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Effects of Cinnamaldehyde-Eugenol and Capsicum on rumen fermentation and feeding behaviour in beef heifers fed a high –concentrate diet

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Take home message

This study shows that feed intake, feed intake pattern and feed intake behavior can be a target for specific plant extract based feed additives in ruminants

Introduction & Objective

According to Cardozo et al. (2005) Increasing dose of eugenol (0. 0.3, 3 mg/L) increased the production of VFA: +23.6%, +21.4%, +20.6% of the negative control (131mM). Increasing dose of cinnamaldehyde (0. 0.3, 3 mg/L) increased the molar proportion of propionate: +9.4%, +15.2%, +23.5% of the negative control (36.2 mol/100mol)^Increasing dose of capsicum oleoresin decreased (0. 0.3, 3 mg/L) the ratio C_2/C_3: -7.7%, -30.8% and -38.4% of the negative control (1.3).

= illustration of the ruminal effect of cinnamaldehyde, eugenol and capsicum.

However, their effect on feed intake, feed intake pattern and feed intake behavior are not well documented.

The objective of the work presented here was to determine the effect of cinnamaldehyde + eugenol and capsicum on feed intake pattern, feed intake behavior and rumen metabolites in growing heifers fed high concentrate diet.

Materials & Methods

Animal, housing – Four Holstein heifers (350 kg BW) fitted with a 1-cm i.d. plastic ruminal trocar. Animal were individually housed in tie-stalls.

Diets – The diet was 10% barley straw and 90% concentrate (DM basis: 32.2% ground barley grain, 27.9% ground corn grain, 13.3% soybean meal, 8.1% soy hulls, 7.5% wheat, 7.2% corn gluten feed , 2.8% sunflower, 1.1% fat and 1.9% minerals and vitamins premix). The diet (DM basis: 16.1% CP, 22.0% NDF, 54.3% NSC) was designed to meet or exceed nutrient recommendations of a 360 kg of BW Holstein heifer with an average daily gain of 1.15 kg/ d *(NRC, 2001)*. Animals were fed once per day at 8:00 with a hand mixed TMR on *ad libitum* basis, at 110% of the intake at the previous day.

Treatments – The heifers were involved in a balanced factorial design organised in a 4 × 4 Latin Square. The 2 treatments were: CAP = 0 vs. 500 mg.head^{-1}.day $^{-1}$ of a product containing 20% of capsicum oleoresin with 6% of capsaïcin and dihydrocapsaicin (product XTRACT 6933™). CIE = 0 vs. 500 mg.head^{-1}.day $^{-1}$ of a mixture of 28% pure eugenol and 17% pure cinnamaldehyde (product XTRACT 6965™). The additives were manually mixed with the daily offered amount of feed.

Measurements – Feed intake, water intake, feed intake pattern, rumen pH, rumen VFA.

Statistical analysis – Data was analysed using PROC MIXED for repeated measures (SAS), differences were declared at $P < 0.05$.

Results & Discussion

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A shown in table 1, CIE decreased DMI (-1.4 %, P=0.051), concentrate DMI (-1.8%, P=0.053), water intake (20.8%, P=0.011). CAP increased DMI (+8.9 %, P=0.007), concentrate DMI (+8.9%, P=0.006), water intake (+17.5%, P<0.001). CAP and CIE increased total DMI (+1.7 %, P=0.184), concentrate DMI (+2.0 %, P=0.254) and water intake (17.06 %, P=0.015). The effect of CIE on feed intake seems dominant vs. the effect of CAP. The effect of CAP on water intake seems predominant vs. the effect of CIE.

Table 1 – Effects of treatments on Feed and water intake

Outcomes	Treatments				RSD	*P*-value				
	CAP = 0		CAP = 1			Animal	Period	CAP	CIE	CAP×CIE
	CIE=0	CIE=1	CIE=0	CIE=1						
Total DMI, kg/d	9.33	9.20	10.16	9.49	0.832	<0.001	<0.001	0.007	0.051	0.184
Water intake, L/day	32.32	25.58	38.03	37.83	6.52	0.253	<0.001	<0.001	0.011	0.015
Concentrate DMI, kg/d	8.33	8.18	9.07	8.50	0.76	<0.001	<0.001	0.006	0.053	0.254
Barley straw DMI, kg/d	0.99	1.02	1.08	0.99	0.100	<0.001	<0.001	0.217	0.188	0.026

Animals fed CAP and CAPxCIE spent more time eating (12.4 and 10.1 vs. 8.7% of the time of the day) and intake pattern was more stable during the day compared with CTR (Fig. 1). As a result, the pH fell to its lowest level 6h after feeding but was lower in CTR compared with CAP, suggesting that the modification of intake pattern induced by CAP was responsible for controlling the sharp drop of pH after feeding (Table 2). The effect of CAP on feed intake pattern and behavior domines vs. CIE.

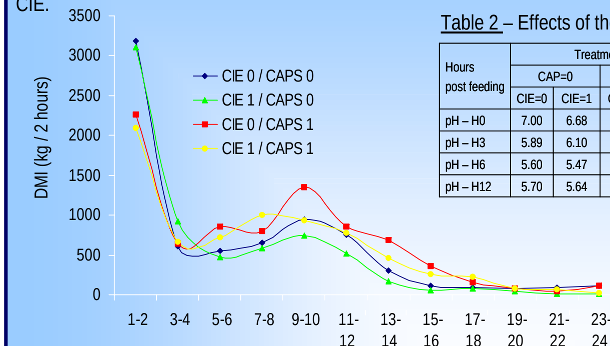

Table 2 – Effects of the 4 treatments on rumen pH

Hours post feeding	Treatments				RSD	*P*-value				
	CAP=0		CAP=1			Period	Animal	CIE	CAP	CAP×CIE
	CIE=0	CIE=1	CIE=0	CIE=1						
pH – H0	7.00	6.68	6.95	7.01	0.302	0.100	0.039	0.120	0.156	0.037
pH – H3	5.89	6.10	5.78	6.34	0.315	<0.001	<0.001	0.485	<0.001	0.057
pH – H6	5.60	5.47	5.67	5.98	0.332	<0.001	<0.001	0.394	0.005	0.029
pH – H12	5.70	5.64	5.61	5.76	0.349	0.072	<0.001	0.925	0.631	0.291

Figure 1 – Effects of the 4 treatments on feed intake pattern

As shown in table 3, CIE numerically increased total VFA (162.5 vs. 141.2 m*M*) in spite of the decrease of DMI => High effect of CIE on VFA production. Total volatile fatty acids tended to be higher in CAP compared with CTR (154.3 vs. 141.2 mM). For both CIE and CAP the C_2/C_3 ratio was numerically decreased (2.76 vs. 3.06; 2.55 vs. 3.06 respectively). Full dose of CAP together with full dose of CIE appears too high as they slightly decreased VFA production.

Table 3 – Effects of the 4 treatments on rumen VFA

	Treatments				RSD	*P*-value					
	CAP=0		CAP=1			Period	Animal	CIE	CAP	CIE×CAP	Hour
	CIE=0	CIE=1	CIE=0	CIE=1							
Ruminal pH	6.05	5.95	6.03	6.27	0.38	<0.001	<0.001	0.183	0.002	0.002	<0.001
VFA, m*M*	141.20	162.50	154.30	129.20	48.23	0.013	0.007	0.794	0.156	0.001	<0.001
C2, mol/100mol	59.90	58.49	59.02	60.14	4.61	<0.001	<0.001	0.826	0.569	0.063	<0.001
C3, mol/100mol	23.80	23.68	26.14	21.74	4.85	<0.001	<0.001	0.003	0.800	0.006	<0.001
C4, mol/100mol	14.06	14.45	11.95	14.54	2.82	<0.001	<0.001	0.001	0.018	0.010	0.301
Iso C4, mol/100mol	0.90	0.84	0.88	0.95	0.24	0.012	0.005	0.883	0.179	0.058	<0.001
Val, mol/100mol	1.90	1.99	1.61	1.42	0.45	0.001	<0.001	0.422	<0.001	0.038	0.106
Iso Val, mol/100mol	0.60	0.60	0.62	0.69	0.19	0.007	0.001	0.245	0.065	0.185	<0.001
BVFA, mol/100mol	1.51	1.44	1.50	1.64	0.42	0.010	0.002	0.547	0.111	0.095	<0.001
Lactique, mol/100mol	0.28	0.13	0.11	0.22	0.44	0.379	0.138	0.711	0.505	0.051	0.397
C2/C3	3.06	2.76	2.55	3.17	0.79	<0.001	<0.001	0.175	0.676	<0.001	<0.001

Conclusion

CIE decreased feed intake but did not modify either pattern or behavior. CAP increased the consumption of water and feed and altered feed intake pattern and behavior. The animals spent more time eating and the pattern of intake was more stable during the day. As a result, the pH fell to its lowest level 6 h after feeding but was higher in CAP diets, suggesting that the modification of the pattern of intake induced by CAP may be responsible for controlling the sharp drop of pH after feeding.