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Juazeiro hay in diets of Morada Nova sheep

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ABSTRACT - This study evaluated intake and apparent digestibility of the nutrients in the diet of Morada Nova sheep that received diets containing increasing levels of *juazeiro* hay in substitution of Tifton 85 bermudagrass hay (0, 33, 67 and 100%). Sixteen non castrated male sheep, weighing an average of 26.75 kg, were used, placed in individual metabolic cages and distributed in a completely randomized block design with four treatments and four replications. Intakes of dry matter, organic matter, crude protein, ether extract, neutral detergent fiber, total carbohydrates, fibrous carbohydrates and non-fibrous carbohydrates and total digestible nutrients were not influenced by the addition of juazeiro hay to the diets, with mean values of 1,042.78 and 595.59 g/day of dry matter and neutral detergent fiber intake, respectively. Linear reduction was observed for digestibility of the dry matter, organic matter, neutral detergent fiber and fibrous carbohydrates. Quadratic reduction was observed for the acid detergent fiber digestibility coefficient. The digestibility coefficients of the crude protein, ether extract, total carbohydrates and fibrous carbohydrates were not significant. The nitrogen balance was not influenced and was positive for all the treatments. The inclusion of juazeiro hay did not influence nutrient intake or nitrogen balance, but reduced the digestibility coefficient of some diet components.

Key Words: roughage, semiarid, *Zizyphos joazeiro*

Introduction

The primary determinants of forage conversion into animal products are intake of dry matter or energy, digestibility of nutrients and the conversion efficiencies of the digestible energy and metabolic energy (Waldo, 1986). As the primary component of this chain, dry matter intake plays an important role in nutrition studies because it establishes a quantity of nutrients available for production and maintenance of animal well-being (NRC, 2001).

The greatest limitation of the nutrient models for feed formulation is their inaccurate prediction of dry matter intake that includes more intimately the variations in production rather than food digestibility (Rayburn & Fox, 1993), which generates a continuous search for procedures to obtain reliable estimates of this variable. Dry matter intake is, in essence, a direct consequence of the genetic potential of the animal (Allen, 2000) where coordinated actions for the determined model of skeletal and muscle growth and the other metabolically active tissues, including homeostatic and homeorhetic directions, contribute to reaching or maintaining a continuous energetic status (long-term regulation) (Mertens, 1996).

Every food or feed ingested triggers, by different mechanisms, the hunger/satiation systems. This is the reason for a series of meals of different sizes, within a circadian biological rhythm, alternating between rumination and rest periods. Therefore, for each food/feed, there is a specific feeding model, and consequently a level of dry matter intake (short-term regulation) (Dulphy & Demarquilly, 1994).

Considering the importance of forage species native to the semi-arid region of Brazil, there is little reported research to assess the quality of these plants. In this case, it is very important to submit these species to nutrient intake and digestibility trials to understand their nutritional qualities and limitations in ruminant feeding.

Thus, the present study was carried out to assess the effects of substituting Tifton 85 Bermudagrass hay with *juazeiro* hay in the diet of Morada Nova sheep.

Material and Methods

The experiment was carried out in the Setor de Ovinocultura of the Departamento de Zootecnia at the Universidade Federal do Ceará, Pici Campus, in the city of Fortaleza, Ceará. The *juazeiro* hay was produced at the experimental farm Vale do Curu, which belongs to the

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Centro de Ciências Agrárias at UFC. To obtain the *juazeiro* hay, the *juazeiro* was collected at the pre-fructification stage, and branches were cut with thickness up to 1.5 cm, preserving tree canopy. They were then chopped in a forage chopping machine and dried. Nutrient intake, digestibility and nitrogen balance were assessed in 16 six-month old uncastrated male Morada Nova sheep weighing an average of 26.75 kg, confined in metabolism cages, supplied with drinker and feeder, equipped with feces and urine collectors and separators. Animals were distributed in four experimental diets consisting of four substitution levels (0, 33, 67 and 100%) of Tifton 85 bermudagrass hay by *juazeiro* hay, in a completely randomized block design with four replications. The experimental period lasted 21 days, 14 days for adaptation to the diets and the metabolism cages and seven days to measure the nutrient intake and digestibility and the nitrogen balance. The diet roughage:concentration relation was 60:40 and the experimental feeds were balanced following the recommendations by the NRC (2007).

Animals were weighed at the beginning and end of the experimental period. The total diet was supplied *ad libitum*, in the form of complete mixture once a day, and the leftovers were collected and weighed every day to determine daily intake. The quantity of feed supplied was calculated to allow approximately 10% leftovers, and water was offered *ad libitum*. Total feces collections were made to determine the nutrient digestibility between the 14th and 21st days of the experimental period. In this period, samples of foodstuffs and leftovers that were stored at -15 °C were also collected. The samples were pre-dried in a forced ventilation chamber, at 55 °C for 72 hours, ground in a Wiley mill with 1 -mm sieve and homogenized to make compound samples per animal/treatment.

Dry matter (DM), mineral matter (MM), crude protein (CP) and ether extract (EE) contents were determined according to the standard procedures reported in AOAC (1995); and those of neutral detergent fiber (NDF) acid detergent fiber (ADF) and cellulose, hemicelluloses and lignin as proposed by Van Soest et al. (1991) (Table 1). The carbohydrate fractioning was obtained according to Sniffen et al. (1992): CT = 100 – (CP% + EE% + MM%).

Urine samples were obtained by collections during 24 hours, stored in plastic containers containing 200 mL 10% sulfuric acid solution (H_2SO_4). After collection, the containers with urine were weighed to determine the total volume produced and then homogenized. Aliquots of approximately 100 mL were removed, labeled and stored at -5°C for later quantification of nitrogen compounds.

Total digestible nutrients intake (TDN) was calculated according to NRC (2001), where: TDN (%) = CPd + NDFd + NFCd + 2.25EEd, where: CPd = digestible crude protein; NDFd = digestible neutral detergent fiber, NFCd = digestible non-fibrous carbohydrates, and EEd = digestible ether extract.

The variables analyzed were interpreted statistically through analyses of variance and regression, using the Statistical Analysis System Institute (SAS, 2001).

Results and Discussion

The effects of *juazeiro* hay were not ascertained on nutrient intake. It is pointed out that the mean DM intake relative to animal live weight ranged from 3.36 to 4.07%, and was close to the value recommended by the NRC (2007) for animals of categories, physiological conditions and weight equivalent to the animals used in this study (Table 2). The mean DM intakes were close to 3.42% BW, reported by Araújo et al. (2004), in diets containing 70% *maniçoba* hay,

Table 1 - Chemical composition of ingredients and experimental diets based on dry matter

	Components of diet			Levels of inclusion of *juazeiro* hay (%)			
	Bermuda-grass hay	*Juazeiro* hay	Concentrate	0	33	67	100
Dry matter	90.30	91.76	94.57	92.01	91.76	92.04	92.88
Organic matter	83.38	83.80	86.23	84.52	84.10	84.18	84.77
Crude protein	10.22	12.05	20.87	14.48	14.10	15.14	15.58
Ether extract	1.01	0.72	2.64	1.66	1.60	1.54	1.49
Mineral matter	6.89	7.74	8.03	7.35	7.47	7.64	7.86
Neutral detergent fiber	85.68	73.67	21.25	59.87	56.97	54.60	52.66
Acid detergent fiber	40.37	46.45	7.36	27.17	28.13	29.33	30.82
Lignin	5.14	13.31	0.70	3.36	4.95	6.57	8.27
Cellulose	31.00	31.93	6.44	21.18	21.17	21.36	21.73
Hemicellulose	23.89	3.57	13.35	19.67	15.51	11.48	7.48
Total digestible nutrients	-	-	-	65.07	66.11	60.66	60.30
Total carbohydrates	80.22	79.27	69.77	79.84	79.32	79.27	79.71
Fibrous carbohydrate	76.61	65.63	1.33	47.45	40.97	34.95	29.21
Non-fibrous carbohydrate	3.61	14.36	77.94	32.39	38.35	44.32	50.50

which is also a tree species native to the Brazilian tropical thorn forest (caatinga).

This confirmed that when using plants that growth in unfavorable edafoclimatic conditions in ruminant feeding, an increase is caused in dry matter intake, because of the unavailability of the nutrients present in the composition. With this, the animals eat more because they seek to satisfy their nutritional requirements and the sensation of satiety is imposed by the physical filling of the space of the gastrointestinal tract (Mertens, 1987).

The mean NDF intake obtained in this study was 2.09% BW. The voluntary ingestion was probably regulated by the physical limitation of the gastrointestinal tract (Van Soest, 1994), thus leading to the limit of ruminal distention, that determines intake interruption (Baile & Forbes, 1974). The energy may have been restricted, because the rumen volume was occupied by the fiber. Mertens (1994) reported that food intake is limited by the physical filling of the ruminal compartment when the daily NDF intake is greater than 13 g/kg BW. According to Mertens (1987) ruminant diets should have a chemical composition that enables an NDF intake of around 1.2% BW, because higher values may cause rumen repletion, which causes physical satiety in the animal, that is, the spaces of the gastrointestinal tract will be occupied by indigestible particles. This experiment for all treatments, consumption, obeisant in % BW, were higher than those recommended by Mertens (1994), showing that nutrient intake was limited by the effect of the digestive tract filling.

Van Soest (1994) suggested that ruminants tended to surpass the NDF intake limit by 0.8 and 1.2% when the diets have low energy levels, in an attempt to compensate the dietetic deficiency.

It can be inferred that because of the higher proportions of *juazeiro* hay in the feeds, the animals submitted to these diets rarely ingested sufficient energy to meet their requirements for potential productions, except in diets formulated with higher concentrate levels.

Juazeiro hay inclusion caused a quadratic reduction for the digestibility coefficients of ADF digestibility, but for CP, EE, TC and NFC the inclusion of juazeiro hay did not present significant variations (Table 3).

Van Soest (1985) reported that feed digestibility was influenced by the amount and type of fiber present, therefore, based on Table 1, we observed that the addition of *juazeiro* hay reduced the NDF content and digestibility of the diets also because of its higher lignin content in the hay with respect to Tifton 85 bermudagrass.

Reduction in the digestibility of some nutrients can be attributed to the increase in the lignin content in the diets with the increase in the level of *juazeiro* hay, which reduced the action of the ruminal microorganisms on nutrient digestion, because for digestion of the cellular contents to take place, the ruminal bacteria must have access to the external wall of the mesophyl cells of the leaves that go through the masticating process (Wilson & Mertens, 1995).

The DM digestibility coefficients decreased from 649.91 g/day (0% *juazeiro* hay) to 533.01 g/day (100%

Table 2 - Intakes of nutrients of the diets, coefficients of variation (CV), coefficient of determination (R^2) and adjusted regression equations (RE)

	Levels of inclusion of *juazeiro* hay (%)				RE	R^2	CV (%)	P
	0	33	67	100				
	Intake (g/day)							
Dry matter	1134.31	906.88	1106.95	1022.99	$\hat{Y}$ = 1042.78	-	10.72	0.0711
Organic matter	1038.78	828.74	1008.01	928.70	$\hat{Y}$ = 951.06	-	10.70	0.0685
Crude protein	185.78	148.73	187.63	178.41	$\hat{Y}$ = 174.97	-	11.91	0.0911
Ether extract	18.63	15.72	20.32	19.30	$\hat{Y}$ = 18.43	-	11.51	0.0814
Neutral detergent fiber	636.53	516.80	638.79	590.23	$\hat{Y}$ = 595.59	-	10.08	0.0591
Total carbohydrate	906.28	722.51	876.58	805.48	$\hat{Y}$ = 827.71	-	10.66	0.0666
Fibrous carbohydrate	461.39	378.51	472.50	432.69	$\hat{Y}$ = 436.34	-	9.87	0.0534
Non-fibrous carbohydrate	429.43	334.57	395.86	367.83	$\hat{Y}$ = 381.93	-	12.27	0.0960
Total digestible nutrients	790.03	679.07	729.13	695.77	$\hat{Y}$ = 726.80	-	12.79	0.0785
	Intake (%BW)							
Dry matter	4.07	336	3.79	3.43	$\hat{Y}$ = 3.66	-	9.64	0.0870
Total digestible nutrients	2.28	1.98	2.18	1.98	$\hat{Y}$ = 2.09	-	9.18	0.0952
	Intake (g/$BW^{0,75}$)							
Dry matter	93.35	76.50	81.10	80.21	$\hat{Y}$ = 84.54	-	9.70	0.0801
Crude protein	15.24	12.54	14.93	14.01	$\hat{Y}$ = 14.18	-	10.94	0.1393
Neutral detergent fiber	52.36	43.60	50.85	46.25	$\hat{Y}$ = 48.26	-	9.18	0.0843

juazeiro hay). One must remember that the activities of the ruminal microorganisms depend directly on the availability of ammonia nitrogen in the rumen (Russell et al., 1992). Therefore, supplementing animals with protein sources with high rumen degradation supplied by a concentrated feed could optimize microbial growth and increase nutrient digestibility (Acedo et al., 2007).

Regarding the carbohydrate digestibility coefficients, *juazeiro* hay inclusion only influenced the fibrous carbohydrates negatively and linearly. Total carbohydrates and non-fibrous carbohydrate digestibilities were not influenced by including *juazeiro* hay and presented means of 186.24 and 580.27 g/day, respectively. The low TC digestibility may be attributed to the chemical composition of the diets, where a high degree of fibrous carbohydrates was observed, and a high percentage of ADF that was present in its composition reduced the fermentation rate of the cell wall, causing a fall in total carbohydrate digestibility. According to Valadares Filho et al. (1987) NFC has an apparent total digestibility coefficient of over 90%, while for fibrous carbohydrates the apparent digestibility is around 50%. These considerations suggested that there was a great DM ingestion in feeds with lower fibrous carbohydrate contents, i.e., in feeds with a greater proportion of concentrate.

Juazeiro hay inclusion did not influence animal nitrogen use efficiency, and presented values of 7.28, 6.01, 6.02 and 4.81 g/day (Table 4).

The nitrogen excreted in the urine measured by urea concentration was positively correlated with the nitrogen concentrations in the plasma and with nitrogen ingestion (Van Soest, 1994), and was an indication of efficient nitrogen use in the rumen.

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Thus, the positive nitrogen balance observed in all the treatments indicated that there were no protein or nitrogen compound losses during the experimental period that showed that the protein fraction of the diets was used efficiently by the animals. This positive balance indicated that there was protein retention in the animal organism, giving conditions so the animals did not lose weight. The average value of retained nitrogen presented in the present study was close to the value of 6.0 g/day obtained by Barros et al. (1991), who administered only *juazeiro* hay.

Table 3 - Digestibility coefficients of nutrients, regression equations (RE), coefficient of determination (R^2) and coefficients of variation (CV)

Varible	Levels of inclusion of *juazeiro* hay (%)				RE	R^2	CV (%)	P
	0	33	67	100				
Digestibility (g/day)								
Dry matter	649.91	618.97	555.08	533.01	$\hat{Y}$ = 651.05 – 0.12JH	0.96	53.30	0.0013
Organic matter	665.33	633.23	569.66	545.56	$\hat{Y}$ = 666.51 – 0.126JH	0.96	54.56	0.0011
Crude protein	713.37	698.06	677.13	671.26	$\hat{Y}$ = 689.95	-	67.12	
Ether extract	714.07	749.85	767.28	707.37	$\hat{Y}$ = 734.64	0.93	70.73	
Neutral detergent fiber	711.24	665.71	657.62	584.82	$\hat{Y}$ = 712.8 – 0.116JH	0.91	58.48	0.0154
Acid detergent fiber	366.15	202.29	207.86	180.41	$\hat{Y}$ = 355.8 – 0.4736JH + 0.0031JH²	0.90	18.04	0.0002
Total carbohydrate	184.05	235.61	174.07	151.24	$\hat{Y}$ = 186.24	-	15.12	
Fibrous carbohydrate	520.60	473.65	373.33	301.65	$\hat{Y}$ = 530.41 – 0.227JH	0.98	30.16	0.0017
Non-fibrous carbohydrate	537.74	622.09	540.41	620.86	$\hat{Y}$ = 580.27	-	62.08	

Table 4 - Mean values for nitrogen (N) compounds ingested, excreted in feces and urine and the nitrogen balance

Parameter	Levels of inclusion of *juazeiro* hay (%)				RE	R^2	CV (%)	P
	0	33	67	100				
N intake g/day	29.31	23.57	29.81	28.38	$\hat{Y}$ = 27.77	-	11.90	0.0785
Fecal N (g/day)	9.98	6.46	10.79	9.98	$\hat{Y}$ = 9.30	-	25.29	0.1438
Urinary N (g/day)	12.05	11.11	13.58	13.58	$\hat{Y}$ = 12.44	-	45.82	0.0836
N balance (g/day)	7.28	6.01	6.02	4.81	$\hat{Y}$ = 6.03	-	62.10	0.1812

RE = regression equation; R^2 = coefficient of determination.

Conclusions

Juazeiro hay inclusion in Morada Nova sheep diets, in substitution of Tifton 85 bermudagrass hay does not influence nutrient intake, but reduces the digestibility of dry matter, organic matter, neutral detergent fiber and fibrous carbohydrate.

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