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CHEMICAL COMPOSITION, *IN VITRO* GAS PRODUCTION, METABOLIZABLE ENERGY AND ORGANIC MATTER DIGESTIBILITY OF LEAVES AND SEED FRACTIONS OF THE TREE *BALANITE AEGYPTIACA*

(With 2 Tables and One Figure)

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SUMMARY

Chemical composition, *in vitro* gas production, metabolizable energy and organic matter digestibility of the tree *Balanites aegyptiaca* leaves and seed fractions were determined. The objective was to asses the potential of fruit and leaves of *Balanites aegyptiaca* as ruminant feed. Gas production was measured for 3, 6, 12, 24, 48, and 72 hours, and gas production kinetics were estimated using the equation $y=a+b(1\text{-}exp^{-ct})$. The results showed that, the crude protein (CP), crude fiber (CF), ether extract (EE) gas production, gas production kinetics, organic matter digestibility (OMD) and metabolizable energy (ME) were significantly different ($p<0.01$) between leaves and seed fractions. Seed kernel cake showed the highest CP content, OMD and lowest CF content, whereas the flesh showed the highest EE, Nitrogen free extract (NFE), gas production at all the time of incubation, gas production from the soluble and insoluble fractions, potential gas production and ME content. It is concluded that, kernel seed cakes, and flesh (pulp) of *B. agyptiaca* are outstanding and they have high potential as ruminant feed, as carbohydrate and protein supplement to low quality tropical basal diets. In addition to chemical analysis, *in vitro* gas production technique found to be a reliable predict to the nutritive value.

Key words: ***B.aegyptiaca seed cake, gas production, metabolizable energy***

INTRODUCTION

The tree *Balanites aegyptiaca*, (Hegleig) is indigenous to of Africa south of the Sahara (Hall and Walker, 1991). The tree is also found in India, Iran and Pakistan (Amalraj and Shankarnarayan, 1986). In the Sudan it has wide natural range, occurring in all climates (Badi *et al.*, 1989). In Africa *Balanites aegyptiaca* had been used as food and oil source (Von Maydell, 1986). The fleshy pulp of the fruit is eaten fresh or dried. It contains 64 – 72% carbohydrates, plus crude protein, (Abu Al-Futuh, 1983). Balanites seed kernel is considered as an extremely useful edible product. It contains good quality oil and high protein content (Abu Al- Futuh, 1983; Mohamed *et al.*, 2002). The extracted oil used for many uses and the remaining cake is used as animal feed (El-Nour *et al.*, 1985). The protein content of kernel ranged between 27% -37% (Abu Al-Futuh 1983; El Khideir *et al.*, 1983; Mohamed *et al.*, 2002; Elfeel, 2010).

Balanites aegyptiaca contributed up to 30% of the dry matter intake of goats in the dry season in Burkina faso (Hall and Walker, 1991). The kernel meal is used for fattening of sheep in the Sudan (Elkhideir *et al.*, 1983), for fattening other animals in Senigal (Vogt, 1995) and as stock feed in Uganda. (Katende *et al.*, 1995). The flesh (pulp) of *B. aegyptiaca* fruits contains, on average, 10.9% moisture, 2.7%ash, 1.4% protein, (Guinand and Dechassa lemessa, 2002).

It is not always possible to evaluate the nutritional characteristics of the individual feed component in a complex feeding experiment. For these reasons there have been a number of attempts to develop rapid, simple reliable and cheap *in vitro* methods which can be used to screen large numbers of raw materials and predict their digestibility and metabolizable energy contents. Menke *et al.* (1979) developed the *in vitro* gas production technique to evaluate the nutritive values of feedstuffs. The *in vitro* gas production is a method that detects a small difference among feedstuffs and allows more frequent sampling than the *in vitro* digestibility technique (DePeter *et al.*, 2003). The gas produced during fermentation can be used as an indirect measure of the dry matter degradability. The gas produced in 24 h from incubating 200 mg feed dry matter can be used together with the concentration of crude protein and ash to estimate metabolizable energy and organic matter digestibility

Menke *et al.* (1979). Gas production is associated with volatile fatty acid production following fermentation of the substrate so the more fermentation of a substrate the greater the gas production (Blummed and Ørskov 1993). The *in vitro* gas production technique has been found reliable to predict the nutritive value of feedstuffs (Maker *et al.*, 1996). *In vitro* gas production method has been used to compare different species of sorghum grain and forage quality (Streeter *et al.*, 1993; Opatpatanakit *et al.*, 1994).

The objective was to assess the potential of fruit and leaves of *Balanites aegyptiaca* as ruminant feed.

MATERIALS and METHODS

Collection of samples:-

Fresh ripe fruits of *Balanites aegyptiaca* were collected from Kordofan State local market. The seed were cleaned and sun dried and stored in bags for further processes.

Preparation of fruits and leaves:

The coat (outer cover) and the flesh (mesocarp) of the fruits were removed manually; then the flesh was sun- dried. The leaves were collected manually from the trees. The kernel was produced by mechanical decortication of the ripened fruit seed. The kernel cake was obtained by mechanical extraction of the oil, from the decorticated seeds, as described by Chapagain and Wiesman, (2005).

Chemical analysis:-

Proximate analysis for chemical components (dry matter (DM), crude protein (C.P) crude fiber (C.F), ether extract (E.E) and ash) were determined by the methods described by the AOAC (1990).

Gas production study:

Rumen fluid was obtained from two fistulated steers fed alfalfa hay ad libitum and 1 kg of concentrate mixture. The samples of fruits and leaves were incubated in the rumen fluid in calibrated glass syringe following the procedures of Menke and Steingass (1988). 200 milligrams (mg) dry weight sample was weighed in triplicate into calibrated glass syringes. The syringes were pre-warmed at 39° C before injecting 30 ml rumen fluid–buffer mixture into each syringe followed by incubation in a water bath at 39° C. The syringes were gently shaken for 30 min after the start of incubation and then after every hour for the first 10 hours of incubation. Gas production was recorded before incubation (0) and 3, 6, 9, 12, 24, 48 and 69 h after incubation. Total gas values were corrected for blank. Cumulative gas production data were fitted to the model of Ørskove and Mc Donald (1979) using the following equation.

P= a + b (1- exp $^{-ct}$). Where:

P: represent gas volume (ml) at time t.

a: the gas produced from immediately soluble fraction (ml).

b: the gas produced from insoluble fraction "but fermentable" (ml).

(a + b): the potential gas production (ml), and

c: the rate constant of gas production during incubation (ml h-1).

The OMD was calculated using equations of Menke *et al.* (1979) as follows:

OMD (%) = 14.88 + 0.889 GP + 0.45 CP + XA, Where

GP = 24 h net gas production (ml / 200 mg), CP = Crude protein (%)

XA = Ash content (%).

ME (MJ/kg DM) content was calculated using equations of Menke *et al* (1979) as follows: ME (MJ/kg DM) = 2.20 + 0.136 GP + 0.057 CP + $0.0029CP^2$.

Where .GP is 24 h .production (ml/200 mg).

CP = Crude protein: CF= Crude fiber.

Statistical analysis:

Data were subjected to one way analysis of variance (ANOVA) to compare gas production kinetics, OMD and ME values using the General Linear Model (GLM) according of statistica, (Analytical software, 2000). Significant differences between individual means were separated by the least significant differences using LSD procedure of the statisticx (analytical software, 2000). Differences between means were considered significant at $P \leq 0.05$. Standard errors of means were calculated from the residual mean square in the analysis of variance.

RESULTS and DISCUSSION

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

Part	DM%	EE%	CP%	CF%	Ash%	NFE%
Leaves	89.51 ±·.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±0.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 ($P<0.05$).

DM : Dry matter.
EE : Ether extract.
CP : Crude protein.
CF : Crude fibre.
NFE : Nitrogen free extract.
Sig : Significance level.
SEM : Standard error of means.
SD : Standard deviation.

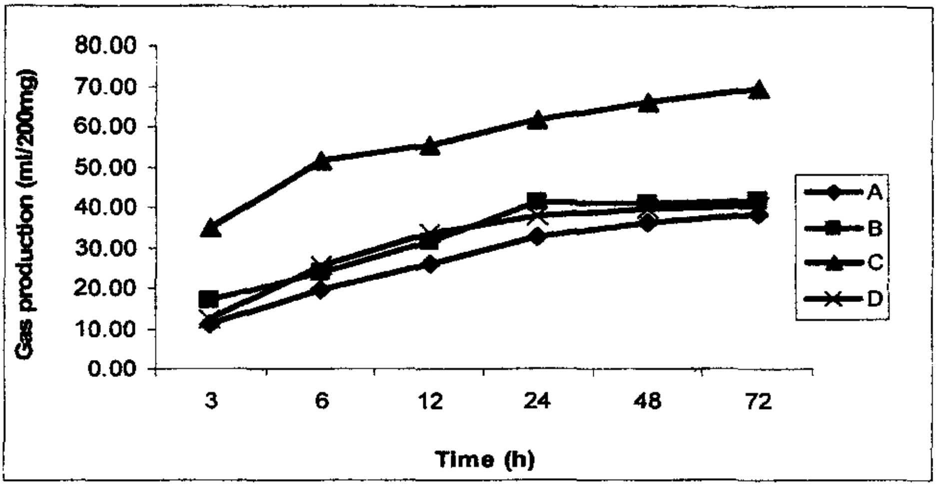

Figure 1: Data of gas production during the incubation period of leaves, coat (hull), flesh (pulp) and kernel seed cake of *B. agyptiaca.*

A . Leaves of *Balanites aegyptiaca.*

B . Coat of *Balanites aegyptiaca*

C . Flesh of *Balanites aegyptiaca*

D . Kernel cake of *Balanites aegyptiaca*

Table 2: Estimates of chemical components from the gas production of leaves, coat (hull), flesh (pulp) and kernel seed cake of *Balanites aegyptiaca* trees.

Part	a	b	a+b	c	OMD%	ME (MJ/kgDM)
Leaves	3.50[b]	33.73[ab]	37.22[b]	0.10[b]	72.72[b]	11.55[a]
Coat	9.73[ab]	21.97[b]	31.71[b]	0.16[b]	59.22[c]	8.99[b]
flesh	22.61[a]	44.85[a]	67.47[a]	0.13[b]	67.69[b]	11.61[a]
Kernel cake	-16.09[c]	46.70[a]	30.61[b]	0.25[a]	80.82[a]	10.40[a]
SEM	5.66	4.61	3.41	0.03	3.59	2.01

Means within the same column with differing superscripts are significantly different.
a= the gas production from the immediately soluble fraction (ml),
b= the gas production from the insoluble fraction (ml).
c= the gas production rate constant from the insoluble fraction (b).
a+b= Potential gas production.
ME= Metabolisable energy
OMD=Organic matter digestibility

The components of the different parts of *B. agyptiaca* is shown in Table 1. The dry matter (DM) and crude fibre (CF) content varied significantly ($p<0.05$) among the different parts. The highest DM and crude fibre (CF) content was observed in the coat while the kernel cake showed the lowest value. The crude protein (CP) content was variable ($p<0.05$). The highest CP content (47.11%) was found in the cake, followed by the leaves, coat and the lowest CP was observed in the flesh. Crude fat (CF) and NFE content varied significantly ($p<0.05$) among the pulp, kernel and leaves. The highest Crude fat (CF) and NFE content was observed in the flesh and the lowest content in the kernel cake. No significant differences were observed in the ash content among the different parts of *B. agyptiaca.*

Gas production of the leaves, coat (hull), flesh (pulp) and kernel seed cake of *B. agyptiaca* at different incubation periods is shown in the Figure 1. It Indicates variation in the B. *agyptiaca* degradability and digestability potential, As can be seen from Figure 1 the gas production at 24 h incubation time ranged between 36.00 and 61.00 per.200g of dry matter. The highest gas production was observed in the flesh, while the leaves showed the lowest gas production. The gas production at 24 h incubation time is consistant with those reported by Mahala and Fadel Elseed, (2007) for *A. nilotica* and *A. Senegal*enses tree in the Sudan and Babayemi *et al.* (2009) for *Albizia saman* and *Albizia rhizonse* in Nigeria.

Table 2 shows the parameters estimated from the gas production of leaves, coat (Hull), flesh (Pulp) and kernel seed cake of *Balanites aegyptiaca* trees.

Gas production from fermentable part (b) and potential gas production (a+b) were significantly ($p<0.001$) higher in flesh than in the leaves and this may due to high content of NFE in the flesh.

The rate of fermentation fraction (c) was significantly higher in seed than in leaves and the gas production of leaves and seed increased with increasing incubation time as reported by Mahala and Fadel Elseed, (2007); (Khazaal *et al.*, 1995).

Gas produced from fermentable fraction (*b*) and the potential gas production (*a+ b*) were significantly ($p<0.001$) higher in pods than in the leaves. This may be due to their higher content of CP and NDF and low content of TCT, whereas the potential gas production (*a +b*), is associated with degradability of feed.

The values of an estimated OMD at 48hrs of *B agyptiaca* varied between 59.22%, 67.69%, 72.72% and 80.82 for kernel seed cake, leaves, coat and flesh respectively. Organic matter digestibility (OMD) varied significantly between the kernel cake and the other parts of *B. aegyptiaca*. Kernel cake had the highest values and this may be attributed to high protein and ash content. OMO of Kernel cake was significantly higher than the values reported by Moboboki *et al.* (2005) for *Acacia* tree in South Africa.

ME content of from four different parts of *B agyptiaca* varied between 8.99 and 17.40 which is consistence with those reported by Moboboki *et al.* (2005); Ondiek *et al.* (2010) for *Acacia* trees in South Africa and Kenya respectively. The calculated Metabolisable energy (ME) content in the flesh was significantly higher than the other parts and this may be attributed to the higher gas production and NFE.

CONCLUSION

Pulp, kernel cakes, and leaves of B *agyptiaca* differed significantly with respect to components, *in vitro* gas production, OMD and ME. Kernel cake and flesh showed the highest values of *in vitro* gas production, OMD and ME. It is concluded that, flesh and kernel seed cake of *B. agyptiaca* have high nutritive and metabolizable energy content and therefore could be used for ruminants as feedstuffs and more so as protein and carbohydrate supplement to low quality tropical basal diet.

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