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Effects of Rabaa Ash Alkali Treatment of Sesame Straw on Chemical Composition and Degradation in the Rumen of Nubian Goats

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Abstract: Effects of Rabaa (*Trianthema pentandra* L.) ash alkali on sesame straw (*Sesamum indicum* L.) chemical composition and artificial fibre bags degradation in the rumen of three Nubian goats fed groundnut haulm were studied. The straw was treated with 0, 3, 5 and 8% Rabaa ash alkali forming diets USE, AT_1SE, AT_2SE and AT_3SE, respectively. The alkali affected the chemical composition by decreasing CF (40.01, 32.43, 34.94 and 34.92) and EE (1.40, 1.09, 0.96 and 1.08) and increased CP (4.52, 5.74, 5.80 and 4.94) and ash (7.84, 13.30, 14.67 and 19.63) for diets USE, AT_1SE, AT_2SE and AT_3SE, respectively. Increasing alkali level significantly increased ash and generally decreased CF and NFE. Increasing the alkali level had generally increased DM and OM degradation at 6, 12, 24 and 72 h. It also increased OM degradation at 6 and 72 h. Increase alkali level had increased DM, OM and CP degradation characteristics including the soluble fraction, the fraction degraded with time and total degradation. Hence it is concluded that Rabaa ash alkali treatment of straw will improve the quality of the sesame straw which could be adopted by farmers.

Key words: Chemical composition, degradation, sesame straw, Nubian goats

INTRODUCTION

Animal production in the Sudan is mainly traditional based on natural pastures which yield about 77.6 million tons DM or about 74.7% of animal feeds in the country (MAW National Strategy, 2002). Seasonal variations in pastures quantity and quality are associated with seasonal rainfall with serious shortages in feeds and deterioration in nutritive value in the dry season affecting livestock performance (Elhag, 1984). Crop residues which form about 19 million tons DM or about 22% of animal feeds (MAW National Strategy, 2002) are used to fill this nutritional gap. However, their nutritive value is low due to high fibres and low CP (Sundstol and Owen, 1984) limiting Dry Matter Intake (DMI) and consequently large amounts are wasted. Sesame is one of the main straws in the Sudan in the quantity and it is known among farmers that it is not preferred by animals and mostly unfed or fed untreated.

Many methods are widely used to improve the nutritive value and DMI of straws including physical, chemical and biological methods and their combinations (Preston, 1995). Many alkalis are used in upgrading straws, but are generally expensive, corrosive and affect soil characteristics (Preston, 1995). Alkalis from plants ash including coca pods (Smith and Osafo, 1987), wood dust (Ramirez *et al*., 1992), from dung ash (Didier *et al*., 2002) and Rabaa (Hamed and Elimam, 2008) are cheap and safe. Rabaa is a widely distributed weed in the Sudan and is high in ash and alkalinity and is used in traditional soap manufacturing.

Rabaa ash alkali improved sorghum stover chemical composition and rumen degradation in Nubian goats (Hamed and Elimam, 2008). Information on the methods of improving the nutritive value of sesame straw is scarce. Consequently, this experiment was conducted to determine the chemical composition and degradation characteristics of Rabaa ash alkali treated sesame straw in the rumen of Nubian goat in the Gezira, Sudan.

MATERIALS AND METHODS

This experiment was conducted at the Goat Research Centre, Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.

Preparation of Rabaa ash alkali treated sesame straw: Rabaa was collected from Elneshashiba farm in Wad Medani, Sudan, dried, ashed and dissolved in 100 l water at 0, 3, 5 and 8%. Sesame straw was treated with 0, 3, 5 and 8% Rabaa ash alkali forming diets USE, AT_1SE, AT_2SE and AT_3SE, respectively.

Degradation: Rabaa ash alkali treated sesame straw rumen degradation was measured by the artificial fibre bags technique described by Qrskov *et al*. (1980).

Artificial fibre bags: The bags were manufactured from nylon filter cloth with 30 μm^2 pores (H5013) made by Henry Simson Ltd., Special Product Division, P.O. Box 20, Stockport, Cheshire, England, SK3 0RT. The bags were 140 x 90 mm and made as described by Qrskov *et al.* (1980).

Animals: Three adult female Nubian goats about 1.5-2 years old and average body weight 25.0±1.5 kg were used in this experiment. They were fitted with permanent polythene rumen canulae with 40 mm internal diameters and 120 mm long. The animals were allowed a month to recover from the surgery and adapt to housing and feeding. The animals were housed in individual pens (1m x 2m).

Feeding: The goats were fed groundnut haulm *ad libitum* in two equal meals at 09.00 am and 04.00 pm. Concentrates (300 g) were offered daily for each animal in two equal meals before the groundnut haulm meals. Clean drinking water was available to each animal.

Incubation procedure: The nylon bags were thoroughly washed with tap water and dried in an oven at 100°C overnight. They were labeled, weighed empty, 5 g air dried samples were added and reweighed. They were then closed using 25 cm polyester cords, soaked in tap water, tied to a wire hook on the canulae covers and incubated for different times (6, 12, 24, 48 and 72 h). They were then thoroughly washed in tap water, dried in an oven at 100°C for 24 h and weighed again. Feeds residues in the bags for each incubation time were mixed for the three goats and stored in tight plastic bags. The residues were analyzed in triplicates for CP and ash as described by AOAC (1995).

Calculations: Degradation characteristics were calculated from the equation exponential equation described by Qrskov and McDonald (1979):

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

Where:

P: Is the degradation at the time (t), a: Is the soluble fraction of feeds, b: Is the part degraded with time, c: is the degradation rate of the b fraction.

Statistical analysis: Data was analyzed by ANOVA for completely Randomized design using the general linear model procedure (SAS, 1997). Mean comparison was carried out by the Scheffes test with an alpha level of 0.05.

RESULTS

Table 1 shows the effects of Rabaa ash treatment on the chemical composition of sesame straw from Gadarif area, Sudan.

The dry matter was generally high (96.10-96.57%) with significant ($p<0.05$) differences among USE and AT_2SE and AT_3SE. Ether extraction was generally low in all treatments (0.96-1.40%). All treatments were almost similar in EE except AT_2SE which had significantly ($p<0.05$) the least EE. Crude protein was also generally low in all treatment (4.52-5.8%). Rabaa ash alkali had significantly ($p<0.05$) increased the CP compared to untreated sesame straw. However this increase was not significant ($p>0.05$) for AT_3SE. Treatment AT_1SE was very close to AT_2SE. Rabaa ash alkali had significantly ($p<0.05$) decreased CF compared to untreated sesame straw. There were no significant ($p>0.05$) differences between AT_2SE and AT_3SE in CF and they were significantly ($p<0.05$) highest compared to AT_1SE. Rabaa ash alkali had significantly ($p<0.05$) increased ash in sesame straw. Ash was significantly ($p<0.05$) increased with increasing the alkali. Nitrogen free extract was significantly ($p<0.05$) increased with 3% Rabaa alkali and decreased with 5 and 8% alkali compared to untreated straw.

Table 2 shows the dry matter, OM and CP degradation of Rabaa alkali-treated sesame straw in the rumen of Nubian goats.

The dry matter degradation was increased with increasing the incubation times for all treatments. Dry matter degradation at 6 h incubation varied among treatments and was significantly ($p<0.05$) the highest for AT_3SE and the least for the untreated. At 12 h incubation difference among treatments were small and not significant ($p>0.05$) and DM degradation was generally decreased with increasing alkali level. At 24 h incubation DM was increased with increasing alkali level and was significantly the highest for AT_3SE and the least for the untreated. At 48 h differences among treatments were not significant ($p>0.05$). It was highest for treatment AT_2SE and was the least in the untreated. There were variations among treatments in DM degradation at 72 h and it was the highest for AT_3SE and the least for untreated.

Generally increasing alkali level had increased the DM degradation of sesame straw except at 12 h. The overall effects show that AT_3SE had the highest optimum effects on DM degradation of sesame straw followed by AT_1SE, AT_2SE and the untreated.

Generally OM degradation was increased with increasing incubation time. The organic matter degradation at 6 h incubation was generally increased with increasing Rabaa alkali level but not significantly ($p>0.05$). It was the highest for AT_2SE and the least for the untreated straw. At 12 h incubation, OM degradation decreased with increasing Rabaa alkali level. It was the highest for the untreated straw and the least for AT_3SE. At 24 h incubation, OM degradation varied among treatments but not significantly ($p>0.05$). It was the highest for AT_3SE and the least for AT_2SE. AT 48 h incubation OM degradation varied among treatments but not significantly ($p>0.05$). It was the highest for AT_1SE and was the least for AT_3SE. At 72 h OM degradation varied among treatments but not significantly ($p>0.05$)

Table 1: The effects of Rabaa alkali treatment on the chemical composition of sesame straw from Gedarif area, Sudan

Treatment	DM	EE	CP	CF	Ash	NFE
USE	96.5a± 0.32	1.40^{a}± 0.27	4.52^{b}± 0.25	40.0^{a}± 1.29	7.84^{d}± 0.10	46.2^{b}± 0.90
AT1SE	96.3^{ba}± 0.12	1.09 ^{a}± 0.13	5.74^{a}± 0.32	32.4^{c}± 0.01	13.3^{c}± 0.15	47.4^{a}± 0.50
AT2SE	96.1^{b}± 0.07	0.96 ^{b}± 0.06	5.80^{a}± 0.24	34.9^{b}± 0.01	14.6^{b}± 0.35	43.6^{c}± 0.26
AT3SE	96.1^{b}± 0.04	1.08^{a}± 0.13	4.94^{b}± 0.29	34.9^{b}± 0.02	19.3^{a}± 0.05	39.7^{d}± 0.43
S.E.M	0.07	0.06	0.18	0.85	1.24	0.91
C.V%	0.18	14.7	5.27	1.81	1.44	1.30

USE = Untreated sesame straw. AT_1SE, AT_2SE and AT_3SE stand for Rabaa alkali-treated sesame straw at 3, 5 and 8% respectively.
S.E.M = Standard error of mean. Means in the same column with different superscripts are significantly ($p<0.05$) different.
C.V (%) = Coefficient of variation

Table 2: The dry matter, OM and CP degradation of Rabaa alkali-treated sesame straw in the rumen of Nubian goat in the Gezira, Sudan

Treat/time	6	12	24	48	72
DM: USE	14.09^{b}	27.15^{a}	31.27^{b}	40.20^{a}	40.89^{c}
AT_1SE	22.34^{a}	27.15^{a}	34.02^{ba}	49.14^{a}	51.20^{ba}
AT_2SE	23.71^{a}	25.78^{a}	34.71^{ba}	45.70^{a}	49.83^{bc}
AT_3SE	24.42^{a}	25.09^{a}	39.52^{a}	42.95^{a}	59.45^{a}
S.E.M	1.42	0.99	1.40	2.05	2.30
C.V%	2.73	3.86	4.37	7.29	4.76
OM: USE	10.22^{a}	23.27^{a}	27.67^{a}	36.61^{a}	37.36^{b}
AT_1SE	14.29^{a}	19.45^{a}	26.43^{a}	42.86^{a}	46.98^{ba}
AT_2SE	15.30^{a}	17.07^{ba}	25.85^{a}	38.73^{a}	42.43^{ba}
AT_3SE	11.08^{a}	11.17^{b}	28.39^{a}	32.31^{a}	50.98^{a}
S.E.M	1.03	1.70	1.17	2.33	2.01
C.V%	3.28	4.36	4.57	8.22	5.26
CP: USE	6.06^{c}	27.27^{c}	36.36^{b}	43.94^{b}	14.14^{c}
AT_1SE	28.20^{b}	28.20^{c}	39.74^{b}	57.69^{a}	62.82^{a}
AT_2SE	41.97^{a}	39.51^{b}	41.97^{b}	38.89^{b}	43.31^{b}
AT_3SE	43.60^{a}	55.07^{a}	50.72^{a}	23.19^{c}	44.93^{b}
S.E.M	4.56	3.51	1.82	4.11	5.37
C.V%	2.03	3.72	3.54	7.10	4.33

USE = Untreated sesame straw. AT_1SE, AT_2SE and AT_3SE stand for Rabaa alkali – treated sesame straw at 3, 5 and 8% respectively.
S.E.M = Standard error of mean. C.V (%) = Coefficient of variation. Means in the same column with different superscripts are significantly ($p<0.05$) different

Table 3: The *in sacco* degradation characteristics of Rabaa alkali treated sesame straw

Treat	USE	AT_1SE	AT_2SE	AT_3SE	S.E.M	C.V (%)
DM: a	8^{d}	16^{b}	14^{c}	17^{a}	1.06	3.64
b	34^{c}	35.2^{b}	35.8^{b}	42.4^{a}	1.00	1.36
p	42^{d}	51.2^{b}	49.8^{c}	59.4^{a}	1.87	0.99
c	0.040^{a}	0.040^{a}	0.040^{a}	0.030^{b}	0.00	0.000002
OM: a	8.33^{c}	9.83^{b}	11.3^{a}	8.33^{c}	0.38	3.05
b	29.3^{d}	36.8^{b}	31.3^{c}	42.3^{a}	1.53	0.83
p	37.8^{d}	46.8^{b}	42.8^{c}	50.8^{a}	1.45	0.65
c	0.05^{a}	0.035^{a}	0.035^{a}	0.038^{a}	3.18	
CP: a	8^{d}	16^{c}	22.5^{b}	38^{a}	3.32	2.37
b	35.9^{b}	46.5^{a}	22.5^{c}	12.5^{d}	3.90	1.70
p	43.9^{d}	62.5^{a}	45.0c	50.5^{b}	2.23	0.99
c	0.060^{a}	0.031^{a}	0.065^{a}	0.085^{a}	0.12	

USE = Untreated sesame straw. AT_1SE, AT_2SE and AT_3SE stand for Rabaa alkali-treated sesame straw at 3, 5 and 8% respectively. a = Readily degradable fraction. b = Slowly degradable fraction. p = Degradable fraction; c = Degradation rate. SEM = Standard error of mean. C.V (%) = Coefficient of variation. Means in same row with different superscripts are significantly ($p<0.05$) different

and was generally increasing with increasing alkali level. It was the highest for AT_3SE and the least for the untreated straw. The overall degradation was higher for AT_1SE and least for AT_3 SE.

The crude protein degradation was generally increased by increasing incubation time. At 6, 12, 24 and 72 h, CP degradation was generally increased with increasing alkali level. At 48 h this order was reversed. At 6, 12 and 24 h treatment AT_3SE had the highest CP degradation and the untreated straw had the least degradation. At 48 h treatment AT_1SE had the highest CP degradation and AT_3SE had the least value. At 72 h treatment AT_1SE had the highest CP degradation and the untreated had the least. This shows that CP degradation was generally increased with increasing Rabaa alkali level and the over all degradation was highest for AT_3SE and was the least for the untreated.

Table 3 shows the *in sacco* degradation characteristics for Rabaa alkali-treated sesame straw.

Rabaa alkali treatments had significantly ($p<0.05$) increased the readily soluble fraction, slowly degradable and degradable fractions of DM compared with USE.

The degradation characteristics except the degradation rate were significantly ($p<0.05$) highest for AT_3SE compared with other treatments. The readily soluble, slowly degradable and degradable fractions of OM were generally increased with increasing Rabaa alkali level. The readily soluble fraction was significantly ($p<0.05$) highest for AT_2SE compared with other treatments. The slowly degradable and degradable fractions were significantly ($p<0.05$) highest for AT_3SE. The degradation rate varied among treatments but not significantly ($p>0.05$). It was the highest for the untreated and almost similar for the other treatments. The degradation characteristics of CP were generally increased for Rabaa alkali treatments compared with USE. The slowly degradable fraction of CP varied among treatments and was the least for AT_3SE followed by AT_2SE and was the highest for AT_1SE compared with USE and other treatments. Increasing Rabaa alkali level had significantly ($p<0.05$) increased the readily soluble and the degradable fractions and none significantly the degradation rate of CP compared with USE.

DISCUSSION

Sesame straw had lower CP and higher CF as for all straws (Sundstol, 1981). The small decline in EE could be due to increased oil extraction with increasing alkali level.

The increased CP with increasing alkali level could be due to delignification and differential solubilization of nutrients associated with alkali.

The marked significant decline in CF with alkali treatment was similar to that for sorghum stover, but was higher for sesame. This could be genetic and was more beneficial than for sorghum stover. It indicated that the higher the CF in straws, the more pronounced are the effects. The increased ash with increasing Rabaa ash alkali level was mainly because ash was the origin of the alkali and ash contaminates were likely to increase with increasing alkali level. These results were similar to those found by Maeng *et al.* (1971); Alawa and Owen (1984) and Didier *et al.* (2002).

Rumen degradation of sesame straw: The increased sesame straw DM, OM and CP degradation by alkali treatment was similar to that found for sorghum stover (Hamed and Elimam, 2008). This effect was also similar to that found by Smith and Osafo (1987) for crop residues using cocoa-pod ash alkali. This could be due to the increased nutrients solubilization and reducing sugar release induced by alkali treatments (Wang *et al.*, 2004). Wang *et al.* (2004) found that 80 h DM degradation was increased with alkali treatment. Gambe hay degradation was also increased by alkali treatment (Lufadeju *et al.*, 1986).

The effects of alkali level on DM, OM and CP degradation were not consistent, but generally they were increased with increasing alkali level. This pattern was in line with that for sorghum stover (Hamed and Elimam, 2008). The variations in response to alkali treatment between sorghum and sesame straw could be due to chemical composition, cell wall structure indicating genetic and/or environmental variations.

Degradation characteristics: Alkali treatment had generally increased DM, OM and CP (a), (b) and (p) values compared to the untreated straw. This effect was in line with that found for sorghum stover (Hamed and Elimam, 2008). The highest alkali level had the highest (a) value. This indicated that alkali treatment had affected the chemical composition, cell wall and likely increased delignification, nutrients solubilization and reducing sugars release. It could be concluded that Rabaa ash alkali treatment improved the nutritive value of sesame straw.

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