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Energy efficiency and methane emission by sheep fed sorghum silages at different maturation stage

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Introduction

The importance of sorghum as a forage crop is growing in many regions of the world due to its high productivity and ability to utilize efficiently water even under drought conditions (Sanchez *et al.*, 2002). The introduction of calorimetric studies in tropical conditions is important for conceptual advances in roughage evaluation, enabling the best way of utilization, optimizing livestock performance (Rodriguez *et al.*, 2007). The objectives of this study were to examine the effects of sorghum genetics and stages of maturity at harvest on efficiency of energy use and methane production by sheep.

Material and methods

Forty five mature wether sheep were housed individually in metabolic cages and fed at 60-80 g DM/kg $BW^{0.75}$ per day. The treatments were silages of the sorghum hybrids BRS 610, BR 700 and BRS 655, harvested at three maturation stages (milk, soft dough and floury). The sorghum hybrids were developed by Embrapa Maize and Sorghum (Sete Lagoas, Minas Gerais, Brazil). Diets were fed for a 20 day adaptation followed by a 5 day collection period. Oxygen consumption, carbon dioxide production, and methane emissions were monitored for a period of 24 h on individual sheep one after the other, in an open-circuit respiration chamber for small ruminants, after adaptation period of two days in another similar respiration chamber. The chambers were made of transparent acrylic resin plates with external dimensions of 1.2 m (wide) × 2.0 m (height) × 2.1 m (length). The equipment and procedure utilized for the respiration study were described by Rodriguez *et al.* (2007). Heat production and fasting heat production were calculated as per Brouwer's equation (Brouwer, 1965).

The experimental design utilized was completely randomized in a 3×3 factorial arrangement. Analysis of variance (ANOVA) was used to analyse data using the General Linear Model Procedure (SAS, 2001). Main effects and interactions of hybrid and maturation stage were evaluated. Treatments means were differentiated using SNK test (SAS, 2001).

Results and discussion

There were no differences among the treatments for the apparent digestibility of gross energy and metabolizability ($P>0.05$). A significant ($P<0.005$) interaction between sorghum hybrid and maturation stage was observed for the efficiency of ME utilization for maintenance (K_m). Silage harvested at the soft dough stage had higher net energy to gross energy ratio (NE/GE) than that harvested at floury stage ($P<0.05$).

No differences were observed among the methane output, as liter per day, by sheep that received silage of the hybrid BRS 610 (without tannin) and those sheep fed silages of the hybrids BRS 700 and BR 655 (with tannin). Likewise, Oliveira *et al.* (2006) found no effect of diets containing sorghum silage with low and high tannin content on methane emission by beef cattle. The methane emission expressed as g per kg of digestible dry matter intake (g/kg DDM) and g per kg of digestible neutral detergent fiber intake (g/kg DNDF) differed among maturation stages, with soft dough stage having lower emission than floury stage ($P<0.05$).

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The lack of differences in total daily methane output indicates that sorghum genetics and maturity at harvest should not be a strategy to reduce enteric methane emissions from ruminants.

Table 1. Energy efficiency and methane emission by sheep fed silages of the sorghum hybrids BRS 610, BR 700 and BRS 655 in three maturation stages (milk, soft dough and floury).

Hybrid	MS	ADGE	q_m	K_m	NE (%GE)	CH_4 (l/d)	CH_4 (g/kg DDM)	CH_4 (g/kg NDFD)
BRS 610	M	50.80	0.44	0.69_{Aa}	30.71	20.93	29.85	59.39
	SD	57.97	0.52	0.76_{Aa}	40.12	19.15	24.06	46.69
	F	51.54	0.46	0.68_{Aa}	31.46	22.44	26.99	73.02
BR 700	M	55.77	0.50	0.68_{Aa}	34.51	18.01	23.88	49.42
	SD	48.00	0.43	0.72_{Aa}	31.38	16.71	24.23	51.57
	F	52.07	0.45	0.71_{Aa}	32.49	24.46	34.36	67.46
BRS 655	M	54.33	0.47	0.61_{Ab}	28.98	22.28	33.75	61.98
	SD	51.68	0.46	0.78_{Aa}	35.99	13.64	24.26	46.14
	F	49.16	0.42	0.53_{Bc}	22.58	20.32	32.10	64.91
SEM		2.86	0.03	0.03	2.72	3.36	3.43	7.59
Main effects								
Hybrids								
BRS 610		53.44	0.47	0.71	34.10	20.84	26.97	59.70
BR 700		51.95	0.46	0.70	32.79	19.73	27.49	56.15
BRS 655		51.72	0.45	0.64	29.18	18.75	30.04	57.68
Maturation stage								
M		53.63	0.47	0.66	31.40_{ab}	20.41	29.16_{ab}	56.93_{ab}
SD		52.55	0.47	0.75	35.83_{a}	16.50	24.19_{b}	48.13_{b}
F		50.92	0.44	0.64	28.84_{b}	22.41	31.15_{a}	68.46_{a}
Probabilities, P≤								
H		0.7284	0.5182	0.0020	0.0871	0.7486	0.5091	0.8482
MS		0.5122	0.3569	0.0000	0.0116	0.1049	0.0489	0.0088
H x MS		0.1246	0.1113	0.0015	0.0583	0.6703	0.2836	0.7173

MS = maturation stage; M = milk; SD = soft dough; F = floury; ADGE = apparent digestibility of gross energy; qm = metabolizability; Km = efficiency of ME utilization for maintenance; NE/(%GE) = net energy to gross energy ratio (%); DDM = digestible dry mater; NDFD = digestible neutral detergent fiber; SEM = standard error of mean; H = significance for the hybrid effect; MS = significance for maturation stage effect; H × MS = significance for hybrid × maturation stage interaction.

Means of the hybrids followed by the same capital letters in columns and means of the maturations stages followed by the same lowercase letters in columns do not differ significantly by SNK test ($P<0.05$).

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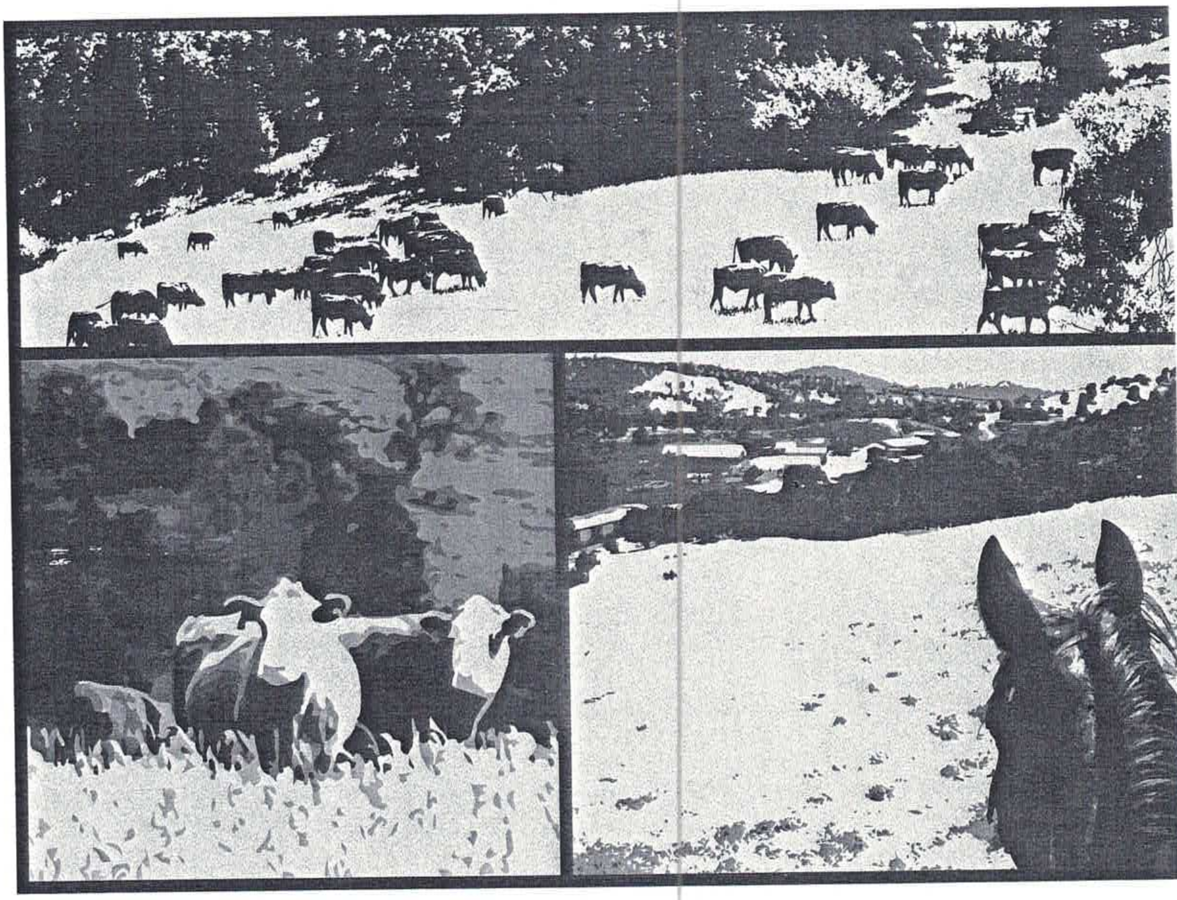

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