



Nutrient and Anti-Nutritional Factor Contents of Four Cultivars of *Mucuna Pruriens* Leaves

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Abstract

Mucuna pruriens is a valuable fodder and feed supplement legumes for ruminants. The *Mucuna pruriens* leaves samples were harvested from Oyo State College of Agricultural and Technology, Igboora pasture plot. The *Mucuna pruriens* leaves were analyzed for proximate, anti-nutrient and mineral composition of four accessions of *Mucuna pruriens* leaves. The experimental plots were laid in randomized complete block design. The Four (4) different cultivars of *Mucuna pruriens* used in the study were Tmp-1, Tmp-3, Tmp-5 and Tmp-12. Significant differences ($P < 0.05$) were observed among the four accessions with respect of dry matter (DM), crude protein (CP), and crude fiber (CF). The proximate analysis of *Mucuna pruriens* leaves show that it contains crude protein ranging between (16.80-18.59%), ether extract (4.12-4.26%), crude fiber (17.96-20.01%), ash (9.28-10.16%) and Dry matter (64.50-69.10%). Significant ($P < 0.05$) differences were observed in the fiber fraction among the four cultivars of *Mucuna pruriens*. The mineral analysis of *Mucuna pruriens* leaves showed that it contain the following essential minerals. Phosphorus (0.36-0.38%) Potassium (0.82-0.92%), Calcium (0.23-0.25%), Magnesium (0.28-0.29%), Iron (188.50-189.70 mg/kg) and Zinc (54.93-53.40 mg/kg). The anti-nutrient content considered among the four cultivars of *Mucuna pruriens* leaves were Saponin, Phytate, Oxalate, Trypsin inhibitor and Hydrogen cyanide. The study showed that *Mucuna pruriens* had substantive amount of nutrients and therefore, could serve as potential supplements for ruminants in Nigeria.

Keywords: *Mucuna pruriens*, nutrient, anti-nutrients, minerals, ruminants

Introduction

Velvet bean (*Mucuna pruriens*) is a tropically adapted legume cover crop that is highly attractive for sustainable farming systems around the world because it is an excellent source of green manure and a promising protein supplement. *M. pruriens* seeds contain 250–350 g crude protein (CP)/kg dry matter (DM) and the whole plant contains 140–190 g CP/kg DM (Nyambati, 2002). Recent studies have shown that *Mucuna* foliage hay is a good CP supplement for ruminants fed low quality forages such as maize stover and tropical grass hays (Nyambati and Sollenberger, 2003). However, *M. pruriens* seeds contain secondary compounds such as tannins (3–61 g/kg DM that can reduce DM digestibility and CP utilization (Makkar et al., 1988, Mangan, 1988). *Mucuna* also contains l-dopa (23–92 g/kg DM), which can be toxic to monogastrics (Szabo and Tebbett, 2002, Del Carmen et al., 2002). Adverse symptoms of ingesting *Mucuna* l-dopa include weight loss, reduced feed intake and feed conversion efficiency in monogastrics (Carew et al., 2002, Del Carmen et al., 2002), and diarrhea, skin lesions, vomiting and confusion in humans

(Szabo and Tebbett, 2002). Because l-dopa is degraded in the rumen (Chikagwa-Malunga et al., 2008a), such effects have not been reported in ruminants (Sandoval-Castro et al., 2003), but the microbes that degrade l-dopa have not been identified. Although maturity influences the nutritive value and secondary compound concentration in seeds, leaves, stems and pods of *Mucuna* (Maasdorp and Titterton, 1997), little is known on the maturity stage at which the nutritive value of *M. pruriens* is optimized. *Mucuna* beans are normally harvested between 110 and 270 days after planting (DAP; Eilitta et al., 2002), depending on location, but when grown for forage, plants are usually harvested between 90 and 120 DAP (Eilitta et al., 2002). Maasdorp and Titterton (1997) reported peak *Mucuna* forage production at 112 DAP, but Ravindran (1988) found that optimum yield occurred at 90 DAP. Information about maturity-related changes in concentrations of key minerals, amino acids (AA) and secondary compounds in *M. pruriens* is particularly lacking.

Mucuna pruriens is a valuable fodder and feed legume. Vines foliage can be used as pasture



hay or silage for ruminant while pod, as seed can be grind into a meal and fed to both ruminant and monogastric (Eilittä and Carsky 2003). Also *Mucuna* leaves contain 15-20% of crude protein (Sidibé-Anago *et al* 2009), but has a high potential as an energy and protein source in livestock feed. The present study was carried out to determine nutrient and anti-nutrient content of four cultivars of *Mucuna pruriens* leaves.

Materials and Methods

Experimental Site

The experiment was carried out at Teaching and Research farm of Oyo State College of Agriculture and Technology, Igboora.

Experimental Layout and Management Practices

The area of land use was 256m². The land was cleared, stumped and leveled manually to obtain a clean seed bed. Four (4) different cultivars of *Mucuna pruriens* (Tmp-1, Tmp-3, Tmp-5 and Tmp-12) procured from the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria were used for the study. They were sown on plot measured 3m x 3m with space of 1m between plots and two treated seed of *Mucuna pruriens* were planted per hole with a space of 50cm x 50cm within the plot. Before flowering, 10 weeks of age, the herbage sample was taken from the plots pooled and mixed; one representative sub sample was taken per accession and dried.

Chemical Analysis

Collected *Mucuna* sample were oven dried at 60°C for 48hrs and ground. The finely ground samples of four cultivars of *Mucuna pruriens* used were analyzed for nitrogen (N) content which was determined by Kjeldal method and CP was calculated as Nx6.25 (AOAC, 1995). Crude fibre estimates were obtained from the loss in weight on ignition of dried residue

following the digestion of fat free sample with 1.25% each of sulphuric acid and sodium hydroxide solution under specified condition. Acid detergent fiber (ADF), Acid detergent lignin (ADL) and Neutral detergent fiber (NDF) were analyzed by method of Van Soest *et al.* (1991). While gross energy was determined use the adiabatic oxygen bomb calorimeter technique.

Mineral Analysis

The mineral elements were analyzed using Walinga *et al.* (1989) method; 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 (ANOVA). Where significant differences occurred, the means were separated using Duncan multiple range F-test of the (17) option.

Results and discussion

Results

Table 1 showed the proximate composition of four cultivars of *Mucuna pruriens* leaves (Tmp-1, Tmp-3, Tmp-5 and Tmp-12). Significant difference ($P < 0.05$) were observed among the four accession with respect of Dry matter (DM), Crude protein (CP), and Crude fiber (CF). Tmp-3 had the highest dry matter (69.10%) with Tmp-1 recording the lowest value (65.38%). Tmp-5 had the highest value of crude protein (18.59%) while similarities were recorded for the other cultivars. There were no significant difference ($P > 0.05$) were noticed in both Ether extract (EE) and Ash.

Table 1: Proximate Composition of Four Accession *Mucuna pruriens* Leaves

Parameters (%)	Dry Matter	Crude Protein	Ether Extract	Crude Fibre	ASH
<i>Mucuna pruriens</i> (Tmp-1)	65.38 ^b	16.80 ^b	4.12	20.01 ^a	10.16
<i>Mucuna pruriens</i> (Tmp-3)	69.10 ^a	17.49 ^b	4.18	19.25 ^a	9.28
<i>Mucuna pruriens</i> (Tmp-5)	64.50 ^b	18.59 ^a	4.26	19.89 ^a	9.58
<i>Mucuna pruriens</i> (Tmp-12)	68.30 ^a	17.67 ^b	4.14	17.96 ^b	9.34
SEM	0.32	0.17	0.15	0.17	0.16

^{a b c d} Means on the same row with different superscript are significantly different ($P < 0.05$).



According to Mowlem (1992), dry matter is the portion of the feed material that contains the nutrients. The CP of all the accession were high and well above the 15% level considered adequate to meet requirement of lactating and growth in dairy cow (Omokanye, 2001). The higher values of crude protein observed in the four accession of *Mucuna pruriens* in the present study is higher than 7% CP requirement for ruminant animals which will provide ammonia requirement by the rumen micro-organism to support optimum microbial activity. Ether extract contents of four accessions of *Mucuna pruriens* ranged (4.12-

4.26%). The value recorded for ether extract observed to be above 4.10% ether extract recorded by Alalade *et al.* (2016) for *Psophocarpus tetragonolobus* leaves. The Ether extract contents of all cultivars in this study fell within the range of 4-10% which is recommended by Campbell *et al.* (2016) for ruminants' animal. The value of ether extract in the all accessions in an indicator of higher energy level for the animal (Babayemi and Bamikole, 2006) and this is a major form of energy stored in plant which is been utilized by the animal for body maintenance and production.

Table 2: Fibre Fraction Present in Four Accession of *Mucuna pruriens* Leaves

Parameters (%)	NDF	ADF	ADL
<i>Mucuna pruriens</i> (Tmp-1)	35.26 ^a	23.30 ^a	15.72 ^a
<i>Mucuna pruriens</i> (Tmp-3)	34.02 ^b	23.10 ^a	15.10 ^a
<i>Mucuna pruriens</i> (Tmp-5)	34.16 ^b	21.25 ^b	14.36 ^b
<i>Mucuna pruriens</i> (Tmp-12)	34.51 ^b	21.44 ^b	14.41 ^b
SEM	0.61	0.68	0.39

^{a b c d} Means on the same row with different superscript are significantly different ($P < 0.05$). NDF: Neutral Detergent Fibre, ADF: Acid Detergent Fibre, ADL: Acid Detergent Lignin

Table 2 revealed the fiber fraction present in four accessions of *Mucuna pruriens* leaves. Significant ($P < 0.05$) differences were observed in the fiber fraction among the four accessions of *Mucuna pruriens*. Higher fiber content was obtained on both *Mucuna pruriens* Tmp-1 for NDF (35.26%), ADF (23.30%), ADL (15.72%) and *Mucuna pruriens* Tmp-3 for NDF (34.02%), ADF (23.10%) and ADL (15.10%) respectively, compared to its counterparts. The crude fiber content of four accessions of *Mucuna pruriens* leaves ranged from (17.96-20.01%) which was higher compared with 14.80% of *Mucuna utilis* leaves reported by Ujowundu *et al.* (2010) but below (23.8%) for *Stylosanthes hamata* (Akinlade *et al.*, 2004). The crude fiber contents of all accessions fell within the (15-20%) recommended for improved intake and production in finishing ruminant (Buxton, 1996). The crude fiber content value of all accessions of *Mucuna pruriens* leaves reported will aid digestion and absorption of water from the body and bulk stool (Ayoola and Adeyeye, 2000). Selected *Mucuna pruriens* leaves used in this study contained these values ranges (34.02-35.26%) for NDF, (21.25-23.30%) for ADF, and (14.41- 15.72%) for ADL. The fiber fraction concentration of the tested fodder falls within the range reported by Njidda *et al.* (2010a). Messner *et al.* (1991) observed that NDF level of forage above 65% can limit feed intake. However, it is interesting to note that

there is no accession of *Mucuna pruriens* leaves of the present study that is up to that threshold level. The values recorded for NDF is relatively low in concentration for all accessions of *Mucuna pruriens* leaves. Hoffman *et al.* (2001) reported that forages, which contain 40% NDF or less, are generally of good quality. The National Research Council NRC (2001) recommends dairy cow diets should contain approximately 30%–35% NDF in the DM. This range represents a balance between increasing voluntary intake of DM and milk production without compromising milk fat (Arelovic *et al.*, 2008). This low level of NDF can be difficult to achieve in subtropical/tropical areas due to the predominance of high NDF forages and so 40% is considered a more achievable target in subtropical grazing systems. The ADF content refers to the cell wall portion of the forage. This portion consists of cellulose and lignin. As the ADF increases, the digestibility of the forage usually decreases (Albayrak *et al.*, 2012), causing consumption of the forage by animal to reduce (Aydin *et al.*, 2010). In this present study ADF content ranged between (21.25-23.30%) for all accessions of *Mucuna pruriens* leaves. The digestibility of feed is related to the fiber because the indigestibility portion has a proportion of ADF, the higher the value of ADF the lower the feed digestibility (Costa *et al.*, 2005). Nussio *et al.* (1998) reported that forage with ADF content around 40% or more shows



low intake and digestibility. This study showed that ADF content was below 40%, indicating that the cultivars are good option for providing quality feed at critical period with good digestibility. The lignin content for all accessions of *Mucuna pruriens* leaves is moderate as it is known that lignin is a component of the cell wall and deposited as part of the cell wall thicken process.

Table 3 presented the mineral composition of four accessions of *Mucuna pruriens* leaves. Significant differences ($P < 0.05$) were observed among the four accessions of *Mucuna pruriens* leaves. The mineral contents determined were Phosphorus (P; %), Potassium (K; %), Calcium (Ca; %), Magnesium (Mg; %), Iron (Fe; mg/kg) and Zinc (Zn; mg/kg). The concentration of Phosphorus among the four accessions of *Mucuna pruriens* leaves varied from 0.36-0.38%. The highest value of Phosphorus was

noted in Tmp-12 (0.38%) and lowest values were observed in both Tmp-1 and Tmp-3 (0.36%). According to result, the concentrations of Ca were higher and similar in values for Tmp-5 and Tmp-12 but least value was observed in Tmp-3 (0.23%). The concentration of Fe (mg/kg) was varying among the four accessions of *Mucuna pruriens* leaves (188.50-189.70 mg/kg). Maximum (Fe mg/kg) contents were observed in both Tmp-3 and Tmp-5 (189.70 mg/kg) and low values were observed in both Tmp-1 (188.57 mg/kg) and Tmp-12 (188.50 mg/kg). Zinc content of *Mucuna pruriens* leaves of four accessions was notable. Higher values were observed in both Tmp-5 (54.90 mg/kg) and Tmp-12 (54.96 mg/kg). While lower values were obtainable in both Tmp-1 (53.40 mg/kg) and Tmp-3 (53.46 mg/kg). No significant different ($P > 0.05$) was observed among the four accession of *Mucuna pruriens* leaves for Magnesium (Mg %).

Table 3: Mineral Composition of Four Accession of *Mucuna pruriens* Leaves

Parameters (%)	P%	K%	Ca%	Mg%	Fe (mg/kg)	Zn (mg/kg)
<i>Mucuna pruriens</i> (Tmp-1)	0.36 ^b	0.92 ^a	0.24 ^b	0.28	188.58 ^b	53.40 ^b
<i>Mucuna pruriens</i> (Tmp-3)	0.36 ^b	0.82 ^b	0.23 ^b	0.28	189.70 ^a	53.46 ^b
<i>Mucuna pruriens</i> (Tmp-5)	0.38 ^a	0.92 ^a	0.25 ^a	0.28	189.70 ^a	54.93 ^a
<i>Mucuna pruriens</i> (Tmp-12)	0.38 ^a	0.92 ^a	0.25 ^a	0.29	188.50 ^b	54.96 ^a
SEM	0.003	0.004	0.003	0.003	0.33	0.12

^{a b c d} Means on the same row with different superscript are significantly different ($P < 0.05$).

The mineral content of all cultivars give the idea that the plant could be used for any feeding trial purpose for ruminants animals. The phosphorus content of all accessions of *Mucuna pruriens* leaves (0.38%) was higher compared to NRC recommended 0.15% for phosphorus (NRC, 2001). The level of phosphorus in all accessions of *Mucuna pruriens* leaves was consistently above the 0.2% level which could satisfy livestock dietary maintenance requirement (NRC, 2001). Phosphorus plays an important role in carbohydrate, lipid, amino acid and metabolism. Phosphorus is required for blood coagulation (Thromboplastin), satisfactory bone calcification, optimum grow rate and optimum utilization of birth calcium and phosphorus (Underwood, 1981). The value of Potassium (K%) content in all accessions of *Mucuna pruriens* leaves was higher than value reported by Akinlade *et al.* (2007) for *Canavalia ensiformis* leaves (0.46%). This present investigation showed that the level of K in all the accessions of *Mucuna pruriens* leaves was

over 0.18% recommended for grazing animals (McDowell 1985). However, it has been suggested that requirement with high producing may require K level above (1.0%). Potassium helps to maintain body weight and regulate water and electrolyte balance in the blood and tissue. The Calcium (Ca) content of all accession of *Mucuna pruriens* leaves (0.2%) was higher than (0.09%) observed in *Canavalia ensiformis* leaves by Akinlade *et al.* (2007). The forage Ca values found in this study was considered adequate for the optimum performance of ruminants. Calcium helps in the regulation of muscle concentration required by kid weaners and teeth development (Margaret and Vickery 1997). The least value (0.28%) of Magnesium content of the four accessions of *Mucuna pruriens* leaves was higher than 0.20% reported for *Canavalia ensiformis* leaves reported by Akinlade *et al.* (2007). The higher forage Mg level (0.29%) found in this study was above 0.12-0.20% of the requirement of the ruminant's diet suggested by NRC (2001).



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 (Fe mg/kg) content of all accessions of *Mucuna pruriens* ranged (188.50-189.70 mg/kg) and higher compared to 181.65mg/kg observed in Iron content of *Psophocarpus tetragonolobus* leaves. The values recorded for iron in *Mucuna pruriens* leaves content in the study was above (50 mg/kg), which is sufficient for the requirement of ruminant animals for optimal performance (Khan *et al.*, 2005). This implies that *Mucuna pruriens* leaves are good source of dietary iron and iron is an important element in the diets of pregnant animals, nursing animals, infant and other related disease, (Anonymous, 1980). The concentration of Zinc in the plant forage samples was determined to be (53.40-54.76 mg/kg) and higher than 44.3 mg/kg recorded for *Clitoria ternatea* leaves. It has been suggested that 30mg/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 *et al.*, 2005).

Anti-nutrient factor was observed among the four accessions of *Mucuna pruriens* in table 4. The anti-nutrient content considered among the four accessions of *Mucuna pruriens* leaves are Saponin, Phytate, Oxalate, Trypsin inhibitor and Hydrogen cyanide. Saponin concentration (%) ranged from 0.42-0.68%. The highest value of Saponin content was observed in *Mucuna pruriens* Tmp-5 (0.68%) while the least value was obtained from *Mucuna pruriens* Tmp-12 (0.42%). The oxalate (%) was considerably

varying among the four accessions of *Mucuna pruriens* from 0.40 - 0.51%. Highest oxalate content was noted in Tmp-5 (0.51%) and lowest values (0.40%) were observed in both Tmp-3 and Tmp-12 an. No significant difference ($P>0.05$) was observed among four accessions of *Mucuna pruriens*. For Tannin content, the highest values were observed in *cultivar* Tmp-5 for both Trypsin inhibitor (25.67 TIU/mg) and HCN (3.28mg/kg). The tannin ranged from (0.04-0.05%). This tannin level is much lower than the level of 5% at which goats may reject feed (McLeod 1974). Tannin at this level protects liable plant protein in the rumen and consequently increases the supply of high quality protein in to the duodenum (McLeod, 1974). However, when forage legume contains high level of condensed tannins, intake and apparent digestion of protein and carbohydrate are depressed (Bamikole *et al.*, 2004). Oxalate in this present study was low (0.40-0.51%). It was reported that 20g/kg oxalate can be lethal to chicken (Acamovic *et al.* 2004). Oxalate has been shown to deplete the calcium reserve, but these legume species were found to contain amount of calcium, magnesium and phosphorus (Akinsoyinu and Onwuka, 1988). The Saponin value ranged from 0.42%-0.68%. Feedstuffs containing saponin 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

Table 4: Anti-nutrient Present in Four Accession of *Mucuna pruriens* Leaves

Parameters (%)	Saponin %	Oxalate %	Phytate %	Tannin %	Trypsin Inhibitor (TIU/mg)	HCN (Mg/kg)
<i>Mucuna pruriens</i> (Tmp-1)	0.47 ^b	0.44 ^b	0.64 ^b	0.05	21.01 ^b	2.91 ^b
<i>Mucuna pruriens</i> (Tmp-3)	0.47 ^b	0.40 ^b	0.64 ^b	0.04	20.78 ^b	2.74 ^b
<i>Mucuna pruriens</i> (Tmp-5)	0.68 ^a	0.51 ^a	0.76 ^a	0.05	25.67 ^a	3.28 ^a
<i>Mucuna pruriens</i> (Tmp-12)	0.42 ^b	0.40 ^b	0.63 ^b	0.04	21.51 ^b	2.88 ^b
SEM	0.015	0.001	0.008	0.003	0.29	0.03

^{a b c d} Means on the same row with different superscript are significantly different ($P < 0.05$).

The Phytate content of *Mucuna pruriens* as shown in table 4 is (0.63-0.76%). However, the value is lower than 25mg/100g reported by Amata (2010) for leaves of *Myrianthus arboreus*. The negative effect of phytate in nutrition is the chelating of certain essential element such as Ca, Fe, Mg and Zinc; this contributes to mineral deficiency in people whose feed on some food rich in phytate for their mineral intake (Hurrell 2003). The Hydrogen cyanide (HCN) contents of the browse species examined were equally low. The HCN ranged from 2.74mg/kg-2.91 mg/kg. The lethal dose of HCN for cattle and sheep is 2.0-4.0mg per kg body weight. The lethal dose for cyanogen would be 10-20 times greater because



the HCN comprised 5-10% of their molecular weight (Conn, 1979). The value of Trypsin inhibitor content was 20.78-25.67mg/kg for *Mucuna pruriens* leaves. Trypsin inhibitors are protease inhibitor occurring in raw legume seeds. Protease inhibitors are the most commonly encountered class of anti-nutritional factors of plant origin. This trypsin inhibitor has been reported to be partly responsible for the growth retarding property of legumes

Conclusion and Recommendation

From the results obtained from this research work, it could be concluded that *Mucuna pruriens* leaves have better nutrient value due to high content of protein and mineral in the leaves which are of great benefit to ruminant animals with relative low levels of anti-nutrient factors. Due to low quality of nutrient in grass plant, *Mucuna pruriens* leaves can be recommended as supplement (leguminous plant) for ruminant animal since it is highly nutrients, have low anti-nutrient value and can be made available all year round.

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