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Effects of monensin level and roughage/concentrate ratio on ruminal fermentation in bovines*

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ABSTRACT

Nine rumen-fistulated cows were used in a completely randomized design replicated three times to evaluate three monensin (0, 150 and 300 mg/animal/day) and three concentrate levels (25, 50 and 75%) in a 3x3 factorial arrangement. Twenty-one day subperiods were used, the first sixteen for diet (Tifton hay+concentrate) adaptation. Monensin decreased DMI only in 50%-concentrate diet ($P<0.05$) and did not influence total VFAs concentrations. For ruminal pH, molar% of VFAs, and NH_3-N concentration collected 7 times/day, the responses to high level of monensin were higher in low-forage diets ($P<0.05$). Responses to low level of monensin were higher in high-forage diets ($P<0.05$).

KEY WORDS: cattle, fibre, ionophores, volatile fatty acids

INTRODUCTION

For a long time nutritionists have tried to manipulate rumen fermentation. This can be done by increasing propionic production, decreasing methanogenesis or proteolysis and deamination in the rumen. Initially, this objective was done through diet manipulation. However, the discovery of rumen active molecules has brought great perspectives on agricultural sciences (Bergen and Bates, 1984).

Ionophores are a class of compounds that have obtained considerable success as additives. However, responses reached with the use of ionophores are variable. This can be explained partially by different experimental conditions (Galloway et

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al., 1993), as concentrate and ionophor level. This trial was carried out to study interaction between these two factors on monensin response.

MATERIAL AND METHODS

Nine dry Holstein cows (470 kg BW), fitted with ruminal cannulas, were used in a completely randomized design replicated three times to determine the effects of different doses of monensin on different forage to concentrate ratio diets. Treatments were constituted of three monensin (Elanco) levels (0, 150 and 300 mg/animal/day) and three concentrate levels (25, 50 and 75%) in a 3 × 3 factorial arrangement. Diet contained Tifton 85 hay, maize grain, soyabean meal and minerals.

Each subperiod lasted 21 days. Cows were fed twice daily at 07.00 and 16.00 h. Until d 16, cows were fed 115% of their daily intake of the previous day. From d 17 to 21, cows were fed 100% of the mean daily intake obtained from d 12 to 16. Refusals and feed samples were collected every morning from d 17 until 21, pooled, and stored in sealed plastic bags at -10°C for later analysis.

On d 21, just prior to morning meal (0 h) and at 2, 4, 6, 8, 10, and 12 h postfeeding, samples containing 500 mL of ruminal fluid were taken. Ruminal pH was determined using a portable pH meter. Following this, 2 mL of fluid were added to 1 mL of sulphuric acid 1 N solution, and frozen at -20°C for later determination of ammonia N. After that, 50 mL of ruminal liquid were centrifugated at 2.000 × g for 15 min, and 1 mL of the supernatant was added to 0.2 mL of formic acid and frozen for later determination of VFAs.

For intake data, variance analysis separated effects of concentrate level, monensin level, interaction and experimental subperiod. Effects of main factors were separated in linear and linearity deviation (quadratic) effects. Interaction was separated in linear effect for both factors ($Con_L Xmon_L$), linear effect for concentrate level and deviation for monensin level ($Con_L Xmon_D$), deviation for concentrate level and linear effect for monensin level ($Con_D Xmon_L$), and deviation effect for both factors ($Con_D Xmon_D$). Ruminal parameters were analysed as described, but added of split-plot factor. The surface equation was obtained by multiple regression procedure (Roush et al., 1979).

RESULTS AND DISCUSSION

Concentrate and monensin levels interacted for molar percentage of C_2, C_3, C_4 and C_2:C_3 ratio, although monensin had no effect on total VFAs concentration (Table 1). Using low monensin levels (ex. 150 mg), as lower was the concentrate level of diet, the greater was the molar% of C_3 (increases of 2.85, 1.34 and -4.93 percentile units for 25, 50 and 75%-concentrate diets, respectively). However,

Table 1. Dry matter intake and ruminal fermentation pattern obtained with treatments[1]

Treatments		Parameters							
Con, %	Mon, mg	DMI	VFAs	C_2	C_3	C_4	C_2/C_3	pH	NH_3-N
				Interactions					
	0	1.75	60.70	80.29	13.83	5.88	5.83	6.76	7.71
25	150	1.58	59.73	77.39	16.68	5.94	4.68	6.65	9.54
	300	1.85	60.51	76.42	17.34	6.24	4.42	6.83	6.44
	0	2.52	73.45	73.23	16.62	10.15	4.43	6.44	10.35
50	150	2.18	62.94	73.52	17.96	8.53	4.11	6.62	9.20
	300	1.67	64.88	71.38	21.01	7.61	3.42	6.57	7.87
	0	1.84	81.65	65.60	25.10	9.30	2.77	6.11	7.28
75	150	1.79	62.92	71.40	20.17	8.43	3.67	6.58	5.14
	300	2.15	73.65	56.65	37.65	5.70	1.63	6.36	3.98
				Main effects					
25		1.73	60.31	78.03	15.95	6.02	4.98	6.75	7.89
50		2.12	67.09	72.71	18.53	8.76	3.99	6.54	9.14
75		1.93	72.74	64.55	27.64	7.81	2.69	6.35	5.47
	0	2.04	71.93	73.04	18.51	8.44	4.34	6.44	8.45
	150	1.85	61.86	74.10	18.27	7.63	4.15	6.62	7.96
	300	1.89	66.34	68.15	25.33	6.52	3.16	6.59	6.10
Mean									
Mean		1.93	66.71	71.76	20.71	7.53	3.88	6.55	7.50
CV		21.15	21.20	10.41	37.08	26.58	32.10	4.56	55.25
				Statistical probabilities					
Concentrate									
Linear (L)		NS	0.0235	0.0001	0.0001	0.0118	0.0001	0.0002	0.0060
Deviation (D)		NS	NS	NS	NS	0.0038	NS	NS	0.0019
Monensin									
Linear (L)		NS	NS	0.0148	0.0032	0.0075	0.0003	NS	0.0075
Deviation (D)		NS	NS	0.0383	0.0476	NS	NS	NS	NS
Interaction									
$Con_L Xmon_L$		NS	NS	NS	NS	0.0208	NS	NS	NS
$Con_L Xmon_D$		NS	NS	0.0092	0.0095	NS	0.0026	0.0115	NS
$Con_D Xmon_L$		0.0126	NS	NS	NS	NS	NS	NS	NS
$Con_D Xmon_D$		NS	NS	NS	NS	NS	NS	NS	NS

[1] Con. - concentrate level, %; Mon.- monensin dose (mg/animal/day); DMI - dry matter intake (% of body weight/day); VFAs - total volatile fatty acids concentration (mM); C_2 - molar percentage of acetate (molar%); C_3 - molar percentage of propionate (molar%); C_4 - molar percentage of butyrate (molar%); C_2/C_3 - acetate:propionate ratio (molar% basis); NH_3-N - ammoniacal-nitrogen concentration (mg/dL); CV - coefficient of variation (%); NS: non-significant

using high doses of the product (ex. 300 mg), the highest response to monensin was obtained with larger proportion of concentrate in the diet (3.51, 4.39 and 12.55 percentile units for 25, 50 and 75%-concentrate diets, respectively). Effects of monensin were lower in high-roughage diets and low doses of product would be enough to produce maximum responses. In high-concentrate diets, responses were larger than in roughage diets, although it was necessary higher doses to produce good responses in those conditions.

Effects of monensin on ruminal pH were absent in high-roughage diets (-1.6 and 1.0% for 150 and 300 mg, respectively), lower in mixed diets (2.8 and 2.0%) and higher in high-concentrate diets (7.8 and 4.1%). For NH_3-N, monensin decreased its concentration independent on concentrate level of diet.

Fibre level or monensin dose interacted for DMI. Concentrate level caused a curvilinear response, with larger intake for mixed diets, and monensin caused a linear response, decreasing DMI. In mixed diet, there was a decrease of 33.0% in DMI caused by monensin, which is high when compared to a decrease of 6.4% observed by Goodrich et al. (1984).

CONCLUSIONS

Responses to monensin vary with fibre level and product dose. Response to monensin is lower in high-fibre diet and lower dose is enough to produce maximum response. On the other hand, response to monensin is higher in low-fibre diet and higher dose is necessary to produce maximum response.

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