52ª Reunião Anual da Sociedade Brasileira de Zootecnia

Zootecnia: Otimizando Recursos e Potencialidades

Belo Horizonte – MG, 19 a 23 de Julho de 2015

Effects of different mineral supplementations in sheep grazing in Caatinga ecosystem: methane emission[1]

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Abstract: The objective of this study was to evaluate the effects of different mineral supplements on methane emission of sheep grazing in Caatinga ecosystem. An experiment in a completely randomized design, in which 15 Santa Inês crossbred sheep (19.3 kg) were randomly assigned to one of three treatments: mineral salt for sheep (control; SALTMC), mineral salt with addition of 750 ppm of zinc per animal (SALTMZn) and mineral salt supplied with 2.5 ml of propylene glycol per kg of metabolic body weight ($BW^{0.75}$; SALTMPeg). Methane emission (CH_4) was performed by technique of sulfur hexafluoride tracer gas (SF6). Treatments did not affect (P>0.05) the intakes (in g/d and g/kg$BW0^{.75}$) of dry matter (DM) and organic matter (OM). Methane emission, in g/d and g/kg of MO ingested, was significantly affected (P<0.05) by treatments and periods. Animals supplemented with SALTMZn had lower CH_4 emission during the period of April to June (P<0.05). During the entire experimental period, a lower total CH_4 emission was observed in animals supplemented with SALTMZn (P<0.05). These results suggest that mineral salt with zinc addition may reduce the CH_4 emissions in sheep finished in Caatinga native pasture.

Keywords: native grass, propylene glycol, zinc

Efeito de diferentes suplementações minerais em ovinos em pastagem nativa da Caatinga: emissão de metano

Resumo: Objetivou-se com esse estudo avaliar o efeito de diferentes suplementos minerais na emissão de metano por ovinos em pastagem nativa da Caatinga. Foram utilizados 15 ovinos mestiços Santa Inês (19,3 kg), distribuídos em um delineamento inteiramente casualisado, em três tratamentos com cinco repetições: sal mineral para ovinos, controle (SALTMC), sal mineral acrescido de 750 ppm de zinco $anima^{-1}$ (SALTMZn) e sal mineral com fornecimento de 2,5 ml por kg de peso vivo metabólico ($PV^{0,75}$) por animal de propilenoglicol (SALTMPeg). A determinação do metano (CH_4) emitido foi realizada através da técnica do gás traçador hexafluoreto de enxofre (SF_6). Não foi verificado diferenças (P>0,05) para consumos de matéria seca (MS) e matéria orgânica (MO) em g/dia e em g/kg$PV^{0,75}$ para os tratamentos. Para emissão de CH_4 em g/dia, g/kgMS e em g/kgMO ingerida, houve efeito (P<0,05) para tratamento e período. Os animais do tratamento SALTMZn emitiram menor quantidade de CH_4, principalmente durante os meses de abril a junho. Para emissão de CH_4 durante todo o período experimental, foi observado menor emissão pelos animais do tratamento SALTMZn (P<0,05). O uso do sal mineral adicionado de zinco contribui para diminuição da emissão de CH_4 por ovinos terminados em pastagem nativa da Caatinga.

Palavras–chave: pasto nativo, propilenoglicol, zinco

Introduction

The availability of feedstuffs for small ruminants production in the Brazilian semiarid is characterized by the seasonality of the forage production throughout the year. As the rainfalls are concentrated in a short period of the year (from February to June), both availability and quality of the forages are compromised in the dry season. Moreover, even in the period of high forage availability, the elevated ruminants' energy expenditure may decrease the performance of finishing animals. Thus, the improvement of nutrients supply, such as protein, energy, and minerals, can improve the feed utilization and minimize the energy losses. Therefore, the increasing on energy efficiency may improve the meat productivity as well as decrease CH_4 emissions in finishing sheep. The objective of this study was to evaluate the effects of different mineral supplements on methane emission of sheep grazing in Caatinga ecosystem.

Material e Methods

The experiment was performed in the facilities of Embrapa Goats and Sheep located at Sobral, Ceará in the period of March to June 2014, during the rainy season. An experiment in a completely randomized design, in which 15 finishing sheep (crossbred Santa Inês, 19.3 kg) were randomly assigned to one of three treatments (five repetitions each): mineral salt for sheep (control; SALTMC), mineral salt with addition of 750 ppm of zinc per animal (SALTMZn) and mineral salt supplied with 2.5 ml of propylene glycol per kg of metabolic body weight ($BW^{0.75}$; SALTMPeg). Propylene glycol was mixed to the concentrate before the animal feeding. The amount of zinc in the SALTMZn was calculated respecting the toxicity levels for sheep, according the NRC (2005). During the experimental period the animals spent the day grazing (from 7 to 16 hour) and the night they were taken into the fold and allocated in collective pens, divided by treatments. Sheep were supplemented with concentrated (0.7% of the average BW) and mineral salt containing different additives. The concentrate was composed by corn and soybean meal. Four intake and digestibility trials were conducted in the months of March, April, May and June. The LIPE® was used as marker to estimate the fecal output per animal. Two animals, cannulated in the rumen, were used to collect samples of ruminal extrusa from the pasture. One hour before sampling, the rumens of the cannulated animals were emptied. Chemical analisys are presented on Table 1 and were performed according to AOAC (2010).

Table 1. Chemical composition of extrusas obtained from sheep grazing in Caatinga native pasture

Item	Periods				Concentrate[β]
	March	April	May	June	
Dry Matter (DM)	93.6	94.5	95.0	93.6	93.7
Dry Matter[¥]	11.8	12.8	14.2	15.8	87.7
Organic Matter (OM)	81.9	81.0	79.8	81.9	90.5
Crude Protein	19.2	18.7	17.6	13.1	25.4
Neutral detergent fiber	59.8	65.6	67.5	61.7	18.5
Acid detergent fiber	49.0	53.2	53.7	51.4	12.1
Hemicelluloses	10.7	12.7	13.8	9.4	6.49
Cellulose	25.3	24.9	24.7	24.9	5.32
Lignin	21.3	19.3	17.5	21.4	1.3
Lignin klason	36.2	38.9	37.1	40.7	4.1
Digestibility *in vitro* DM[†]	53.7	40.8	42.4	44.1	95.4
Digestibility *in vitro* OM	46.8	33.3	35.3	35.9	93.9

[β]Corn. soybean meal and limestone; [¥]Dry matter on the basis of natural matter; [†]According Tilley and Terry (1963).

The DM intake was calculated as: DMI = feces production / 1 - digestibility. Methane emission (CH_4) was performed by technique of sulfur hexafluoride tracer gas (SF_6), adapted for sheep measurements according to by Primavesi et al. (2004). Animals were weekly weighted for performance calculations. Data were analyzed using the PROC GLM in SAS 9.0 (SAS Institute Inc., Cary, NC). Significance was established at $\alpha = 0.05$.

Results and Discussion

Treatments did not affect ($P > 0.05$) the intakes of DM and OM in g/d and $g/kgBW^{0.75}$ (Table2). However, there was a period effect ($P<0.05$) wherein animals had a lower intake in the months of April, May and June. The lower intake in this period may be related with the grazing behavior, which could be affected by the higher rain precipitation that occurred in these months. In addition, the lower availability and nutritional quality of the pasture in June (Table 1) may explain the lower intake in that month. Methane emission, in g/d and g/kg of MO ingested, was significantly affected ($P<0.05$) by treatments and periods (Table 2). Animals supplemented with SALTMZn had lower CH_4 emission during the period of April to June ($P<0.05$). Minerals play important roles in the ruminal environment, since they may changing the osmotic pressure, buffering capacity and dilution rate. Thus, have been found that higher zinc concentrations in the diet could increase the propionate production and decrease the acetate: propionate ratio (Arelovich et al., 2000). Therefore, the decrease on acetate: propionate ratio could be related with the lower CH_4 emissions in sheep supplemented with SALTMZn, since the propionate production competes by hidrogen with the CH_4 production.

Table 2. Effects of different mineral supplementations on intake and methane emission of sheep grazing in Caatinga native pasture in different periods

Item	Periods												SEM	*p*-value		
	March			April			May			June						
	SALTc‡	Zn†	Pegβ	SALTc	Zn†	Pegβ	SALTc	Zn†	Pegβ	SALTc‡	Zn†	Pegβ		T	P	TxP
DMI																
g/d	648	641	718	550	602	570	561	560	539	541	562	580	10.5	0.42	<0.001	0.52
g/kgBW$^{0.75}$	67.4	65.3	73.5	58.1	61.3	58.4	57.9	55.2	55.2	53.7	53.5	56.3	1.20	0.53	<0.001	0.73
OMI																
g/d	579	569	641	489	537	507	500	500	480	472	489	506	9.90	0.48	<0.001	0.55
g/kgBW$^{0.75}$	60.2	57.9	65.6	51.6	54.8	51.9	51.6	49.3	49.1	46.8	46.5	49.0	1.12	0.56	<0.001	0.72
CH_4																
g/d	17.4	15.1	16.7	16.8	16.4	19.4	16.3	15.8	24.3	13.8	14.2	15.7	0.556	<0.006	<0.03	0.19
g/kgDM	27.9	23.9	23.4	31.7	28.2	35.0	29.5	28.6	44.6	25.5	25.5	27.1	1.17	<0.07	<0.008	0.92
g/kgOM	31.4	27.0	26.2	35.9	31.8	39.5	33.2	32.0	50.1	29.3	29.3	31.1	1.32	<0.08	<0.01	0.17

‡SALTMINC: Mineral Salt (control); †SALTMZn: Mineral salt+Zinc; βSALMPeg: Mineral salt+propylene glycol; DMI: Dry matter intake; OMI: Organic Matter (OM) intake; CH_4: Methane: SEM: Standard error of mean; T: Treatment; P: Period TxP: interation between treatment x period. For all analyses, P≤0.05 was considered significant.

During the entire experimental period, a lower total CH_4 (kg) emission was observed in animals supplemented with SALMZn (P<0.05; Table 3). However, treatments did not affect (P>0.05) the CH_4 emissions expressed in g CH_4/ kg of total weight gain and g CH_4/kg of cold carcass weight. Therefore, the increasing of efficiency on native pasture utilization, as well as strategic supplementation may decrease CH_4 emissions by kg of meat produced in finishing sheep.

Table 3. Effects of different mineral supplementations on performance and total methane emission of sheep grazing in Caatinga native pasture

Item	SALTMINC	SALTMZn	SALTMPeg	SEM	*p*-value
Total BW gain (kg)	3.62	4.31	5.24	0.389	*ns*
Cold carcass weight (kg)	7.40	8.20	8.28	0.266	0.398
Total methane emission (CH_4) (kg)	2.00	1.87	2.36	0.089	0.049
gCH_4/kg of total weight gain	575	446	490	31.0	*ns*
gCH_4/kg of cold carcass	270	228	290	12.1	0.113

SALTMINC: Mineral Salt (control); SALTMZn: Mineral salt+Zinc; SALMPeg: Mineral salt+propylene glycol; SEM: Standard error of mean. NS: not significant; For all analyses, P≤0.05 was considered significant

Conclusions

The results of this study suggest that mineral salt with zinc addition may reduce the CH_4 emissions in sheep finished in Caatinga native pasture.

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