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Improvement of millet *Pennisetum glaucum* straw as animal feed Using physical and chemical treatment

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Abstract

This study was carried out at North Darfur State, Sudan. The main objective of the study is to improve the nutritional value of agricultural residues and use techniques methods to take advantage of animal feed at the level of the farmer. The methods which used in study involve physical and chemical treatments for millet straw. The mechanical treatments were chopping (by machines with knives or flails) cuts the blades of straw into relatively long sections (from 1 to 10 cm) and grounding by hammer mill into relatively ground (from 2 to 5 mm). the chemical treatment were used three steps including preparation of urea solution, sprinkling of solution on straw and pressing the straw during treatment process, have been eliminated which resulted in saving labour by 55%. The results define of chemical treatment was CP% both in the ground and chopped form (14.58 and 14.61 respectively) compared with untreated straw (7.8 and 11.9 respectively). The study concluded that unwise the new method of urea treatment of millet straw is simpler with less involvement of labour. However, for binding of nitrogen it is 30% less efficient than the conventional urea treatment method.

Key words: North Darfur State, millet straw, urea treatment, chopping, improvement.

Introduction

Millet (*Pennisetum glaucum*) is the second most important cereal staple food crop grown in Sudan, Sorghum being the first crop. The area under millet is estimated at 2.5 million ha about 95% of which is found in Western Sudan namely Darfur and Kordofan Regions. Mean grain and straw yields of pearl millet for the years 2010-2014 were 0.45 and 6.6 million ton respectively. These were obtained from a harvested area of 0.55 million ha (Ministry of Agriculture, North Darfur State, May 2015). In Darfur straw is used as building materials, for fuel and as animal feed. The nutritive value of millet straw is generally low resulting in low feed intake and animal performance. Crop straws partly resist rumen degradation so their digestion is far from complete leading to reduced dry matter intake (DMI) because of limits to rumen capacity due to a long retention time in the rumen (Fadlalla et al. 1987). This is

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mostly related to their specific cell wall structure and to chemical composition, but also to deficiencies of nutrients essential to ruminal micro-organisms, such as nitrogen, sulphur, phosphorus and cobalt (Feng, 1996).

Different methods are available to improve the nutritive value and DMI of straws including physical, chemical and biological methods and their combinations. However, most procedures are costly, laborious, hazardous and not feasible in rural areas.

Therefore, the strategy for improving production should be to optimize the efficiency of utilization of the available feed resources, and thereby attempt to maximize animal production (Jayasurya, 2001). The present study aims at improving the nutritive value of millet straw as feed for ruminants using physical (grinding) and chemical (urea) treatments and thereby enhancing performance.

Material and methods

Study area

The study was carried out at North Darfur State, Sudan. The state lies between latitudes 12° 30' and 21° 55' *N* and longitudes 24° 00' and 27° 30' *E* within the arid and semi-arid zones. Based on average annual rainfall amounts and soil types the state can be divided into two main geographical zones namely desert and semi-desert. The area of the state amounts to 296,400 km^2; about 60% of it is rangelands.

Experimental design and dietary treatments

A 100 kg of ground millet straw were treated with 4 kg of urea dissolved in 50 liters of water and 1% salt was added. Straw was then stored in a plastic bags after thorough mixing Likewise a 100 kg of chopped millet straw were treated similarly and stored in plastic bags after thorough mixing. The urea treated straw bags were pressed during treatment process, sealed to exclude air and stored under air-tight conditions for three weeks at room temperature. Straw was dried under the sun before feeding to animals the local name of the millet variety used in the study is Dimbi.

A4x4 Latin square design was used where four desert rams, about one year of age and weighing 23.5 kg on average were bought from local market and treated against endo-

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and ecto-parasites. Four experimental diets were then offered to rams for a three week preliminary period followed by a 10 day experimental period to determine digestibility and dry matter intake. During experimental period feed offered, refusals and faeces were collected dried and weighed. The diets were ground urea treated ground millet straw (A), ground untreated millet straw (B), chopped urea treated millet straw (C) and chopped untreated millet straw (D).

Chemical analysis of diets

Samples of the experimental feeds were analyzed for dry matter, ash, crude protein, ether extract, crude fiber, nitrogen free extract and ADL. Crude protein was determined by the Kjeldahl method and the minerals were determined by atomic absorption spectrophotometry.

Data analysis:

Data were subjected to ANOVA using a Statistix 9 program.

Results and discussion

Table (1) shows the chemical composition of millet straw under different treatments. Treatment with urea resulted in increased CP% both in the ground and chopped form (14.58 and 14.61% respectively) compared with untreated straw (7.8 and 11.9% respectively). Neutral detergent fiber was also lower in urea treated straw compared with untreated both in the ground and chopped form (62.50 and 66.0 % respectively) compared with untreated straw (65.50 and 72.50% respectively).

The crude protein values of millet straw in this study were comparable with values reported by Fall et al. (2005) and Redden (2012) , However the values were higher than \the 4.4% for natural grass in Botswana harvested at full maturity (APRU, 1975). Content of CP of pearl millet straw in the present study was higher than that of pearl millet straw in studies by Elnazeir and Suaad (2013), Ramana (1990) and Mattoni et al. (2007). This variation among studies may be due to environmental factors, including location, climate, soil fertility and soil type. It might also involve varietal differences. The mean CP in the present study (9.8%) was higher than that obtained for grain sorghum stover tested by Youngquist et al (1990) in Botswana. It was also

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higher than the mean of 6.2% for grain sorghum residue reported by Snyman and Joubert (1995) in South Africa. Kamalamma Krishnamoorthy et al. (1996) also recorded lower amounts of CP% for finger millet straw than was observed in the present study.

Table (1): Chemical composition of experimental diets

Treatments	DM%	ASH%	C.P%	EE%	CF%	NDF%	ADL%
Ground+ urea (A)	94.90	28.98	14.58	0.40	31.20	62.50	28.50
Ground (B)	94.80	17.50	7.8	2.40	29.40	65.5	28.00
Chopped +urea (C)	94.00	13.62	14.61	1.60	34.80	66.50	27.50
Chopped (D)	92.20	13.91	11.9	1.20	30.20	72.50	28.50

DM = Dry matter; E.E. = Ether Extract; CP = Crude protein; CF = Crude fiber; NDF = Neutral detergent fiber; ADL = Acid detergent lignin

Data on digestibility are presented in Table 2. Urea treatment had a positive influence on millet straw digestibility. Dry matter digestibility of urea treated millet straw was higher both when straw was ground or chopped (64.1 and 65.0% respectively) compared with that of untreated straw (56.5 and 52.4% respectively). The improvement in digestibility could be attributed to an enhancement of rumen microbial activity as a result of increased nitrogen. Ground untreated millet straw also had a higher digestibility than untreated straw in the chopped form, however the difference was not significant ($P>0.05$). Grinding usually avails a larger surface area for microbial action by breaking the lignin bonds of straw and exposing cellulose and hemicelluloses for microbial degradation.

Table (2) Effect of treatments on dry matter digestibility of millet straw (%)

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Ram No	Diet physical form			
	Ground+ urea (A)	Ground (B)	Chopped+ urea (C)	Chopped (D)
11	62.0(1)	50.0(2)	66.0(4)	54.5(3)
22	65.5(4)	54.0(3)	67.0(1)	46.0(2)
33	61.0(2)	61.0(4)	60.0(3)	54.0(1)
44	68.0(3)	61.0(1)	67.0(2)	55.0(4)
Mean	64.13	56.5	65.0	52.4
LSD	P< 0.05 =2.53 0.01			
	P<0,0 =3.83		3.83	

Effect of treatments on dry matter intake of millet straw by rams is presented in Table 3. Ram weights were averaged for all treatments and periods and mean ram weight of 25.4 kg was obtained. Metabolic body was calculated as 11.32 Wkg0.$^{75.}$ Dry matter intake was not significantly different between treatments it was 3.2 to 3.3 % of live body weight. When intake was expressed in terms of metabolic body weight it was in the range of 71.3 to 75.0 g/kg W $^{0.75}$. A similar result was found by Shehata and Nour (1986) where addition of urea or urea and molasses to millet straw and rice straw in complete chopped or ground diets did not increase feed intake. Data by other authors supported this finding (Abdullah and Wanyoike, 1987; Pond et al., 1995) However, voluntary intake of millet straw may be limited by physical factors causing

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low rates of passage, Grinding usually breaks the lignin bonds of the cell wall and exposes a larger surface area to rumen microbial action, resulting in faster removal of digest a from the rumen.

This fast removal of residues from the rumen allows more feed intake from ground feeds. However in some cases very fine grinding may limit intake due to dust. In the present study dry matter intake by sheep fed urea treated millet straw was slightly higher than those given millet straw without addition of urea but differences were not significant.

Table (3) Mean voluntary dry matter intake (DMI)

Parameter/ diet	Ground+ Urea A	Ground B	Chopped+ Urea C	Chopped D
Number of sheep	4	4	4	4
DMI (g / day)	848.0	807.3	848.6	834.3
DMI (g / kg $W^{0.75}$)	74.9	71.3	75.0	73.7
DMI (kg / 100 kg BW)	3.3	3.2	3.3	3.3

Conclusion

Treatment of millet straw with urea may be an appropriate technology for smallholder farmers in North Darfur, Sudan. Urea is available and can be used to enhance dry matter digestibility of millet straw both when offered in the chopped or ground form. A positive effect of urea treatment of millet straw on dry matter intake was not established in this study and requires further research.

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