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EVALUATION OF BALANITE AEGYPTIACA: LEAVES, SEED KERNEL CAKE, FRUIT COAT AND FLESH AS RUMINANTS FEED

(With 5 Tables)

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SUMMARY

The study aimed to evaluate the nutritive value of *Balanite aegyptiaca* leaves, different fruit parts viz. coat, flesh and it's industrial by product seed kernel cake. Chemical composition and *in situ* dry matter and crude protein degradability were determined. Samples were incubated in rumen for 6, 12, 24, 36, 48 and 72 hrs using three fistulated steers. Significant variation ($P<0.05$) were observed in the chemical composition among the leaves, fruit coat, fruit flesh, and seed cake. The seed cake showed the highest crude protein and ash content and lowest crude fibre content. The highest value of nitrogen free extract and ether extract were recorded in the flesh. The fastest dry matter and crude protein degradability were observed in the flesh and the lowest was in the coat. The information provided by this study could be useful in planning for ruminants feeding especially during the dry season.

Key words: *Balanite aegyptiaca, Leaves, Coat, Flesh, Seed cake, Degradability*

INTRODUCTION

In the Sudan, livestock production is challenged by scarcity of feed, due to seasonal fluctuations in feed quantities, and prices. In addition to that, the concentrated feedstuff produced annually is competed for by humans and livestock. Neglected and underutilized trees often play a vital role in securing food and livestock feed, income generation and energy needs of rural populations, however, Smallholders rely on subsistence farming, with few or no inputs, but trees are usually available and generally provide the sole source of nutrition to the animal (McDermott *et al.*, 1999). Several indigenous and exotic multipurpose trees and shrubs are being evaluated for development of integrated crop and livestock agroforestry technologies. (Duguma *et al.*, 1994).

The Balanite trees can be used as animal feed, the fresh and dried leaves, fruit and sprouts are all eaten by livestock. Balanites kernel cake (BKC) is characterized by high protein (36.8%), low crude fibre (5.9%) content and non toxic to ruminant and its addition at the rate of 20%, together with 10% straw, can replace 30% cotton seed cake in the diet (Elkhaideir *et al.,* 1983). Balanites aegyptiaca contributes up to 30% of the dry matter intake of goats in the dry season in Borkinafaso, (Hall and Walker, 1991)- kernel meal, was used for fattening of sheep in the Sudan (Elkhideir, *et al.*, 1983) and for other animals in Senigal, (Vogt, 1995) and as stock feed in Uganda. (Katende *et al.*, 1995).

The objective of this study was to evaluate the potentiality of fruits, leaves, coat and kernel cake of B. *aegyptiaca* trees as ruminant's feed.

MATERIALS and METHODS

Collection and preparation of the samples:

Well –ripened fresh fruits of *Balanites aegyptiaca* were collected from Kordofan State Local Market.

The coat and the flesh of the fruits were removed manually; then the flesh was sun- dried. The leaves were picked from the trees. The seed kernel was obtained by mechanical decortication of the ripened fruit seeds. The kernel cake was obtained by mechanical extraction of the oil from the seeds kernels at an oil mill.

Chemical analysis:

Proximate analysis for the different chemical components viz. dry matter (DM), crude protein (C.P), crude fibre (C.F), ether extract (E.E) and ash were determined as described by the AOAC (1990), and the nitrogen free extract was calculated.

Degradability study:

Three steers were prepared with rumen cannulas, and were fed at a maintenance level a mixture of concentrates and roughages. The dry matter and crude protein disappearance in the rumen was determined by in situ polyester bag technique according to Mehrez and Qrskov, (1977). Four gms of the different *Balanites aegyptiaca* tree parts, were ground to pass; then incubated in the rumen (2 bags/animal/period/ sample) for 3, 6, 12, 24, 36, 48 and 72 hours.

Calculation of ruminal degradability:

Dry matter of residues in the bags was calculated as follows:

$$\frac{\text{Incubated sample weight} - \text{Weight of residue}}{\text{Weight of incubated sample}} \times 100$$

Residues from samples after incubation for every period were separately mixed, pooled and made ready for analysis.

Degraded crude protein (CP) from all residues was calculated as follows:

$$\frac{\text{CP of sample incubated} - \text{CP of residue after incubation}}{\text{CP of sample incubated}} \times 100$$

The degradation kinetics of the different parts was described by curve-linear regression of DM or CP loss from the bags with time by the equation of Ørskov and McDonald (1979).

$P = a + b\,(1 - \exp\text{-}ct)$

Where:

P=potential degradability (%).

a= the soluble and completely degradable substrate (%)

b= the insoluble but potentially degradable (%).

c= the rate of degradation of b(%/hr).

t=incubation time (hour).

Effective degradability (Ed) of DM and CP was determined, at 0.02, 0.05, and 0.08 ruminal outflow rates, using the equation of Ørskove and McDonald (1979)

Ed. = $a + (b \times c / c + k)$, where a,b and c are constants defined in equation 1

K= small particles out flow rate.

Statistical analysis:-

The data obtained were subjected to one way analysis of variance to compare the DM and CP degradation kinetics of the different balanites tree parts. Significant differences among the parts were assessed using Least Significant Differences (LSD) test according to Gomez and Gomez, (1984). The Statistical Package for Social Sciences Program (SPSS) was used.

RESULTS

The chemical composition of the leaves, coat flesh and seed kernel cake of *B. agyptiaca* are shown in Table (1). The highest DM content was shown in the coat and lowest value found in the kernel cake. The crude protein (CP) content was variable ($p<0.05$). A high CP content (47.11%) was found in the kernel cake, followed by the leaves, coat and the lowest CP was observed in the flesh. The crude fibre (CF) content of the coat recorded the highest value 29.38%, while the kernel cake showed the lowest value 8.54%. The highest Crude fat (CF) content was observed in the flesh (10.2%) and the lowest content in the kernel cake (4.5%). Significant differences, in the ash content among the different parts of *B. agyptiaca*, were observed and the cake showed the highest value. The nitrogen free extract (NFE) content is significantly variable among the different tree parts ($P<0.05$), the highest value was observed in the kernel cake (52.8%) while the leaves showed the lowest value

Table 1: Chemical composition %of the leaves, coat, and flesh and kernel seed cake of *B. agyptiaca* (means ±SD).

Part	DM%	EE%	CP%	CF%	Ash%	NFE%
Leaves	89.51 ± ٠.06^c	9.04 ± 0.01^b	35.67 ± 0.01^b	20.77 ± 0.01^b	2.60 ± 0.02^b	21.43 ± 0.04^d
Coat	96.05 ± 0.07^a	2.15 ± 0.07^d	12.77 ± 0.01^c	29.38 ± 0.02^a	3.00 ± 0.01^b	50.74 ± 0.01^b
Flesh	94.00 ± 0.01^b	10.20 ± 0.01^a	10.55 ± 0.07^d	18.18 ± 0.01^c	2.25 ± 0.07^c	52.80 ± 0.01^a
K. cake	88.44 ± 0.06^d	4.51 ± 0.01^c	47.11 ± 0.01^a	8.54 ± 0.04^d	5.04 ± 0.01^a	$23.24\pm0.o2^c$
SEM	1.19	1.15	5.82	1.89	1.62	10.20
Sig.	*	*	*	*	*	*

Means within the same column with different superscripts are significantly different ($P<0.05$).

Sig : Significance level ($P<0.05$).

SEM: Standard error of means.

SD : Standard deviation.

The degradability parameters for both CP and DM are presented in Tables (2, 3, 4, 5). DM degradability of *B. aegyptiaca* different parts increased from 6hrs incubation time and reached the maximum at 72hrs incubation time. The DM degradability rate and effective degradability in this study were highest in the flesh and lowest in the coat.

Table 2: In situ dry matter degradability (%) of leaves, fuits coat and flesh and seed kernel cake of B. agyptiaca (means ±SD).

Incubation time (h)	Zero/hrs	6hrs	12hrs	24hrs	36hrs	47hrs	72hrs
Leaves	08.36^{d}	40.21^{d}	45.95^{c}	57.88^{c}	63.85^{c}	67.13^{c}	70.62^{c}
Coat	15.05^{c}	43.86^{c}	44.82^{c}	46.42^{d}	46.42^{d}	47.39^{d}	48.67^{d}
Flesh	20.37^{b}	84.91^{a}	87.42^{a}	88.36^{a}	89.92^{a}	90.86^{a}	91.18^{a}
kernel cake	33.90^{a}	57.78^{b}	60.14^{b}	63.97^{b}	81.37^{b}	83.13^{b}	84.60^{b}
SEM	2.84	5.29	4.59	4.62	5.05	5.02	4.92
Sig. level	*	*	*	*	*	*	*

Means within the same column with different superscripts are significantly different ($P<0.05$).
Sig : Significance level ($P<0.05$).
SEM : Standard error of means.
SD : Standard deviation.

Table 3: Degradation Kinetics of the dry matter of leaves, coat, flesh and seed kernel cake of B. *aegyptiaca* (means ±SD)

	a.	b.	c.	pd	Ed(0.02)	Ed(0.05)	Ed(0.08)
leaves	62.70^{a}	18.66^{b}	0.04^{a}	81.36^{b}	70.76^{c}	65.46^{c}	6٤.93^{c}
coat	61.00^{a}	18.23^{b}	0.02^{a}	79.23^{b}	62.70^{d}	62.70^{d}	62.70^{c}
flesh	62.00^{a}	36.20^{a}	0.04^{a}	98.20^{a}	95.00^{a}	92.86^{a}	91.86^{a}
kernel cake	62.00^{a}	38.00^{a}	0.03^{a}	100	84.54^{b}	73.83^{b}	69.43^{b}
SEM	0.31	3.21	0.01	3.31	9.65	9.12	8.99
Significant level	NS	*	NS	*	*	*	*

a, b ,c and d : means within the same row followed by different superscripts are significantly ($p< 0.05$) different.
a: washing loss.
b: degradation of water insoluble.
c: rate constant of b function
Pd: potential degradability (%)
Ed: Effective degradability at different and flow rate (0.02, 0.05and 0.08).
SEM: standard error of means.

The CP degradation characteristic varied among the different plant fractions. The kernel cake showed the highest soluble fraction (a).

The flesh showed the highest effective degradability while the coat showed the lowest effective degradability. The (c) value of the kernel cake protein was higher than that of the other parts.

Table 4: Rumen degradation % of crude protein of leaves, coat (Hull), flesh (Pulp) and kernel seed cake of *Balanites aegyptiaca* tree.

	6hrs	12hrs	24hrs	36hrs
leaves	47.04^{d}	52.12^{c}	65.22^{c}	72.00^{b}
coat	49.08^{c}	50.13^{d}	50.92^{d}	51.77^{c}
flesh	73.41^{a}	77.68^{a}	83.66^{a}	85.92^{a}
kernel cake	65.42^{b}	67.82^{b}	71.99^{b}	85.74^{a}
SEM	5.26	5.13	4.67	4.65
Sig. level	*	*	*	*

Table 5: Degradation kinetics of crude protein of leaves, coat, flesh and seed kernel cake of *Balanites aegyptiaca* trees.

	a.	b.	c.	pd	Ed(0.02)	Ed(0.05)	Ed(0.08)
leaves	38.50^{d}	57.37^{a}	0.03^{ab}	95.87^{a}	74.43^{b}	66.33^{b}	64.03^{b}
coat	48.66^{c}	51.13^{a}	0.02^{b}	99.80^{a}	62.63^{c}	62.45^{c}	62.22^{c}
flesh	63.60^{b}	51.13^{a}	0.03^{ab}	95.90^{a}	84.10^{a}	76.87^{a}	73.27^{a}
kernel cake	66.47^{a}	32.30^{b}	0.04^{a}	88.64^{b}	83.77^{a}	78.57^{a}	75.97^{a}
SEM	3.43	4.34	0.01	1.46	2.65	2.06	1.75
Significant level	*	*	*	*	*	*	*

a, b ,c and d : means within the same row followed by different superscripts are significantly ($p< 0.05$) different.

a: washing loss.

b: degradation of water insoluble.

c: rate constant of b function

Pd: potential degradability (%)

Ed: Effective degradability at different out flow rates (0.02, 0.05and 0.08).

SEM: standard error of means.

DISCUSSION

The DM content of *Balanites aegyptiaca* kernel cake was 88.44%, which is lower than that of groundnut cake (94.4%), sesame cake (94.6%), cotton seed cake (95.6%) and sunflower (94%) as reported by Afaf and Sulieman (1999).

The DM content of *Balanites aegyptiaca* leaves was 89.51 %' this result is similar to that obtained by Ondiek *et al.* (2010) for Acacia tortilis, (89%), Acacia nilotica, (89.9%), and Grewia bicolour, (89.4%); and higher than that reported in the leaves of Balanite aegyptiacaleaves, (86.7%) (Ondiek *et al.,* 2010) and *Zizyphus abyssinica* (75.3%) (Elamin and Babiker, 2000), and is lower than the DM content for the leaves of *Adansonia digitata* 93.6 (Ikhimioya, *et al.*, 2005).

Crude protein content of *B. aegyptiaca* kernel cake was 47.11 %, which is comparable to that of sesame seed cake (46.0%) (Omar, 2002) and higher than that reported in *B. aegyptiaca* kernel cake (Elkhidir *et al.*, 1983), groundnut cake(43.5%), sesame seed cake (41.1 %), cotton seed cake (24.4 %) and sunflower cake (26.9 %) (Afaf and Sulieman, 1999) .

Crude protein of leaves in this study was 35.67%, this finding was higher than that reported for Acacia tortilis, (11.7%), Acacia nilotica, (12.1%), Grewia bicolour, (19.6%) and *B. aegyptiaca* leaves (13.7) (Ondiek, *et al.*, 2010) *Acacia mellifera,* (Elamin and Babiker, 2000), Acacia Senegal and Acacia nilotica (Mahala and Assad 2007).

Crude protein of *Balanites aegyptiaca* flesh was found to be 10.55% in this study, which is far higher than the CP of *Balanites aegyptiaca* flesh reported by Guinand and Lemessa, (2002).

The CF content of *B. aegyptiaca* kernel cake is in line with that of sesame seed cake and groundnut cake and lowers than that of cotton seed cake (22%) and sunflower cake (9.5 %) (Afaf and Sulieman, 1999).

Crude fat content of *B. aegyptiaca* kernel cake is higher than the crude fat content of sesame seed cake (1.4%), (Omar, 2002) and lower than that reported by Afaf and Sulieman, (1999) in groundnut cake (7.1.%), cotton seed cake (7.8 %) sunflower cake (13.9 %) and sesame seed cake (11.9 %). There are clear differences in the nutrient content of kernel cake and other types of cakes; this may be attributed to species differences, treatment of the seeds before oil extraction and/or method of oil extraction.

The variation in the chemical composition of the present work and that of other researchers may be attributed to species differences, the plant parts, the age of plant, (Norton 1994); climatic conditions, the state of hydration (fresh wilted or dry) (Palmer and Schlink, 1992) and drying procedure (Dzowela *et al.*, 1995).

DM degradability of all *B. aegyptiaca* parts increased from 6hrs incubation time and reached the maximum at 72hrs incubation time. The obtained values were comparable with that reported by, Fekadu and Ledin, (1997) and Tolera and Sundstol, (1999).

The leaves DM degradability rate was comparable with that reported by, (Ikhimioya *et al.,* 2005) in *Ficus exasperate* leaves. While, Elamin and Babiker (2000) recorded higher values for fractions a, b, a+b and c respectively from *Ficus sp, Acacia mellifera* and *Zizyphus spp* leaves.

The effective degradability of leaves in this study at these three out flow rates (k= 0.02, 0.05 0.08) agreed with the results obtained by Fekadu and Ledin (1997) and Ikhimioya *et al.* (2005) in the leaves of *Ficus exasperate*. Higher effective degradability of leaves at these different flow rate was reported in the leaves of *Tectonia grandus, Terminolia catappa* and *Spondias monbin* (Ikhimioya *et al.*, 2005).

The DM degradability of *Balanites aegyptiaca* kernel cake at different times of incubation in this study, increased from 6hrs incubation period to 36hrs and slowed up to 72hrs. This result was similar to that obtained by Nidaa (2008) and Aplang (2008) in groundnut cake and sesame seed cake respectively.

The degradation characteristics of *Balanites aegyptiaca* kernel cake are comparable with that reported by, Mahala and Assad, (2007), in *Fehderbia albida* pods; Nidaa (2008) and Aplang (2008) recorded higher values for fractions a, b, a+b and c respectively from Sesame meal, groundnut cake and sesame cake respectively, and lower values than that of the present work were reported by Mahala and Assad (2007), in sesame seed cake.

The effective degradability of *B. aegyptiaca* kernel cake dry matter in this study at the different flow rates (k= 0.02, 0.05 and 0.08) were 84.54%, 73.83% and 69.43%, respectively, a matter which is similar to the values in sesame seed cake (85.2, 74.8 and 70.5%), (Aplang, 2008) and higher than in groundnut cake (43.69%, 34.93% and 29.77%), (Nidaa.2008).

The crude protein (CP) degradation characteristics varied among the different plant fractions. These accords with the reports of Mahala and Assad (2007) who said that different parts of browse vary in degradation kinetics.

The kernel cake showed the highest soluble fraction (a) and this may be attributed to its low fibre content compared with the coat and leaves.

The coat showed the lowest effective degradability; this may be caused due to their contain high fibre content than the other parts; this accords with Van soest and Wine (1967), who found that the more lignified the forage the lower its degradability will be.

The flesh showed the highest effective degradability and this may be to its high soluble carbohydrates contents.

The (c) value of the kernel cake protein was higher than that of the other parts which showed that the kernel cake protein is more attacked by the rumen microbes than the other parts.

The leaves and coat showed comparable values for (a) and (c) to that reported by Elamin and Babiker, (2000), in *zizyphus sp* and *Acaciad mellifern* leaves. Lower values in all CP degradation characteristics than in the leaves of the present work are reported in plantin leaves (11.25) and dry ficus leaves (23), by Sudan and Ikhimioya *et al.* (2005) in Nigeria and Elamin and Babiker (2000), in the Sudan.

The coat of *Balanites aegyptiaca* showed comparable (a) values to that of mesquite pods (47.6) as reported by Batista, *et al.* (2002), the variation can be attributed to species differences. Lower CP soluble fraction for (a) than that of B.aegiptiaca cake was found in the mustard cake(MC), Groundnut cake (GNC), Cotton seed cake (CSC) and linseeds cake (LSC) as reported by Satoo *et al.* (1993). The previous authors reported higher b and c values for MC (59.4), GNC (87.54), CSC (56.56) and LSC (90.70) than that of *Balanites aegyptiaca* kernel cake of the current study.

The variation in the kinetics of CP degradation of this study and that of the other cakes may be explained by to species variation, methods of oil extraction and stage of plant maturity.

The variation in the degradability kinetics of the different *B. aegyptiaca* parts of this work with those findings of other workers may be attributed to species variation, environmental condition, stage of plant growth and differences in chemical composition.

Although the nylon bag technique was widely used to determine the degradation characteristics in the rumen (Orskov and McDonald 1979), there are many factors which may cause variations between the different research laboratories. Example of these factors are sample preparation, washing procedure, fistulated animals etc (Nocek 1988). Lack of standard of this technique may be responsible for the variation of the present work with those of other workers studies in rumen degradation characteristics.

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