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In Vitro DIGESTIBILITY AND *In Situ* DEGRADABILITY OF SUGARCANE BAGASSE TREATED WITH UREA AS ENERGY SOURCE IN TOTAL MIXED RATION FOR GOAT

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ABSTRACT: This study was carried out to investigate the effect of replacing sorghum grains (SG) by sugarcane bagasse treated with 5% urea (SCBU) as energy source in total mixed ration. *In vitro* dry matter digestibility (IVDMD) and *in situ* DM degradability were adopted to conduct the experiment. In order to meet the nutrient requirement of goat, the following four iso-caloric and iso-nitrogenous rations were formulated: A= 0% SCBU (control); B= 2.6% SCBU replaced 10% SG; C= 5.2% SCBU replaced 20% SG; and D= 7.8% SCBU replaced 30% SG. The IVDMD was significantly (P≤0.05) affected by dietary level of SCBU which was decreased gradually with increasing SCBU levels in examined rations. Ration A gained the highest value of IVDMD (88.50%) followed by ration B (84%), C (78%) and D (74.50%). An *in situ* DM degradability results showed that the readily soluble fraction (a), slowly fermented material (b) and the potential degradability (PD) were significantly (P≤0.05) higher for ration A than rations B, C and D. Although DM digestibility and degradability of rations B, C and D were decreased with progress level of SCBU in the rations, the values obtained from present study might be considered within the range of moderate to high level of digestibility and degradability especially ration B which replaced 10% of SG. More research is needed to study the effect of replacing SG by SCBU regarding the nutrients intake, animal performance in an *in vivo* experiment and to determine its economic feasibility.

Keywords: Sorghum Grains, Bagasse, Urea, Energy, Total Mixed Ration

INTRODUCTION

To address problems associated with poverty and food shortage, scientists investigated alternative food sources, evaluated present land use and utilization of food, thus feeding grains to ruminants is questioned because man and monogastric can utilize grains directly. On the other hand ruminants are characterized by their ability to convert low quality roughage to high nutritive products, which are useful to man e.g. (meat, milk, natural fibers, leather and manure) (Gertenbach and Dugmore, 2004).

Agricultural by-products such as bagasse have enough potential to be used as non-conventional roughage for animal feed in Sudan, particularly when forages are in short supply. Bagasse is the main byproduct of sugarcane industry; it contains 60 to 70% carbohydrate, mostly in the form of polysaccharides and is a potential source of dietary energy for animals. The major limitation of bagasse as feed is its low digestibility which is due to association of lignin with cellulose and hemicelluloses (Atta Elmnan et al., 2007, 2009, 2011, 2015).

To improve the nutritive value of these agriculture residues, it is important to breakdown the linkages among cellulose and lignin by mechanical, chemical or biological and combined biological plus chemical treatments. Many scientists suggested the use of ammonia and urea to increase the crude protein contents of the poor quality roughages (Shoukry et al., 1992, Fouad et al., 1998, Atta Elmnan et al., 2007, 2009, 2011). However, chemically and physically treated crop residues and other poor quality forages have been investigated extensively throughout the last years; there have been limited research studied the inclusion of these treated materials in total mixed ration (TMR) in Sudan.

The aim of the present study was to investigate the possibility of replacing sorghum grains by 10%, 20% and 30% of treated baggasse, which represent 2.6%, 5.2% and 7.8% of total ration component, respectively. The specific objectives were to determine the effect of inclusion different levels of treated bagasse instead of sorghum grains on *in vitro* dry matter digestibility and *in situ* dry matter degradability.

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MATERIALS AND METHODS

Experimental site

The experiment was conducted at the laboratory of department of animal nutrition, faculty of animal production, university of Khartoum, Sudan.

Feeds preparation

Four iso-caloric and iso-nitrogenous rations were formulated Table 1 to meet the daily nutrient requirement of goat according to NRC (1985). Table 2 showed the ingredients of the different rations which can be namely as follow: A= 0% SCBU (control); B= 2.6% SCBU replaced 10% SG; C= 5.2% SCBU replaced 20% SG; D= 7.8% SCBU replaced 30% SG.

Table 1 - Calculated Chemical Analysis of Experimental Rations

Term \ Treatments	A	B	C	D
CP (%)	12.92	12.86	12.92	12.57
ME (MJ/Kg DM)	10.43	10.08	9.81	9.59

A: 0% of treated bagasse, B: contained 2.6% treated sugarcane bagasse which replaced 10% of sorghum grains, C: contained 5.2% trea sugarcane bagasse which replaced 20% of sorghum grains and D: contained 7.8% treated sugarcane bagasse which replaced 30% of sorgh grains.

Table 2 - Ingredients (%) of the experimental diets

Term \ Treatments	A	B	C	D
Sorghum	26.00	23.40	20.80	18.20
Treated bagasse	0.00	2.60	5.20	7.80
Molasses	33.00	35.00	32.00	30.00
Groundnut cake	6.00	8.00	8.00	7.00
Wheat bran	34.00	30.00	33,00	36,00
Salt	0.50	0.50	0.50	0.50
Lime stone	0.50	0.50	0.50	0.50
Total	100	100	100	100

A: 0% of treated bagasse, B: contained 2.6% treated sugar cane bagasse which replaced 10% of sorghum grains, C: contained 5.2% treated su cane bagasse which replaced 20% of sorghum grains and D: contained 7.8% treated sugar cane bagasse which replaced 30% of sorghum grains.

Chemical Analysis

Samples of feed examined and residues were analyzed for their proximate components, dry matter (DM), ash, ether extract (EE), crude protein (CP), crude fiber (CF) according to AOAC (1990). While nitrogen free extract (NFE) calculating using the following equation: NFE% = DM – (CP% + EE% + ash% + CF %).

In- vitro Dry Matter digestibility

The two steps procedure was used for *in vitro* determination of digestibility of rations using four replicates to all treatments. Rumen liquor was collected by stomach tube from four mature goats. In the first step, dried rations were incubated in test tubes with rumen fluid. The tubes also contain buffer solution, macro-minerals, trace-minerals, nitrogen sources, and reducing agents to maintain pH and provide nutrients required for growth of rumen bacteria. Because oxygen is toxic to rumen bacteria, solutions are gassed with carbon dioxide to maintain anaerobic conditions, and temperature is held at 39°C (body temperature) during the incubation. In the second step, after 48 hours of incubation, an enzyme solution is added to stimulate digestion in the small intestine (Tilley and Terrie, 1963).

In situ dry matter degradability

Degradability study of was carried out in the rumen of two fistulated adult Nubian goat according to the nylon bag technique described by Ørskov et al., (1980). The fistulated animal was fed at maintenance level on a balanced roughage concentrate diet with free access to water and mineral blocks. The feeds were ground through a 3-mm sieve and three replicate samples of each, weighing about 5g, were put into nylon bags and incubated in the rumens of two fistulated adult Nubian goats to determine the degradability of the dry matter. The incubation periods were 4, 8, 16, 24, 48, 72 and 96 hrs Washing losses were determined in triplicate by weighing about 5g of each feed sample into nylon bags, soaking them in warm water (39° C) for an hour and subsequently washing the bags in a washing

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machine as was done for those incubated in the rumen and finally drying the samples in an oven (60°C) for 48h. The course of degradation of the feeds was described by using the equation of McDonald (1981), p -a + b (1 - e-ct).

Statistical analysis

Data obtained from experiment were subjected to analysis of variance (ANOVA) according to Completely Randomize Design. Where the F test was significant, Means between treatments were compared using the least significant difference (LSD).

RESULTS AND DISCUSSION

In-vitro dry digestibility of tested rations

The results of *in vitro* dry digestibility (IVDMD) was significantly affected (P≤0.05) by dietary level of treated sugarcane bagasse (SCBU) which was decreased gradually with increasing treated bagasse levels in the rations Table 3. Treatment A (0% SCBU) secured the highest value of IVDMD, in contrast ration D (7.8% SCBU) recorded the lowest value. This result implies that microbes in treatment A had high nutrients uptake, readily available energy and protein contents which might had improved microbial growth and fermentation (Chatterjee et al., 2006). Although, the four diets were iso-caloric and iso-nitrogenous the IVDMD was decreased with the increasing percentage level of treated bagasse, this may be due to longer retention time of the high fiber rations in association with low soluble carbohydrates since the SG was replaced by 10%, 20%, and 30% of SCBU for rations B, C and D respectively. There are several previous studies proved that the fiber fraction of a food had the greatest influence on its digestibility. Adewusi and Matthew (1994) and Atta Elmnan et al. (2007, 2009, 2011) reported that the increase of CF content in diet resulted in decreases in DM digestibility. The major limitation of bagasse as feed is its low digestibility which is due to association of lignin with cellulose and hemicelluloses (Atta Elmnan et al., 2009; 2011). Ensminger et al. (1990) reported that bagasse has high fiber content which resulted in low dry matter digestibility (25%). The same result was obtained by Jayasuriya (2000), Chappidi et al. (2014) who reported that the increase in the roughage component of the total mixed ration decreased the IVDMD. Similarly, Hindrchsen et al. (2002) concluded that the large proportion of lignified cell wall of fibrous materials leading to attachment difficulty by rumen microorganisms resulted in low DM digestibility.

As can be observed from the current study the IVDMD is very high than the result reported by Ensminger et al. (1990), this could be explained by the fact that bagasse in the present study was inclusion in total mix ration after treated with urea resultant in high IVDMD. Maximum benefits from agricultural/agro-industrial by-products as feed will be achieved when the deficient nutrients like energy, protein and minerals were supplemented to these materials which resulted in promoting the efficiency of rumen microbes' growth and thus increased digestibility (Aletor, 2010). Also Ahmed and Fadal Allseed (2007) reported that the higher fermentable carbohydrates, available nitrogen, better nutrient availability for rumen microbes was achieved when crop residues supplemented with concentrates.

Table 3. *In vitro* dry matter digestibility (%) of tested rations

Treatments	IVDMD%
A	89[a]
B	84[b]
C	78[c]
D	75[d]
SEM±	1.4

A: 0% of treated bagasse, B: contained 2.6% treated sugar cane bagasse which replaced 10% of sorghum grains, C: contained 5.2% treated sugar cane bagasse which replaced 20% of sorghum grains and D: contained 7.8% treated sugar cane bagasse which replaced 30% of sorghum grains. SEM standard error of means: a-d means with different superscripts in the same column were significantly different (P≤0.05).

In-situ DM degradability of tested rations

Figure 1 showed the result of *in-situ* degradability of the tested rations during incubation time which extended from 0 to 96 hours. There was an increase in DM disappearance associated with increasing incubation time, while the increasing level of treated bagasse associated with reduction in DM disappearance. Obviously the low degraded materials recorded by rations B, C and D could be justify by the high fiber content in these rations. Generally high crude fiber content of feed stuff which bound to the cell walls and thus mostly unavailable to microbial enzymatic to attack the feed, resulted in low degradability (Nherera et al., 1998; Atta Elmnan and Hawa, 2011; Atta Elmnan et al., 2007; 2009; 2011).

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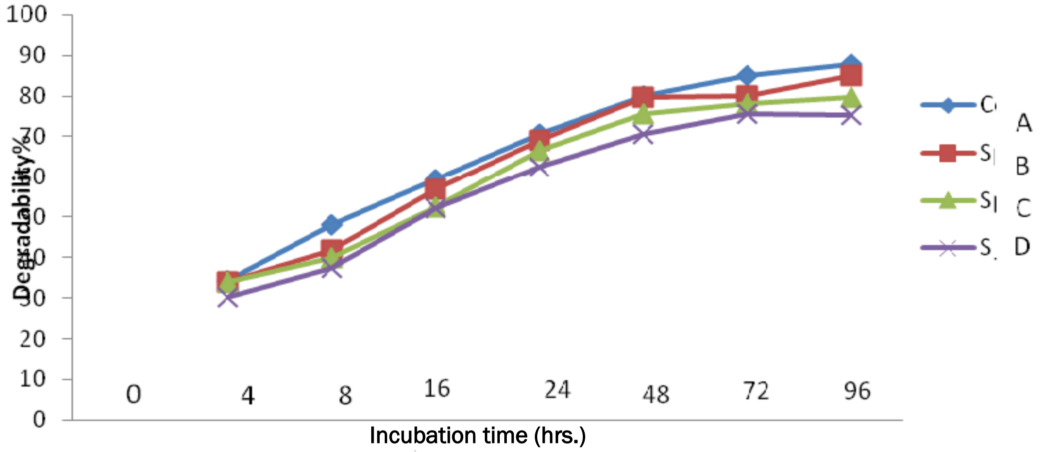

Figure 1. Rumen degradation of DM% of tested rations

Estimation of Kinetics degradability of tested rations

Table 4 showed the results of kinetic for *in-situ* degradability from different rations. The readily soluble fraction (a) was higher significantly (P≤0.05) for ration A which contain 0% of bagasse whereas rations B and C which contain 10 and 20 had moderate value of this fraction. Ration D that contained 30% recorded the lowest value of readily soluble fraction (a). A slowly fermented material (b) is measure the proportion of the feed that can be fermented in the rumen (Mupangwa et al., 1997), in the present study this fraction for different treatments can be ranked as follow rations A and B followed by rations C and D. The maximum value of potential degradability (PD) was recorded by ration A followed by rations B, C and D. The maximum value of PD for ration A may be due to its high content of readily degraded of soluble carbohydrates and N and low content of CF. Consequently the low value of PD recorded by B, C and D rations could be explained by their high CF and low ME content. There are negative correlation with rate of degradability as well as potential degradability and effective degradability of DM with the CF content (Smith et al., 1991, Ramana et al., 2000, Melkau et al., 2003, Kiran et al., 2007 and Atta Elmnan et al., 2013). Also Bakhashwain et al., (2010) demonstrated that the negative effect of cell wall content on PD could be due to the reduction of the microbial activity through increasing the adverse environmental conditions.

The four rations showed no differences in the rate of fermentation c among them which concluded the four rations can be considered as a good feedstuff for the animals feeding. The same fermentation rates indicate same nutrient availability for ruminal microorganisms (Mirzaeiet et al., 2011 and Fievezet et al., 2005). Although DM digestibility and degradability of rations B, C and D were decreased with progress level of treated bagasse in the rations, the values obtained from present study may considered within the range of moderate to high level of digestibility and degradability especially ration B (84. %) that replaced 10% of sorghum grains which can be used effectively during dry season.

Table 4 - Kinetics degradability of tested rations

Term	A	B	C	ED 0.02	ED 0.05	ED 0.08	PD
A	23.00^{a}	63.64^{a}	0.056^{a}	69.80^{a}	56.50^{a}	49.10^{a}	86.70^{a}
B	20.16^{b}	63.54^{a}	0.056^{a}	67.10^{b}	53.90^{b}	46.50^{b}	83.70^{b}
C	20.38^{b}	59.59^{b}	0.054^{a}	63.90^{c}	51.50^{c}	44.60^{c}	80.00^{c}
D	17.83^{c}	58.12^{b}	0.056^{a}	60.80^{d}	48.80^{d}	42.10^{d}	75.70^{d}
SEM	0.36	0.40	0.06	0.05	0.05	0.04	0.04

a: Readily degradable fraction; b: slow degradable fraction; a+b: Potential degradability; c: Rate of degradability; ED: Effective degradation at three levels of rumen out flow rate; A: 0% of treated bagasse, B: contained 2.6% treated sugarcane bagasse which replaced 10% of sorghum grains, C: contained 5.2% treated sugarcane bagasse which replaced 20% of sorghum grains and D: contained 7.8% treated sugarcane bagasse which replaced 30% of sorghum grains, SEM standard error of the mean: a-c means with different superscripts in the same column were significantly different (P≤0.05).

CONCLUSION

The values of DM digestibility and degradability of tested rations are within the range of moderate to high level of digestibility. Readily energy source must be added to treated bagasse in total mix ration to enhance ME content of treated bagasse which may improve digestibility. More study is needed to evaluate the treated sugarcane bagasse in total mix ratio in *in vivo* feeding trial and to approve the economic appraisal.

DECLARATIONS

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Author's contribution

Balgees AAE and Reem AI participated in the design of study. Reem AI performed the experiments. Balgees AAE analyzed the data, and critically revised the manuscript for important intellectual contents. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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