1998), roughage with less than 40% ADF are categorized as high quality and those with greater than 40% as poor quality. Based on this assertion, the cultivar of *Cajanus cajan* foliage used in this study can be classified as high quality browse legume forage because their ADF values were below 40%.

Table 3: Nutrient intakes (g/day) of Growing West African Dwarf rams fed dietary inclusions of *Cajanus cajan* hay and *Panicum maximum*

Parameters	100PM	70PM30CJ	50PM50CJ	30PM70CJ	100CJ
DM intake	702.00±16.59 ^b	687.20±7.78 ^c	767.31±11.90 ^a	685.80±8.28 ^c	683.10±5.50 ^c
OM intake	241.86±4.71 ^c	258.18±7.78 ^b	252.18±6.08 ^c	261.57±2.18 ^a	246.85±2.62 ^d
CP intake	47.72±5.57 ^c	52.83±5.32 ^c	58.03±3.73 ^b	58.87±3.69 ^b	67.65±2.89 ^a
CF intake	60.78±4.64 ^d	62.80±3.04 ^d	65.08±4.08 ^c	67.21±4.15 ^b	74.13±2.73 ^a
EE intake	51.95±3.99 ^d	58.67±2.94 ^a	56.49±4.02 ^b	53.71±2.11 ^c	59.21±4.15 ^a
NFE	60.75±5.29 ^c	63.38±3.34 ^d	68.52±2.45 ^b	65.78±3.67 ^c	70.43±4.17 ^a

^{abcde} Means along the same row with different superscripts are significantly different ($P < 0.05$). DM = Dry matter, OM = Organic matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFE = Nitrogen free extract

Nutrient intake of growing West African dwarf rams fed *Panicum maximum* with varying proportions of *Cajanus cajan* foliage hay are shown in Table 3. The dietary treatment had significant effect on the nutrient intake. Feed intake is an important parameter in determining the nutritive value of animal's feed as it account for nutrient supply. In the present study, there is significant difference in intakes of DM, OM and CP and these parameters increased with increasing supplementations level of *Cajanus cajan* hay which is consistent with the findings of Sánchez *et al.*, 2006. The significant dry matter intake (DMI) had highest value (767.31g/d) in ram fed mixture of diet 50PM50CJ and the lowest value (683.10g/day) was recorded in rams fed sole 100CJ diet. This agrees with the findings of Arigbede *et al.* (2005) who reported increasing dry matter intake with increasing level of browse supplementation. The higher dry matter intake (DMI) obtained in rams maintained on 50PM50CJ diet may be due to greater palatability and higher protein content of the diet. Richter *et al.*, (2003) opined that low quality livestock fodders or rations can be improved by adding browse plant (Moringa) as supplement which increases the dry matter intake (DMI) of the ration by livestock. It was also reported that diet with higher protein content increases feed intake (Mhamed *et al.*, 2001). Lower DMI in the diet 100CJ might be as a result of lower fiber content of the diet as agreed with the reports of Okah *et al.*, (2012) and Ahamefule (2005) who reported a higher DMI for diets with high fibre content than those with low fibre content. However, the nature of fibre and its interaction with other nutrients like protein might also influence intake. Similarly, the residual effect of CT (Condensed Tannins) of diet 100CJ may be attributed to reduced DM intake by the rams. Tannins have been reported to reduce feed palatability and consumption due to its astringent property (Olafadehan *et al.*, 2014). The DM intake recorded in this current study (683.10 – 767.31g/d) was higher than intake range of 433 - 443g/d reported for Savanna brown goat fed graded levels of *Gmelina arborea* leaf meal in complete diets (Abdu *et al.*, 2013) but slightly lower than the DM intake range value of 740.00 – 979.30g/d reported by Mekonnen *et al.* (2016) for the Horro sheep breed fed *Cynodon dactylon* alone or supplemented with *Cajanus cajan*, *Lablab purpureus* or their mixture. According to

Oladotun *et al.* (2003) variations in feed intake can be attributed to differences in breed, body weight, type of diet and length of time spent on the diet. The average CP intake values (47.72 – 67.65g/day) obtained in this current study was corroborated to the value of 57.10 g/day obtained by Osakwe *et al.* (2004) for *Daniella oliveri* as a fodder tree for small ruminant. However, the values of the CP intake in this study were lower than the range (90.00 - 108.90g/day) reported by Yeshambel *et al.* (2012) fed Washera sheep with mixture of lowland bamboo leaves and natural pasture hay at different ratios. According to Topps (1996), fibrosity of forages indicates the extent to which it can be degraded by rumen micro-organisms. The highest nitrogen free extract (NFE) intake (70.43g/d) was obtained in rams fed on T₅ diet while the lowest value for NFE intake (60.75g/d) was recorded in rams fed on T₁ diet. ARC (1984) reported that supplementation of protein based supplement enhances intake and growth performance. Supplementation of poor quality forages was reported to increase dry matter intake and performance of animals. The increase in dry matter intake by rams was due to increased protein intake as a result of browse plants supplementation which gave higher live weight gain (Ferdous *et al.*, 2011). Furthermore, the high dry matter intake of rams on *P. maximum* with varying levels of *Cajanus cajan* hay fodder combinations could be due to high CP content.

Table 4: Nitrogen utilization of growing West African Dwarf rams fed diets with different levels of *Cajanus cajan* hay and *Panicum maximum* (%).

Parameters	100PM	70PM30CJ	50PM50CJ	30PM70CJ	100CJ
Nitrogen Intake (g/d)	6.83±1.33 ^c	8.67±1.25 ^{ab}	8.35±1.06 ^{bc}	7.71±1.22 ^{bc}	10.21±1.62 ^a
Faecal Nitrogen (g/d)	2.87±1.30 ^c	5.21±1.30 ^b	4.26±1.45 ^{bc}	2.75±1.18 ^c	7.03±1.21 ^a
Urinary Nitrogen (g/d)	2.46±1.04	1.83±0.56	2.01±0.91	1.86±0.56	1.70±0.51
Total N output (g/d)	5.33±0.89 ^{bc}	7.04±0.53 ^b	6.27±1.89 ^b	4.61±1.33 ^c	8.73±1.16 ^a
Nitrogen balance (g/d)	1.50±0.71 ^b	1.63±0.49 ^b	2.08±0.92 ^{ab}	3.10±1.14 ^a	1.48±0.62 ^b
N utilization (%)	21.96±1.82 ^c	18.80±1.93 ^d	24.91±3.62 ^b	40.21±2.26 ^a	14.50±1.46 ^e

^{abcde} Means on the same row having different superscripts are significantly different ($P < 0.05$).

Nitrogen utilization of growing West African dwarf rams fed *Panicum maximum* with varying proportions of *Cajanus cajan* foliage hay are shown in Table 4. Nitrogen (N) intake increased progressively from animals maintained on diets 100PM to 100CJ hence it has significant direct relationship with dietary level of *Cajanus cajan* hay. This is probably due to increased CP intake with increasing level of Pigeon pea hay inclusion in the experimental diets as reported above. The average N intake values recorded in this current study were similar to 9.2 g/ day obtained by Alli- Balogun *et al.* (2003) for Yankasa/WAD sheep crosses fed grass supplemented with cassava foliage or groundnut hay. Faecal N differ across the dietary treatments and this results, however, did not agree with the report of Black *et al.* (1978) that faecal N was not significantly affected by N intake. On the other hand, faecal N increased progressively from rams fed diets 70PM30CJ to 100CJ, this was in conformity with the findings of Ahamefule *et al.* (2006). N digestion is directly correlated with level of Pigeon pea hay inclusion. Hence, values of N digestion recorded for the animals fed supplemented diets were significantly higher than the

animals fed on control diet. This suggests that additional nitrogen (N) consumed by the animals on Pigeon pea hay supplementation was well digested and absorbed. Total N output followed the same pattern as urinary N, with diets 100PM and 30PM70CJ having the least values in both parameters, and from diet 50PM50CJ the values increased steadily up to diet 100CJ. This is probably because the protein content of the Pigeon pea hay-supplemented diets was more soluble than that of the control diet. According to Brooker *et al.* (1995), when feed is high in soluble plant protein, N metabolism occur mainly in the rumen rather than in the lower digestive tracts leading to the production of large quantities of ammonia N in excess of the requirements of rumen microorganisms. The ammonia N not utilized by the bacteria is converted to urea by the animal and excreted in urine. This means that more rumen ammonia would be produced with the Pigeon pea hay-supplemented diets which would have increased as N intake increases from the rams fed diets 70PM30CJ to 100CJ. This perhaps explains why significantly higher values of urinary N and total N output were recorded as the level of Pigeon pea hay supplementation increased in this study. All the treatments gave positive N balance and N retention values, an indication that the protein requirement for maintenance in the experimental animals was adequately met by the dietary treatments. Animals fed on diet 30PM70CJ had the highest N balance and N retention, and the values were similar to that obtained by Lamidi *et al.* (1998) for WAD sheep fed *Ficus thonningi* at the 25% level of supplementation. The implications of the rams fed diet D having the best N-balance and N-retention in this study is that the optimum level of supplementation with *Cajanus cajan* hay is probably at about 70% and that at higher inclusion levels efficiency of protein utilization increases. Positive nitrogen balance is associated with periods of growth, hypothyroidism, tissue repair and pregnancy. This means that the intake of nitrogen into the body is greater than the loss of nitrogen from the body, so there is an increase in the total body pool of protein (Elango *et al.*, 2011). The effect of the diets at different proportion of *Cajanus cajan* hay supplementation on Nitrogen (N) utilization of rams followed the pattern of the feed intake of the diets. Hence the rams could have increased N- intake with increased in daily feed intake to meet their protein requirement from the diets. The observed increase in N-output in treatments could be attributed to inhibitory effects of residual toxic and astringent factor associated with *Cajanus cajan* hay. Okoruwa *et al.* (2013) made similar observation with West African Dwarf sheep fed pineapple waste. The higher urinary N-output observed in rams maintained on diets 100PM and 50PM50CJ compared with diets 70PM30CJ, 30PM70CJ and 100CJ could be probably due to a reflection of nitrogen in the rumen that depend on the quantity and solubility of the diets, which might have been lost from the rumen as ammonia and later converted to urea before excreted as urine. This confirm the report of Ahamefule and Udo (2010) that nitrogen excreted in urine would depend on urea recycling and the efficiency of ammonia utilization produced in the rumen by microbes for microbial protein synthesis. However, Nitrogen retention (Nitrogen balance) is the proportion of nitrogen utilized by farm animals from the total nitrogen intake for body process, hence the more the nitrogen is consumed and digested the more the nitrogen retained and vice versa, as observed by Okeniyi *et al.* (2010). Nitrogen retention/Nitrogen balance in g/day was best in rams fed diets 70PM30CJ and 50PM50CJ respectively possibly because of nitrogen utilization in the rumen. This observation further buttressed by the fact that the diet was well balanced in energy and protein which reduced nitrogen excretion in the urine (Noblet and Van Milgen, 2004) which were attributed to better nitrogen retention in animals fed diet 30PM70CJ. The percentage of nitrogen utilization values (14.50 – 40.21%) recorded in this study was fell within the range value of 17 to 79% reported by Okoruwa and Adewumi (2010). Amount of nitrogen utilization differed across the dietary treatments with rams fed on diet 30PM70CJ having the highest value (40.21%) compared to the other treatments. Generally, the intake and absorbed nitrogen was significantly influenced by the

dietary treatment groups.

Conclusion

The results of the study indicated that combination of grass based diet (*Panicum maximum*) with *Cajanus cajan* hay have appreciable nutrient and energy profile and, therefore, potentials as fodder for ruminants. However, diet T₄ promoted nutrient intake, and also enhance nitrogen utilization in growing WAD rams fed 30% *Panicum maximum* + 70% *Cajanus cajan* hay combinations.

Recommendation

It is therefore, recommended that the tropical grass (*Panicum maximum*) be supplemented with browse fodder in diets of growing ram to enhance the nitrogen utilization of the rams. The combination ratio might however, depend on the production status of the animal and the quality of both the basal grass diet and the browse plant species. It might be necessary, however, to further investigate the ratio of grass: browse fodder that will be best for different production status of rams with different qualities of both basal grass diet and browse fodders. Supplementation of basal grass diet with browse, particularly 30% *Panicum maximum* + 70% *Cajanus cajan* hay is therefore recommended in the humid tropics of Nigeria for rams, especially during the dry season when there is decline in quality and quantity of the basal grass diet.

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Conflict of interest

There is no conflict of interest to declare.

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