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Short communication

Intake and ruminal digestion determined using omasal and reticular digesta samples in cattle fed diets containing sugar cane *in natura* or ensiled sugar cane compared with maize silage

L.D.S. Mariz*, S.C. Valadares Filho, E. Detmann, O.G. Pereira, L.G.R. Pereira, M.I. Marcondes, S.A. Santos, F.A.C. Villadiego, D. Zanetti, L.F. Prados, A.N. Nunes

Department of Animal Science, Universidade Federal de Viçosa (UFV), Viçosa, MG 36570-000, Brazil

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ABSTRACT

Sugar cane is widely used in an *in natura* forage in tropical countries, but the adoption of silage methods facilitates the preservation of its nutritional value and improves the logistics of its use. To explain differences in performance using alternative forages, it is important to conduct studies that evaluate the various digestion sites for the nutrients provided in diets. However, considering that the collection of omasal digesta is quite laborious and requires the use of a vacuum pump, reticular sampling has been suggested as a promising alternative. Thus, the objective of this study was to evaluate the intake and ruminal digestibility obtained from samples of digesta collected in the reticulum and omasum of cattle fed different diets. Five rumen-fistulated crossbred cattle with an average initial live weight of 336 ± 16.6 kg were used, being distributed in a 5×5 Latin square design. Five diets were evaluated, which contained 60% forage and 40% concentrate on dry matter basis using different forages: maize silage (CS); sugar cane *in natura* (SCIN); sugar cane silage (SCS0%); sugar cane silage treated with 0.4% calcium oxide (SCS0.4%) or 0.8% calcium oxide (SCS0.8%) on wet basis. The percentage of crude protein (CP) in all of the forages was corrected to 11% based on dry matter (DM) using a mixture of urea/ammonium sulfate (9:1). Six collections of reticular and omasal digesta were obtained over three days at 12 h intervals. To calculate the flow of reticular and omasal nutrients, a double marker system was employed, using cobalt–EDTA and indigestible neutral detergent fiber (NDFi) as markers. The reticular and omasal digesta were similar ($P > 0.05$) to estimate ruminal digestibility of DM, organic matter (OM), CP, neutral detergent fiber (NDF) and non-fiber carbohydrates (NFC). However, the ruminal digestibility of ether extract (EE) and the intestinal digestibility of CP and EE differed ($P < 0.05$) between sampling sites. The results indicate that the omasal digesta is more suitable than the reticular digesta for measuring the ruminal digestion of diet components.

1. Introduction

In Brazil, the high portion of forage in diets for ruminants is attributed to the lower cost of this component in the diet. Maize silage has a high nutritional value and is widely used in feedlots because it increases animal performance. Sugar cane is also traditionally used in cattle diets because this crop is less expensive than maize silage and its production coincides with the period of increased scarcity of forage in the country. In addition, sugar cane has an inferior nutritional value when compared with maize silage.

* Corresponding author. Tel.: +55 31 93843669.
E-mail addresses: laysmariz@yahoo.com.br, lalamariz@hotmail.com (L.D.S. Mariz).

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Sugar cane is widely used in an *in natura* or unprocessed form, but the adoption of silage methods facilitates the preservation of its nutritional value and improves the logistics of its use. Chemical additives, like calcium oxide, are utilized in sugar cane silage to reduce losses from processing and improve the fermentation standards and the digestibility of the sugar cane fiber, which together represent the major limitations of the use of this type of forage, impacting animal performance.

To explain differences in performance, it is important to conduct studies that evaluate the various digestion sites for the nutrients provided in diets and the rates of fiber digestion. Different sampling methods and marker systems are currently used to estimate ruminal flow (Krizsan et al., 2010). However, considering that the collection of omasal digesta is quite laborious and requires the use of a vacuum pump, reticular sampling has been suggested as a promising alternative to omasal sampling because, according Krizsan et al. (2010), it involves less interference with the animals themselves.

Therefore, the aims of this study were to evaluate the ruminal digestibility of dry matter and other constituents in the diet using samples obtained from the omasum and reticulum and to evaluate intake and digestibility of sugar cane *in natura* or ensiled sugar cane compared with maize silage for beef cattle.

2. Materials and methods

All procedures involving animals were approved by the Brazilian committee for animal care and experimentation.

2.1. Animals, experimental design, and diets

This study was conducted in the Department of Animal Science at the Universidade Federal de Viçosa, located in Viçosa, MG, Brazil. Five rumen-fistulated crossbred cattle (Holstein × Zebu) with an average initial live weight of 333 ± 17 kg were used in the experiment, distributed in a 5 × 5 Latin square design. The experiment lasted 105 days, corresponding to five 21-day periods. These periods were sub-divided into periods of nine days, during which the animals were allowed to adapt to the experimental diets, location and gas collector apparatus, and 12 days, during which collections were performed.

The animals were weighed, identified and vermifuged prior to the experiment and housed in individual pens (8 m²) fitted with feeders and waterers.

A total of five diets containing 60% forage and 40% concentrate based on dry matter (DM) and containing different forages were tested: maize silage (CS); sugar cane *in natura* (SCIN); a sugar cane silage control (SCS0%); sugar cane silage treated with 0.4% calcium oxide (SCS0.4%); and sugar cane silage treated with 0.8% calcium oxide (SCS0.8%), based on wet basis. The percentage of crude protein (CP) in all of the forages was corrected to 11% by the daily addition of a mixture of urea/ammonium sulfate (9:1) to the forage based on the DM content in the forage.

From Monday to Friday, the *in natura* sugar cane was cut and chopped daily and then provided to the animals. The *in natura* sugar cane provided on weekends was crushed on Friday morning and maintained in stacks over the weekend. This system was based on a report by Menezes et al. (2011) that indicated that animal performance is not altered when sugar cane is chopped and stored for three days before being fed to animals.

Isoproteic diets with approximately 12% crude protein were used. The proportion of the ingredients in the concentrate mixture and the chemical composition of the diets are shown in Table 1. In the diets SCS0.4% and SCS0.8%, limestone ($CaCO_3$) was substituted for sand in the same proportions, in order to not extrapolate calcium requirements.

2.2. Experimental procedures and sampling

Forage provided and leftovers were sampled daily during the collection period and subjected to partial drying in a forced ventilation oven set at 60 °C for 72 h. The ingredients that comprised the concentrate were sampled directly from the feed mill silos on the days that they were mixed.

Table 1
Percentages of ingredients used in the concentrate and in the experimental diets and the compositions of the concentrate and the diets.

Parameter	Concentrate	Diets
DM (g kg^{-1})		
Forage	–	600.0
Corn grain	851.0	340.0
Soybean meal	131.0	52.89
Calcium phosphate	7.6	3.40
Limestone or sand[a]	6.6	3.0
Salt	3.2	0.4
Premix[b]	0.6	0.03

		Diets				
Parameter	Conc.	CS[c]	SCIN[d]	SCS0%[d]	SCS0.4%[d]	SCS0.8%[d]
Chemical composition of concentrate and diets in DM basis						
DM (g kg^{-1})	872.4	533.2	532.0	524.3	525.1	533.3
In g kg^{-1} DM						
OM	962.2	962.5	969.0	953.9	945.5	937.6
CP	137.3	120.0	121.3	121.5	122.8	121.9
EE	30.1	26.3	23.0	19.6	19.1	22.4
NDF	94.8	322.8	302.4	391.5	358.9	367.2
NFC	700.0	509.0	552.0	451.7	476.0	456.5
NDFi	7.12	119.26	159.71	203.62	189.85	191.19
Lignin	12.4	33.52	38.82	62.86	55.26	65.65
pH[e]	–	3.53	–	3.39	3.84	4.14

Conc.—concentrate; CS—corn silage; SCIN—sugar cane *in natura*; SCS0%—untreated sugar cane silage; SCS0.4%—sugar cane silage treated with 0.4% calcium oxide; SCS0.8%—sugar cane silage treated with 0.8% calcium oxide; DM—dry matter; OM—organic matter; CP—crude protein; EE—ether extract; NDF—neutral detergent fiber corrected for ash and protein; NFC—non-fiber carbohydrates; NDFi—indigestible neutral detergent fiber.

[a] For the diets containing sugar cane silage treated with 0.4% and 0.8% calcium oxide limestone was substituted for washed and dried sand.

[b] Chemical composition of the premix: 2.1 g kg^{-1} of cobalt sulfate. 167.8 g kg^{-1} of copper sulfate. 3.59 g kg^{-1} potassium iodate. 262.3 g kg^{-1} of manganese sulfate. 0.93 g kg^{-1} sodium selenite. 563.3 g kg^{-1}of zinc sulfate.

[c] 16.5 g of urea+ammonium sulfate per kg DM of forage intake.

[d] 32.0 g urea+ammonium sulfate per kg DM of forage.

[e] For pH measurement, 25 g humid sample was processed with 225 ml of ringer solution, for 1 min. The pH was measured in the water extract.