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Nutritional potential of *Cajanus cajan* foliage hay on growth performance and nutrient digestibility of West African dwarf growing rams fed *Panicum maximum*

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ABSTRACT

Pigeon pea (*Cajanus cajan*; CJ), a browse legume, generates a lot of foliage which may be suitable for livestock feeding. The foliage could serve as a cheap source of nutrients to alleviate dry season feed shortage affecting ruminant production. A total of 30 growing WAD rams of 6 – 9 months old weighing 10.75 – 11.68 kg were randomly grouped into six rams per treatment in a completely randomized design for 90days feeding trial to assess the growth performance and nutrient digestibility of rams fed varying proportions of *Cajanus cajan* hay with *Panicum maximum.* The study was carried out at the Teaching and Research Farm of Oyo State College of Agriculture and Technology Igbo-ora, Nigeria. 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: T_1 (100%PM), T_2 (70PM30CJ), T_3 (50PM50CJ), T_4 (30PM70CJ) and T_5 (100%CJ). There were significant ($P<0.05$) differences in all parameters determined on growth performance across the dietary treatments. Ram maintained on T_3 diet had the highest Dry matter intake (51.18g/d), while the lowest value (45.54g/d) for DMI was recorded on ram fed diet T_5. The results revealed that ram fed diet T_1 recorded the least daily weight gain (8.00g/d) while the highest daily weight gain (18.22g/d) was recorded in ram fed diet T_4 that contained 30%PM70%CJ. The feed conversion ratio (FCR) ranged 4.65 – 10.83 showed significant difference across all treatments. Hence, ram fed diet T_4 that contained 30%PM70%CJ hay recorded the best feed utilization value of 4.65. There were significant ($P<0.05$) differences in all parameters determined on nutrient digestibility across the dietary treatments. Rams maintained on T3 (50%PM50%CJ had the highest dry matter digestibility (88.24%), while the lowest value (86.87%) for DMD was recorded in T_2 diet. Rams fed T_5 diet had the highest crude protein digestibility (CPD) value of 81.72%, followed by T4 (78.54%), while T1 diet had the lowest CPD of 63.32%. Rams fed T_5 diet had the highest crude fibre digestibility (CFD) value of 71.97%, while 67.32, 65.89%, 68.10% and 67.82% were recorded for T_1, T_2, T_3 and T_4 diet respectively. T_5 was observed to have the highest ash digestibility value of 29.10% with T_1, T_2, T_3 and T_4 having the value of 25.21%, 23.08%, 24.69% and 28.14% respectively. It can be concluded that 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 growth performance of the rams in terms of weight gain and feed utilization and improved nutrient utilization in terms of crude protein digestibility without any deleterious effects on the animals.

INTRODUCTION

Small ruminant production is a major component of the livestock sector in Nigeria. At smallholder level, sheep are the major source of food security serving a diverse function including cash income, savings, cash for fertilizer purchase and sociocultural functions (Solomon *et al.,* 2013). However, the productivity of sheep per head is low mainly because of inadequate year round nutrition, both in terms of quantity and quality, unimproved genetic potential and due to prevalence of diseases and parasites (Markos *et al.,* 2006). Nowadays most of natural pasturelands are put under intensified crop production due to the increasing human population pressure. Aftermath grazing and crop residue accounts for 60 to 70% of available basal diet in the tropical region. Such feeds are inherently low in nutritive value such as protein, digestible energy and minerals, which may result in sub-optimal rumen fermentation and lowered animal performance (Malede and Tekele, 2014). The other option of increasing livestock production can be achieved through cultivation of high quality forages with high yielding ability that are adapted to different environmental stresses (Muia *et al.,* 2001; Tessema *et al.,* 2010). Improved forages could be fed to the animals by direct grazing, cut and carry, or stored and conserved as hay or silage. The potentials of browse fodders in overcoming this problem have been recognized (Okoli *et al.,* 2002; Olafadehan *et al.,* 2015; Olafadehan and Okunade, 2018). Tropical trees, shrubs and browse legume plants are an important component of the fodder resources for livestock and wildlife. Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding systems in Nigeria (Fajemisin, 2015). The ability of their foliages to remain green and maintain their crude protein (CP) content makes them potential sources of protein and energy (Olafadehan, 2013). The fodder value of their leaves and fruits are often superior to herbaceous plants, particularly in the case of legumes (Fadiyimu *et al.,* 2011). Forage legumes generally contain high protein, minerals and vitamins (Idowu *et al.,* 2013); hence, they are often used as protein source to correct the protein deficiency of natural pastures (Tufarelli *et al.,* 2010). Incorporating fodder legumes into ruminant diet as supplementary feed has been noted to improve feed efficiency and feed intake (Mendieta-Araica *et al.,* 2009; Pen *et al.,* 2013). Leguminous trees, shrubs and herbs can be easily grown by smallholder farmers, and their inclusion in animal's diet can reduce overall feeding cost (Ososanya *et al.,* 2013). The potential of legumes for grazing is limited due to their susceptibility to trampling and the preferential grazing by livestock that adds pressure to legumes (Phelan *et al.,* 2015). 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 Growth performance and nutrient digestibility of West African Dwarf growing rams fed different proportions of *Cajanus cajan* foliage hay with *Panicum maximum*.

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.

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: T_1 (100%PM), T_2 (70PM30CJ), T_3 (50PM50CJ), T_4 (30PM70CJ) and T_5 (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

Feed Intake and Live Weight Gain: Adjustment period of one week was allowed before data collection commenced. At the beginning of the experiment, the rams were weighed and subsequently on a weekly basis prior to feeding in the morning. The initial live weight was subtracted from the final live weight to determine the weight gained by the animals. Feed offered and reminant (left over) were weighed daily to determine the feed intake of the animals. Both values were used to determine Feed conversion ratio, Dry Matter Intake (DMI), the mean initial body weight, weekly body weight, feed intake, and feed conversion ratio were calculated.

Nutrient digestibility

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 0oven-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 020 C 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).

RESULTS AND DISCUSSION

Table 1: Composition of the experimental diet (%)

Forage	A	B	C	D	E
Fresh *P. maximum*	100.00	70.00	50.00	30.00	0.00
C. cajan 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=Panimum maximum; C. cajan=Cajanus cajan; DM=Dry matter, OM=Organic matter, CP=Crude protein, CF=Crude fibre, EE=Ether extract, NFE=Nitrogen free extract

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

Parameters	*Cajanus cajan* foliage	*Panicum maximum*
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

Growth performance 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 feed intake, dry matter intake and weight gain. Highest dry matter intake (8.53g/day) was recorded in ram fed mixture of diet 50PM50CJ and the lowest value (7.59g/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 was lower 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). Lower intake in the current study could be due to sex effect, as doelings were used compared to most studies that used buckling. Higher final body weight value obtained in rams fed diet 30PM70CJ and 50PM50CJ compared with other treatment diets could be an indication of a good nutritive value of the test diets (Pigeon pea hay and *Panicum maximum*) and their combination ratios that were optimally utilized by the rams. This lends support from the report of Odunsi *et al.,* (2009) that the diet that is optimally utilized by animals has a positive effect on the final body weight of the animals. However, the numerically increased values (1.64kg) in average weight gain for rams with corresponding increase in inclusion level of Pigeon pea hay with *Panicum maximum* in the diet 30PM70CJ might be ascribed to the nutrient availability and utilization which eventually translated to the improvement in growth rate of the rams. This fact supports the findings of some researchers (Ogbuewu *et al.,* 2011; Adjorlolo *et al.,* 2016) who reported that when diets of ruminants consists of a mixed forages and lesser neem seed cake regime, higher weight gain is obtained than when diets consists of concentrate alone. Rams fed diet 100PM had a significantly depressed daily weight gain (8.00g/d) which could be attributed to the low crude protein intake of the rams fed only *Panicum maximum*. There were significant differences in intake of *Cajanus cajan* hay *and Panicum maximum* mixture diets among the treatments. The highest feed intake was observed for rams offered 50PM50CJ diet followed by diet 100PM. Feeding of *Cajanus cajan* hay has resulted in increase in weight gain of growing rams. The highest weight gain was observed for rams that received diet 30PM70CJ. The result of the study conducted by incorporating pigeon pea in mixture with cassava peel based diets showed a generally enhanced intake in West Africa dwarf goats (Ahamefule *et al.,* 2006). According to Bonsi *et al*. (1994), the positive effects of supplementation on feed intake might have been a reflection of the increase in the intake of essential nutrients such as energy, vitamins, minerals and in particular nitrogen (N). Leguminous fodder trees, as supplements, alleviate N deficiency thereby improving the rate of degradation of the basal diet and the fractional rate of liquid matter from the rumen and hence feed intake. Moreover, leguminous fodder trees increase protein supplies to the host animal by increasing the supply of both degradable and un-degradable protein, and by creating a favorable rumen environment resulting in enhanced fermentation of the basal roughage and thus increased microbial protein synthesis (Osuji *et al.,* 1995). The improvement in weight gain (growth) of rams supplemented with pigeon pea hay is associated with higher N contents of pigeon pea leaves. In other supplementation study using pigeon pea leaves in animal's diet, it was noted that it increases the intake of low quality herbage resulting in high animal live weight (Karachi and Zengo, 1998). According to Pamo *et al*. (2002), almost twice weight gain was observed for kids supplemented during the dry season than the un-supplemented due to the protein level in the multipurpose trees which was 84 to 140% higher than in the grasses. This clearly justifies the use of pigeon pea forage as feed supplements in ruminant nutrition during periods of forage scarcity. The production of adequate quantities of good quality dry season forage to supplement crop residues and pasture roughages is the only way to economically overcome the dry season feed shortage by small scale farmers in developing countries. Feed conversion ratio (FCR) of rams fed dietary treatments showed significant difference. The low feed conversion ratio (4.65) of rams maintained on diet 30PM70CJ could be ascribed to the quality of nutrient which was capable of increasing feed efficiency and growth rate. Rams fed diet 30PM70CJ had recorded lower FCR value followed by rams that assigned to diet 50PM50CJ. Brown *et al.* (2001) pointed out that animals that have a high feed efficiency ratio (FER) and low FCR are considered as efficient users of feed. From this point of view, rams fed with diet 30PM70CJ was the best feed converters followed by those rams on diet 50PM50CJ. Similar findings of improved FER in supplemented groups versus non-supplemented group were reported in literature (Biru, 2008; Tewodros, 2011; Yeshambel *et al*., 2012; Getahun, 2014). Thus, rams on diet 30PM70CJ efficiently utilized their feed better than those rams fed diets 100PM, 70PM30CJ, 50PM50CJ and 100CJ. This further attest the comparable growth performance observed in rams on diet 30PM70CJ.

Table 3: Performance of Growing West African Dwarf Rams fed *Panicum maximum* with *Cajanus cajan* foliage hay

Parameters	**100PM**	**70PM30CJ**	**50PM50CJ**	**30PM70CJ**	**100CJ**
Average initial weight (kg)	10.75±0.09^{c}	11.45±0.08^{b}	11.62±0.05^{a}	11.50±0.08^{b}	11.68±0.06^{a}
Average final weight(kg)	11.47±0.62^{c}	12.38±0.58^{b}	13.09±0.39^{a}	13.14±0.68^{a}	12.55±0.19^{b}
Average weight gain (kg)	0.72±0.63^{b}	0.93±0.61^{b}	1.47±0.38^{a}	1.64±0.65^{a}	0.87±0.18^{b}
Daily weight gain(g/day)	8.00±0.01^{b}	10.33±0.13^{ab}	16.33±0.12^{a}	18.22±0.21^{a}	9.67±0.03^{b}
Dry matter intake (g/head/d)	7.80±0.05^{a}	7.64±0.03^{b}	8.53±0.06^{a}	7.62±0.03^{b}	7.59±0.02^{b}
Total DMI(g/day)	46.80±1.36^{b}	45.84±1.40^{b}	51.18±1.48^{a}	45.72±1.39^{b}	45.54±1.47^{b}
Feed Conversion Ratio	10.83±1.12^{a}	8.22±0.67^{ab}	5.80±0.45^{c}	4.65±0.41^{c}	8.72±0.73^{ab}

^{abcde} *Means on the same row with different superscript are significantly different (P< 0.05).*

The nutrient digestibility summary of growing West African dwarf rams fed *Panicum maximum* with *Cajanus cajan* foliage hay are shown in Table 4. The dry matter (DM) digestibility was significantly highest in the rams fed diet 50PM50CJ compared to the other experimental diets which suggests that combining browse plants with grass species promotes dry matter digestibility. Tona *et al.,* (2014) reported a similar range of 77.47 to 81.67% for goats fed *Panicum maximum* with concentrate diets containing graded levels of *Moringa oleifera* leaf meal. Crude protein digestibility increased linearly with increasing supplementation of *Cajanus cajan* hay while the highest (81.72%) crude protein digestibility was recorded in rams fed diet 100CJ (sole *Cajanus cajan* hay) and lowest value (63.32%) was recorded in rams fed diet 100PM. The digestibility of nutrients in the current experiment is consistent with the reports of Ahmed and Abdalla (2005) and Maglad *et al*. (1984) in sheep fed different protein sources. Patra *et al.* (2006) fed concentrate containing soybean and leaf mixtures and observed similar digestibility of DM, OM and CP among treatments in does fed wheat straw. Moreover, Haddad (2005) fed different ratio of forage to concentrate and observed an increase in DM, OM and CP, while the digestibility of NDF and ADF decreased with increasing levels of concentrate in the diet. Except CP digestibility, similar digestibility was observed when *Moringa oleifera* leaf meal replaced soybean meal in dairy cows fed a basal diet of hay (Mendieta- Araica *et al.,* 2011). The study made by Richards *et al*. (1994) indicated that the digestibility of OM and fiber declined with increasing levels of gliricidia in relation to concentrate in goats. Also, Ndemanisho *et al*. (1998) reported declined digestibility of DM, OM and CP with increasing levels of leucaena as a substitute to cotton seed cake. The variation in digestibility value among legume supplementation could be due to the presence of condensed tannin in tropical tree legumes (Reed *et al.,* 1990). The CP digestibility was significantly lower in the rams fed diet 100PM than in other experimental diets. Significant differences were observed in digestibility of CP among the supplemented and non-supplemented groups in the current study. Rams of the supplemented groups had higher digestibility of CP than those animals in the control group. However, rams fed diets 30PM70CJ and 100CJ had higher values in digestibility of CP. This was attributed to the fact that as the concentration of Pigeon pea hay increased in the supplement diets the digestibility of CP was increased. The significant improvement of CP digestibility in the supplemented groups as compared to the control group is in agreement with literature reports (Tesfaye, 2007; Tewodros, 2011; Yeshambel *et al.,* 2012; Getahun, 2014). The current result is also in agreement with the report of Berhanu *et al.* (2014). The authors reported higher digestibility of CP for supplemented groups compared to the non-supplemented group in Washera sheep breed fed with natural pasture hay as basal diet and supplemented with *Millettia ferruginea* (Birbra) foliage. The difference in digestibility of CP obtained between supplemented and control groups in the current study could be due to the presence of high CP content in the diets of the supplemented groups compared to control group. Akinyemi *et al*. (2010) also observed higher CP digestibility in animals supplemented with Moringa than in the control group. The likely explanation may be Moringa fodder consists more degradable components especially crude protein. Yeshambel *et al.* (2012) reported that inclusion of lowland bamboo leaf hay significantly improved CP digestibility as compared to sole natural pasture grass hay in lambs of Washera sheep breed. Devendra (1982) also stated that supplementation with forage legumes increased the digestibility of poor-quality roughages. According to McDonald *et al*. (2002) protein rich feeds promote high microbial population in the rumen and also facilitate rumen fermentation. The authors also suggested that high CP intake is usually associated with better CP digestibility. The CP digestibility increased with increase in the levels of pigeon pea hay with guinea grass in the diets. Crude protein digestibility increased linearly with increasing supplementation of *Cajanus cajan* hay while the highest (81.72%) crude protein digestibility was recorded in rams fed sole 100CJ diet. This observation was in agreement with the reported values observed by Fadiyimu *et al.* (2010) who obtained 84.96% CP digestibility in sheep on sole Moringa foliage diet. There were significant differences in crude fibre (CF) digestibility among treatments. Animals fed on *Panicum maximum* supplemented with *Cajanus cajan* hay in diets 50PM50CJ, 30PM70CJ, and 100CJ had significantly higher CF digestibility than animals maintained on diet 100PM. This result indicated that the higher the CP level of the *Panicum maximum* and *Cajanus cajan* hay mixture diets 50PM50CJ, 30PM70CJ and 100CJ positively influenced CF digestibility which agrees with the reports of Fasae *et al.,* (2005) and Okah *et al.,* (2012) that CF digestibility and CP digestibility increase with increasing level of CP in diet. This results were also in line with the report of Minson (1990) that supplementation of browse to a basal grass diet can help improve the dietary protein as well as improve the DMI and digestibility of the diet. The value of Ash digestibility content recorded from the result ranged from 23.08 to 29.10%. This indicated that ash digestibility content is useful in assessing the quality grading of diets and also gives an idea of the amount of mineral elements present in the leaves (Smart, 1996). The value obtained in this study fell above (10.90%) the value reported by Ibeawuchi *et al.,* (2002) and also higher than the value (6.29%) reported by (Mecha and Adegboola 1980). This suggested that the browse plant (*Cajanus cajan*) hay could be a better source of essential valuable and useful minerals needed for good metabolic that will enhance good production of small ruminants. The significant increase in the digestibility of Nitrogen free extract (NFE) as a result of pigeon pea hay supplementation is in agreement with the findings of Abule *et al.,* (1995). This can be attributed to an increasing level of the crude protein that was ingested. It agrees with the previous study on the effect of increasing dietary crude protein level on nitrogen or crude protein digestibility (Sahlu *et al.,*1993). The higher NDF digestibility values observed for the animals fed supplemented diets 70PM30CJ, 50PM50CJ, 30PM70CJ and 100CJ compared to diet 100PM (sole *Panicum maximum*) could be due to the presence of higher crude protein content in the supplement diets than the diet 100PM sole (*Panicum maximum*) which provides more nitrogen for microbial utilization (Yahaya *et al.,* 2000; Abdulrazak *et al.,* 1997). This is also in consonance with a study by Mc Meniman *et al*. (1988) who reported an increase rate of rice straw degradation when supplemented with leguminous hay. Likewise, Ndlovu and Buchanan-Smith (1985) found similar observations when Lucerne hay was used as a supplement for barley straw. These results indicated that the sole *Panicum maximum* digestibility was lower due to the high fibre concentration. Mostly, the feeding value of forages and the extent of forage degradation in the rumen are constrained by the amount of fibre content (NDF) (Von Keyserlingk *et al.,* 1990; and Aregheore, 2007). Forages containing high cell wall content show restricted voluntary intake due to their slow degradability and accumulation of fibre in the rumen (Martin-Orou *et al.,* 2000). The ADF digestibility was significantly higher in the rams fed diet 100CJ than in other experimental diets. ADF digestibility increased linearly with increasing levels of Pigeon pea hay. This indicates that increasing the level of Pigeon pea hay increased the activities of fibrolytic bacteria in the rumen due to the availability of essential nutrients in balanced proportions for improved microbial growth and multiplication, resulting in efficient fiber utilization. It has been reported that DM digestibility was above 70%, which place them in category of high quality feeds (Meissner *et al.,* 2000). Manaye *et al.,* (2009) also reported that supplementation of *Sesbania sesban* with napier grass improved DM, OM, CP and neutral detergent fiber (NDF) digestibility in sheep, leading to higher animal performance. The results of the present study clearly indicate that Pigeon pea hay played a positive role in improving rumen function and digestibility compared to the sole *Panicum maximum* based diet.

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

Parameters	100PM	70*PM*30*CJ*	50PM50CJ	30PM70CJ	100CJ
DMD	87.26±1.62^{b}	86.87±2.85^{c}	88.24±2.23^{a}	86.89±2.97^{c}	87.14±2.71^{b}
CPD	63.32±1.74^{d}	75.13±2.40^{c}	76.06±1.25^{bc}	78.54±3.37^{b}	81.72±1.59^{a}
CFD	67.32±2.10^{c}	65.89±2.06^{d}	68.10±1.53^{b}	67.82±2.83^{c}	71.97±1.42^{a}
ASH	25.21±2.31^{b}	23.08±1.42^{b}	24.69±2.77^{b}	28.14±1.44^{a}	29.10±2.14^{a}
NFE	62.24±2.82^{b}	61.46±1.67^{b}	63.30±3.73^{bc}	65.07±1.83^{ab}	67.48±1.98^{a}
NDF	60.42±2.82^{d}	62.09±2.51^{c}	64.05±3.67^{c}	67.60±3.03^{ab}	69.09±2.34^{a}
ADF	58.81±2.72^{c}	61.05±1.57^{bc}	65.61±2.86^{b}	66.57±3.47^{ab}	68.89±3.76^{a}
Lignin	10.27±0.89^{bc}	12.06±1.84^{b}	14.89±1.37^{a}	11.07±1.11^{b}	9.10±2.11^{c}

[abcde] Means in the same row not follow by the same superscripts are significantly (P<0.05) different. DMD= Dry Matter Digestibility, CPD= Crude Protein Digestibility, CFD= Crude Fibre Digestibility, EED= Ether Extract Digestibility, NFE=Nitrogen Free Extract, NDF=Neutral Detergent Fiber, ADF= Acid Detergent Fibre

CONCLUSION

The study showed that feeding 70% *Cajanus cajan* foliage hay with 30% *Panicum maximum* mixture resulted in better feed intake, weight gain, feed conversion ratio and enhanced nutrient digestibility. Hence, it could serve as a good substitute for dry season feeding of growing rams.

RECOMMENDATION

Feeding of *Cajanus cajan* foliage hay at 70% inclusion level with guinea grass improved total DM intake, body weight gain, and nutrient digestibility to the minimum levels acceptable for growing rams on a maintenance ration. Thus, smallholder ruminant farmers in the rain forest zone of the country who are unable to use concentrate supplement and experience extreme feed scarcity during the peak of the dry season can therefore use this ration to maintain the body weight of non-producing animals.

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