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Nutritional potential of differently processed *Cajanus cajan* leaves on nutrient digestibility and nitrogen utilization of West African dwarf growing rams fed *Panicum maximum*

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Abstract

Browse legume plants particularly pigeon pea forage generates a lot of underutilized leaves which if properly harnessed can be a cheaper source of nutrients for small ruminant animal production, during dry season feed shortages. In this study, the nutrient digestibility and nitrogen utilization of West African dwarf growing rams fed differently processed Cajanus cajan leaves and Panicum maximum basal diet for 56 days feeding trial. A total of sixteen (16) growing WAD rams between 6 - 9 months with an average body weight of 7.00 - 12.00kg were randomly allocated to 4 treatments with 4 rams each and 2 rams per replicate. The experimental diet was fed at 3% body weight of individual ram while fresh, wilted, and dried forms of Cajanus cajan leaves supplemented at varied inclusion levels (0%, 30% fresh, 30% wilted and 30% dried) with Panicum maximum. There were significant (P<0.05) differences in all parameters determined on nutrient digestibility across the dietary treatments. Animals maintained on T_4 (70% Panicum maximum and 30% dried Cajanus cajan leaves) had the highest dry matter digestibility (60.46%), while the lowest value (48.56%) for DMD was recorded in T_1 diet. Rams fed T_2 diet had the highest mean crude protein digestibility (CPD) value of 11.30%, followed by T_2 (10.68%), 10.02% for T_1, while T_4 diet had the lowest mean CPD of 9.21%. Rams fed T_1 diet had the highest mean crude fibre digestibility (CFD) value of 37.65%, while 35.03, 33.18 and 32.71 were recorded for T_4, T_2 and T_3 diet respectively. T_4 was observed to have the highest mean ash digestibility value of 17.07% with T_3, T_1 and T_2 having the value of 16.02, 14.28 and 13.36 respectively. There were significant (P<0.05) differences in all parameters determined on nitrogen utilization across the dietary treatments. Ram maintained on T_2 diet had the highest mean intake of 4.42g/d while T_1 diet had the lowest mean value of 2.64g/d. The lowest mean nitrogen balance (NB) of 0.43g/d was observed in rams fed T_1 diet while rams on T_2 diet had the highest NB value of 2.18g/d. Rams fed T_4 diet had the highest faecal nitrogen value of 2.14g/d. However, rams maintained on T_4 diet had the highest value urinary nitrogen of 1.07g/d. The nitrogen utilization fluctuated significantly (P<0.05) across the dietary treatments. It can be concluded that supplementation of fresh Cajanus cajan forages at 30% inclusion with Panicum maximum at 70% for growing rams can enhance nutrient utilization in terms of crude protein digestibility and nitrogen utilization without any deleterious effects on the animals.

Keywords: Tropical grass, Processed Cajanus cajan forages, WAD rams, Digestibility, Nitrogen utilization.

Introduction

Ruminants are important livestock species in Nigeria and form an integral part in smallholder farming systems as they provide adequate nutrients required as food. Small ruminants, in particular, are useful to humans during periods of cyclical and unpredictable food shortages (Birteeb *et al.,*

2012). Despite the importance of these animals, poor nutrition, especially during the dry season, has been indicated as a major threat to their sustainable production (Lamidi and Ologbose, 2014). An adequate supply of fodder is, however, essential for the development of livestock and a major way to overcome dry season fodder shortage is to source for crop residues during the cropping season and preserve for dry season feeding. Poor livestock production in the developing countries, particularly under smallholder farmers condition, is attributed to over-dependence on low digestible, poor quality and inadequate feed supply from natural pastures. Sometimes, feed from natural pastures especially at maturity cannot even meet the maintenance requirements of the animals, and to address this situation, fodder trees, shrubs and herbaceous legumes have been used as supplementary feed for ruminants (Aregheore and Perera 2004; Hassen *et al.,* 2006; Fadiyimu *et al.,* 2010; Abegunde and Akinsoyinu 2011; Barakat *et al.,* 2013). 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). Tropical browse plants such as Pigeon pea (*Cajanus cajan*) is a multipurpose nitrogen-fixing crop that provides the seed as human food and poultry feed, the leaves and young stems as animal fodder for the subsistence farmers (Lorgyer, 2009).

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. To preserve for future use and to reduce the effects of some inherent anti-nutritive factors present in the leaves of some browse species either drying or wilting is employed at the On-farm level of production.

This study was therefore designed to investigate the nutrient digestibility and nitrogen utilization by West African dwarf growing rams fed *Panicum maximum* supplemented with differently processed *Cajanus cajan* leaves.

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. Sixteen (16) growing West African dwarf rams weighing between 7.00 - 12.00kg and of 6 – 9 months of age were used. The animals were allowed to acclimatize for two weeks and treated against ectoparasites and endoparasites prior to the commencement of the experiment.

Harvesting and processing of experimental diets

The forages were harvested from pasture demonstration plot of the college farm. *Cajanus cajan* leaves 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* leaves including twigs and petioles were harvested and sun-dried for four to five days by spreading on a concrete floor and turning thoroughly to facilitate uniform drying for saving storage while the wilting was carried out for 14hours between 3.00 pm - 8.00 am under the shade a day preceding the feeding day. *Panicum maximum* was harvested daily (Zero grazing) and chopped manually into 3-5 cm length before feeding.

Experimental layout, design and feeding method

The animals were allocated by weight into four treatments of four rams per treatment and two animals as replicate in a completely randomized design (CRD). The experimental diets' composition is T_1 (100% *Panicum maximum* solely), T_2 (70% *Panicum maximum* and 30% fresh *Cajanus cajan* leaves), T_3 (70% *Panicum maximum* and 30% wilted *Cajanus cajan* leaves) and T_4 (70% *Panicum maximum* and 30% dried *Cajanus cajan* leaves). The chemical composition of fresh, wilted, and dried *Cajanus cajan* leaves and *Panicum maximum* are shown in Table 1. Each group of animals was assigned to an experimental diet and were fed *ad libitum* while fresh water was made available.

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^{0}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 -20^{0}C for analysis. The faecal samples were chemically analyzed using A.O.A.C procedure (AOAC, 1995). All nutrient digestibility and nitrogen utilization data obtained were subject to one-way analysis of variance (SAS, 1999). Differences among the means were separate using Duncan's multiple range test (Duncan, 1955).

Table 1: Chemical composition of fresh, wilted, and dried *Cajanus cajan* leaves and *Panicum maximum*

Parameters	Fresh *Cajanus cajan* leaves	Wilted *Cajanus cajan* leaves	Dried *Cajanus cajan* leaves	*Panicum maximum*
DM	44.50	86.60	91.48	32.80
CP	22.31	21.20	19.00	5.30
CF	25.26	26.86	27.12	22.20
EE	4.79	4.64	4.50	2.90
ASH	9.12	9.32	9.45	3.30
NDF	33.20	33.52	33.83	51.00
ADF	29.50	29.47	29.40	31.00
Lignin	10.12	11.01	12.40	13.47
NFE	15.98	24.58	8.52	66.00
M.E (Kcal/Kg)	3427.07	3804.98	3206.84	4223.06

DM=Dry matter, CP=Crude protein, CF=Crude fib re, EE=Ether extract, NDF= Neutral detergent fibre, ADF=Acid detergent fibre, NFE=Nitrogen free extract and ME= Metabolizable energy

Results and discussion

The proximate composition and fibre fractions percentage of different forms of *Cajanus cajan* forages and *Panicum maximum* is presented in Table 1. The DM values ranged from 44.50% in the fresh *Cajanus cajan* leaves to 91.48% in the dried *Cajanus cajan* leaves. The values for the DM content of different forms of *Cajanus cajan* leaves 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 fresh *Cajanus cajan* leaves had the highest crude protein (CP) content of 22.31% with the dried *Cajanus cajan* leaves having the least value of 19.00%. The proportion of CP obtained in the different forms of *Cajanus cajan* leaves used in the study were within the range (21 to 38%) reported in the literature (Cook *et al.,* 2005; Belete *et al.* 2013; Diriba *et al.,* 2013). Variations observed across literature could be due to the concentration of plant constituents, which

could vary from one geographical location to another depending on the age of the plant, differences in topographical factors, varietal differences, and the nutrient concentrations of the soil as well as processing methods. The range of the CP values observed across different forms of *Cajanus cajan* forages in this study could however enhance the intake of this legume browse plant by ruminants as they could supply critical nutrients needed to enhance ruminal microbial growth and fermentation of feed (Raghuvanis *et al.,* 2007). In general, all forms of *Cajanus cajan* forages had a CP concentration more than 7% which indicates their great nutritive value in terms of CP. Norton (1994) reported that feeds with less than 6% of CP levels are unlikely to provide the minimum ammonia levels required for maximum microbial growth in the rumen. The ether extract (EE) values which represented the crude fat content was higher in a fresh form of *Cajanus cajan* leaves and was also richer in fat compared to the wilted and dried forms. The EE values recorded for different forms *Cajanus cajan* leaves, however, showed that they contained adequate crude fat to satisfy the energy requirement of ruminant animals for productive purposes. Feedstuffs having a crude fat value of 1-2% have been found sufficient to maintain good health by reducing the risk of diseases and ageing caused by its excess consumption (Sodamade *et al.,* 2013). Variations were observed in the fibre fractions composition of different forms of *Cajanus cajan* leaves. The dried form had the highest value (33.83%) for neutral detergent fibre (NDF) with least values in the fresh form (33.20%), while the acid detergent fibre (ADF) recorded the highest and lowest values of 29.50% and 29.40% for fresh and dried forms of *Cajanus cajan* leaves, respectively. The NDF concentration of the different forms of *Cajanus cajan* leaves was below 60% which has been reported as the threshold level of NDF in tropical plants beyond which feed intake of ruminants is affected (Meissner *et al.,* 1991). The NDF is the best indicator to predict fodder quality as it is related to the intake potential of the fodder and energy value. The low fibre content of different forms of *Cajanus cajan* leaves, suggests it as a potential and important source of readily fermentable carbohydrates in ruminant feeds. The nutrient digestibility summary of growing West African dwarf rams fed *Panicum maximum* supplemented with differently processed *Cajanus cajan* leaves are shown in Table 2. The highest DM digestibility (60.46%) was observed in T_4 diet (70% *Panicum maximum* and 30% dried *Cajanus cajan* leaves) which could be enough to meet the production and maintenance requirements of growing rams. There were significant differences ($P<0.05$) in the DM digestibility values measured across the dietary treatments. The digestibility values obtained in this study might be evidence of proper utilization of dried *Cajanus cajan* leaves by (WAD) rams than sole *Panicum maximum*. The progressive increase in DM digestibility as the level of supplements inclusion increased probably reflects the better palatability and or acceptability of different forms of *Cajanus cajan* leaves by WAD rams than *Panicum maximum* solely. The CP digestibility of the diet ranged from 9.21% (T_4) – 11.30% (T_2), and this was adequate to support the maintenance requirement, growth and performance of small ruminants. The CP digestibility content was in line with the report of Getachew *et al.* (2000) that the browse plants are higher in crude protein than tropical grasses and roughages.

However, the CP digestibility content of the plants studied were all above 8% (CPD) required to satisfy the maintenance requirement of ruminant animals (Norton, 2003), and above the minimum level necessary to provide sufficient nitrogen

required by rumen micro-organisms to support optimum activity (McDonald *et al.,* 2002). The high level of CP digestibility recorded across treatments in the study indicates that processed *Cajanus cajan* leaves in different forms could serve as potential protein supplements that will enhance the intake and utilization of low-quality grass and fibrous crop residues by ruminants. The values of CF digestibility content ranged from 32.71% (T_3) -37.65% (T_1), which was very good as it will have high hemicelluloses and cellulose for better utilization by the system of the ruminant animals. The ash digestibility content ranged from 13.36% (T_2) – 17.07% (T_4), which indicated that ash content was useful in assessing the quality grading of leaves, and also gives an idea of the number of mineral elements present in the leaves (Smart, 1996). The recorded values in this study were higher than 10.90% reported by Ibeawuchi *et al.* (2002), thus, making *Cajanus cajan* leaves in different forms a better source of essential valuable and useful minerals needed for good metabolic which will enhance small ruminants production. The highest EE digestibility (2.13%) was recorded for rams fed T_2 diet while T_1 has the least of 2.05%; these values were below the range of 4 - 10% ether extract recommended by Preston and Leng (1995) for small ruminants. The highest NDF, ADF and ADL digestibility of 74.60%, 58.31% and 20.55% was recorded in T_2, T_4 and T_2, respectively, which could be attributed to the fact that as the plant matures, the fibre fraction also increases. This observation was in accordance with the findings of McDonald *et al.* 1998, who reported that with an advance in forage plant maturity; there is an attendant increase in its dry matter, ADF, NDF and NFE content with an appropriate decrease in its crude protein.

Table 2: Nutrient digestibility of West African dwarf growing rams fed Panicum maximum supplemented with differently processed Cajanus Cajan Leaves

Parameters	T_1	T_2	T_3	T_4	SEM
DM Digestibility	48.56^{d}	50.92^{c}	57.85^{b}	60.46^{a}	2.43
CP Digestibility	10.02^{c}	11.30^{a}	10.68^{b}	9.21^{d}	0.86
CF Digestibility	37.65^{a}	33.18^{c}	32.71^{cd}	35.03^{b}	2.50
Ash Digestibility	14.28^{c}	13.36^{d}	16.02^{b}	17.07^{a}	0.34
EE Digestibility	2.05^{c}	2.13^{a}	2.08^{b}	2.10^{b}	0.13
NDF Digestibility	60.54^{d}	74.60^{a}	67.20^{b}	64.03^{c}	2.59
ADF Digestibility	53.22^{c}	56.83^{b}	52.91^{cd}	58.31^{a}	1.15
ADL Digestibility	10.71^{d}	20.55^{a}	19.93^{b}	15.07^{c}	0.97

DM=Dry matter; CP=Crude protein; CF=Crude fibre; NFE=Nitrogen free extract; NDF=Neutral detergent fibre; ADF= acid detergent fibre. $^{a\,b\,c\,d}$ Means on the same row with different superscript are significantly different ($P< 0.05$).

The nitrogen utilization summary of growing West African dwarf rams fed *Panicum maximum* supplemented with differently processed *Cajanus cajan* leaves are shown in Table 2. The nitrogen intake (4.42g/d) of rams fed T_2 diet was higher ($p>0.05$) than nitrogen intakes of rams fed T_1, T_3 and T_4 diets. Animals fed T_4 diet had the highest value (2.14g/d) of faecal nitrogen output than other treatment groups. The percentage of nitrogen utilization recorded in this study ranged between 16.29 to 49.32%, which fell within the range of 17 to 79% reported by Okoruwa and Adewumi (2010) for West African dwarf sheep. Fajemisin *et al.* (2012) might attribute the observed values to feeding intake, protein quality and digestibility of the diet while observed nitrogen retention values corroborated the

reported values. However, the nitrogen utilization values observed in this study was favourably compared to the values reported by Jokthan *et al.* (2009) for Yankasa sheep fed rice straw supplemented with pigeon pea forage. Higher nitrogen intake of T_2 rams could be that the diet contained more crude protein (CP) than the other dietary treatments. The observed increase in faecal nitrogen output noted in T_4 diet could be attributed to inhibitory effects of residual toxic and astringent factor condensed tannins (CTs) associated with *Cajanus cajan* forage. Okoruwa *et al.* (2013) made a similar observation with West African dwarf sheep fed pineapple waste. Hence, the more the nitrogen consumed and digested the more the nitrogen retained and vice versa (Okeniyi *et al*., 2010). Based on this, it is logical to infer that the superior nitrogen absorbed and retained by T_2 rams might be due to the higher nitrogen intake (4.42g/d). Higher nitrogen retention by the animals fed T_2 diet indicate superior nitrogen utilization efficiency of 30% fresh *Cajanus cajan* leaves and 70% *Panicum maximum*

Table 3: Nitrogen utilization of West African dwarf growing rams fed *Panicum maximum* supplemented with differently processed *Cajanus Cajan* Leaves

Parameters	T_1	T_2	T_3	T_4	SEM
Nitrogen intake (g/d)	2.64^{b}	4.42^{a}	4.24^{a}	3.89^{ab}	0.35
Faecal nitrogen (g/d)	1.96^{ab}	1.92^{ab}	1.85^{b}	2.14^{a}	0.05
Urinary nitrogen (g/d)	0.25^{c}	0.32^{bc}	0.57^{b}	1.07^{a}	0.16
Total N output (g/d)	2.21	2.24	2.42	3.21	0.21
Nitrogen balance (g/d)	0.43^{cd}	2.18^{a}	1.82^{b}	0.68^{c}	0.37
Nitrogen utilization (%)	16.29^{d}	49.32^{a}	42.92^{b}	17.48^{c}	4.12

^{abcd} *means on the same row with different superscript are significantly different ($p<0.05$).*

Conclusion

In conclusion, the study reveals that different forms of *Cajanus cajan* forages are highly digestible and contain high concentrations of crude protein and low cell wall contents that could make it a good source of nutritional supplement in the diet of ruminants thereby minimizing nutrient deficiencies faced by ruminant grazing animals especially during the dry season. The findings from this study, also revealed that *Panicum maximum* supplemented with differently processed *Cajanus cajan* leaves has a good nutrient profile for feeding small ruminant animals. Growing rams fed 70% *Panicum maximum* and 30% fresh *Cajanus cajan* leaves showed the T_2 is palatable, accepted and increase rams' nutrient digestibility and nitrogen utilization. Hence, incorporating fresh *Cajanus cajan* leaves into growing ram diets can solve the problem of inadequate nutrients due to a shortage of feed during the dry season faced by smallholder ruminant farmers and enhance their performance characteristics.

Recommendation

It can be recommended from this research that 30% fresh form of *Cajanus cajan* leaves and 70% *Panicum maximum* should be incorporated into WAD sheep diet, as either basal or supplement diet, for better nutrient digestibility and nitrogen utilization to alleviate the nutrient requirement and body weight loses that are usually experienced during dry period.

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