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Original Article

In- situ Degradability and *In vitro* Gas Production of Selected Multipurpose tree Leaves and *Alfalfa* as Ruminant Feeds

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ABSTRACT

In-situ degradability and in vitro gas production technique were used to evaluate the nutritive value of Albizia lebbeck (AL), Leucaena leucecophala (Lu), Sesbania sesban (SE), Sesbania fermuza (SF) leaves and Alfalfa (ALF). In the In-situ degradability study the sample were incubated at a different time (2, 4, 8, 16, 24, 48 and 72 hrs.) in the rumen of two fistulated, adult crossbred cattle. The gas production was continuously measured by incubating samples in buffered rumen from two adult crossbred cattle (2,4,8,16,24,48 and 72 hrs.) The results indicated that CP content ranged from 17.21 to 21.28% and significantly higher ($P< 0.05$) for SE 21.28% while ALF had a lower CP content 17.21%. NDF and ADF contents were higher for leaves of AL and ALF than leaves of LU, SE and SF. Total tannins content of the leaves range from 2.31 to 9.41% for ALF and LU respectively. OM and CP degradability kinetics (effective degradability, potential degradability, and slow degradation fraction) were significantly higher ($P< 0.05$) for SF and SE than LU, AL and ALF. Significantly higher ($P< 0.05$) in gas production were observed in SF and ALF compared to SE, AL and LU.

KEY WORDS: Tree Leaves, Chemical Composition, Degradability, Gas Production

INTRODUCTION

In Sudan, as in various parts of tropical areas, most small scale farmers rely on grasses as material feed input for animal maintenance. However, forage quality such as (digestibility, protein content and mineral content) decline during dry seasons which leads to nutritional imbalance that causes weight loss. CP content of tropical grasses during dry season falls far below the minimum 8% required for maintaining animal condition (McDonald *et al.,* 2002).

The fodder trees can currently be considered as important source of energy and protein to be utilized in the different animal production system. Fodder tree leaves have the potential for alleviating some of the feed shortage and nutritional differences in dry season on small holder farms (Salem *et al.,* 2006). Reddy and Elanchezhian stated that tree leaves could be considered promising and interesting sources for incorporation into ruminant diets. Also Hail and Tolemariam (2008) concluded that the fodder trees resources represent a great potential for sheep production in area where they are available.

The study was designed to determine the nutritional value of leaves of fodder trees species namely (*Albizia lebbeck*, *Leacaena leucocephala*, *Sesbania sesban* and *Sesbania fermuza* compared to *alfalfa*. The study included proximate analysis, *in-situ* degradability and *in vitro* gas production test.

MATERIALS AND METHODS

This study was carried out at the Department of Animal Nutrition; Faculty of Animal Production; U. of K.

Sample Preparation

Mature leaves from 4 species were collected during dry season from different areas of Khartoum North city, picked up by hand from randomly selected 6 individual trees of each species. The samples were taken at three heights (top, middle and the bottom of the tree) polled, air dried in shaded place then ground in a hammer mill to pass 2.5 mm Mondal et al (2008) screen for *in -situ* study and to pass 1 mm screen for chemical analysis.

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Chemical analysis

Samples of tree leaves and *Alfaalfa* were analyzed for their proximate components, DM, ash and CP according to AOAC (1990). NDF, ADF were determined according to Goering and Van Soest (1970) method. All the analysis was run in triplicate.

Degradability study

Degradability study of tree leaves and *Alfaalfa* carried out in the rumen of two fistulated, adult crossbred cattle (250-300 kg) according to the nylon bag technique described by (Ørskov *et al.*, 1980). The two fistulated animal were fed at maintenance level on a balanced roughage concentrate diet with free access to water and mineral blocks.

***In vitro* gas production test**

In-vitro gas production test was done as described by (Menk and Steingus, 1988). Rumen fluid was obtained from two healthy adult crossbred cattle weighing (250-300 kg. It was strained trough 4 layers of cheesecloth and stored in thermos containers saturated with carbon dioxide (CO_2) and maintained at 39°C. The syringes, prewarmed at 39°C and contained two hundred grams of single substrates or mixtures, were inoculated with 30 ml inoculum under continuous CO_2 reflux. They were incubated in an incubator at 39°C for 72 hours. The gas production of each syringe was recorded after 2, 4, 6, 8, 24, 48 and 72 hours of fermentation. Each run included in triplicate, a blank (syringes incubated with the inoculum alone).

Statistical analysis

Data obtained was subjected to statistical analysis of variance (ANOVA) for completely randomized design using computerized program known as statistix[8].Where the F test was significant; the treatment means were compared using least significant difference (LSD).

RESULTS

Chemical composition

As shown in Table 1 there was no significant difference (P<0.05) in DM, OM and ash content among leaves of fodder trees and *alfalfa*. The CP content was highest (P< 0.05) for SE (21.28%) while ALF had a lowest CP content (17.21%). The NDF was significantly (P<0.05) different among treatments, the highest value recorded by AL was (48.56%) and the lowest value recorded by LU was (31.38%). The higher ADF content was (34.89%) for ALF, while the lowest ADF content was (25.95%) for LU.

Table 1. Chemical composition (%) of leaves of trees and *alfalfa*

Parameters	DM	CP	NDF	ADF	ASH	OM	CT
AL	95.10	18.20b^{c}	48.56^{a}	32.28^{ab}	9.55	90.45	0.78
LU	94.61	19.72^{ab}	31.38^{c}	25.95^{b}	9.77	90.23	0.94
SE	94.41	21.28^{a}	42.14^{ab}	29.50^{ab}	9.39	90.61	2.44
ALF	94.57	17.21^{c}	44.18^{a}	34.89^{a}	9.42	90.58	2.31
SF	93.49	19.83^{ab}	36.23^{ab}	30.18^{ab}	9.98	90.02	3.93
SEM	0.56	0.78	2.30	5.60	0.44	0.44	

AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* ALF *Alfalfa*; SF *Sesbania fermuza;* CT condensed tannins; SEM standard error of the mean; $^{a-c}$ means with different superscripts in the same row were significantly different (P< 0.05)

***In- situ* degradability**

Average proportion of OM and CP disappearing from different leaves of fodder tree and *alfalfa* at different periods of incubation in the rumen were shown in Tables 2 and 3 and plotted graphically in Fig. 1 and 2. It can be seen from Tables 2 and 3 that at each time intervals, the proportion of CP disappearing from leaves of fodder trees was higher for SF than SE, AIF, Lu and AL.

Estimated of OM and CP characteristics were illustrated in Tables 4 and 5. As can be seen from these tables the value of ready soluble fraction (a) was significantly higher for ALF than other leaves of fodder trees. Slow degradable fraction (b) and effective degradability at rate of 2 and 5% were significantly higher for SF and SE than ALF, AL and LU.

Table 2. Rumen degradation of OM (%) of leaves of trees and *alfalfa*

OM% loss(hrs)	AL	ALF	LU	SE	SF
2	28.33	30.96	20.4	26.6	26.0
4	31.53	34.49	23.3	29.8	29.2
8	36.74	40.34	28.4	35.1	34.6
16	43.78	48.46	36.1	42.8	42.4
24	47.95	53.50	41.8	47.8	47.7
48	52.94	60.23	53.7	55.6	56.5
72	54.16	62.45	62.9	59.8	61.7

AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;*ALF *Alfalfa*; SF *Sesbania fermuza*

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Table 3. Rumen degradation (%) of CP of leaves of trees and *alfalfa*

CP loss % (hrs)	AL	ALF	LU	SE	SF
2	40.60	43.94	41.22	34.58	42.14
4	44.28	48.31	46.44	39.11	47.58
8	50.25	55.30	54.55	46.96	56.52
16	58.16	64.46	64.56	58.80	68.70
24	62.76	69.79	69.85	66.86	75.95
48	68.19	76.28	75.29	78.67	84.48
72	69.59	77.99	76.32	82.42	86.39

AL *Albizia lebbeck*;;ALF *Alfalfa*; LU *Leucaena leucocephala;* SE *Sesbania sesban* SF *Sesbania fermuza*

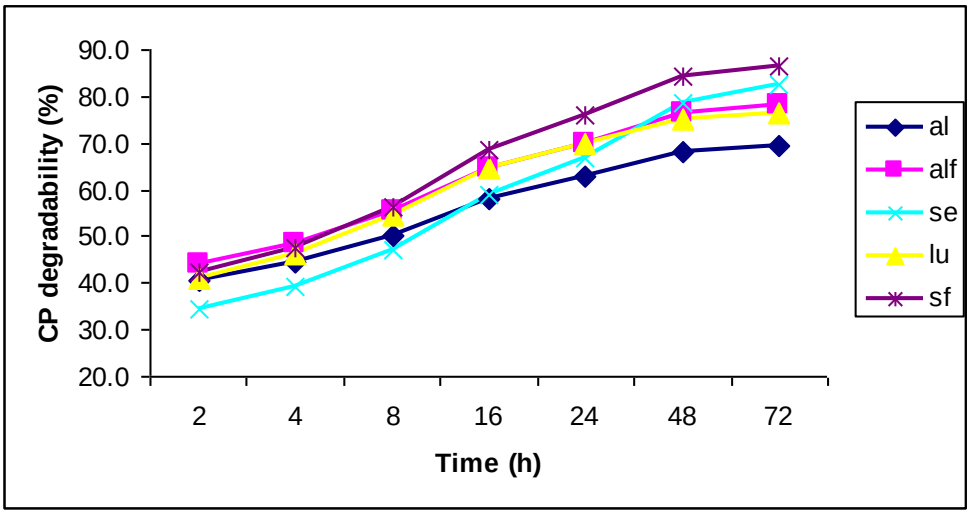

Figure 1. Rumen degradation of CP (%) of fodder leaves and *alfalfa*
(AL *Albizia lebbeck*; ALF *Alfalfa*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* SF *Sesbania fermuza*)

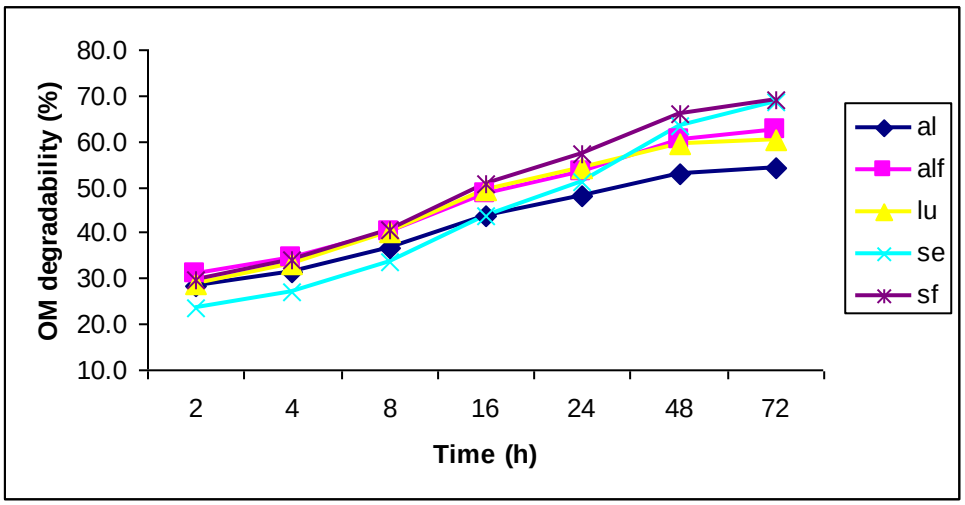

Figure 2. Rumen degradation of OM (%) of fodder leaves and *alfalfa*.
(AL *Albizia lebbeck* ALF *Alfalfa;* LU *Leucaena leucocephala;* SE *Sesbania sesban*; SF *Sesbania fermuza*)

Table 4. OM fractions degradability (%) of tree leaves and *Alfa alfa*

Parameters	a	b	c	PD	ED		
					2%	5%	8%
SF	25.03^{ab}	46.33^{ab}	0.05	71.37^{a}	57.80^{a}	48.13^{a}	43.00^{a}
SE	19.70^{b}	52.87^{a}	0.04	72.60^{a}	54.03^{a}	42.37^{ab}	36.67^{c}
LU	23.77^{ab}	36.70^{bc}	0.07	60.47^{bc}	52.67b^{c}	45.70^{ab}	41.50^{ab}
AL	24.67^{ab}	29.97^{c}	0.06	54.63^{c}	47.40^{b}	41.40^{b}	37.93^{bc}
ALF	26.93^{a}	37.37^{bc}	0.06	64.33^{b}	53.67^{ab}	46.10^{ab}	41.98^{ab}
SEM	2.17	3.15	0.01	1.94	2.00	1.84	1.52

(a) Readly degradable fraction; (b) slow degradable fraction; (c) rate of degradable fraction; (ED) effective degradability; SEM standard error of the mean: a-c means with different superscripts in the same column were significantly different (P< 0.05). AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* ALF *Alfalfa*; SF *Sesbania fermuza*

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Table 5. CP fractions degradability (%) of tree leaves and *Alfalfa*

Parameters	a	b	c	PD	ED		
					2%	5%	8%
SF	35.93[a]	51.03[a]	0.07	87.00[a]	74.83[a]	64.63[a]	58.70[a]
SE	29.60[b]	54.60[a]	0.05	84.20[a]	68.10[b]	56.27[cd]	50.03[c]
LU	35.00[ab]	41.60[b]	0.08	76.60[b]	68.60[b]	60.30[bc]	55.60[ab]
AL	36.33[a]	33.93[c]	0.07	70.27[c]	62.03[c]	55.37[d]	51.50[bc]
ALF	38.83[a]	38.87[bc]	0.07	78.70[b]	69.07[b]	61.23[ab]	56.73[a]
SEM	1.92	2.19	0.01	1.43	1.24	1.37	1.33

(a) Readly degradable fraction; (b) slow degradable fraction; (c) rate of degradable fraction; (ED) effective degradability SEM standard error of the mean: a-d means with different superscripts in the same column were significantly different (P< 0.05). AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* ALF *Alfa alfa*; SF *Sesbania fermuza*

***In vitro* gas Production**

Gas production of leaves of fodder tree and *Alfalfa* was presented in Table 6. The gas production increased with increasing incubation time. Fermentable parameters for leaves of fodder tree and *Alfaalfa* were presented in Table 7. There were no significant (P<0.05) differences among feeds in the rate of gas production (c). The gas volumes from soluble fraction (a) was significantly (P<0.05) lower in ALF and slow degraded fraction (b) was significantly (P<0.05) lower in AL and LU.

Table 6. Gas production (ml/500 mgDM) for tree leaves and *alfalfa*

Gas production (hrs)	2	4	8	16	24	48	72
SF	9.08	18.25	32.64	53.72	67.22	80.97	84.86
SE	1.75	14.25	29.06	52.39	63.63	77.59	83.85
LU	6.67	12.33	25.08	34.85	50.38	59.06	62.46
AL	6.75	12.08	26.81	41.64	50.18	59.12	62.78
ALF	6.50	17.17	35.72	58.47	73.81	86.14	88.03

AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* ALF *Alfalfa*; SF *Sesbania fermuza*

Table 7. Gas production constants (ml/500 mgDM) for tree leaves and *alfalfa*

Parameters	a	b	c
SF	-2.21[a]	89.33[a]	0.07
SE	-3.77[a]	88.43[a]	0.07
LU	-1.11[a]	65.43[b]	0.05
AL	-2.46[a]	64.84[b]	0.07
ALF	-8.28[b]	97.57[a]	0.07
SEM	1.37	3.17	0.003

(a) Ready degradable fraction; (b) slow degradable fraction; (c) rate of degradable fraction SEM standard error of the mean: [a-b] means with different superscripts in the same column were significantly different (P< 0.05). AL *Albizia lebbeck*; LU *Leucaena leucocephala;* SE *Sesbania sesban;* ALF *Alfalfa*; SF *Sesbania fermu*

DISCUSSION

Generally there was no significant difference in DM, OM and ash content among fodder trees and *alfalfa* (control). Leaves of fodder trees had a higher CP content compared to *Alfalfa*. Feed containing less than 8% CP can'not provide the minimum ammonia level required by rumen microorganism to support optimum activity according to Kamalak *et al.* (2004). The leaves of fodder trees examined in this study have shown that the CP content was sufficiently high to warrant consideration of their as protein supplement to low quality diet. NDF and ADF content were significantly different among leaves of tree; this could be attributed to difference in species of fodder trees selected. The chemical composition of the AL, LU and SE leaves in the present study at in the range of the values that was reported by Smith (1991). High CP content and low NDF and ADF content suggest that browse trees with potential degradability as N supplement to ruminants that are fed with low quality roughage during dry season (Salem *et al.*, 2006).

SF and SE had higher *in-situ* degradability parameters for OM and CP than ALF, AL and LU as can be seen in Tables 4 and 5. These differences are attributable to difference in the chemical composition of fodder trees. The ALF and AL had higher NDF and ADF content than SF and SE. This constituent of fodder trees and *alfalfa* were negatively correlated with extent and rate of degradability as well as potential and effective degradability of OM and CP. This is in agreement with other studies that attributed higher degradable of *S. sesban* to low content of NDF and ADF compared to *Leucaena leucocephala* (Melkau *et al.*, 2003). Ramana *et al.* (2000) also reported that there is a strong negative correlation between DM degradability and NDF and ADF content. Leaves of AL and LU had the lowest value of total tannins, SE and SF had moderate tannins content. In ruminant dietary condensed tannin (2 – 5% in DM) has shown to have beneficial effects because they reduce the wasteful protein degradation in the rumen by forming protein – tannin complex, species with moderate level of tannin have higher proportion of escape protein than those without tannin (Kamalak, 2005).

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There was no significant difference in degradation rate (c) of OM and CP among leaves of fodder trees and *alfalfa* and they had a moderate rate of degradation. This phenomenon may be desirable. Fast rate of degradation of feed may not always be desirable particularly with regard to the rate of N degradation. Extensive ruminal degradation of feed N to ammonia above the level that can be utilized for microbial protein synthesis or observed into rumen is converted into urea and excreted in urine; this will put a limit on animal production (Melkau *et al.*, 2003).

Gas production

The increase in gas production of SF compared to AL and Lu emphasized the negative effect of NDF, ADF and tannins content on digestibility. Low rates and extent of gas production from *in-vitro* incubation of Lu and AL compared to SF was in agreement with observation of Melkau *et al*. (2003) who reported a lower extent (b) of gas production from *in- vitro* incubated *Leuceana pallieda* compared to *S. sesban*. Salem *et al*. (2006) also reported negative relation between gas production and concentration of tannins content in leaves.

CONCLUSION

Leaves from AL, SF, SE and Lu had higher CP content compared to *alfalfa* and low ADF and NDF content compared to grasses in tropics, high degradable OM, CP. The results conclusively revealed that the leaves of *Albizia lebbeck, Sesbnia sesban, Leucana leucocphala* and *Sesbnia fermuza* had great potential as livestock feed, especially during dry season. In general fodder trees and shrubs not only degraded fairly well and rapidly in the rumen supplying soluble carbohydrate and fermentable N to the rumen but also are digested post ruminally often at a higher level than tropical grasses and should therefore improve the intake and digestibility.

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