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Intake, apparent digestibility, and productive parameters of dairy goats fed sugarcane replacing corn silage

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Abstract. An experiment was carried out to evaluate the replacement of corn silage with fresh sugarcane, at a roughage:concentrate ratio of 40:60, on the intake, dry matter (DM) and nutrient digestibility, milk yield and composition, and feeding behavior of lactating goats. Eight goats were distributed into two balanced 4 × 4 Latin squares, where the replacement levels of 0, 33, 67, and 100% were used as independent variables. Dry matter intake, which averaged 2.302 kg/day, showed a quadratic response with the minimum value observed at the sugarcane inclusion level of 68.04%. The treatments did not affect the intakes of crude protein (CP), neutral detergent fiber (NDF), or net energy, whereas non-fibrous carbohydrates (NFC) and total digestible nutrients (TDN) intakes responded quadratically and ether extract (EE) intake decreased with the increasing sugarcane levels. The levels of replacement of corn silage with sugarcane did not influence the digestibility coefficients of DM, CP, NDF, or NFC, but EE digestibility exhibited had a quadratic response. There were no significant differences for milk yield, which averaged 1.512 kg/day, even when yield was corrected for 3.5% fat; or the concentrations of protein, fat, lactose, total solids, and solids-not-fat in milk. Milk urea nitrogen, on the other hand, increased with the sugarcane levels. Fresh sugarcane can replace corn silage in the diet of low-yielding goats with a 40:60 roughage:concentrate ratio, as it will not change milk yield.
Key words: crude protein, dry matter, milk production, rumen,urea

Introduction

In dairy goat farming, the low availability of feed—roughage, mainly—during times of scarcity concerns producers to stock feed, either preserved or in the form of grass for cutting, to ensure year-round productivity and stability in milk production. In this respect, fresh sugarcane constitutes a feed alternative for these periods, as it helps to maintain the milk production of goats while contributing for feed costs not to increase. The main advantage of sugarcane over other forage species is that it reaches its greatest forage potential and high levels of soluble sugars in the dry season. However, as a disadvantage, when used as exclusive feed or at high percentages in ruminant diets, its low protein and minerals levels and high fiber content impair digestibility.

Sugarcane may cause a reduction in intake due to its low fiber digestibility, as its average fiber content, of 54.00%, is lower than the 60.00% of silage (Campos et al., 2010). The digestibility of this feedstuff does not determine voluntary intake per se, but the physical nature of the diet and its ability to efficiently stimulate rumen function by supplying bypass nutrients, especially protein, are also contributing factors (Preston, 1982). If included in a diet, sugarcane must be accompanied by a concentrate that allows an adequate nutrient intake to meet the energy needs of production animals.

Because goats are selective animals, their forage intake depends mainly on the nutritional value of the feed and their rumen-fill capacity. The feed particle size influences the feeding behavior of animals because it affects their dry matter intake as well as the feeding and rumination activities (NRC, 2001). Accordingly, the time spent on rumination is influenced by the nature of the diet and is proportional to the cell wall content of roughages. Thus, higher percentages of roughage in the diet translate into a longer rumination time (Van Soest, 1994).

In view of the above-stated facts, this study was conducted to examine the effects of replacing corn silage with fresh sugarcane at the levels of 0, 33, 67, and 100% on the intake, nutrient digestibility, performance, and feeding behavior of lactating dairy goats.

Materials and Methods

The experiment was conducted in the municipality of Botucatu - SP, Brazil (22°53'09 " S and 48°26'42 " W, 840 m above sea level). According to the Köppen climate classification, the region has a Cwa climate type, characterized as mild, with an average temperature of 22 °C.

Eight lactating Alpine goats (post-lactation peak) with a body weight of 51.95 ± 3.29 kg were used. The animals were housed in individual 3.5-m^2 stalls inside a covered shed equipped with a drinker, a salt trough, and a feed trough.

The experimental diets were supplied twice daily, at 08.00 h and 16.00 h, as a complete ration and in sufficient quantity to allow 10% orts for sampling. Water was available *ad libitum*.

The experiment was laid out in a Latin square design. The animals were distributed into two 4 × 4 Latin squares according to milk yield (MY), to evaluate the levels of replacement (dry matter [DM] basis) of corn silage with chopped fresh sugarcane, at the rates of 0, 33, 67, and 100%. Treatments were thus as follows: 0% sugarcane + 100% corn silage; 33% sugarcane + 67% corn silage; 67% sugarcane + 33% corn silage; and 100% sugarcane + 0% corn silage (Table 1).

The experimental diets were previously formulated, according to the NRC (2007), to meet the nutritional requirements of lactating goats with a MY potential of 2.5 kg/day, with a protein content of 15% (DM basis) (Table 2).

Seedlings of sugarcane variety RB 72454 were acquired from sugarcane fields in the region, for planting. The corn belonged to variety Ag 4051, classified as a dent-texture hybrid, which was ensiled in a bag silo.

The sugarcane was chopped daily and incorporated into the corn silage and concentrate forming a complete mixture, observing a roughage:concentrate ratio of 40:60 (DM basis). These proportions were maintained throughout the experiment with adjustments in the amount of roughage supplied, based on their DM.

The experimental period was 72 days, which were divided into four 18-day periods, consisting of 12 days of adaptation and adjustment of voluntary feed intake and six days of data collection. The body weight dynamics was monitored by weighing the animals at the start of each period and at the end of the experiment, before the morning milking.

Chemical analyses of the ingredients were carried out according to the methodology described in Silva and Queiroz (2002) for protein (CP), ash, ether extract (EE); and Van Soest et al. (1991) for neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, and lignin. Total carbohydrates (TC), non-fibrous carbohydrates (NFC), and total digestible nutrients (TDN) were estimated by the equations below:

$$TC = 100 - \%CP - \%EE - \%Ash,$$
according to Sniffen et al. (1992);

$$NFC = 100 - (\%CP + \%EE + \%Ash + \%NDF),$$
according to Van Soest et al. (1991); and

$$TDN = DCP + DNFC + DNDF + DFA \times 2.25 - 7,$$
according to NRC (2001),

in which:
$DCP = CP \times Exp[-1.2 \times ADIP/CP]$ for roughage;
$DCP = [1 - (0.4 \times ADIP/CP)] \times CP$ for concentrate;
$DNFC = 0.98 \times NFC$;
$DNDF = 0.75 \times (NDF - L) \times [1 - (L/NDF) \times 0.667]$;
$DFA = EE - 1$; and 7 represents the fecal metabolic TDN.

In these secondary equations, DCP represents truly digestible protein; DNFC, the truly digestible NFC; DNDF, the digestible NDF; DFA, the truly digestible fatty acids; ADIP, acid detergent indigestible protein; and L, acid detergent lignin.

To calculate the metabolizable energy (ME) and net energy (NE) values, the TDN and digestible energy (DE) values were used in the following equations suggested by the NRC (2001):

$$DE\ (Mcal/kg) = 0.04409 \times TDN\ (\%)$$

$$ME\ (Mcal/kg) = 1.01 \times DE\ (Mcal/kg) - 0.45$$

$$NE\ (Mcal/kg) = 0.0245 \times TDN\ (\%) - 0.12$$

At the beginning of the data collection period, the feeding behavior of the animals was observed and recorded. Feed intake and MY were recorded and samples were collected for five consecutive days in each period. Milk was sampled on the 4th and 5th days of each collection period.

The voluntary intake of feed and nutrients was calculated as the difference between the supplied amount and orts. Feed and orts were collected and frozen for further analyses, which were performed after the samples were thawed, pre-dried in a forced-air oven at 55 °C for 72 h, and ground in a Wiley mill with 2-mm sieves. Feces samples were also collected to determine apparent digestibility.

In the chemical analysis of orts and feces, the methodology described in Silva and Queiroz (2002) was used for CP and EE; and in Van Soest et al. (1991) for NDF and ADF. Non-fibrous carbohydrates, TDN, and NE were estimated from the previously described equations.

To calculate the digestibility of DM and nutrients from the diets, feces were collected directly from the rectum of the animals for four consecutive days in each experimental period. Fecal output was estimated using iNDF (indigestible NDF) as a marker, by 168 h of *in situ* ruminal incubation (Berchielli et al., 2005) of samples of feed, orts, and feces inside nylon bags with 50 µm porosity, following to the standardized technique mentioned by Vanzant et al. (1998). After incubation, the bags were washed in running water and dried in a forced-air oven at 55 °C for 72 h. Analyses of NDF were carried out as proposed by Van Soest et al. (1991), using an ANKON200 instrument (Ankom Technology Corp., Fairport, NY, USA). Then, fecal output was estimated using the following equations:

$$FO = iNDF_I/iNDF_{Fc}$$

and

$$iNDF_I = iNDF_{Fd} - iNDF_O$$

in which FO = fecal output (kg/day); $iNDF_I$ = iNDF intake (kg/day); $iNDF_{Fc}$ = iNDF concentration in the feces (kg/kg); $iNDF_{Fd}$ = iNDF intake from the feed (kg/day); and $iNDF_O$ = iNDF present in orts (kg/day).

The goats were milked twice daily, at 07.30 h and 15.30 h, and their MY was recorded for five consecutive days, in the different experimental periods. Milk samples from two milk-testing days, in the proportions of 2/3 of the morning milking and 1/3 of the afternoon milking, were collected in 30-mL plastic tubes containing the preservative bronopol (2-bromo-2-nitropropane-1, 3-diol) and sent for analysis of constituents. The milk protein, fat, lactose, total solids, solids-not-fat, and urea nitrogen contents were determined.

The data were subjected to analysis of variance using SAEG computer software (Statistical and Genetic Analysis System, version 9.0). Traits that showed a significant effect for treatment were studied by regression analyses, in which the effects were separated into linear, quadratic, and cubic ($P<0.05$).

Results and discussion

Dry matter intake responded quadratically to the increasing levels of corn silage replaced with sugarcane, with a minimum intake value of 2.126 kg/day recorded at the sugarcane level of 68.04%. The same was not true for DM intake evaluated as a percentage of live weight (LW). The average DM intake was 2.272 kg/day and 4.41% LW (Table 3), and the average CP intake was 0.378 kg/day (Table 4). Ether extract intake decreased linearly as the sugarcane levels replacing corn silage were increased.

Neutral detergent fiber intake did not differ significantly between the animals subjected to the different treatments, averaging 0.429 kg/day.

The intakes of NFC and TDN differed between the animals on the different levels of corn silage replaced with sugarcane. The same was not true for net energy intake. The minimum NFC intake was 1,168 kg/day, which was recorded at 67.10% sugarcane inclusion.

Total digestible nutrient intake was influenced by the levels of replacement of corn silage with sugarcane. This variable responded quadratically, with a minimum value of 1.507 kg/day recorded at 65.71% sugarcane.

There was no significant effect for the digestibility of DM, CP, NDF, or NFC between the replacement levels. However, EE digestibility differed significantly (Table 3), showing a quadratic response, with a maximum coefficient of 81.04 recorded at 23.325% sugarcane.

There were no differences in MY or 3.5% fat-corrected MY between the treatment groups, despite the observed differences in DM intake.

The lack of synchronization between the nitrogen sources and soluble carbohydrates to form microbial protein possibly influenced the low MY, as verified by the urea nitrogen values (Table 5), which indicate excess CP that was not used for production. Another factor to be considered, regarding the low MY, is that net energy intake was not sufficient to meet the requirements of goats with a production potential of 2.5 to 3.5 kg/day of milk (NRC, 2007).

Magalhães et al. (2004) found a linear decrease in DM intake as they increased the amount of sugarcane replacing corn silage, whereas Mendonça et al. (2004) observed higher DM intake using corn silage versus sugarcane, in the diet of lactating cows with a 60:40 roughage:concentrate ratio. These authors reported that DM intake may have been affected by the quality of roughage regardless of the feeding strategy, indicating that sugarcane has a reducing effect on intake as a consequence of the low digestibility of its fiber. The NFC content, especially sugars, and the preference for the juicier parts, may have contributed to the higher DM intake by the 100% sugarcane treatment group.

The average DM intake of 2.272 kg/day and 4.41% LW (Table 3) is within the recommended range for goats with a LW of 50 kg, which should produce from 1.47 to 2.30 kg/day of milk (NRC, 2007). As also indicated by the council, depending on MY, dairy goats consume from 4.00 to 7.00% of their LW in DM. In the present experiment, DM intake met the energy requirements of the lactating goats (Table 3). The greater percentage of concentrate in the diets likely favored the availability of energy for the maintenance and production of the animals.

Several authors that worked with diets with roughage:concentrate ratios greater than 50:50 and roughages with low fiber digestibility, as is the case of sugarcane relative to corn silage, found that DM intake decreased, affecting the MY of lactating cows (Magalhães et al., 2004; Costa et al., 2005; Pires et al., 2010). In dairy goats, this ratio is also determinant for intake, since goats with greater intake capacity have greater potential for milk production (Resende et al., 2007).

Crude protein intake, which averaged 0.378 kg/day, was not affected by the levels of replacement of corn silage with sugarcane. The higher intake is likely due to the participation of non-protein nitrogen in the form of urea and the excess CP. However, the diets were isoproteic to meet the protein requirements of the goats, given the larger particle size of the roughage that was mixed with the concentrate daily. In addition, the preference for the concentrate may have influenced the higher CP intake in the treatments. This intake value is similar to the 0.368 kg/day described by Fonseca et al. (2006) in dairy goats fed a diet with 15.5% CP.

For EE, results were similar to those found by Magalhães et al. (2004) and Mendonça et al. (2004), who replaced corn silage with sugarcane in diets for lactating cows. The lower EE content of sugarcane favored the lower intake of this nutrient in comparison with corn silage.

Results for NDF were contrary to those described by Magalhães et al. (2004) and Mendonça et al. (2004), who mentioned that NDF intake decreased as the amount of sugarcane replacing corn silage was increased. The observed NDF intake may be a consequence not only of the higher percentage of concentrate, but also the similar level of this nutrient in the chemical composition of the diets.

The intake of NDF was also lower than the 0.710 and 0.876 kg/day found by Branco et al. (2011) and Carvalho et al. (2006), respectively, using diets with increasing levels of NDF for lactating goats. These authors reported that the increased percentage of NDF in the diet induced a decrease in DM intake, and concluded that, based on MY and the intakes of DM, fiber, and energy, the ideal NDF content is 35%. The NDF level used in the diets in the current experiment was 24.03%, which is below the values proposed by Branco et al. (2001) and Carvalho et al. (2006). Moreover, the reduction in DM intake with the sugarcane-based diets may be related to the quality of the sugarcane fiber, given its low digestibility and/or low rates of digestion and passage through the rumen (Pires et al., 2010), and not only the NDF content, as some studies showed higher NDF contents in corn silage when compared with sugarcane (Magalhães et al., 2004; Mendonça et al., 2004).

Due to the preference of the animals, the sugar content of sugarcane and the starch of corn silage may have favored the increase in NFC intake in the group fed the roughage-only diet. The result for NFC intake is contrary to those reported by Magalhães et al. (2004), who found no differences in NDF intake using diets with levels of sugarcane replacing corn silage; and by Mendonça et al. (2004), who described higher NFC intake using diets with corn silage in comparison with sugarcane in the feeding of lactating cows.

As reflected by DM intake, the higher NFC intake from the diet with corn silage relative to sugarcane may have contributed to the higher TDN intake shown by these treatment groups. The average intake of 1.56 Mcal/kg met the net energy requirement of 1,180 Mcal/kg recommended by the NRC (2007) for goats producing 1,500 kg/day of milk. This value is related to nutrient digestibility. The increase in DM intake with highly digestible nutrients favored the intake of net energy, and, consequently the increase in production. There is a negative correlation between MY and the fiber content of the diet and a positive correlation between MY and the net energy content of the forage (Morand-Fehr and Sauvant, 1980).

Results for DM and CP digestibility agree with those described by Magalhães et al. (2006) and Mendonça et al. (2004), who worked with diets containing corn silage and/or sugarcane with a 60:40 roughage:concentrate ratio to feed lactating cows.

The mean DM digestibility of 69.16% was higher than the 65.18% found by Vilela et al. (2003) in diets with the inclusion of sugarcane and urea with different concentrates; and also higher than the 66.75% described by Costa et al. (2005) in diets with corn silage or sugarcane for dairy cows. The roughage content of 40% and the similar NDF contents of the experimental diets may have contributed to the greater digestibility of DM. In addition, this digestibility can be attributed to the greater proportion of NFC in the experimental diets, since, as the roughage fraction increases, DM digestibility decreases due to the increase in structural carbohydrates (Rode et al., 1985).

The higher lipid content of the corn grains and silage forage and the consequent higher percentage of EE relative to sugarcane may have contributed to its greater digestibility, since the lipids of forage are hydrolyzed to form fatty acids, galactose, and glycerol in the rumen, the latter of which are rapidly fermented to short-chain fatty acid (Palmquist and Mattos, 2006). This greater digestibility favors the fat content of milk.

The average digestibility coefficients of NDF and NFC were 23.59 and 87.12%, respectively. These coefficients were lower and similar to those reported by Mendonça et al. (2004) and Costa et al. (2005), respectively, who found greater digestibility of NDF in corn silage diet as compared with the sugarcane diet (means: 39.23 vs. 43.59%). However, NFC digestibility was inversely proportional to NDF digestibility, with higher values occurring in the sugarcane diets and lower coefficients obtained with corn silage (means: 92.9 vs. 86.22%).

Dry matter intake is one of the main determinants of production, as goats with greater intake capacity have greater potential for milk production (Resende et al., 2007). In this study, as there was no change in DM intake, this result can be attributed to the intake of CP. The DM intake of 2.272 kg/day was reflected in the MY of 1.512 kg/day, which is in agreement with the requirements defined by the NRC (2007) for this production level.

In an experiment with fresh or ensiled sugarcane in diets with a 50:50 roughage:concentrate ratio for lactating goats, Mendes (2006) found no significant differences between the treatments for MY, which averaged 1.520 kg/day.

In dairy cows, Magalhães et al. (2004) reported that MY and 3.5% fat-corrected MY decreased linearly as the levels of substitution of corn silage with sugarcane were increased, suggesting that the quality of the sugarcane fiber limited the individual performance of the animals.

In a study with dairy cows, Costa et al. (2005) observed that MY was lowest when the animals received a diet with 60% sugarcane, intermediate with 50%, and highest with 40%. The latter treatment provided similar production to the diet with 60% corn silage. These authors attributed the lower MY obtained with diets with higher percentages of sugarcane to the lower DM intake, which resulted in less intake of nutrients.

Corroborating the aforementioned, in a study with lactating cows fed diets containing increasing levels of sugarcane replacing corn silage, Pires et al. (2010) found higher yields using treatments with 100, 75, and 50% silage and less production with treatments containing 75 and 100% sugarcane in the roughage. For the authors, the decrease in milk was affected by the lower intakes of DM and, consequently, of energy.

Like bovine milk, the composition of goat milk varies with several factors, including breed, age, lactation stage, and diet. No differences were found for the CP, fat, lactose, total solids, or solid-not-fat components across the levels of replacement of corn silage with sugarcane. Magalhães et al. (2004) and Mendonça et al. (2004) observed similar results for protein, total solids, and solid-not-fat; and Costa et al. (2005) for CP, lactose, and solid-not-fat. The CP content of goat milk (3.40%) was within the range of 2.2 to 5.1% reported by Villalobos (2005).

The average milk fat content of 3.63% was higher than the 2.8% observed by Canizares et al. (2011); 2.95% by Fonseca et al. (2006); 3.24% by Carvalho et al. (2006); and 3.32% by Branco et al. (2011) in dairy goats. In the case of the first authors, the experiment involved diets with a greater percentage of concentrate, whereas the latter worked with increasing levels of NDF in the diet. The fat content may be considered high in the case of diets with a greater proportion of concentrate, in which there is a greater production of short-chain fatty acids, especially propionic acid. The MY, which may be deemed low, possibly resulted in concentrated levels of fat, increasing its percentage.

The aforementioned corroborates the findings of Pires et al. (2010), who reported that diets containing 50, 75, and 100% sugarcane provided a higher concentration of fat in the milk of cows as compared with diets containing 100 and 75% corn silage. According to the researchers, a possible explanation would be the dilution effect caused by the higher MY obtained with the treatments with corn silage.

In experiments with dairy cows, Magalhães et al. (2004), Mendonça et al. (2004), and Costa et al. (2005) found no difference in the milk fat content between treatments with corn silage and/or sugarcane, having described mean values of 4.06, 3.82, and 3.44%, respectively. These authors expected a lower value for the 40% sugarcane treatment, suggesting that the increased proportion of concentrate in the diet causes a decline in acetic:propionic acid ratio and, consequently, in the fat content of milk.

Surplus ammonia in the rumen, a product of the degradation of protein and non-protein nitrogen present in urea, increases urea formation in the liver. Excess urea is then excreted in the urine and, to a lesser extent, in milk (Giaccone et al., 2007). For this reason, urea nitrogen has been used as an indicator to monitor excess CP in the diet, either in a degradable or soluble form.

The urea nitrogen concentration responded linearly to the levels of replacement of corn silage with sugarcane, which was intensified with the increasing amounts of sugarcane. The preference of the goats to consume the concentrate, coupled with the higher urea content and excessive CP for the milk production level of the goats, may have contributed to this increase in the treatments that involved sugarcane. The average urea nitrogen concentration of 29.85 mg/dL was high, which may be due to the greater amount of easily fermentable carbohydrates from sugarcane. These, in turn, generated the lack of synchronization with the rate of degradation of the nitrogen sources.

No reports have been found that allow establishing urea nitrogen values that can be considered normal in goat milk. This is not the case for cows, for which, according to Peres (2001), values considered normal are within the range of 12-18 mg/dL. This author stated that low values indicate a deficiency of degradable and soluble CP, whereas high values denote a deficiency of carbohydrates and excess CP. In the present study, the urea nitrogen values were high, especially for the treatment with 100% sugarcane (32.73 mg/dL), meaning that there was an excess of nitrogen, which is related to CP that was not used for the production of microbial protein and, consequently, for milk production. This is explained by the preference of the animals to consume the concentrate first, which contained urea in increasing amounts as the levels of sugarcane were raised.

Table 1. Concentrates and forages chemical composition expressed in grams per kilogram of dry matter

Nutrients (g/kg)	Concentrates for each replacement level				Forages	
	0%	33%	66%	100%	Corn silage	Sugarcane
Dry matter	889	890	890	890	350	298
Organic matter	964	963	962	962	957	984
Ash	36	37	38	38	43	16
Crude Protein	204	216	230	242	76	20
Ether extract	40	39	38	38	41	16
Neutral detergent fiber	116	117	118	119	416	433
Acid detergent fiber	54	55	56	57	241	272
Total carbohydrates	689	680	669	659	841	948
Non-Fibrous Carbohydrates	572	563	551	541	424	516
Calcium	11	11	11	11	3	2
Phosphor	6	7	7	7	2	1
Total digestible nutrients	869	844	814	764	744	685
Metabolizable energy (Mcal/kg)	3.49	3.38	3.24	3.02	3.34	3.07
Net energy (Mcal/kg)	2.01	1.95	1.87	1.75	1.70	1.56

Table 2. Experimental diets chemical composition

Nutrients (g/kg)	Replacements levels (%)			
	0	33	67	100
Dry matter	674	667	660	653
Organic matter	961	964	968	971
Ash	39	36	32	29
Crude protein	152	153	153	154
Ether extract	40	36	33	29
Neutral detergent fiber	236	239	242	244
Acid detergente fiber	129	133	138	143
Total carbohydrates	749	758	767	775
Non-fibrous carbohydrates	513	519	525	531
Calcium	8	8	8	8
Phosphor	5	5	4	4
Total digestible nutrients	819	796	770	732
Metabolizable energy (Mcal/kg)	3.265	3.160	3.041	2.872
Net energy (Mcal/kg)	1.887	1.830	1.766	1.675

Table 3. Dry matter and nutrient intake of lactating goats fed diets with different replacement levels of corn silage by sugarcane

Variables	Replacement levels (%)				Means	VC (%)
	0	33	67	100		
Dry matter (kg/d)	2.491	2.267	2.102	2.227	2.272	9.69
	[1]$\hat{Y}$= 2.50239 – 0.0107805X + 0.0000792201X^2 (R^2 = 0.97; Y_{min} = 2.136 for X = 68.04)					
Dry matter (%PV)	4.723	4.457	4.177	4.289	4.412	8.98
Crude protein (kg/d)	0.397	0.369	0.355	0.389	0.378	9.79
Ether extract (kg/d)	0.100	0.086	0.074	0.071	0.083	11.21
	[1]$\hat{Y}$= 0.097761 – 0.000301782X (r^2 = 0.94)					
Neutral detergent fiber (kg/d)	0.468	0.427	0.376	0.442	0.429	14.23
Non-fibrous carbohydrates (kg/d)	1.355	1.231	1.155	1.219	1.240	8.84
	[1]$\hat{Y}$= 1.35938 – 0.00569362X + 0.0000424255X^2 (R^2 = 0.98; Y_{min} = 1.168 for X = 67.10)					
Total digestible nutrients (kg/d)	1.757	1.544	1.529	1.566	1.599	8.58
	[1]$\hat{Y}$= 1.74957 – 0.00738404X + 0.0000561865X^2 (R^2 = 0.97; Y_{min} = 1.507 for X = 65.71)					
Net energy (Mcal/kg)	1.573	1.504	1.629	1.550	1.564	9.07

VC = variation coeficient; [1]P<0,05.

Table 4. Apparent digestibility of dry matter and nutrients in diets with different replacement levels of corn silage by sugarcane of lactating goats

Variables (%)	Replacement levels (%)				Means	VC (%)
	0	33	67	100		
Dry matter	68.71	66.63	73.42	67.89	69.16	8.71
Crude protein	75.22	71.66	78.74	74.99	75.10	8.12
Ether extract	80.78	79.00	79.92	70.80	77.63	5.94
	[1]$\hat{Y}$= 80.1509 + 0.0763989X – 0.00163828X^2 (R^2 = 0.88; Y_{max} = 81.04 para X = 23.32)					
Neutral detergente fiber	28.74	17.65	25.36	22.63	23.59	60.41
Acid detergente fiber	84.80	85.97	90.17	87.56	87.12	5.23

VC = variation coeficient; [1]P<0,05.

Table 5. Production and milk composition from lactating goats fed diets with different replacement levels of corn silage by sugarcane

Variables	Replacement levels (%)				Means	VC (%)
	0	33	67	100		
Milk production (kg/d)	1.670	1.441	1.474	1.465	1.512	18.03
Milk Production 3,5% fat (kg/d)	1.741	1.528	1.464	1.463	1.549	16.35
Proteina (g/kg)	32.3	34.4	34.7	34.4	34.0	6.93
Fat (g/kg)	36.4	37.6	36.3	34.7	36.3	9.85
Lactose (g/kg)	43.5	44.5	44.0	44.2	44.0	3.33
Total solids (g/kg)	120.5	125.0	123.2	120.4	122.3	4.49
Degreased dry extract (g/kg)	84.1	87.3	86.8	85.7	86.0	3.12
Urea nitrogen (mg/dL)	26.84	28.84	31.01	32.73	29.85	11.71
	[1]$\hat{Y}$= 26.8936 + 0.0595189X (R^2 = 0.99)					

VC = Variation coeficient; [1]P<0,05.

Conclusion

Sugarcane can replace 100% of corn silage, at a 40:60 roughage:concentrate ratio, in the diet of dairy goats without changing dry matter digestibility, milk yield, or the milk protein, fat, lactose, and total solid contents. However, sugarcane inclusion increases the urea nitrogen concentration in the milk of lactating goats.

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