

Digestibility and rumen degradability of bagasse based diets (bbd) fed to beef cattle

Abstract

Four experimental bagasse based diets (BBD) were evaluated by studying the digestibility and degradability of CP and DM. Results showed that, the digestibility of crude protein and organic matter of the sugarcane bagasse (SCB) were improved ($P < 0.05$) in two diets out of the four experimental (BBD). On the other hand, the CP and DM degradation characteristics showed variable results. The CP degradability of the four diets ranges between 83.7-89.1. The higher CP degradation (P) might be attributed to the higher degradation characteristics of groundnut meal proteins used in these diets.

Keywords: synthetic fibre bag, complete diet system, degradability, baggara bull

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Abbreviations: SCB, sugarcane bagasse; ME, metabolizable energy; CDS, complete diet system; BBD, bagasse based diets; APRC, animal production research centre; DMI, dry matter intake; DM, dry matter; ED, effective degradability

Introduction

Very little data are available on the digestibility of all concentrate rations or the influence of roughage on the digestibility of finishing beef rations. However, the influence of energy and protein on the digestibility of high roughage ration has been extensively investigated.

Sugarcane bagasse (SCB) is a fibrous material left over in sugar factories after extraction of all the juice from sugarcane.¹ It is cheap agro-industrial byproduct. Ensminger² reported that, bagasse is high in fibre, of low DM digestibility (about 25%). However, bagasse has been used efficiently as a carrier of molasses, the combination of which yields a relatively high fibre, high energy yield. The increase in sorghum straw prices together with the decrease productivity of rangelands and limited forage production have increased the importance of sugarcane bagasse (SCB) for ruminants feeding as a source of fibre instead of the expensive sorghum grain and straw. The poor nutritive value of (SCB) (47.9%CF and 1.72MJ/kg DM metabolizable energy (ME)),³ necessitates some treatments and techniques to improve its poor nutritive value. In this study, the complete diet system (CDS) and pelleting were used to improve the nutritive value of (SCB) for beef cattle. Nutritional feed values are currently based on aggregate criteria such as fecal digestibility. Digestibility is the result of two competing processes: digestion and passage. In order to develop mechanistic model of digestion to be used for feed evaluation, both processes have to be quantified.⁴

Since the 1960s many pasture and range studies have coupled fecal output estimates with *in vitro* digestibility measurements to calculate intake.⁵ However, several researchers have reported that *in vitro* estimates are unreliable estimates of *in vivo* digestibility because of associative effects,⁶ rate of passage differences⁷ and variation in

botanical composition of the diet.⁸ Other less animal dependant techniques used to determine digestibility are *In situ* degradability, *in vitro* digestibility⁹ and gas production.¹⁰

New feeding systems placed emphasis on quantifying ruminal protein¹¹ therefore, it is necessary to access rapidly and accurately the degradation of feed proteins. ARC¹² defined the extent of ruminal protein degradation in terms of proportion of dietary nitrogen that does not reach the duodenum. Considerable variation in degradability of nominally similar feedstuffs were apparent in the published values. Additional information was available from studies using synthetic fibre bags suspended in the rumen. Such studies clearly showed differences between and within classes of feedstuffs in both, the rate and the ultimate extent of disappeared N from the bags. The degradability of CP and DM of feeds are therefore key variables for the metabolizable protein feeding systems.¹³ The objective of this study is to determine the digestibility and rumen degradability of (CP) and (DM) of (BBD) fed to beef cattle and its effect on nutrient utilization and nitrogen balance (Table 1).

Table 1 Ingredients composition of experimental diets

Ingredient	MM%	MSM%	MSP%	SM%
Molasses	52	35	35	-
Sorghum grain	-	20	20	45
Wheat bran	24	15.5	15.5	14
Groundnut cake	5	10	10	25
Bagasse	15	15	15	15
Urea	3	1.5	1.5	-
Limestone	-	2	2	-
Common salt	1	1	1	1

MSM, molasses+sorghum grains diet (mash); SM, sorghum diet (mash); MSP, molasses+sorghum grains diet (pelleted); MM, molasses diet (mash)

Materials and methods

Twelve Sudan desert rams were selected randomly, each ram was placed in a metabolic unit at the Animal Production Research Centre (APRC), Hillat Kuku, with free access to water and mineral block. The four experimental bagasse based diets (BBD) were fed in one meal of 8:00a.m. each day. The dry matter intake (DMI) was adjusted 1-1.5% of the animal live body weight.

The experiment continued for 17days, the first 3days were change over period, followed by 7days adaptation period, at the end of which faeces were collected daily for 7days. Faeces were collected in a zipped canvas bags attached to webbing harness.¹⁴ The harness was fitted to the sheep 3days before the beginning of the collection of faeces by total collection method. Faeces of each ram were collected in a plastic bucket and transferred quantitatively to a tarred polythene bags, weighed to the nearest 50g, on a 10kg top loading balance. 10% of the faecal samples were taken and stored at -20°C until the end of the experiment. One (1) gram of the fresh sample was weighed into an 800ml kjeldhal flask for nitrogen determination. The rest of the thawed and then homogenized (10%) sub-sampling was dried into a forced dry oven at 60°C for 48hrs), and then dry matter (DM) content was determined and then sample was ground for chemical analysis.

The degradability study of the four experimental bagasse based diets (BBD) was carried out in two fistulated bulls, according to the Dacron nylon bag technique of Mehrez & Ørskov.¹⁵ Approximately (2gm) of the sample materials were weighed into labeled nylon bag measuring 7 x 12 cm and with pore size 40µm, this giving a sample weight to surface area ratio of 18mg/cm³.¹⁴ These bags were then introduced into the rumen of a two fistulated bulls, thereby ensuring two replicates per sample. The test time were for 0, 6, 12, 24, 36, 48 and 72hrs. Bags corresponding to the longest incubation time were inserted first and followed by other bags in sequentially decreasing time.¹⁶⁻¹⁸ This was to ensure that all the bags were withdrawn at about the same time. On withdrawal of the bags from the rumen they were washed under running tap water until the rinse water was clear and the bag-attached microbe contamination assumed to have been reduced to the nearest minimum. At the end of the rinse the bags were then dried at 65°C for 48hrs to a constant weight to determine rumen residue dry matter (DM) content. To determine the water loss at zero hour, that is, loss due to non-incubation for both the DM and CP components, samples of the test materials were soaked into warm water (approximately 37°C) for one hour followed by washing and drying as done with the residue from incubation. DM and CP losses were computed as the difference in weight between the pre-incubated and post-incubation samples and expressed as percent. The weight data gathered were subsequently analyzed by NEWAY computer program for estimating degradability constants, by fitting them into the non-linear equation

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

of McDonald,¹⁹ where P is the potential degradation of the nutrients components under investigation after time "t", "a" the water soluble fraction, "b" the insoluble but rumen degradable fraction, and "c" the rate of degradation of the rumen degradable fraction "b".

Effective degradability (ED) of the examined nutrients components were calculated using the outflow rates of 0.02, 0.05, and 0.08/hrs according to Ørskov et al.²⁰ model:

$$ED = a + \frac{bc}{c + k}$$

where ED is effective degradability and "a", "b" and "C" are the constant as described earlier in the non-linear equation above and "k" is the rumen fractional outflow rates.

Results

The data describing the means of *in vivo* apparent ruminal digestibility (ARD) of the experimental diets containing 15% sugarcane bagasse (SCB) were summarized in Table 2. The digestibility of dry matter (DDM) showed no significant (P>0.05) differences among the treatment groups. Rams used in the digestibility trial showed improved digestibility coefficients for the organic matter (DOM) when fed the bagasse based diet (SM) over the remaining groups. The digestibility of crude protein (DCP) was found to be higher (P<0.05) for diets (M) and MSP bagasse based diet than the other diets. No significant (P>0.05) differences observed for the digestibility of EE, CF and NDF. Degradability characteristics of (DM) and (CP) of the different bagasse based diets were evaluated and presented in Table 3. The potential degradability of DM ranged from 55.5 to 81.5. Effective degradability (ED) of DM decreased with increase in out flow rates ranging from a low of 49.3%(K=0.02) to 41.4%(K=0.08) for the MM diet from 70%(K=0.02) to 64.8(K=0.08) for the MSP diet, from 69.8% K(0.02) to 55.2%(K=0.08) for the SM diet and from 771.1%(K=0.02) to 65.2(K=0.08) for the MSM diet.

Table 2 Chemical composition of experimental diets

Parameter	MM%	MSM%	MSP%	SM%
Dry Matter(DM)	79.39	81.13	92.61	92.61
Crude Protein(CP)	16.98	14.7	16.43	16.45
Crude Fiber(CF)	16.64	9.28	13.84	10.75
Ether Extract(EE)	6.59	1	1.54	4.16
Ash	6.32	7.43	8.37	5.86
Nitrogen Free Extract(NFE)	32.86	48.72	49.72	55.39
Metabolizable Energy ME/kg/DM	9.5	10.4	10.4	11.6
Acid Detergent Fiber(ADF)	12	21.04	22.06	17.17
Neutral Detergent Fiber(NDF)	33	35	36.5	30.14

Potentially the degradability of CP in the four treatment diets was between 83.7(MM diet) to 89.1 (Table 3). The least effective degradability (K=0.08) and the highest (K=0.02) are almost similar. The immediately soluble fraction "a" of DM showed that, the MSP pelleted diet seemed to be less soluble, while the other diets showed similar patterns of solubility. The insoluble but degraded part was higher in the MSP diet (53%) while MM diet showed the least degraded part (24.4%). This is a reflection of the fact that the DM components of MM were most readily soluble (Table 3). The rate of degradation (b) of CP was higher in the pelleted diet (MSP) and (SM) diet than that of the MM and MSM diets (Table 4).

Table 3 Mean(±S.E) Digestibility coefficients of the experimental bagasse based diet fed to beef cattle

Item	Experimental diets					Level of significance	
	No. of sample	MM3	MSP3	SM3	MSM3		±SEM
DDM		70.57	68.52	74.57	68.93	2.43	NS
DOM		72.89 ^{ab}	71.55 ^b	79.33 ^a	67.64 ^b	2.14	*
DCP		70.11 ^b	76.74 ^a	80.91 ^a	70.36 ^b	1.91	*
DEE		87.27	83.95	80.3	78.84	2.48	NS
DCF		41.79	47.26	50.52	35.61	4.7	NS
DNFE		76.97	76.84	78.91	74.19	2.08	NS

SEM, standard error of the means from anova d.f. 8; NS, not significant (P> 0.05); *, significant at 5% (P<0.05); ab, values in the same row with different superscripts are significantly different (P>0.05).

Table 4 Dry matter and crude protein degradation characteristics of the bagasse based diets fed to beef cattle

Parameter		MM	MSP	SM	MSM
Dry matter	A	31.1	20.3	35.9	37.9
	B	24.4	53.8	45.3	38.3
	PD	55.5	74.1	81.2	76.2
	C	0.058	0.109	0.06	0.082
	ED (K=0.02)	49.3	70	69.8	71.1
	ED (K=0.05)	44.3	66.6	60.5	67.1
	ED (K=0.08)	41.4	64.8	55.2	65.2
Crude protein	A	24.6	18.9	26	38.2
	B	59.1	66.7	63.1	50
	PD	83.7	85.6	89.1	89.1
	C	0.012	0.186	0.21	0.19
	ED (K=0.02)	82.3	81.3	83.1	84.8
	ED (K=0.05)	78.3	76.4	79.7	80.1
	ED (K=0.08)	77.1	72.9	78.6	76.6

a, b, c, constants in the equation $P = a + b(1 - e^{-ct})$

where P is level of degradation at time “t”, “a” readily soluble fraction, “b” insoluble fraction but degradable in the rumen, “c” rate of degradation of “b” per hour

PD, a+b, potentially degradable fraction; ED(K=0.02, 0.05, 0.05): Effective degradability calculated with outflow rates; ab, values in the same row with different superscripts are significantly different (P≥0.05)

Discussion

The results of digestibility study indicated that the SM and MSP diets significantly (P<0.05) improved the digestibility of CP and OM. This could be attributed to the methods of feed preparation and constituents. Despite similar content of fraction and metabolizable energy, the MSP diet had improved the digestibility of CP and OM over the MSM diet, this is due to that, MSP diet was prepared in a pelleted form whereas heat treatments used during pelleting, had improved the nutrient utilization of the (SCB) and hence rendered the MSP diet to be more digestible than the mash form MSM diet. The values of digestibilities of DM, EE and CF of the bagasse based diets reported in this study were similar to those reported by Itidal²¹ for diets containing 10 and 20% SCB.

The degradability study showed different patterns of CP and OM degradation characteristics of the tested (BBD). The effective degradability (ED) of DM was found to be decreased with the increase of the out flow rates (Table 3). The immediately soluble fraction (a) of DM showed that, the MSP diet was less soluble in comparison to the remaining diets. Again MSP diet was found to be less soluble than MSM diet, despite the similar ingredients, this could be related in part to the differences in the physical form and way of preparation of the two diets. This result indicated that, pelleting the SCB with concentrates reduces the DM solubility of molasses diets. This might be due to the improvement of the roughage portion of the diet by pelleting. The degradable part of the dietary CP (b) was found to be higher in the MSP diet compared to the remaining diets. This indicated that, pelleting had increased the degradability of the dietary DM of the molasses diets.

The rate of CP degradation (P) was found to be slightly higher in the MSP diet, followed by SM diet (Table 3). This might be attributed to the higher CP degradability of the groundnut cake+sorghum used in these diets. The results were similar to those assigned by Intesar²² who studied CP degradability of different protein sources, Ørskov & McLeod,¹⁶ Abuswar & Darag.³ They reported that groundnut cake has a low bypass protein and low CF content. This result indicated that, proteins of high degradation could be used in beef cattle diets satisfactorily because their protein requirements were lower than that of dairy cows in early lactation or early weaned calves and lambs as reported by Broderick et al.²³

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Conflict of interest

Author declares that there is no conflict of interest.

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