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The Feeding Value of *Mangifera indica* and Its Effects on Crude Protein Metabolism and Energy Partitioning When Fed to Djallonke Sheep

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Target Audience: Animal Scientist, Nutritionists and Livestock farmers.

Abstract

Nine castrated West African Dwarf (WAD) sheep (Djallonke, 28.8 ± 4.2 kg BW), of about 24 months old were used to evaluate the feeding value of Mangifera indica (MI) leaves in a nitrogen and energy balance trial. Dried leaves of Mangifera indica were offered at two levels (25% and 50% of DMI) as supplement to a basal hay diet (Agrostis stolonifers grass species). Animals on diet with 50% MI showed a significantly (P<0.05) lower CP digestibility and negative N-balance than those on control and 25% MI diets. Sheep on 50% MI also showed a significantly (P<0.05) lower methane, metabolisability, q´ and digestible energy than the control and 25% MI diets. The results showed that dried leaves of Mangifera indica could be fed as supplement to Agrostis stolonifers grass hay at about 25% level of inclusion.

Key words: *Mangifera indica*; chemical composition; nitrogen balance; energy partitioning; sheep.

Description of Problem

Africa has an increasing demand for food by a continuously growing population. Livestock production in sub-Saharan Africa is essentially a low input adjunct attracting minimum investment in housing, feed and health-care. Out of the over 250 million head of domestic animals kept by smallholders and pastoralists in the sub-region, only 5% are kept on ranches (1).

Growing feed crops in the traditional farming systems in order to provide high quality forage for cattle, sheep and goats is uncommon because of competition for land and labour for human food production. This trend has aggravated the numerous constraints to livestock production in the region namely; those constraints relating to shortages in quantity and quality of feed during the long dry season.

Fodder trees and shrubs (Browse) which are part of the natural vegetation are accessible to the majority of smallholder farmers and could serve as useful protein supplements (2). The species used for feed, primarily leaves and fruits often have additional benefits when integrated into farming systems. These benefits include fuel and timber, increased soil fertility (leguminous species), control of wind erosion, shade for man and livestock, folk medicine, etc, (3). These species are referred to as multipurpose trees (MPTs).

The main advantage of MPTs as compared to alternative protein supplements, such as seed cakes (4), or molasses/urea blocks (5), is their ubiquitous distribution across all agroecological zones and they are of no practical cost. Since high quality feed is hardly available during the dry season, browse foliage is especially valuable

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because some species, such as various Acacia species, *Balanites aegyptiaca*, *Maerua crassifolia*, etc,. are very drought resistant and have high palatability (6,7). Preliminary screening of some browse trees (8,9) indicated that some of these browse trees are less suitable as protein supplement for small ruminant than might be expected from their high crude protein content Past research and development efforts have concentrated on a narrow range of the available MPTs, to the exclusion of some other valuable trees including *Mangifera indica*. This study was therefore undertaken to determine the feeding value of *Mangifera indica* and its effects on nitrogen balance and energy partitioning when fed to sheep

Materials and Methods

Feed description

Mangifera indica: This plant grows up to 15 metres tall. Its fruit called is the second most important fruit after banana in the tropics. Its origin is India. The leaves are fed to ruminants and the fruits are used against scorbot and heart diseases (7). Branches from mature *Mangifera indica*, a tree of the Anacardiaceae family, were collected from Cotonou/Benin in the months of November/ December. About 100 kg of the dried leaves were collected. The *M indica* leaves were packed in plastic containers after sun-drying and then transported to the University of Hohenheim, Germany for analysis and feeding trial.

Hay: The hay consisted primarily of cool-season grasses harvested in mid-October at the Hohenheim University. Grass species composition was predominantly redtop bend grass (*Agrostis stolonifers*).

Composition of Mangifera indica

Dried leaf samples were ground in a cutting mill to pass a 1mm mesh sieve for chemical analysis. N content was determined by the Kjeldahl method and for ash by burning at 550°C (10). Crude protein was calculated as 6.25xN. NDF, ADF, and ADL were determined as described by (11). The difference between NDF and ADF was designated as hemicellulose, and between ADF and ADL as cellulose. Samples of faeces were dried at 65 °C for 48 h, ground through a 1 mm diameter screen and together with urine were analysed for N (10). Gross energy of feed and faeces were measured by bomb calorimetry (IKA-Calorimeter, model C-4000 adiabatic) using benzoic acid as a standard.

Analyses of Tannins

Extractable tannins were analysed as described by (12). Total extractable phenol and tannin phenol were as described by (13).

Animals and Feeding

Nine castrated WAD sheep (Djallonke, 28.8 ± 4.2 kg BW) about two years of age, were used in a completely randomised design with three treatments and four animal replicates per treatment. Dried leaves of *M indica* were offered as supplement at two levels (25% and 50% of DMI, diets D2 and D3 respectively) replacing hay in the basal hay diet. Sheep were fed twice a day at 0800 and 1600hr and had free acess to drinking water and mineral premix supplement (10g/d). Four sheep each were randomly assigned to the control/ hay (D1), D2 and D3 diets, respectively. The sheep were adapted for 10 d to the experimental diets. This was followed by 8 days of collection in which the sheep were kept in individual metabolic cages for measurement of feed intake, and to collect faeces and urine outputs. The animals were then transferred to respiration chambers for 2 days, for the measurement of gas exchange namely: carbon dioxide, methane and oxygen.

Statistical Analyses

Analysis of Variance (ANOVA) was carried out using the General Linear Model Procedure (14). A level of $P < 0.05$ was chosen as the minimum for significance.

Results and Discussion

The composition and gross energy content of *Mangifera indica* and the experimental diets are presented in Tables 1and 2.

Table 1: Chemical composition of *Mangifera indica* [% dry matter]

Item	*Mangifera indica* (MI)
CP	9.1
Ash	12.0
Ether extract	1.1
Crude fibre	26.6
NFE	44.6
NDF	44.6
ADF	39.6
ADL	11.6
Cellulose	28.0
Hemicellulose	5.0
Total phenols [1]	8.9
Tannin Phenol [1]	7.8
Condensed tannins [2]	0.8
GE [kJg^{-1} DM]	18.8

[1]As tannic acid equivalent; [2]As leucocyanidin equivalent

Nitrogen Balance

The results obtained for nitrogen balance are presented in Table 3. The nitrogen balance trial showed a significant effect among treatments. There were significant differences in faecal and retained nitrogen. Faecal nitrogen of animals on diet 3 was significantly (P<0.05) higher than those on diets 1 and 2 respectively. Similarly, the urinary nitrogen of sheep on diet 3 was higher (P>0.05) than those on diets 1 and 2 respectively, leading to a significantly (P<0.05) negative nitrogen balance in diet 3 compared to diets 1 and 2 respectively. It would appear that the significantly lower and negative nitrogen retention observed with the highest level of supplementation could be as a result of the significantly higher faecal nitrogen loss of diet 3 compared to diets 1 and 2 respectively.This observation is in agreement with the findings of (15).

Table 2: Composition of Experimental Diets [% of DM]

Item	Diet 1 (Hay) *A stolonifers*	Diet 2 (25%MI +75% hay)	Diet 3 (50%MI+ 50% hay)
CP	11.52	10.9	10.3
Ash	9.9	10.4	11.0
Ether extract	1.5	1.4	1.3
Crude fibre	30.2	29.2	28.1
NFE	40.7	41.7	42.7
NDF	59.6	55.9	52.1
ADF	36.5	37.3	38.1
ADL	4.3	6.1	8.0
Cellulose	32.2	31.2	30.1
Hemicellulose	4.2	4.4	4.6
Total phenols [1]	-	2.2	4.5
Tannin Phenol [1]	-	2.0	3.9
Condensed tannins [2]	n.a.	0.2	0.4
GE [kJg^{-1} DM]	17.8	18.1	18.3
Mineral premix[3] (g/d)	10	10	10

[1]As tannic acid equivalent; [2]As leucocyanidin equivalent; n.a.: Not applicable; [3]Composition/kg: vit A 600,000 IU, vit D3 75,000 IU, vit E 300mg, Zn 3,000mg, Mn 480mg, Co 12mg, Se 10mg.
MI =*Mangifera indica*

Table 3: The effect of *Mangifera indica* supplementation on nitrogen balance in sheep

Item	Diet 1	Diet 2	Diet 3	SEM	Sig. Level
N-intake [g/d]	10.0	9.4	9.0	0.5	n.s.
Faecal N [%]	39.2[c]	52.0[b]	60.2[a]	1.7	*
Urinary N [%]	42.5	33.4	43.3	4.1	n.s.
Retained N [%]	18.3[a]	14.6[a]	-3.5[b]	2.6	*
Digestible N [%]	60.8[a]	48.0[b]	39.8[c]	1.7	*

a,b,c Means in row with different superscript differ significantly (P<0.05)
* P<0.05, n.s.= Not significant

There was however, an attempt to compensate for this higher loss of faecal nitrogen with a lower loss of urinary-N in diet 2 but not with diet 3. This compensatory ability was also observed by (16,17). Although *Mangifera indica* has a very low condensed tannin content, its total phenol and tannin phenol (89 g/kg and 78 g/kg) respectively were quite high and could be responsible for this depression and negative balance by the animals in diet 3. Its nitrogen digestibility decreased significantly (P<0.05) with increasing level of supplementation. The low (P<0.05) nitrogen digestibility with level of supplementation might be due to the inhibitory effects of tannins on crude protein digestibility, probably due to inhibition of protein degradation and bacterial protein synthesis in the rumen. Similar observations have been reported by (18,19,20,21,22).

Energy Partitioning

The results obtained for energy partitioning are presented in Table 4. The result indicated that there were significant (P<0.05) depression of methane energy, metabolisability and digestible energy with higher level of *Mangifera indica*. The percentage of methane energy from digestible energy intake decreased significantly (P<0.05) in diet 3 compared with diet 1. This decrease in methane energy and metabolisability is in agreement with the findings of (23) who reported that inhibition of cellulose digestion should lead to reduction of matabolisable energy in the rumen. The faecal energy of animals on diet 3 was significantly (P<0.05) higher than those of both diets 1 and 2 respectively. In addition, diet 3 had a reasonably high urinary energy leading to a negative energy retention.

Consequently, at the highest level of supplementation, the energy balance for sheep was negative, an indication of weight loss at that supplementation level. The energy balance trial therefore probably confirmed the nitrogen balance trial which showed a negative balance at the highest level of supplementation. *Mangifera indica* could be classified as a plant of low fodder value. This low feeding value could be attributable to its relatively high tannin phenol content (78 g/kg). Nevertheless, dried leaves of *Mangifera indica* may be fed as supplement at about 25% level of inclusion.

Table 4: The effect of *Mangifera indica* supplementation on energy partitioning in sheep

Item	Diet 1	Diet 2	Diet 3	SEM	Sig. Level
Energy intake (MJ GE/d)	9.7	9.7	10.0	0.5	n.s.
Faecal energy [%]	36.6[c]	43.5[b]	48.3[a]	0.9	*
Urinary energy [%]	5.2	4.8	4.9	0.3	n.s.
Methane energy [%]	8.1[a]	6.4[b]	4.9[c]	0.3	*
Metabolisability ,q´ [%]	50.1[a]	45.3[ab]	41.9[b]	1.2	*
Digestible energy [%]	63.6[a]	56.5[b]	51.7[c]	0.9	*
Retained energy [kJ/d]	755	615	-88	254	n.s.
Methane-E/DE intake (%)	12.8[a]	11.4[ab]	9.5[b]	0.5	*

a,b,c Means in row with different superscript differ significantly ($P<0.05$), * $P<0.05$, n.s.= Not significant

Conclusions and Applications

(1) From this study, dried leaves of *Mangifera indica* could be fed at about 25% level of inclusion as supplement to *Agrostis stolonifers* hay diet.

(2) An inclusion level of 50% of the dried leaves may lead to weight loss by the animal as evidenced in the negative nitrogen and energy balance.

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