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Mesquite pod meal in diets for lactating goats[1]

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ABSTRACT - The objective of this study was to evaluate the effects inclusion of 0%, 33.3%, 66.7% and 100% natural matter (NM) of mesquite pod meal (MPM), in substitution of corn, on the intake, digestibility and feeding behavior of lactating Saanen goats. The forage:concentrate ratio in the diet was 40:60, using elephant grass silage as a forage source. Eight adult lactating goats with about 60 days in milk and weighting 50 kg were divided into two 4 × 4 latin squares and four 17-day experimental periods. Dry matter (DM), crude protein (CP) and total digestible nutrient (TDN) intakes were not influenced by MPM levels. Ether extract (0.51; 0.34; 0.36; 0.20 kg/day) and non-fiber carbohydrate (NFC) (0.54; 0.53; 0.49; 0.36 kg/day) intakes showed a linear effect with increased MPM. Organic matter (OM) and NDF intakes presented a quadratic behavior. The maximum OM intake was estimated with the replacement of 40.5%. The maximum estimated intakes for NDF were 0.665 kg/day and 14.8 g/kg body weight, with a replacement close to 60%. Nutrient digestibility coefficients and TDN levels (655.0 g/kg) were not affected, except for NFC. The time spent eating, ruminating and idle was not influenced by the addition of MPM. The feeding rate of DM had a linear decrease which reflected the intake restriction. Corn replacement with MPM should not exceed 40.5%, although its total replacement does not interfere with the intake of DM, CP and TDN on the apparent digestibility of nutrients and most ingestive behavior parameters.

Key Words: alternative foods, digestibility, ingestive behavior, intake, *Prosopis juliflora*, semiarid

Introduction

In spite of being regarded as the most limiting factor for meeting the nutritional requirements of ruminants, energy is essential for the animal to fulfill its productive potential. Corn is the most widely used energy source present in concentrate diets for ruminants; however, price fluctuations have generally limited its use, since feeding is the major cost related to the livestock activity. Thus, alternative energy sources for replacing corn without affecting animal performance have been sought.

Mesquite [*Prosopis juliflora* (Sw.) D.C.] was introduced in Brazil - mainly in the Northeastern region - over 50 years ago. This is one of the few species that can withstand droughts, with an average yield of 6 t/ha/year, distributed in two annual crops coinciding with the critical period of forage scarcity (Ribaski et al., 2009). Currently, mesquite pod has been used in meal production. In addition, it is characterized by having energy and protein concentrations similar to corn, with a high non-fiber carbohydrate content.

Yet, mesquite pods contain toxins and anti-nutritional factors such as polyphenolics, alkaloids, lectins and non-protein amino acids that may limit their use in animal feeding (Ortega-Nieblas et al., 1996; Tabosa et al., 2000; Svensson et al., 2004; Andrade-Montemayor et al., 2011).

Alves et al. (2010) assessed the chemical composition of mesquite pod meal and verified 9.1% crude protein, 28.2% ash and protein-free neutral detergent fiber and 58.4% non-fiber carbohydrates. However, in order for this feedstuff to be efficiently used in animal production, it is necessary to know both its chemical composition and its nutrition and production effects on ruminants.

Accordingly, the objective of this study was to assess the effects of mesquite pod meal inclusion in substitution of corn on intake and digestibility of nutrients and the feeding behavior of lactating goats.

Material and Methods

The experiment was conducted at the Goat Farming Unit of Universidade Estadual do Sudoeste da Bahia – UESB, Itapetinga, Bahia State, Brazil, in February-May 2006.

Eight Saanen goats with an average body weight of 50 kg and lactating for about 60 days at the beginning of

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the experiment were used. The animals were distributed into two 4 × 4 balanced latin squares, in four 17-day experimental periods whereof the first 10 days were assigned for adaptation and the 7 other days for data collection. The four treatments consisted of isonitrogenous diets containing 40% of elephant grass silage and 60% of a concentrate with four replacement levels of milled corn grain by mesquite pod meal (0%, 33.3%, 66.7% and 100%) in the natural matter (Tables 1 and 2). The animals were handled in individual stalls and fed *ad libitum* twice daily (08h00 and 04h00). To estimate intake, the diet supplied and leftovers were weighed daily considering every animal individually; the leftovers varied around 100 g/kg of the total.

For chemical analyses, samples of the feed provided and its leftovers per animal and period were collected, packed into properly labeled plastic bags, and stored in a freezer at -20 °C. Next, the samples were subjected to drying under forced ventilation at 55 ºC for 72 hours, and ground using 1 mm mesh sieves. Analyzes were carried out for determining the dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), neutral detergent nitrogen (NDIN), acid detergent nitrogen (ADIN), lignin (LIG) and minerals (MM), as described by Silva & Queiroz (2002).

The concentration of non-fiber carbohydrates (NFC) was calculated as described by Hall (2003), as follows:

NFC (%DM) = (100 – %NDF – %CP – %EE – %ash).

The total digestible nutrients levels (TDN) were calculated according to Weiss (1999), using the following equation:

TDN (%) = DCP + 2.25 DEE + DNDF + DNFC.

Where: DCP = digestible crude protein; DEE = digestible ether extract; DNDF = digestible neutral detergent fiber; and DNFC = digestible non-fiber carbohydrates.

In order to evaluate the apparent digestibility, the total stool collection was carried out from the 15th to the 16th day of each experimental period. Each collection per animal was made with the aid of Napa leather bags adapted to the animals. Stools were weighed in the morning and afternoon, and approximately 10% of them were removed. Stool samples were pre-dried and milled in a shredder equipped with 1.0 mm mesh sieves. Composite samples were daily made considering each animal.

Weighing was conducted at the beginning and at the end of each experimental period, always after the morning milking.

Ingestive behavior was assessed on the 12th day of each experimental period, and the animals were watched every 10 minutes in a period of 24 hours for observing the time spent eating, ruminating and idle. The recording of the time spent eating, ruminating or idle was conducted by trained observers in alternate shifts, strategically placed so as not to disturb the animals.

Table 1 - Ingredient composition of the diets (g/kg of dry matter)

	% replacement of corn by mesquite pod meal			
	0	33.3	66.7	100
Elephant grass silage	400.0	400.0	400.0	400.0
Milled corn grain	468.6	315.2	158.9	0.00
Mesquite pod meal	0.0	152.5	307.7	465.7
Soybean meal	79.8	79.4	79.1	78.8
Cottonseed meal	29.5	29.8	30.0	30.3
Mineral mixture	22.1[1]	23.1[2]	24.3[3]	25.2[4]
Total	1000	1000	1000	1000

[1] Dicalcium phosphate - 399.0 g/kg; common salt - 201.00 g/kg; commercial mineral salt - 400.00 g/kg.
[2] Dicalcium phosphate - 423.0 g/kg; common salt - 192.00 g/kg; commercial mineral salt - 385.00 g/kg.
[3] Dicalcium phosphate - 444.0 g/kg; common salt - 186.00 g/kg; commercial mineral salt - 370.00 g/kg.
[4] Dicalcium phosphate - 464.0 g/kg; common salt - 179.00 g/kg; commercial mineral salt - 357.00 g/kg.

Table 2 - Chemical composition of forage, mesquite pod meal (MPM) and concentrates (g/kg dry matter)

Item	Elephant grass silage	Mesquite pod meal	Concentrates (% replacement of corn by mesquite pod meal)			
			0	33.3	66.7	100
Dry matter	291.1	927.5	897.3	901.9	916.4	922.5
Organic matter	855.9	958.3	940.8	935.9	927.9	911.5
Crude protein	30.7	78.2	138.7	137.7	135.4	134.4
Ether extract	24.9	16.4	39.4	29.0	25.0	18.7
Neutral detergent fiber	800.4	296.5	261.4	298.3	330.2	347.6
Acid detergent fiber	585.9	241.5	96.4	133.0	190.6	235.8
Neutral detergent insoluble nitrogen[1]	160.0	25.0	181.1	95.0	56.0	46.0
Acid detergent insoluble nitrogen[1]	150.0	17.0	47.0	38.0	29.0	26.0
Lignin	67.4	45.2	47.0	54.5	52.5	50.7
Non-fiber carbohydrates	0.0	567.2	511.3	471.0	437.8	410.9
Total carbohydrates	804.6	863.7	762.7	769.3	768.0	758.5
Mineral matter	144.0	41.7	49.2	64.0	71.6	88.4

[1] g/kg of total nitrogen.

On the following day, the number of cuds-chewing per bolus (NCCB/bolus) and the time spent ruminating each bolus (TRB - s/bolus) were assessed using a digital chronometer. In order to estimate the chewing and time-related averages, three ruminal boli were observed at three different periods (10-12; 14-16 and 18-20h). The variables referring to time and number of chews for each ruminal bolus per animal were calculated.

Feeding and rumination efficiency expressed as g DM/hour and g NDF/hour were calculated by dividing the average daily intake of dry matter and neutral detergent fiber by the total time spent eating and/or ruminating within a 24-hour period, respectively. These and other variables obtained in this experiment, such as daily number of ruminal boli (NRB), total chewing time (TCT) and number of chews (NC) were obtained according to the methodology described by Bürger et al. (2000) and Polli et al. (1996).

The dependent variables (intake, digestibility and feeding behavior) were assessed by analysis of variance and regression, using the Statistical Analysis System (SAEG, version 8.0). The criteria used to choose the regression model were the coefficient of determination (R^2) and significance determined by the F test at 5% probability.

The variables were analyzed using the following statistical model:

$$Y_{ijkl} = \mu + LS_i + T_j + (P/LS)_{ik} + (G/LS)_{il} + QL \times T_{ij} + \varepsilon_{ijkl}$$

Where: Y_{ijkl} = observation of goat l, in period k, subjected to treatment j in the latin square i; μ = overall effect of the mean; LS_i = i effect of the Latin square, where i = 1,2; T_j = effect of treatment j, where j = 1, 2, 3, 4; $(P/LS)_{ik}$ = effect of period k on the latin square i, where k = 1, 2, 3, 4; $(G/LS)_{il}$ = l effect of the goat on the Latin square i, where l = 1, 2, 3, 4; LS x T_{ij} = effect of the interaction between latin square i × treatment j; ε_{ijkl} = random error associated with each observation, NID assumption (0, σ^2).

Results and Discussion

Dry matter intake was not affected (P>0.05) with the inclusion of mesquite pod meal in the diet (Table 3), showing averages of 1.42 kg/day, 33.8 g/kg body weight (BW) or 45. 10 g/kg $BW^{0.75}$. According to Wilkinson & Stark (1987), the DM intake by goats generally lies between 30.0 and 50.0 g/kg of BW.

The results of this study are agree with those found by Silva et al. (2005a), who evaluated corn replacement by cocoa meal and palm kernel cake at 15% and 30% in diets for lactating goats and did not observe any effect on dry matter intake. Likewise, when assessing the replacement of corn by cassava bran in diets for lactating Saanen goats, Mouro et al. (2002) did not observe any effect on dry matter intake, averaging 3.5% of body weight. The average dry matter intake (3.38% BW) obtained in this study was similar to that found by these authors, whereas this small difference may be related to lower CP and higher NDF levels when compared with the values from the diets they used.

According to the interpretation of results reported in the literature, it can be verified that the replacement of traditional foods by alternative sources without increasing the NDF levels that limit intake and the fact that the diets were isonitrogenous do not affect dry matter intake.

Crude protein intake in both forms of expression (kg/day and g/kg BW) was not affected (P>0.05) when ground corn was replaced with mesquite pode meal (MPM). This can be explained by the fact that the diets were isonitrogenous, with no change in dry matter intake. By contrast, NFC intake (kg/day and g/kg of BW) was found to decrease with increasing MPM levels, since NFC levels were altered as a function of the varying proportion of dietary corn, presenting a higher NFC concentration when compared with MPM.

Goats fed diets containing higher MPM levels showed lower (P<0.05) EE intake (Table 3). Such behavior can be accounted to the concentration of this nutrient in the diet, which decreased with MPM inclusion; in comparison with corn, MPM has a lower EE concentration.

Neutral detergent fiber intakes expressed as kg/day and g/kg of BW (Table 3) were influenced by MPM levels (P<0.05), with maximum intakes of 0.665 kg/day and 14.8 g/kg BW for 60.3 and 60.9% replacement of corn by MPM, respectively. One must observe that these levels are similar. Since the NDF concentration increased with MPM addition, it was expected that intake would behave the same way. However, Mertens (1994) predicted that dry matter intake would be limited by the filling when the daily NDF intake was greater than 11 to 13 g/kg of BW.

These parameters are not yet fully understood for lactating goats, but Santini et al. (1992) and Carvalho (2002) have shown evidence that the mechanism for controlling fiber intake in this the study is seemingly due to physical factors. In this experiment, animals fed diets containing 60.9% of MPM had a NDF intake above the limiting capacity; therefore, one may interpret that the replacement of corn by MPM above such level limits OM intake probably due to physical limitations of the rumen (Table 3).

On the other hand, MPM addition (P<0.05) in the diets of lactating goats had no significant effect (P<0.05) on organic matter intake expressed in kg/day. In turn, regression served as basis for estimating that the maximum

Table 3 - Minimum square means regarding the intake of nutrients as a function of mesquite pod meal (MPM)

Item	% of corn replacement by mesquite pod meal				CV (%)	P value		
	0	33.3	66.7	100		Linear	Quadratic	Cubic
Intake (kg/day)								
Dry matter	1.41	1.48	1.52	1.27	13.4	0. 323	0. 096	0. 162
Organic matter	1.29	1.35	1.39	1.12	13.3	0. 175	0. 038[1]	0. 065
Mineral matter	0.13	0.13	0.13	0.14	16.7	0. 268	0. 792	0. 359
Crude protein	0.16	0.16	0.16	0.13	16.3	0. 055	0. 056	0. 063
Ether extract	0.05	0.03	0.03	0.02	27.9	0. 000[2]	0. 000	0. 000
Neutral detergent fiber	0.54	0.62	0.68	0.60	12.7	0. 177	0. 042[3]	0. 113
Non-fiber carbohydrates	0.54	0.53	0.49	0.36	14.6	0. 000[4]	0. 020	0. 541
Total digestible nutrients	0.92	1.01	0.98	0.83	21.0	0. 357	0. 214	0. 388
Intake (g/kg of BW)								
Dry matter	33.5	35.0	36.2	30.5	15.61	0.429	0.254	0.377
Organic matter	32.8	31.2	31.5	25.1	32.89	0.019[5]	0.032	0.281
Mineral matter	2.97	3.08	3.19	3.38	19.7	0.310	0.868	0.992
Neutral detergent fiber	12.1	13.8	15.2	13.5	12.75	0.187	0.043[6]	0.185
Non-fiber carbohydrates	12.8	12.5	11.7	8.8	16.93	0.002[7]	0.003	0.009

*Significant (P<0.05) by the t test; **Significant (P<0.01) by the t test.
[1] $\hat{Y}$ = 1.27 + 0.006MPM*- 0.00007MPM^2**
[2] $\hat{Y}$ = 0.05 – 0.0003MPM**
[3] $\hat{Y}$ = 0.54 + 0.004 MPM**- 0.00003MPM^2*
[4] $\hat{Y}$ = 0.5632 – 0.001667MPM**
[5] $\hat{Y}$ = 33.559 – 0.006809MPM**
[6] $\hat{Y}$ = 11.9 + 0.009MPM**-0.00008MPM^2*
[7] $\hat{Y}$ = 1.3389 – 0.003864MPM**

intake would occur when MPM levels were 40.5%. Yet, when organic matter intake was expressed as g/kg of body weight, while the MPM levels increased, OM intake decreased.

The OM intake response (Table 3) presenting a quadratic response (P<0.05) when expressed as kg/day differed from that expressed as g/kg of BW. The diet nutrient levels did not differ from each other, but the varied consumptions cannot be explained by MM intake due to the response similarity between the diets (Table 3). Thus once it is possible to prevent some intake variations by expressing intake as a percentage of body weight, one may infer that the effect of MPM on OM intake-related restriction could be related to the effect of secondary metabolites present in mesquite pods.

Mahgoub et al. (2005) observed that goats have substantially gained weight on a basis of 200 g/kg of dry matter, for a period of eight weeks, whereas those fed 300 g/kg were observed to gain less weight and presented reduced intake. The authors believe that such reduction results from the presence of tannins and other phenolic compounds in the pods, leading to reduced intake. It must be emphasized that, in this study, the maximum organic matter intake was estimated with the addition of approximately 186.0 g of MPM/kg of dry matter.

As regards the digestibility of DM, OM, CP, EE, NDF and total digestible nutrients, the diets did not differ from each other (P>0.05) (Table 4).

The digestibility coefficients observed in this study are consistent with those found by Silva et al. (2005b), who worked with Saanen goats fed corn silage and corn-based concentrate as an energy source. The observed averages were 66.0; 64.3; 59.4; 88.6; 47.3; and 81.2 g/100 g for DM, OM, CP, EE, NDF and NFC, respectively.

With regard to EE digestibility, no significant difference (P>0.05) occurred with MPM inclusion, although the mean change ranged between 80.7 g/100 g and 71.6 g/100 g. This numerical reduction in digestibility can be explained by the reduced EE percentage in the dry matter ingested, with the addition of MPM (Table 4).

An increasing linear effect (P<0.05) of the replacement levels by MPM was observed for the NFC digestibility coefficients. Figueiredo et al. (2007) reported that MPM shows more fibrous fractions in the carbohydrate content, tending to reduce the digestibility in relation to corn. Nonetheless, the digestibility results observed for diets containing MPM in place of corn are not consistent with the assertions of these authors, even though the values are very close.

There was no effect (P>0.05) of the MPM levels on the TDN content of the diets studied; likewise, TDN intake was not influenced, thus generating an average value of 0.93 kg/day (Table 3).

By evaluating the dry matter intake data predicted by NRC (2007) for goats at the first third of lactation - 50 kg body weight, producing 1.62 kg of milk corrected for

35.0 g/kg of fat - the daily intake of 1.94 kg was higher than the average verified in this experiment (1.42 kg).

Nevertheless, the TDN and metabolizable energy requirements predicted by the NRC (2007) - 1.03 kg/day and 3.70 Mcal/day, respectively - are very close to the mean values: 0.995 kg/day and 3.74 Mcal/day, found for diets containing 33.3% and 66.7% of MPM, wherein the goats had an average daily production of 1.91 kg of milk or 1.70 kg of corrected milk for 35.0 g/kg fat.

There was no significant effect (P>0.05) for the time spent eating, ruminating and idle, as a function of the replacement levels of corn by MPM (Table 5). Indeed, many factors can affect feed intake by ruminants and thereby cause a direct effect on their ingestive behavior, including NDF content and the physical form of the diet, which, according to Van Soest (1994), may affect rumination.

The lack of significant effects on the rumination activities, however, may be explained by the reduced particle size of the fiber obtained from mesquite, once the forage was the same, only differing as to the MPM inclusion levels. Considering the above, it is clear that - besides the NDF levels - the physical features of the fiber (size and density) can also significantly influence the behavioral activities, especially rumination.

In this study, the mean times spent eating (4.21 hours/day), ruminating (8.76 h/day) and idle (11.13 h/day) were similar to those observed by Church (1988) for goats - 4.23 m/day and 7.43 hours/day for feeding and rumination, respectively - and those observed by Santini et al. (1992) for lactating female Alpine goats, whose maximum feeding and rumination times were 4.38 min/day and 6.06 hours/day, respectively, when subjected to a diet containing 474.0 g of NDF/kg.

The daily number of feeding periods and the average length of these periods were not influenced by MPM levels, with an estimated average value of 25.26 periods, and 10.70 s/g of DM, respectively (Table 6).

Consistent with these results, dry matter intake was not altered (Table 3). Yet, the NDF intake subjected to quadratic effect (P<0.05) with a maximum level of corn replacement by MPM near 60% demonstrates that, in the short term, changes in NDF intake could not be predicted by measures of ingestive behavior.

Thus, the study of ingestive behavior parameters in the short term could not fully explain the changes observed in the daily NDF intake of lactating goats, since OM was reduced when mesquite pod meal was below the peak of NDF intake. This suggests that the quadratic variation in NDF intake occurred as a consequence of the organic matter intake.

According to Forbes (2005), higher-quality feeds decrease the relative time of ingestion and the frequency of intervals between meals. Nonetheless, the same author reported that cows fed silage or concentrate-based diets have shown similar interval patterns both between meals and regarding their number, suggesting that this results from the fact that cows control their daily intake by mechanisms other than changes in the intervals between meals; in other words, their eating behavior is flexible, but over time, modest meal periods are totaled making their use unviable as a parameter for studying the mechanisms which control voluntary intake in the long term.

Table 4 - Least square means regarding the digestibility and total digestible nutrient coefficients (g/100 g dry matter)

Item	% of corn replacement by mesquite pod meal				CV (%)	P value		
	0	33.3	66.7	100		Linear	Quadratic	Cubic
Dry matter	65.3	70.5	66.2	67.9	12.7	0. 842	0. 651	0. 371
Organic matter	69.2	72.9	67.7	70.5	11.8	0. 933	0. 906	0. 330
Crude protein	70.3	73.9	72.8	76.4	10.8	0. 226	0. 998	0. 506
Ether extract	80.7	75.6	77.6	71.6	10.3	0. 153	0. 365	0. 406
Neutral detergent fiber	38.9	50.4	44.5	48.3	31.9	0. 452	0. 561	0. 360
Non-fiber carbohydrates	88.97	92.92	93.50	93.14	3.7	0. 043[1]	0. 122	0. 089
Total digestible nutrients	65.3	67.8	64.4	64.6	10.6	0. 690	0. 717	0. 509

*Significant (P<0.05) by t test.
[1] $\hat{Y}$ = 90.16 +0.04MPM*.

Table 5 - Mean time spent eating, ruminating and idle (h/day) and coefficient of variation (CV)

Item	% of corn replacement by mesquite pod meal				CV (%)	P value		
	0	33.3	66.7	100		Linear	Quadratic	Cubic
Feeding	3.87	4.14	4.49	4.04	24.1	0. 578	0. 269	0. 384
Rumination	8.28	8.82	9.50	8.42	15.3	0. 610	0. 103	0. 383
Idle	11.84	10.95	10.19	11.54	14.1	0. 475	0. 274	0. 394

Table 6 - Least square means for the parameters of ingestive behavior

Item	% of corn replacement by mesquite pod meal				CV (%)	P value		
	0	33.3	66.7	100		Linear	Quadratic	Cubic
Feeding time of dry matter (s/g DM)	9.88	10.08	11.30	11.53	24.1	0.084	0.458	0.854
Rumination time of dry matter (s/g DM)	21.25	21.84	22.92	24.08	15.3	0.369	0.107	0.685
Feeding time of NDF (s/g NDF)	25.73	24.00	25.00	24.11	12.7	0.243	0.830	0.940
Rumination time of NDF (s/g NDF)	55.17	52.36	50.98	50.28	13.2	0.562	0.767	0.368
Feeding efficiency of dry matter (g DM/h)	386.32	381.15	365.17	314.11	17.2	0.046[1]	0.437	0.853
Feeding efficiency of NDF (g NDF/h)	148.14	159.40	163.79	151.83	16.6	0.768	0.326	0.857
Rumination efficiency of dry matter (g DM/h)	176.45	167.77	162.02	151.78	13.0	0.107	0.943	0.878
Rumination efficiency of NDF (g NDF/h)	67.58	70.73	73.03	73.32	10.4	0.369	0.767	0.957
Total chewing time (h/day)	12.16	12.97	13.77	12.46	11.9	0.464	0.052	0.368
No. of ruminated boli per day (no./day)	478.82	531.76	573.38	503.23	13.8	0.562	0.173	0.612
No. of cud-chewing per day (no./day)	2819.1	2954.7	3240.5	2856.6	15.7	0.685	0.243	0.406
No. of chews per ruminated bolus (no./bolus)	58.76	56.17	59.29	57.72	39.5	0.998	0.830	0.337
Rumination time per bolus (s/bolus)	62.74	60.65	62.97	62.57	6.6	0.906	0.807	0.644

NDF - neutral detergent fiber; DM - dry matter; h - hour; CV - coefficient of variation.
* Significant (P<0.05) by t test.
[1] $\hat{Y} = 396.57 - 0.698$ MPM*.

The feeding efficiency of dry matter decreased linearly (P<0.05) with the addition of MPM in the concentrate; therefore, there was a decline of 0.698 g of DM/hour for every MPM percent unit increased. This suggests that, when regulated by physical mechanisms and/or by factors that arise in the long term, such parameter can be used to predict intake. It should be emphasized that the organic matter intake of the diets analyzed in this study also decreased linearly when expressed as a percentage of body weight probably due to metabolic factors, which overlapped the physical factors in the short term. Taking into account that all diets had the same forage:concentrate ratio (40:60) even with different energy sources, the results revealed they did not change most of the ingestive parameters. Yet, as MPM limited OM intake probably due to metabolic factors, one may suggest that determining the feeding rate in a study of short-term feeding behavior can be used to predict daily intake in diets in which mesquite pods meal is used in place of corn.

Conclusions

Mesquite pod meal can be used in the replacement of up to 40.5% of corn grain, since it does not interfere in the intake of most nutrients; still, higher levels do not affect the apparent digestibility and total digestible nutrient concentration. Therefore, mesquite pod meal exceeding 200 g/kg of dry matter is not recommended, since organic matter intake may be lowered due to metabolic mechanisms. Further studies are therefore required to determine if the reduced feeding efficiency of dry matter is associated with the presence of secondary metabolites.

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References

ALVES, E.M.; PEDREIRA, M.S.; OLIVEIRA, C.A.S. et al. Comportamento ingestivo de ovinos alimentados com farelo da vagem de algaroba associado a níveis de ureia. **Acta Scientiarum**, v.32, n.4, p.439-445, 2010.

ANDRADE-MONTEMAYOR, H.M.; CORDOVA-TORRESB, A.V.; GARCÍA-GASCAC, T. et al. Alternative foods for small ruminants in semiarid zones, the case of Mesquite (*Prosopis laevigata* spp.) and Nopal (*Opuntia* spp.). **Small Ruminant Research**, v.98 p.83-92, 2011.

BÜRGER, P.J.; PEREIRA, J.C.; QUEIROZ, A.C. et al. Comportamento ingestivo em bezerros holandeses alimentados com dietas contendo diferentes níveis de concentrado. **Revista Brasileira de Zootecnia**, v.29, n.1, p.236-242, 2000.

CARVALHO, S. **Decomposição e comportamento ingestivo de cabras em lactação alimentadas com dietas contendo diferentes níveis de fibra**. 2002. 118f. Tese (Doutorado em Zootecnia) - Universidade Federal de Viçosa, Viçosa, MG.

CHURCH, D.C. **El ruminat: fisiología digestiva y nutrición**. Zaragoza: Acribia, 1988. 641p.

FIGUEIREDO, M.P.; CRUZ, P.G.; COSTA, S.S. et al. Fracionamento dos carboidratos e componentes nitrogenados do farelo e diferentes partes integrantes da vagem de algaroba (*Prosopis juliflora (*Swartz*) D. C)*. **Revista Brasileira Saúde Produção Animal**, v.8, n.1, p.24-31, 2007.

FORBES, J.M. Voluntary feed intake and diet selection. In: DIJKSTRA, J.; FORBES, J.M.; FRANCE, J. (Eds). **Quantitative aspects of ruminant digestion and metabolism**. 2.ed. Cambridge: CAB International, 2005. p.607-625.

HALL, M.B. Challenges with non-fiber carbohydrate methods. **Journal of Animal Science**, v.81, n.12, p.3226-3232, 2003.

MAHGOUB, O.; KADIM, I.T.; FORSBERG, N.E. et al. Evaluation of Meskit (*Prosopis juliflora*) pods as a feed for goats. **Animal Feed Science and Technology**, v.125, p.319-327, 2005.

MERTENS, D.R. Regulation of forage intake. In: FAHEY, G.C.; COLLINS JR., M.; MERTENS, D.R. et al. (Eds.) **Forage quality,**

evaluation, and utilization. Madison: American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 1994. p.450-493.

MOURO, J.F.; MACEDO, F.A.F.; GUIMARÃES, K.C. Substituição do milho pela farinha de mandioca de varredura em dietas de cabras em lactação: fermentação ruminal e concentrações de uréia plasmática e no leite. **Revista Brasileira de Zootecnia**, v.31, n.4, p.1840-1848, 2002.

NATIONAL RESEARCH COUNCIL - NRC. **Nutrient requirements of ruminants**: Sheep, goats, cervids, and new world camelids. Washington, D.C.: National Academy Press, 2007. 384p.

ORTEGA-NIEBLAS, M.; VÁZQUEZ-MORENO, L.; ROBLES-BURGUEÑO, M.R. Protein quality and antinutritional factors of wild legume seeds from the Sonoran desert. **Journal of Agriculture and Food Chemistry**, v.44, p.3130-3132, 1996.

POLLI, V.A.; RESTLE, J.; SENNA, D.B. et al. Aspectos relativos à ruminação de bovinos e bubalinos em regime de confinamento. **Revista Brasileira de Zootecnia**, v.25, n.5, p.987-993, 1996.

RIBASKI, J.; DRUMOND, M.A.; OLIVEIRA, V.R. et al. Algaroba *(Prosopis juliflora)*: **Árvore de uso múltiplo para a região Semiárida Brasileira**. Colombo, 2009. (Comunicado técnico, 240).

SANTINI, F.J.; LU, C.D.; POTCHOIBA, M.J. et al. Dietary fiber and milk yield, mastication, digestion, and rate of passage in goats fed alfafa hay. **Journal of Dairy Science**, v.75, p.209-219, 1992.

SILVA, D.J.; QUEIROZ, A.C. **Análise de alimentos**: métodos químicos e biológicos. 2.ed. Viçosa, MG: Imprensa Universitária. 2002. 156p.

SILVA, H.G.O.; PIRES, A.J.V.; SILVA, F.F. et al. Farelo de cacau (*Theobroma caco* L.) e torta de dendê (*Elaeis guineensis*, Jacq) na alimentação de cabras em lactação: consumo e produção de leite. **Revista Brasileira de Zootecnia**, v.34, n.5, p.1786-1794, 2005a.

SILVA, H.G.O.; PIRES, A.J.V.; SILVA, F.F. et al. Digestibilidade aparente de dietas contendo farelo de cacau ou torta de dendê em cabras lactantes. **Pesquisa Agropecuária Brasileira**, v.40, n.4, p.405-411, 2005b.

SVENSSON, B.; FUKUDA, K.; NIELSEN, P.K. et al. Proteinaceous α-amylase inhibitors. **Biochimica et Biophysica Acta (BBA) - Proteins Proteomics**, v.1696, p.145-156, 2004.

TABOSA, I.M.; QUINTANS-JÚNIOR, L.J.; PAMPLONA, F.V. et al. Isolamento biomonitorado de alcalóides tóxicos de *Prosopis juliflora* (algaroba). **Revista Brasileira de Farmacognosia**, v.9/10, n.1, p.11-22, 2000.

VAN SOEST, P.J. **Nutritional ecology of the ruminant**. 2.ed. Ithaca: Cornell University Press, 1994. 476p.

WEISS, W.P. Energy prediction equations for ruminant feeds. In: CORNELL NUTRITION CONFERENCE FOR FEED MANUFACTURERS, 61., 1999, Ithaca. **Proceedings…** Ithaca: Cornell University, 1999. p.176-185.

WILKINSON, J.M.; STARK, B.A. **Producción comercial de cabras**. Zaragoza: Acribia, 1987. 165p.