DIGESTIBILITY AND INTAKE OF VARIOUS NATIVE AND INTRODUCED FORAGES BY GOATS AND HAIR SHEEP IN NORTHEAST BRAZIL

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ABSTRACT - Results from a series of studies conducted at the EMBRAPA/CNPA were used to evaluate the quality of various native and introduced forages fed to goats and tropical hair sheep. Reduced forage quality was attributed to a decreased dry matter intake and digestibility, decreased nitrogen content and increased rumination and total chewing activities. Decreased intake appeared to be associated more with an increase in cell wall components, and a reduction in digestibility more with lignification. Dry matter intake and digestibility were affected by stage of maturity and forage species. Dry matter intake was lower for the grasses and digestibility was lower for the range species.

Index terms: Goats, Sheep, Digestibility, Forages, Semi-arid Tropics.

DIGESTIBILIDADE E CONSUMO DE VÁRIAS FORRAGENS NATIVAS E INTRODUZIDAS PARA CABRAS E OVELHAS LANADAS NO NORDESTE DO BRASIL

RESUMO - Uma série de estudos foram conduzidos no EMBRAPA/CNPC para avaliar a qualidade de várias forrageiras nativas e exóticas fornecidas a caprinos e ovinos deslanados. Reduções na qualidade das forrageiras estiveram associadas com decréscimos no consumo, na digestibilidade da matéria seca e no conteúdo de nitrogênio aliadas a aumentos na atividade de ruminação e mastigação. Aparentemente, o decréscimo no consumo esteve mais associado com o aumento nos componentes da parede celular enquanto que, as reduções na digestibilidade com a lignificação das forrageiras. Consumo e digestibilidade da matéria seca foram afetadas pelo estádio de maturidade e espécie forrageira. Aparentemente, a gramínea foi a menos consumida enquanto que, as espécies lenhosas apresentaram a menor digestibilidade.

Termos para indexação: Caprinos, Ovinos, Digestibilidade, Forragem, Trópico semi-árido.

Introduction

In the developing countries, most ruminants subsist wholly on forages. Forage quality is one of the most important factors limiting ruminant production, particularly in regions with

tropical climates. Forage intake by ruminants is greatly affected by forage quality. High quality forages are more digestible and have a lower retention time in the gastrointestinal tract, thereby maximizing energy intake.

In Northeast Brazil, year round forage availability is also an important factor affecting ruminant performance. The regional precipitation patterns mark two defined seasons within the year. During the wet season there is an abundance of forage in the native range (caatinga). During the first months of the dry season, which may extend for as many as eight months, a relatively abundant biomass exists in forms such as dried leaf litter from deciduous trees. This source of feed becomes scarce by the end of the dry season at which time goats and sheep may lose weight if they are not supplemented (Pfister et al., 1983).

Ideally, feeding systems should be developed to diminish the variable nutrient availability resulting from the large seasonal fluctuation in forage biomass production from the caatinga. Preservation of forage as silage has an advantage over hay-making during the wet season. However, ensiling requires that the forage contain enough nonstructural carbohydrates for adequate fermentation. Less material is lost in the hay-making process and it may be more suitable for preservation of small amounts of forage by small holders.

Forage quality evaluation studies conducted at the CNPC had as objectives: (1) to adapt forage preservation methods for both dry season range supplementation and confinement systems; and (2) to evaluate the quality of various native and introduced forages and its effect on the digestive and metabolic function of goats and sheep.

Materials and Methods

Several studies (Barros et al., 1985; Carneiro et al., 1985; Freire et al., 1985; Kawas et al., 1985; Vale et al., 1985) were conducted at the EMBRAPA/CNPC to evaluate the quality of various native and introduced forages fed to goats and tropical hair sheep. All goats were SRD (undefined genotype) and all sheep were of the Santa Inês genotype. The legumes studied were cunhã (*Clitoria ternatea*) and mata pasto (*Cacia cericea*). Forage sorghum (*Sorghum vulgare*) and some woody species (juazeiro leaves, *Zizyphus joazeiro*; and jurema preta seedpods, *Mimosa acutistipula*, a woody legume) were also studied. Forages were preserved as silage, hay, or both. Before ensiling, the forage material was sun-wilted to reduce its water content. The forages were ensiled in concrete stave silos, 2m high and 1.5m in diameter.

In one study (Kawas et al., 1985), stage of maturity of the ensiled forage was evaluated. Areas cultivated with cunhã (*Clitoria ternatea*) and forage sorghum (*Sorghum vulgare*) were divided into equal parts and cut at two stages of maturity. The

cunhã was harvested at 42 (ECT) and 70 (LCT) days after a uniform cutting. In a similar manner, forage sorghum was cut at the milk and late stages of maturity.

In all experiments 9 or 10 animals were confined in metabolism crates for a 14-day adaptation and 7-day collection period. Forages were offered ad libitum as the only feed, twice daily, allowing for a 15% feed refusal. Animals had free access to water and to a trace mineral-salt mix.

Body weights were recorded two days before the beginning and two days before the end of the collection phase. Dry matter intake (DMI) and digestibility (DMD) (total fecal collection) were determined in all studies. Nitrogen balance and chewing activity (eating and rumination times recorded every 5 minutes for a 24 hour period) were obtained in some of the studies (Barros et al., 1985; Kawas et al., 1985).

Oven-dried (60C) forage, refused feed and fecal samples were ground through a 1mm screen before analysis. Absolute dry matter (DM) was determined after oven drying at 105C for 24 hours. Samples were analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and $KMnO_4$ lignin (Goering & Van Soest, 1970). Nitrogen content of all samples was determined by Kjeldahl (AOAC, 1975).

Results and Discussion

Chemical composition of the forages (% dry matter) is presented in Table 1. Dry matter content of silages and hays ranged from about 30 to 83% and 86 to 93%, respectively. In general, CP content was highest for legumes, intermediate for woody species and lowest for grasses. An exception was the annual legume mata pasto (7.0-7.6% CP) which was cut at a mature stage at the end of the wet season. The cell wall components, hemicellulose and cellulose, were higher for the grasses than for both woody species and legumes. Lignin, however, was higher in woody species.

Results on the intake of dry matter (DM) and digestible DM by goats and hair sheep are in Table 2. Kawas et al. (1985) reported a greater DM consumption by goats fed the legume cunhã (CT) than goats fed forage sorghum (FS) at any stage of maturity. Digestibility of DM decreased with an advance in maturity of either CT or FS (Table 3). Concurrently, there was a tendency for digestible DM to decrease with an advance in maturity. Time spent ruminating by goats fed ECT, LCT, EFS and LFS were 407^{b}, 474^{ab}, 554^{a}, and 575^{a} min/day, respectively. Time spent eating by goats fed ECT, LCT, EFS and LFS were 369^{a}, 357^{a}, 285^{b}, and 254^{b} min/day, respectively. Goats consuming FS silages spent more ($P<.05$) time ruminating and less ($P<.05$) time eating than with CT and with an advance in maturity of the forages. Total chewing time (min/day) was significantly higher ($P<.05$) for ECT (831 min/day) than for LCT (776 min/day). Goats consuming the

TABLE 1. Chemical composition of forages fed to goats and tropical hair sheep.

FORAGE	STAGE OF MATURITY[a]	METHOD OF PRESERVATION	DRY MATTER (%)	CRUDE PROTEIN (%)	CELL WALL COMPONENTS (% of DM)				REFERENCE No.
					NDF[b]	HEMI CELLULOSE	CELLULOSE	KMnO4 LIGNIN	
LEGUMES									
Cunha	SPF	Hay	92.5	22.6	49.7	17.4	23.8	8.3	4
Cunha	42 DWC	Silage	69.4	19.2	49.8	15.1	24.7	9.6	6
Cunha	70 DWC	Silage	83.1	17.6	55.9	21.3	23.4	10.7	6
Mata Pasto	Mature	Hay	90.9	7.6		16.4	15.9	7.8	2
Mata Pasto	Mature	Silage	36.8	7.0	55.3	16.8	28.0	7.8	2
GRASSES									
F. Sorghum	Milk	Silage	30.5	4.6	77.4	29.0	39.3	8.4	6
F. Sorghum	Mature	Silage	38.0	4.9	69.3	26.3	33.3	9.2	6
WOODY SPECIES									
Juazeiro (leaves)	Mature	Hay	92.3	15.2	66.7	24.8	27.6	14.2	4
Jurema Preta (seedpods)	Mature	Hay	86.0	12.7	52.9	17.4	22.1	12.7	8

[a] SPF, seed pod formation; DWC, days within cuts.

[b] NDF, neutral detergent fiber; DM, dry matter.

Table 2. Intake of dry matter (DM) and digestible DM by goats and hair sheep.

FORAGE	STAGE OF MATURITY	METHOD OF PRESERVATION	AVERAGE WEIGHT (Kg)		INTAKE (g/Kg.75) DRY MATTER		DIGESTIBLE DRY MATTER		REFERENCE No.
			GOATS	SHEEP	GOATS	SHEEP	GOATS	SHEEP	
LEGUMES									
Cunha	SPF	Hay	25.7	37.7	68.0 (13.0)	78.9 (13.0)	42.9 (7.9)	42.0 (7.9)	4
Cunha	42 DWC	Silage	21.0	--	75.5 (11.7)	--	50.8 (5.2)	--	6
Cunha	70 DWC	Silage	21.0	--	77.2 (12.6)	--	46.0 (7.7)	--	6
Mata Pasto	Mature	Hay	23.1	36.6	10.0 (3.5)	48.7 (9.6)	--	25.5 (5.9)	2
Mata Pasto	Mature	Silage	13.5	23.9	72.0 (12.0)	86.6 (10.8)	60.4 (2.5)	53.8 (4.5)	2
GRASSES									
F. Sorghum	Milk	Silage	21.0	--	65.9 (8.7)	--	51.0 (8.3)	--	6
F. Sorghum	Mature	Silage	21.0	--	59.6 (4.9)	--	43.2 (5.4)	--	6
WOODY SPECIES									
Juazeiro (leaves)	Mature	Hay	26.9	37.7	76.6 (15.7)	87.1 (14.2)	33.5 (8.7)	34.8 (10.1)	4
Jurema Preta (seedpods)	Mature	Hay	19.0	24.1	69.5 (9.4)	69.2 (6.0)	33.4 (8.9)	32.8 (2.4)	8

a
SPF, seed pod formation; DWC, days within cuts.

b
( ), standard deviation.

Table 3. Forage digestibility (DMD) and nitrogen balance by goats and hair sheep.

FORAGE	STAGE OF MATURITY	METHOD OF PRESERVATION	DRY MATTER DIGESTIBILITY (%)		NITROGEN BALANCE (G / DAY)		REFERENCE No.
			GOATS	SHEEP	GOATS	SHEEP	
LEGUMES							
Cunha	SPF	Hay	54.8 (4.6)	53.2 (4.2)	15.3 (2.8)	16.7 (9.9)	4
Cunha	42 DWC	Silage	66.8 (1.8)	--	10.1 (3.5)	--	6
Cunha	70 DWC	Silage	59.8 (3.8)	--	9.7 (1.7)	--	6
Mata Pasto	Mature	Hay	--	53.9 (3.7)	-2.4 (4.2)	0.9 (1.5)	2
Mata Pasto	Mature	Silage	53.2 (4.1)	60.4 (2.5)	--	--	2
GRASSES							
F. Sorghum	Milk	Silage	77.4 (1.4)	--	1.2 (0.4)	--	6
F. Sorghum	Mature	Silage	72.3 (3.6)	--	1.4 (0.6)	--	6
WOODY SPECIES							
Juazeiro (leaves)	Mature	Hay	43.7 (3.9)	39.9 (7.2)	6.7 (4.5)	6.0 (3.2)	4
Jurema Preta (seedpods)	Mature	Hay	48.0 (8.9)	47.4 (3.3)	--	--	8

a
SPF, seed pod formation; DWC, days within cuts.

b
NDF, neutral detergent fiber.

c

three silages with greater fiber component levels spent the same time chewing, about 14 hours.

In a study by Barros et al., (1985), both sheep and goats consumed more of the legume mata pasto when it was preserved as silage rather than as hay. Digestibility estimates were not comparable due to the marked differences in intake between the two methods of preservation. We have observed that mata pasto, an annual range legume, is not consumed by sheep or goats in the green form.

From all forage intakes reported (Table 1), that of forage sorghum was lowest probably due to its highest cell wall content. Digestibility of woody forages by both goats and sheep (Table 3) was lower than for other forage species perhaps due to their higher lignin content. Digestibility of the sorghum silages was higher than expected.

Several studies (Barros et al., 1985; Freire et al., 1985; Vale et al., 1985) in which both goats and sheep were used, DM intakes tended to be greater for sheep than for goats on a $kg^{\cdot 75}$ basis. Barros et al. (1985) reported that sheep fed the same diet as goats spent more time ruminating (479 vs. 420 min/day). However, DM digestibilities reported were not different between the two animal species.

Nitrogen balance of sheep and goats (Table 3) appeared to be dependent on the nitrogen content of the forage as well as on the feed intake. Negative nitrogen balance of goats consuming mata pasto hay was due to the low feed intake (10 $g/kg^{\cdot 75}$) and consequently to a low N intake.

Conclusions

Reduced forage quality was associated to a decreased intake and digestibility, decreased N content and increased rumination and total chewing activities. DM intake and digestibility were affected by stage of maturity of forages and forage species. DM intake was lower for the grasses, and digestibility was lower for the range species. With the information available, it is not clear how much of the nitrogen in the range forage species is utilized and if lignin phenolic components or other secondary compounds are affecting nitrogen utilization.

REFERENCES

AOAC. Official Methods of Analysis (12th ed.) Washington, DC, Association of Official Analytical Chemists, 1975.

BARROS, N.N.; KAWAS, J.R.; JOHNSON, W.L. & SHELTON, J.M. Comparative intake and digestion of mata pasto (Cacia cericea) by goats and hair sheep. EMBRAPA/CNPC Internal Document, 1985.

CARNEIRO, H.; KAWAS, J.R.; BARROS, N.N.; DE ARAÚJO FILHO, J.A.; DOS SANTOS, J.W.; SHELTON, J.M.; JOHNSON, W.L. & FREIRE, L.C.L. Efeito da ensilagem na composição química do sorgo forrageiro (Sorghum vulgare) e da cunhã (Clitoria ternatea). Florianópolis, Brasil, Reunião Anual da Sociedade Brasileira de Zootecnia, (Abst.), 1985.

FREIRE, L.C.L.; BARROS, N.N.; CARNEIRO, H.; LOPES, E.A. & JOHNSON, W.L. Valor nutritivo de algumas forrageiras para caprinos e ovinos no nordeste. Florianópolis, Brasil, Reunião Anual da Sociedade Brasileira de Zootecnia, (Abst.), 1985.

GOERING, H.K. & VAN SOEST, P.J. Forage Fiber Analysis. USDA Handbook No. 379 Ag. Res. Serv. Washington, D.C., 1970.

KAWAS, J.R.; CARNEIRO, H.; BARROS, N.N.; FREIRE, L.C.L.; KAWAS, F.N.; SHELTON, J.M. & JOHNSON, W.L. Valor nutritivo para caprinos das silagens de sorgo forrageiro (Sorgum vulgare) e da cunhã (Clitoria ternatea) em dois estágios de maturidade. Florianópolis, Brasil, Reunião Anual da Sociedade Brasileira de Zootecnia, (Abst.), 1985.

PFISTER, J.A.; DE QUEIROZ, J.S.; KIRMSE, R.D. & MALECHEK, J.C. Rangelands and small ruminant production in Ceará State, Northeastern Brazil. Rangelands, 5(2):72, 1983.

VALE, L.V.; DE ARAÚJO FILHO, J.A.; ARRUDA, F.A.V. & SERPA, M.B.M. Valor nutritivo da vagem de jurema preta. Florianópolis, Brasil, Reunião Anual da Sociedade Brasileira de Zootecnia, (Abst.), 1985.