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Dry Matter Degradation Characteristics of Some Selected Browse Plants Using the *In Sacco Technique*

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Target Audience: Nutritionist, Animal Scientist

Abstract:

Three ruminally fistulated Yankasa rams were used to evaluate the nutritive value of some selected browse plants in the northern Guinea savanna, using the in sacco degradability method. . The selected browse plants were: Shea butter (Butyrospermum parkii) leaf (SBL), Acacia (Faidherbia albida) leaf (FAL) and Parkia (Parkia biglobosa) leaf (PBL), were used for the study at this incubation periods 0, 3, 6, 12, 24 and 48 h. The result of the proximate analysis was different among the browse plants studied. The CP contents were of 12.19, 22.25 and 17.19% for PBL, SBL and FAL respectively. The tannin and saponin values (g/100mg) were 1.24, 1.28 for PBL, 1.26, 0.96 for SBL and 0.64, 0.84 for FAL respectively. The highest potential degradability (a+b) was in FAL, which was significantly ($p<0.05$) higher than in SBL and PBL. The rate of degradation constant (c) was significantly ($p<0.05$) lower in PBL (0.030) followed by SBL (0.037) and FAL (0.043) being the highest. Effective dry matter degradation significantly ($p<0.05$) decreased with increase in outflow rate across browse plants, with FAL having the highest followed by SBL and PBL. From the result of this study, FAL had the highest degradation characteristics over the other leaves.

Key words: Browse plants, *Butyrospermum parkii*, *Faidherbia albida*, in sacco, *Parkia biglobosa*, rumen degradation

Description of Problem

Livestock play a vital role in the lives of many people on a global scale, mainly as a source of income and in provision of egg, meat and milk, which are considered as first class protein source. RIMS [1] reported that Nigeria had an estimate population of about 22 million sheep kept primarily for meat production. They contribute about 11% of the total meat supply in the country.

However, due to high feed cost, many small scale livestock farmers cannot afford to supplement the diet of their animals with highly expensive feed ingredients [2].

Nigeria is blessed with diverse range of vegetation zones stretching from the dense rain forest in the south to plain and sandy arid zone in the extreme north. This wide ecological variation gives an enabling environment for different types of flora to grow. Several indigenous browse species growing in fallow lands are commonly use by small holder farmers as cut and carry fodder for confined sheep and goats [3].

Quantitative information on biomass production [4] and chemical composition [5] of some species have been documented. However information on voluntary intake and digestibility of some of these promising browse species is limited and constraining to their extensive use as sources of feed for ruminants. Furthermore, comparative utilization of promising browses in sheep commonly kept by smallholder crop-livestock farmers and agro pastoralist have been reported but these plants have not been tested on ruminant thus the need of rumen degradation using Shea butter, Faidherbia albida and Parkia leaves. The objectives of this study are to evaluate the nutritional value, antinutritional factors and rumen degradation characteristics of the selected browse plants using Yankasa sheep.

Materials and methods

Location and site

This experiment was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. Located on latitude 11^0 11′N and longitude 07^0 38′E. It is situated at an altitude of 686m above sea level and lies within the Northern Guinea Savannah zone.

Feed samples

Three most commonly used browse plants in feeding ruminant animals were sampled. All samples collected were dried in a forced air oven at 60^o C and ground to pass a 1 mm screen and stored for chemical analysis and the degradability study. The browse plants investigated were; Shea butter (*Butyrospermum parkii)* leaf (SBL), Acacia (*Faidherbia albida*) leaf (FAL) and Parkia (*Parkia biglobosa*) leaf (PBL)

Animal and Diets

Three ruminally fistulated Yankasa sheep weighing 28±15 kg were used as replicates to determine *in sacco* degradability of browse leaf meals. The sheep were housed in individual pens and fed *ad libitum* maize stover and concentrate (12% CP) at 70:30 ratios. Water and mineral block were fed ad libitum. The diets were offered in two equal meals at 07.00h and 16.00h. The animals were adapted to the basal feed for two weeks prior to insertion of the bags in the rumen.

Ruminal Disappearance

The dry matter disappearances in the rumen were estimated for each feed sample using the nylon bag technique (Ørskov and McDonald 1979). The bags

(7x 14cm) were made from dacron cloth with a pore size of 38 µm. Approximately 3.0 g of dried (60^{o}C) feed samples were weighed into previously dried bags and tired to a nylon string. The bags were inserted in the rumen at the same time, but are withdrawn simultaneously at each time point, as described by [6] sequential withdrawal. Bags for each feed sample were removed after 0, 3, 6, 12, 24 and 48 h of incubation. Immediately after removing the bags from the rumen, the bags were washed in cold running tap water until cleaned and dried in forced air oven at 60^{o}C to constant weight. The bags were weighed and residues were removed and then analyzed for dry matter. The 0 h incubation samples were washed and dried in similar conditions as the incubated samples and the bags were weighed according to the procedure described by [7].

Degradation studies

Data for ruminal disappearance characteristics of dry matter (DM) and organic matter (OM) were fitted to the exponential equation following the procedure described by [7].

$$P = a+b\ (1-e^{-ct})$$

where,

P = disappearance rate at time t (%),

a = the intercept of the degradation curve at time zero (%),

b = the fraction of dry matter which was degraded when given sufficient time for digestion in the rumen (%),

c = a rate constant of disappearance of fraction b (h-1), and

t = time of incubation (h).

The effective degradability of dry matter was calculated by using the following equation [8].

$$ED= a+ \{(bc)/(c+k)\}$$

Where,

k = assuming the rate of particulate outflow from the rumen, k, is taken at 0.02, 0.03, 0.04 and 0.05 h^{-1}.

Chemical Analysis

The dry matter content was determined by drying the samples at 60ºC to constant weight. Kjeldahl nitrogen analyses [9] were performed in duplicate on dried leaf samples and CP calculated as (N x 6.25), crude fiber (CF) content – by means of Foss Tecator Analyzer, ether extract content – by Soxtec System 1040 and ash content – by combustion at 550ºC in Muffle furnace for six hours, using the method described by [9]. Tannin was estimated by the Vanillin-HCL method [10] and saponins were estimated by using methanol extraction following the [9] method.

Statistical Analysis

Data were analyzed by Analysis of variance (ANOVA) according to a complete randomized design (CRD) procedure [11]. Treatment means were ranked using Duncan's multiple range test (DMRT)

Results and Discussion

The results of the chemical composition of the browse plants are presented in Table 1. The crude protein (CP) content

of the feed samples were 12.19, 22.25 and 17.19% for PBL, SBC and FAL respectively. While the crude fiber content were 20.00, 26.42 and 21.30% for PBL, SBC and FAL respectively. FAL had the lowest tannin content of 0.64mg/100g, followed by PBS and SBL having 1.24 and 1.26mg/100g respectively. Similarly, saponin content were 0.84, 0.96 and 1.28mg/100g in FAL, SBC and PBS respectively)

Table 1: Chemical composition of the browse plants studied

Parameters	PBL	SBC	FAL
Dry matter	92.37	92.11	94.5
Crude protein	12.19	22.25	17.19
Crude fiber	20.00	26.42	21.30
ASH	9.22	13.76	11.3
Tannin(g/100mg)	1.24	1.26	0.64
Saponin(g/100mg)	1.28	0.96	0.84

PBL = Parkia biglobosa SBL = Shea butter
FAL = Faidherbia albida

The chemical composition of the browse leaf meals were comparable to those reported by [12, 13, 14] for most browse plant in West African sub region. There is a variation in the chemical composition between the leaf meals studied. The major factor contributing to this difference could be the age at the time of harvest as leaves develop their structure and morphology according to their age and management [15].

The degradation of DM in the test leaves differed significantly ($P < 0.05$) both in their disappearance rates and fermentation characteristics at the different incubation periods as shown in Table 2 and 3. The readily soluble fraction (a) for DM was significantly more in *FAL* with a value of 32.99 as compared to the least value of 20.33 in PBL. Van Soest [16] reported that degree of lignification has a negative effect on cell wall solubility in forages.

The insoluble but potentially degradable fraction (b-values) for DM is 67.63 for FAL, 43.00 for SBL and 37.30 for PBL. The difference in their degradation characteristics could be attributed to their chemical composition especially tannin and the fiber content, which could not be easily attacked by micro-organisms in the rumen [17, 14].

Table 2. Dry-matter loss at different incubation period in the rumen of cannulated Yankasa sheep

	Browse plants			SEM
Incubation time (h)	FAL	SBL	PBL	
3	38.56[a]	28.99[b]	21.59[c]	0.111
6	39.83[a]	33.33[b]	23.31[c]	0.148
12	55.35[a]	35.99[b]	29.34[c]	0.105
24	60.66[a]	36.40[b]	32.34[c]	0.074
36	63.68[a]	37.27[b]	34.66[c]	0.019
48	67.63[a]	43.00[b]	37.30[c]	0.014

[a,b,,c,] means with different superscript within the same raw differ significantly ($p<0.05$) SEM=standard error of means PBL = Parkia biglobosa SBL = Shea butter FAL = Faidherbia albida

The disappearance of the DM contents in the leaves by the end of 48 hrs of incubation, generally considered to be equivalent to digestibility [18] and being the mean retention time of fibrous feeds in ruminants [19], revealed that *FAL* had more than 50% DM loss compared to the 43% value obtained for SBL and the least value 37.30% for PBL.

Table 3. Rumen Degradation characteristics of PBL SBL FAL in rumen cannulated Yankasa rams

	Degradation characteristics			
Browse plants	a	b	a+b	c
FAL	32.99[a]	67.63[a]	100.62[a]	0.043[a]
SBL	28.99[b]	43.00[b]	71.99[b]	0.037[b]
PBL	20.33[c]	37.30[c]	57.63[c]	0.030[c]
SEM	0.333	0.333	0.332	0.0003

[a,b,,c,] means with different superscript within the same column differ significantly ($p<0.05$) SEM=standard error of means PBL = Parkia biglobosa SBL = Shea butter FAL = Faidherbia albida

The rate constant (c) at which b is degraded for DM differed significantly ($p<0.05$). The rate constant ranged between 0.043 for FAL to 0.037 for SBL and 0.030 for PBL/h. The slowest rate of degradation (c) per hour of the rumen degradable fraction was observed in PBL. Preston [20] reported that the rate of degradation (c) was an important parameter in the assessment of the

fermentation in the rumen, which shows PLS as a potential sources of energy for use by microorganisms in the rumen.

The Effective degradability (ED) of DM calculated at 2, 3, 4 and 5% outflow rates from the rumen presented in Table 4, showed that FAL consistently had significantly highest values while the least value was recorded in *PBL*. Effective DM degradability decreased with increase in outflow rates in this study. Similar trend in ED of DM to decrease as the outflow rate increased has been reported by [21]. The lower ED of PBL observed in this study may be attributed to the tannin, as was observed by [14].

Table 4. Effective degradability (ED) of dry matter (DM) of PBL, SBL and FAL calculated at four different passage rates

	Passage rates %/h			
Browse plants	2	3	4	5
PBL	76.84[a]	70.34[a]	65.49[a]	61.75[a]
SBL	58.34[b]	54.23[b]	51.27[b]	48.87[b]
FAL	42.71[c]	38.90[c]	36.32[c]	34.32[c]
SEM	0.33	0.33	0.33	0.30

[a,b,,c,] means with different superscript within the same column differ significantly ($p<0.05$) SEM=standard error of meansPBL = Parkia biglobosa SBL = Shea butter FAL = Faidherbia albida

Conclusions and application

1. The result from this study confirms that browse leaves contain appreciable amount of nutrients that could be harnessed with what
2. Some of these browse leaves also contain antinutritive factors that may limit the bio availability of their nutrients for utilization by ruminants
3. The degradation characteristics of the FAL was more than 50% DM loss compared to the 43% value obtained for SBL and the least value 37.30% for PBL
4. The degradation kinetics in this study could provide a useful information when considering supplementation strategies for ruminant using browse leaf meal.

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