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EVALUATION OF NUTRITIVE QUALITY AND ANTI-NUTRIENT CONTENTS OF PIGEON PEA (*Cajanus cajan*) FOLIAGE AS INFLUENCED BY CUTTING REGIMES IN DERIVED SAVANNA ZONE OF NIGERIA

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ABSTRACT

Feed shortage during the dry season in the tropical environment negatively impacts the ruminant's productivity as well as the farmers' income, hence critical evaluation of the available forages will help in ameliorating this challenge. Pigeon pea (*Cajanus cajan*, CJ) produce a high quantity of biomass, and are an alternative way to increase fodder supply to small ruminants. This study evaluated the nutrient (proximate) composition, anti-nutrient contents and mineral composition of the cultivar foliage of light seed coat Pigeon pea variety (Accession TCc-6) at three different stages of growth (4, 6 and 8 weeks of age) in a completely randomized block design experiment. It was observed that the proximate composition of CJ was significantly influenced (p<0.05) by cutting at different stage of growth as highest dry matter content (96.00%), neutral detergent fibre (58.00%), acid detergent lignin (11.50%) and hemicellulose (23.00%) were recorded in CJ foliage cut at 8 weeks as compared to those cut at 4- and 6- weeks while highest crude protein (23.10%), ether extract (7.25%), Non-fibre carbohydrate (12.41%) was observed in CJ foliage at 4 weeks. The percentage value of anti-nutritional factors in CJ foliage ranged from 0.74 to 0.87 for tannin, 0.01 - 0.02 (oxalate), 0.48 to 0.97 (phytate), 0.46 - 0.72 (saponin), 0.15 – 0.20 (phenol) and 20.23 - 21.67mg/kg (trypsin inhibitor). Our result revealed a significant difference in the mineral composition as the CJ foliage cut at 4-weeks of age had the highest phosphorus (0.39%), potassium (0.86%), calcium (0.27%), magnesium (0.28%), iron (191.25 mg/kg) and zinc (51.72 mg/kg) compared to those cut at 6- and 8-weeks. It was concluded that nutrient and mineral contents, and anti-nutrient factors of CJ foliage were influenced by cutting different ages of cultivation, though the anti-nutrient contents do not pose any deleterious effect to ruminant animal's feed or feeding regime.

Keywords: Proximate, Anti-nutritional contents, Mineral composition, Cajanus cajan foliage.

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. Feeding standards of ruminant livestock could be significantly enhanced through the cultivation of improved quality forages, which are suitable for different agro-climatic conditions in tropical Africa (Adebisi, 2021). Nowadays most of the 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). 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 (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).

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. This species calls farmers attention for tolerance to acid and low fertility soil, hydric scarcity, besides supplying grains for human food, as well as branches and leaves for animal feed (Chen *et al.,* 2019). Incorporating fodder legumes into ruminant diet as supplementary feed has been noted to improve feed efficiency and feed intake (Mendieta-Araica *et al.,* 2011; Pen *et al.,* 2013). 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). 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 composition, anti-nutritional factors and mineral composition of *Cajanus cajan* foliage at three stages of growth.

MATERIALS AND METHODS

Experimental site, layout and management

The experiment was carried out at Pasture Demonstration Plot of Teaching and Research Farm of the Oyo State College of Agriculture and Technology, Igbo-ora. The region is on latitude $7^0$43' North and $3^0$29' East, located at an elevation of 17m above sea level (World atlas, 2015).

A total experimental area of 50m x 50m (2500m^2) was used for the experiment. The area was divided into three main plots (A, B and C) and replicated three times. Each plot measures 5m x 5m with inter and intra row spacing of 0.5m between the plots. Land preparation involved ploughing, harrowing and ridging. Pigeon pea seeds were procured from the International Institute of Tropical Agriculture (IITA), situated in Ibadan, South-Western region of Nigeria. Treated seed of Pigeon pea of light seed coat variety (Accession TCc-6) were planted at 25cm intra row and 35cm inter row spacing. Two seeds per standing were sown with a cutlass to depth of about 3-5cm. Before flowering at 4-, 6- and 8-weeks of age, the forages were cut using sickle at a height of 30cm above the ground level before flowering stage to allow for good re-growth. The herbage sample was taken from three replications pooled and mixed, one representative sub-sample was taken per plot and saved pending chemical analysis after drying.

Laboratory analysis of Proximate composition

The air-dried leaves were ground into fine powder. About 10.0 g of the grounded leaves was exhaustively processed for various parameters according to the Association of

Official Analytical Chemists methods; (AOAC, 1990; AOCS, 2000). The proximate analysis (fats, crude protein, moisture, crude fiber and ash) of the leaves were determined using AOAC methods. The fiber content was estimated from the loss in weight of crucible and its content on ignition. The nitrogen value, which is the precursor for protein of a substance, was determined by micro kjeldah method, involving digestion, distillation and finally titration of the sample (AOCS, 2000). The nitrogen value was converted to protein by multiplying with a factor of 6.25. The determination of crude lipids content of the samples was done using Soxhlet type of direct solvent extraction method. The solvent used was petroleum ether (boiling range 40 - 60^0C). Non-fibre carbohydrate was calculated as NFC= 100 - (CP + Ash + EE + NDF). Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was calculated as the difference between NDF and ADF. The result of proximate value was all estimated as percentage (AOAC, 1990; AOCS, 2000).

Anti-nutritional factor and mineral analysis

Oxalate was determined by the method of Krishna and Ranjina, (1980) while phytate was determined by AOAC, (1990) method. The tannin was determined by the procedure of (Polshettiwar, 2007). Trypsin inhibitor activity was determined according to the method of Kakade *et al.* (1974). The mineral elements were analyzed using the method of Walinga (1989); the elements in the samples were brought into solution by wet digestion technique using a mixture of concentrated nitric, perchloric and sulphuric acid. In the ratio 9:2:1 respectively. K, Fe, Zn, Ca, and Mg were determined by atomic absorption spectrometer and phosphorus was determined by using Vanadomolybdate Calorimetric Method (AOAC, 1995).

Statistical analysis

Data obtained were subjected to analysis of variance using General linear model of SAS, (2000). The significant means were separated using Duncan Multiple Range Test (DMRT; Duncan, 1955).

RESULTS

The proximate composition and fiber fractions of Cajanus cajan foliage

The proximate composition and fiber fractions of CJ forages harvested at different cutting intervals of age are presented in Table 1. There were significant differences ($P<0.05$) in proximate composition and fiber fractions among the pigeon pea forage harvested at different cutting intervals of age. In the present study, dry matter (DM) content was higher ($P<0.05$) in CJ foliage (96.00%) cut at 8weeks and lower at 4 weeks of age (86.75%). CJ foliage harvested at 4 weeks of age recorded the highest CP value of 23.10% followed by cutting at 6 weeks of age (21.80%).

Table 1: Proximate Composition and Fibre fractions of *Cajanus cajan* foliage at three stages of growth (%)

Parameters	Cutting age of *Cajanus cajan* foliage		
	4weeks	6weeks	8weeks
Dry matter	86.75±1.50	95.50±1.00	96.00±0.82
Crude protein	23.10±1.00^{a}	21.80±0.61^{b}	21.16±0.53^{b}
Ether extract	7.25±0.96	6.25±0.96	6.00±1.15
Ash	7.75±0.50^{ab}	7.50±1.00^{b}	9.25±1.26^{a}
Non- fibre carbohydrate	12.41±1.91^{a}	11.95±2.30^{a}	5.60±2.90^{b}
Acid Detergent fibre	31.50±1.91^{b}	33.50±1.00^{ab}	35.00±1.15^{a}
Neutral Detergent Fibre	49.50±1.00^{c}	52.50±1.91^{b}	58.00±1.63^{a}
Acid Detergent Lignin	9.00±1.15^{b}	9.50±1.00^{b}	11.50±1.00^{a}
Cellulose	25.00±2.52	24.00±0.00	23.50±1.91
Hemicellulose	18.00±2.83^{b}	19.00±2.58^{b}	23.00±2.00^{a}

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

Anti-nutrient content of Cajanus cajan foliage at three stages of growth

Table 2 shows the results of anti-nutrient content present in pigeon pea foliage harvested at three stages of growth. The concentration of tannin level of the forage ranged from 0.74% to 0.87%. Highest (P<0.05) tannin content (0.87%) was noted in CJ forage at 4 weeks' harvest in plot-A followed by CJ forage (0.84%) in Plot-C at 8 weeks and the least value (0.74%) was observed in CJ forage harvested at 6 weeks in Plot-B. Oxalate level in CJ forage (0.02%) was higher (P<0.05) in plot-A and C at cutting intervals of 4 and 8 weeks compared to CJ forage with value of (0.01%) in plot-B at 6 weeks. Phytate level ranged from 0.48% to 0.97%. Highest (P<0.05) phytate content was observed in CJ forage (0.97%) in plot-A at 4 weeks and the lowest value (0.48%) was recorded in Plot-B that contained CJ forage harvested at 6 weeks.

The saponin content of the forage examined ranged from 0.46% to 0.72%. Highest (P<0.05) saponin value (0.72%) was observed in CJ forage in Plot-B at 6 weeks and the least value (0.46%) was noted in CJ forage in plot-A harvested at 4 weeks. The highest (P<0.05) value (0.20%) of phenol was recorded in CJ forage in plot-B harvested at 6 weeks and the least value (0.15%) was observed in CJ forage in plot-C harvested at 8 weeks. The trypsin inhibitor varied among the three stages of growth of the forage from 20.23 mg/g to 21.67 mg/g with the highest (P<0.05) value (21.67 mg/g) of trypsin inhibitor content noted in CJ forage in plot-B harvested at 6 weeks and lowest value (20.23 mg/g) of trypsin inhibitor was however observed in CJ forage in plot-A harvested at 4 weeks.

Table 2: Anti-nutritional factors of *Cajanus cajan* foliage harvested at three stages of growth

Parameters	Cutting age of *Cajanus cajan* forage		
	4weeks	6weeks	8weeks
Tannin (%)	0.87±0.01[a]	0.74±0.03[c]	0.84±0.01[b]
Oxalate (%)	0.02±0.01	0.01±0.00	0.02±0.01
Phytate (%)	0.97±0.08[a]	0.48±0.02[c]	0.64±0.03[b]
Saponin (%)	0.46±0.02[b]	0.72±0.05[a]	0.67±0.03[a]
Phenol (%)	0.18±0.01[a]	0.20±0.04[a]	0.15±0.01[b]
Trypsin inhibitor (mg/g)	20.23±2.65	21.67±2.47	21.59±2.35

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

Mineral contents of Cajanus cajan foliage at three stages of growth

Results of the mineral contents of the CJ foliage harvested at different ages of growth are presented in Table 3. Significant (P<0.05) difference was observed among the foliage at three stages of growth in terms of mineral contents. The highest (P<0.05) concentration of phosphorus (0.39%) was noted in CJ foliage harvested at 4 and 6 weeks while the lowest (P<0.05) value (0.38%) phosphorus was recorded at 8weeks. The concentration of potassium (K) content varied, and their values ranged from 0.84% to 0.86% at the three stages of growth. The highest (P<0.05) value of potassium was noted at 4 weeks of growth (0.89%) while the least value (0.84%) was recorded at 8 weeks of growth. Calcium contents varied among the three cutting regimes from 0.24% to 0.27%. Highest (P<0.05) calcium content was observed in CJ foliage (0.26%) harvested at 4 weeks while least value (0.24%) was recorded in CJ foliage harvested at 8weeks. The highest (P<0.05) values for iron (191.25 mg/kg) and zinc (51.72 mg/kg) were obtained in CJ foliage harvested at 4weeks followed by CJ foliage at cutting age of 6 weeks on iron (190.87 mg/kg) and zinc (51.08 mg/kg), the least value obtained in CJ foliage harvested at 8weeks for iron (190.32 mg/kg) and zinc (50.68 mg/kg). The concentration of magnesium (Mg) among the CJ foliage at different cutting regimes varied from 0.27% to 0.28%. Comparable value (0.27%) was observed in both CJ foliage harvested at 6weeks and 8weeks.

Table 3: Mineral composition of *Cajanus cajan* foliage harvested at three stages of growth

Parameters	Cutting age of *Cajanus cajan* forage		
	4weeks	6weeks	8weeks
P (%)	0.39±0.01[a]	0.39±0.01[a]	0.38±0.02[b]
K (%)	0.86±0.01[a]	0.85±0.02[b]	0.84±0.01[c]
Ca (%)	0.27±0.06[a]	0.25±0.02[b]	0.24±0.03[c]
Mg (%)	0.28±0.02[a]	0.27±0.04[b]	0.27±0.03[b]
Fe (mg/kg)	191.25±3.81[a]	190.87±3.52[b]	190.32±3.68[b]
Zn (mg/kg)	51.72±2.65[a]	51.08±2.47[a]	50.68±2.35[b]

[a b c] Means on the same row with different superscript are significantly different (P< 0.05).
P= phosphorus; K= potassium; Ca=calcium; Mg=Magnesium; Fe=Iron; Zn=Zinc.

DISCUSSION

It is quite evident that there were great variations in the chemical composition of the CJ foliage harvested at different ages of growth as revealed in the study which can be due to stage of growth maturity, plant species/variety, soil, climate, grazing, plant fraction (Maasdorp *et al.* 1999, Promkot and Wanapat, 2004). The percentage crude protein (CP) observed were above the 8% required to satisfy the needs and maintenance of ruminants (Norton, 2003) and above the minimum nitrogen required by rumen micro-organisms for their optimum activity and forages intake (McDonald *et al.,* 2002), thus our finding corroborates the result of Getachew *et al*. (2004) that browse forages are higher in CP than tropical grasses and roughages such as hay, straw and stover. Our observed CP values fell within the range of 21 to 38% as reported by Belete *et al*. (2013), Shenkute *et al*. (2013) and Diriba *et al.,* (2013). The observed ether extract values (6.00 - 7.25%) were above the reported values of 1.40%, 1.26%, 3.07% by FAO, (2003), Adegun (2014) and Babayemi *et al.* (2006) respectively as well as 4.10% reported by Alalade *et al.* (2016) for *Psophocarpus tetragonolobus* leaves.

Our observed ether extract values in the CJ forage were 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. Despite our observed significant but slight change in the ash content, it does not conform with the reports of Dele (2012) and Onyeonagu *et al.* (2012) that with advancement in age, total ash content decreases which might be as a result of decline in silicic acid, a major component of the total ash content, with reduction in water uptake by plants (Quigley and Anderson, 2014). The non-fibre carbohydrate (NFC) content of the CJ forage harvested at three different stages of growth were influenced by the interaction of cultivar, processing and age at harvest of the forages, and the values were lower than the reported range of 17.01 - 33.53% by Fadiyimu (2009) but fell within 12.70 – 25.90% reported by Anele *et al*. (2009). This indicates that NFC of CJ foliage can be easily degraded or fermented as it is a crude estimate of the carbohydrate pool that differ in digestibility from NDF. Furthermore, it has been reported that NFC has a positive relationship with ammonia nitrogen (NH_3-N) utilization in the rumen (Tyluki *et al.,* 2008).

Acid detergent fibre (ADF) values of CJ forage recorded in this study were significantly influenced by stages of growth of the forage, and with the values of 31.50 – 35.00 which is considered to be high quality roughage according to Rusdy (2016) and Kellems and Church (1998) classification that any forage with an ADF value less or greater than 40% are categorized as high-quality or poor/low-quality roughage respectively. The assessed neutral detergent fibre (NDF) quality of 49.50 - 58.00% is lower than was reported by Gomez (2011) but similar to the values reported by Minson (1990) for tropical forage. The increase in NDF with regrowth at different age is related to physiological, morphological and histological changes as plant ages leading to a decrease in highly soluble components in the cell cytoplasm (cell contents) which is followed by an increase in cell wall fibre components (Nogueira *et al.,* 2000). As CP and NDF concentrations in diets are the most important factors affecting DMI, Singh and Oosting (1992) opined that roughage feeds containing less than 45% NDF are classified as high-quality, those with NDF value of 45 - 65% are medium, and those having more than 65% NDF are considered low-quality. High NDF value is a limiting factor to dry matter intake, as dry matter intake and NDF content are negatively correlated (Van Soest, 1994). Based on this, our result revealed that the cultivar of CJ forage used in this study is of medium quality considering the observed NDF value of 49.50 - 58.00%. In addition, the observed increase in NDF and ADF contents of the used CJ forage cultivar at 8-weeks compared to the first cut at 4-weeks corroborate with the

findings of Zinashi *et al.* (1995) that forage fibre content increases with increased cutting intervals which can be attributed to an increase in cell wall content as the plant mature, as well as fibre content increases as crude protein decreases (Olanite *et al.* 2006).

Our anti-nutrient content results varied significantly at different cutting ages. We observed tannin concentration of 0.74 – 0.87% which is liable plant protein in the rumen and consequently increases the supply of high-quality protein into the duodenum because it is much lower than the 5% toxic level at which goats may reject feed (McLeod, 1974). However, feed intake and apparent digestion of protein and carbohydrate are depressed when forage legumes contain high level of condensed tannins, (Bamikole *et al.,* 2004). Tannin is an anti-nutritional factor found in forage legumes which is known to be bitter and form high polyphenol complex with protein thereby making it unavailable in the diet (Nupo *et al.,* 2013), thus can be used as a natural additive in ruminants' diet since forages or feeds containing tannin can enhance protein complex formation in the rumen (Barry and McNabb, 1999) which reduced rumen protein digestibility and improved the protein availability and digestion at the ruminants' lower gut (Sanusi *et al.,* 2013). Oxalate in this present study was low (0.01-0.02%). It has been reported that 20 g/kg oxalate can be lethal to chickens (Acamovic *et al.,* 2004). Oxalate has been shown to deplete the calcium reserve, but this browse species was found to contain reasonable amount of calcium, magnesium and phosphorus (Akinsoyinu and Onwuka, 1988). Calcium and carbon are also released from hydrolysis of calcium oxalate, some of which will be either absorbed or excreted by the ruminant animals. With calcium absorption rate of ruminant put at 31% (Haenlein, 1987) and P at 4% absorption (Adeloye and Akinsoyinu, 1985) reasonable amount of the calcium and phosphorus intake will be lost via feaces .and urine to the soil.

Our result revealed a saponin value range of 0.46 - 0.72% which is believed to pose no problem to the animals, and the presence of saponin in feedstuffs had been shown to be defaunating agents (Teferedegne, 2000) and capable of reducing methane production (Babayemi *et al.* 2004). Cheeke (1971) reported that saponin have effect on erythrocyte haemolysis, reduction of blood and liver cholesterol, depression of growth rate, bloat (ruminant) inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absorption. Moreso, saponin have been reported to alter cell wall permeability resulting in production of toxic effect when ingested (Belmar *et al.,* 1999), and can confer bitter and astringent characteristics causing reduced forage palatability (Enujiugwa *et al.,* 2014). Phytase is an acid phosphohydrolase that catalyzes the hydrolysis of phosphate from phytic acid to inorganic phosphate and myo-inositol phosphate derivatives (Roopesh *et al.,* 2006). However, phytate has negative effect in nutrition by chelating essential element such as Ca, Fe, Mg and Zn, and contribute to mineral deficiency in people who relies on some food rich in phytate for their mineral intake (Hurrell, 2003). Nevertheless phytate, a phytonutrient, has an antioxidant effect as it is reported to prevent colon cancer by reducing oxidative stress in the lumen of the intestinal tract due to its mineral binding properties (Vucenik and Shamsuddin, 2003). Trypsin inhibitor, a protease inhibitor commonly encountered anti-nutritional factor of plant origin, has been reported in raw legume seeds, and found to be partly responsible for the growth retarding property of legumes. The retardation has been attributed to the protein digestion inhibition, but there is evidence of pancreatic hyperactivity causing increased trypsin production leading to loss of lysine and methionine (Donald, 1995). Trypsin inhibitor has been implicated in reducing digestibility of protein and in pancreatic hypertrophy (Liener, 1994).

The mineral contents of all CJ foliage at different cutting regimes gave the idea of

possibility of using it as a complete diet for ruminant animals. The phosphorus content of all CJ foliage (0.38 – 0.39%) were higher compared to NRC recommendation of 0.15%, and were consistently above the 0.2% level required to satisfy livestock dietary maintenance requirement (NRC, 1985). Phosphorus plays an important role in carbohydrate, lipid, and amino acid metabolism as well as are required for blood coagulation (Thromboplastin), bone calcification, optimum growth rate (Underwood, 1981). The calcium value (0.24 – 0.27%) obtained in this current study of all CJ foliage at different cutting ages was higher than 0.09% reported for *Canavalia ensiformi* leaves by Akinlade *et al.* (2007). Our observed Ca values were considered adequate for the optimum performance of ruminants as it helps in the regulation of muscle as well as the development of bones and teeth in weaners and foetus, although this would not meet up the theoretical calcium requirement of 0.30% recommended in diet of ruminants (ARC, 1980). The magnesium content of CJ foliage at three stages of growth (0.27%) were higher than 0.20% reported by Akinlade *et al*. (2007). The higher Mg level (0.28%) found in this study was higher than 0.12 - 0.20% recommended in the ruminant's diet by NRC (1985). Magnesium is an important mineral element in connection with its role in circulatory disease such as ischemic heart disease and calcium metabolism (Ishida *et al.*, 2000).

The Iron content of CJ foliage at different cutting regimes (190.32 - 191.25 mg/kg) were higher compared to 181.65 mg/kg found in *Psophocarpus tetragonolobus* leaves by Alalade *et al.* (2016), 50 mg/kg required by ruminant animals for optimal performance as well as above 30-50 mg/kg considered to be critical Fe level in animal tissue (Khan *et al.* 2005). Thus, indicating that foliage of this cultivar is good source of dietary iron, which is an important element in the diets of pregnant animals, nursing animals, and infants (Anonymous, 1980). The concentration of zinc in the plant foliage samples was found to be 50.68- 51.72 mg/kg which is higher than 44.3 mg/kg recorded for *Clitoria ternatea* leaves by Swati and Varsha (2014). It has been suggested that 30 mg/kg zinc is a critical dietary level, although it has been recommended that concentration of 12-20 mg/kg are adequate for growing ruminants (Melaku 2005). Zinc is said to be an essential trace element for protein and nucleic acid synthesis and normal body development during period of rapid growth such as infancy and recovery from illness (Barry and Duncan, 1984).

CONCLUSION

The observed result of nutrients composition of *Cajanus cajan* foliage (CJ) revealed that the diets will be useful sources of protein, minerals and energy in ruminant feeding. The presence of tannin and saponin below toxic level in the diet indicates the tendency to suppress methanogenesis and improve the availability of protein and minerals to ruminant at the lower gut. The enhanced values of crude protein (CP), dry matter (DM), and non-fibre carbohydrate (NFC) connote the potential of the foliage to meet nutrient requirements of small ruminant in tropical regions particularly during the dry season.

RECOMMENDATION

The study revealed that *Cajanus cajan* foliage can be recommended as a reliable leguminous browse plant supplement for ruminant animals, thereby alleviating the crisis of poor-quality feed and feeding of ruminant animals during the dry season. Higher content of protein combined with relatively low levels of anti-nutrients would make them good supplements to poor quality roughage diets, especially during the dry season when the quality of available pasture-based feed resources for ruminant animals is poor.

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