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Feeding Values of Mixtures of Grass with Some Processed Nitrogen Fixing Multipurpose Tree Species at Varying Proportions

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Abstract

The nutritive value of mixtures of *Megathyrsus maximus* (MM) and leaf protein concentrates of *Albizia lebbeck* (AL) and *Leucaena leucocephala* (LL) the nitrogen-fixing multipurpose tree species (NFTS) were evaluated in this study. The treatment consists of *M. maximus* and each of the multipurpose tree species leaf protein concentrates – MM100, MM90:AL10, MM80:AL20, MM70:AL30, MM90:LL10, MM80:LL20 and MM70:LL30 respectively. Results revealed an increase (P<0.05) in CP with an increase in leaf protein concentrate inclusion while there was a decline (P<0.05) in NDF contents of the mixtures with a decrease in grass inclusion. The highest CP values (P<0.05) were recorded in treatment MM85:AL15 and MM85:LL15 respectively and the lowest value of CP was recorded in MM100. The highest significant (P<0.05) value of NDF was recorded for MM100 while treatments MM90:LL10 and MM100 had the highest values of ADF. The DMD values of all the mixtures of the grass and leaf protein concentrates had higher (P<0.05) values compared with sole grass (MM100) which recorded the least value. Treatment MM85:LL15 had the highest significant (P<0.05) mean value of OM. The DMI, RFV and CC were significantly (P<0.05) higher in treatments MM85:AL15, MM90:LL10 and M85:LL15 respectively. The study concluded that nutrients and digestibility of mixtures of grass and leaf protein concentrates of NFTS investigated were higher than in the sole grass with mixtures of *M. maximus* 85: *A. lebbeck* 15 and *M. maximus* 85: *L. leucocephala* 15 having the highest nutritive value.

Keywords: Comparative evaluation, grass, tree leaves; leaf protein concentrate, nutritive value

Introduction

Lowered ruminant production, which was reflected in the loss of weight, low birth weights, lowered immunity high mortality rate of animals has been attributed to the unavailability of good nutritive quality and quantity feeds (Fajemisin *et al.*, 2010). This has resulted in the persistent shortage in the availability of animal protein in humans' diets which has negative effects on their growth, performance, intelligence and defence against avoidable diseases.

Aside from the consumption of animal products, ruminants also serve as a source of income for farmers. In tropical Africa, the majority of ruminants rely on pasture plants for their nutrition which are mainly from natural pastures and which decline in quality during the dry season (Aderinola *et al.*, 2007). This has led to a reduction in the nutrient composition of limited forages that are available during the dry season, resulting in problems for livestock survival (Amole *et al.*, 2011). In order to improve the productivity of ruminants and the availability of animal protein intake by humans, it, therefore, becomes necessary to supplement the seasonal fluctuation in the quality of natural forages with alternative feeds.

The use of browse plants particularly those based on high-yielding nutritive values has been advocated as one of the ways of achieving year-round quality feeds for ruminants because they supply nutrients, particularly Nitrogen (N). They provide essential nutrients to the rumen microbial population and also satisfy the animal's requirement which increases the efficiency of feed utilization (Elliot and McMeniman, 1987).

However, due to seasonal effects, the browse plants have been found to respond to the seasonal variations vis-à-vis changes in colouration from green to yellow, and shedding of leaves which eventually affect the yield, quality and availability to animals (Packham *et al.*, 1992). Therefore, there is a need to conserve the quality of the browse plants before the onset of unfavourable weather situations to enhance the quality of feed available for animals during the dry season. Oresegun *et al.* (2016) reported the production of leaf protein concentrate which is the separation of indigestible fibre and soluble anti-nutrients in the fresh leaves of green plants in order to have more protein, vitamins and minerals contents. It has therefore become necessary to provide suitable and affordable feed rich in both protein and carbohydrate, especially during the dry season when nutrients from grazing become qualitatively and quantitatively limited for grazing livestock.

This study therefore assessed the nutritive quality in the composite mixtures of *Megathyrsus maximus* and leaf protein concentrate of nitrogen-fixing multipurpose trees.

Materials and methods

Experimental site

The experiment was carried out at the Pasture and Range Management (PRM) experimental unit of the College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The site lies within the latitude 7°10' N and longitude 3°2' E. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with a mean annual rainfall of about 1037 mm and a temperature of about 34.7°C (Google Maps, 2022).

Collection and processing of plant materials

Megathyrsus maximus grass was planted and fertilized with poultry layer manure at 120 kg N/ha. The grass was harvested at 6^{th} week from 15 cm above ground level. The harvested grass was dried and milled.

Leaves of two nitrogen-fixing multipurpose tree species (*Albizia lebbeck* and *Leucaena leucocephala*) were collected from the multipurpose tree arboretum PRM unit. The leaves were separated from the stems and rinsed in clean water.

The leaves of the browse plants that had been separated from the stems were milled in an electric grinding machine to extract the juice. Water was poured at intervals to allow the free flow of the leaves from the grinder. The ground samples were poured into four layers of cheesecloth and squeezed manually with hand in other to extract the juice. Water was added to the content in the cheesecloth and squeezed until the juice coming from the cheesecloth appeared colourless. The extracted juice was heated at 90 °C for 10 minutes to coagulate the leaf protein concentrate. As the protein coagulates on top of the pot on fire, it is scooped from it until all the coagulates are removed. The coagulates obtained in the form of paste were air-dried at room temperature. This was the leaf protein concentrate.

The leaf protein concentrates of each browse tree and milled grass were mixed on dry matter weight at different proportions. The treatments were as follows:

M. maximus 95: *Albizia lebbeck* 5 (M95:AL5)
M. maximus 90: *A. lebbeck* 10 (M90:AL10)
M. maximus 85: *A. lebbeck* 15 (M85:AL15)
M. maximus 95: *Leucaena leucocephala* 5 (M95:LL5)
M. maximus 90: *L. leucocephala* 10 (M90:LL10)
M. maximus 85: *L. leucocephala* 15 (M85:LL15)
M. maximus 100 (M100)

Experimental design

The experiment was arranged in a completely randomized design with seven different treatments replicated three times.

Data collection

Chemical composition

The mixtures from each treatment were milled and allowed to pass through a 1 mm sieve screen and were subjected to chemical analysis. The dry matter content (DM), crude protein (CP), ether extract (EE) and ash were determined according to AOAC (2000). The fibre fractions, neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Van Soest *et al.* (1991) procedure. Hemicellulose was estimated as the difference between NDF and ADF. The following formulas were used to calculate the chemical composition of the results.

Organic Matter = 100 – Ash (Lanyasunya *et al.*, 2007), Carbohydrate content – CHO (g kg^{-1} DM) = OM content – (CP + EE); Arieli *et al.* (1999). Where CHO = Total carbohydrates, Dry matter digestibility – DMD (% DM) = 88.9-0.779x ADF (% DM), dry matter intake – DMI (% Bodyweight) = 120/NDF (% DM). Relative feed value = [(88.9 – (0.78 × ADF%)) × (120/NDF%)]/ 1.29 (Agric-facts, 2006), Cell contents are determined by subtracting NDF from 100 (Linn and Martin. 1999).

Statistical analysis

Data obtained from this experiment were analysed using a one-way analysis of variance option of the SPSS (IBM SPSS Statistics 23) software. Treatment means were statistically compared using Duncan's Multiple Range Test to identify differences between means and significant differences were declared if P<0.05.

Results and discussion

The proximate composition and fibre fractions of mixtures of *Megathyrsus maximus* and leaf protein concentrate of nitrogen-fixing multipurpose tree leaves at varying proportions were significantly different (P<0.05) from one another (Table 1). Significant highest values of EE were recorded in all treatments aside from MM95: AL5 and MM100. Highest CP values (P<0.05) were recorded in treatment MM85: AL15 and MM85:LL15 respectively and the lowest value of CP was recorded in MM100. The highest significant (P<0.05) value of NDF was recorded for MM100 while treatments MM90: LL10 and MM100 had the highest values of ADF.

The proximate and fibre composition of the grass with the inclusion of leaf protein concentrate (LPC) indicated their potential as feed resources. For example, the CP content of the mixtures is higher than 7% CP required by ruminant animals. The lower CP content in sole grass validates the reason why LPC should be included to augment the quality of the sole grass (Njoka-Njiru *et al.,* 2006). The ruminant animal needs feeds that can supply the required CP that is needed for their body to function normally. This study showed incorporation of leaf protein concentrates into grass improved the quality which will supply sufficient nutrients required by the animals than when feeding sole grasses (Salunkhe *et al*., 1990; Barry & McNabb, 1999). As the level of leaf protein concentrates increased in the mixtures, the CP contents in the mixture were enhanced. The CP levels in mixtures of grass and leaf protein concentrates in the current study were higher than the range of 110 - 130 g kg^{-1} DM which is considered adequate for the maintenance and growth of small ruminants (NRC, 1984).

Saidu and Adunbarin, (1998) reported a 6.63% for ash value which falls with the value in this study. Higher ash content values in this study indicate that they were good sources of mineral elements (Kitabe & Tamir, 2005).

The moderate fibre contents of grass incorporated with some percentage of leaf protein concentrates suggests their high nutritive value since fibre plays a significant role in voluntary intake and degradation by rumen microbes in ruminants. The range of hemicellulose concentration shows that the mixtures have the potential to support rumen contraction and relaxation, proper rumen function and promote dietary efficiency. Kumar *et al*. (2021) opined that the higher the hemicellulose fraction, the higher the feed value.

Table 1: Proximate composition and fibre fractions of mixtures of *Megathyrsus maximus* and leaf protein concentrate of nitrogen-fixing multipurpose trees at different proportions

Treatments	DM	EE	Ash	CP	NDF	ADF	HEMI
M95:AL5	91.50[ab]	15.50[b]	9.41[a]	14.44[c]	58.50[b]	32.50[bc]	26.00[ab]
M90:AL10	86.00[bc]	18.00[ab]	6.90[bc]	17.60[bc]	59.50[b]	29.50[c]	30.00[a]
M85:AL15	90.50[abc]	22.50[a]	6.44[c]	24.94[a]	50.50[c]	31.00[bc]	19.50[a]
M95:LL5	85.50[c]	17.50[ab]	8.37[ab]	16.63[bc]	58.00[b]	34.50[ab]	23.50[ab]
M90:LL10	90.00[c]	20.00[ab]	6.41[c]	15.17[c]	54.00[bc]	28.00[c]	26.00[ab]
M85:LL15	86.50[bc]	18.50[ab]	4.43[d]	20.42[ab]	50.33[c]	30.50[bc]	19.50[b]
M100	95.00[a]	7.50[c]	8.00[abc]	8.83[d]	68.50[a]	38.00[a]	30.50[a]
SEM	0.91	1.16	0.38	1.16	1.41	0.83	1.24
P-value	0.017	0.003	0.001	0.000	0.000	0.004	0.054

[a,b,c,d,] Means along the same column with different superscripts are significant ($P<0.05$), DM: Dry matter; EE: Ether extract; CP: Crude protein; NDF: Neutral detergent fibre; ADF: Acid detergent fibre; HEMI: Hemicellulose; SEM: Standard error of mean; (M95:AL5): *M. maximus* 95: *Albizia lebbeck* 5; (M90:AL10): *M. maximus* 90: *A. lebbeck* 10; (M85:AL15): *M. maximus* 85: *A. lebbeck* 15; (M95:LL5): *M. maximus* 95: *Leucaena leucocephala* 5; (M90:LL10): *M. maximus* 90: *L. leucocephala* 10; (M85:LL15): *M. maximus* 85: *L. leucocephala* 15; (M100): *M. maximus* 100

Singh and Oosting (1992) classified feeds with NDF contents between 45% and 65% as medium-quality feeds and those with NDF contents less than 45% as high-quality feeds. The NDF values of grass and LPC mixtures in this study were below the 65 g kg^{-1} DM suggested as the limit above which intake of tropical feeds by ruminants would be limited (Eastridge, 2006). Ruminants will require adequate fibre in their diets to aid rumen microorganisms to perform optimally. The low to moderate fibre contents of mixtures suggest their high nutritive value since fibre plays a significant role in voluntary intake and digestibility.

Table 2 shows the dry matter digestibility, dry matter intake and relative feed value of mixtures of *Megathyrsus maximus* and leaf protein concentrate of nitrogen-fixing multipurpose trees at different proportions. The DMD values of all the mixtures of the grass and leaf protein concentrates had higher (P<0.05) values compared with sole grass (MM100) which recorded the least value. Treatment MM85:LL15 has the highest significant (P<0.05) mean value of OM. The DMI, RFV and CC were significantly (P<0.05) higher in values in treatment MM85:AL15, MM90: LL10 and M85: LL15 respectively and the lowest significant (P<0.05) value of DMI, RFV and CC were recorded in M100, respectively. Higher CHO was recorded in treatment MM100 compared to treatment MM85: AL15 which recorded the least value.

The mean estimated DMD compared favourably with a mean value of 65.0 7% reported by Hanlin *et al*. (2011) for several tropical legumes in China. The values of RFV for all the treatments were within the range of 100 as the reference for hay except for MM95:LL5 and sole grass with lower RFV values. All the mixtures may be regarded as having high relative feed value for ruminants based on this ranking.

Isah *et al*. (2012) reported an increase in predicted dry matter intake (DMI) value, as NDF for browses investigated declined. A similar result was observed in this study. The implication of this is that, as the percentage of NDF increases in forage, animals will consume less (Schroeder, 1994). All the mixtures investigated in this study may be regarded as having high relative nutritive value for ruminant feeding.

Table 2: Dry matter digestibility, dry matter intake and relative feed value of mixtures of *M. maximus* and leaf protein concentrate of nitrogen-fixing multipurpose trees at different proportions

Treatments	OM	CHO	DMD	DMI	RFV	CC
				%		
M95:AL5	90.60^{d}	60.66^{b}	63.60^{ab}	2.05^{b}	101.35^{b}	41.50^{b}
M90:AL10	93.10^{bc}	58.04^{b}	65.92^{a}	2.02^{b}	103.15^{b}	40.50^{b}
M85:AL15	93.60^{b}	46.12^{c}	64.75^{ab}	2.39^{a}	119.82^{a}	49.50^{a}
M95:LL5	91.63^{cd}	57.50^{b}	62.02^{bc}	2.07^{b}	99.55^{b}	42.00^{b}
M90:LL10	93.60^{b}	58.42^{b}	67.10^{a}	2.24^{ab}	115.90^{ab}	46.00^{ab}
M85:LL15	95.60^{a}	56.55^{b}	65.14^{ab}	2.40^{a}	120.45^{a}	49.67^{a}
M100	92.00^{bcd}	75.66^{a}	59.30^{c}	1.75^{c}	80.53^{c}	31.50^{c}
SEM	0.38	1.95	0.65	0.52	3.14	1.42
P-value	0.001	0.000	0.004	0.000	0.000	0.000

[a,b,c,d,] Means along the same column with different superscripts are significant (P<0.05); OM: Organic matter; CHO: Carbohydrate; DMD: Dry matter digestibility; DMI: Dry matter intake; RFV, Relative feed value; CC, Cell content; SEM, Standard error of mean; (M95:AL5): *M. maximus* 95: *Albizia lebbeck* 5; (M90:AL10): *M. maximus* 90: *A. lebbeck* 10; (M85:AL15): *M. maximus* 85: *A. lebbeck* 15; (M95:LL5): *M. maximus* 95: *Leucaena leucocephala* 5; (M90:LL10): *M. maximus* 90: *L. leucocephala* 10; (M85:LL15): *M. maximus* 85: *L. leucocephala* 15; (M100): *M. maximus* 100.

Conclusion

With the relatively high nutrients and digestibility of mixtures of grass and leaf protein concentrates of browse plants investigated, it is suggested that LPCs can improve the nutritive contents of low-quality grasses that are available to animals, especially during the dry season. A mixture of grass with the highest proportion of leaf protein concentrates (*M. maximus* 85: *A. lebbeck* 15 and *M. maximus* 85: *L. leucocephala* 15) is therefore recommended for their high crude protein contents and digestibility.

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