EFFECT OF DIETARY N-BUTYRIC AND ACETIC ACIDS ON THE FEED INTAKE AND MILK QUALITY OF DAIRY COWS

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ABSTRACT

The aim of this study was to examine the effects of n-butyric and acetic acids on feed intake and milk quality of dairy cows. Adding 10.0 g/kg of n-butyric acid or 16.5 g/kg of acetic acid to TMR (DM basis) decreased the first meal duration, but did not affect total eating time, DMI, and performance of late lactating dairy cows.

Keywords: acetic acid, butyric acid, intake, volatile fatty acids

INTRODUCTION

Well-preserved silages are virtually free of n-butyric acid. Compared with acetic acid, whose formation in silage can be promoted by inoculation with heterofermentative lactic acid bacteria aiming to improve the aerobic stability (Arriola *et al.*, 2021), the n-butyric acid has a greater antifungal potential. Experiments with addition of pure n-butyric acid to animal diet are rare in the literature, and its effects on DMI and performance are equivocal. In animal tissues, n-butyric acid is converted to ketone bodies (β-OH-butyrate, acetoacetate and acetone), which may diffuse from the blood to the rumen digesta. In the rumen, acetone can be converted to isopropanol by rumen microorganisms. Isopropanol is then absorbed and partially imparted to milk (Bragatto *et al.*, 2022). Therefore, the objective of this study was to examine the effects of dietary n-butyric and acetic acids on feed intake, performance and milk quality of dairy cows.

MATERIAL AND METHODS

Nine late lactating dairy Holstein cows (554 ± 45 BW; 25.4 ± 3.9 kg/d of milk) were assigned to three 3 × 3 Latin squares, with 18-d periods (14-d adaptation and 4-d sampling), to receive one of three dietary treatments: 1) CON: basal diet containing (DM basis) 400 g/kg chopped Bermuda grass hay and 600 g/kg concentrates; 2) BUT: basal diet added with 10 g/kg DM of n-butyric acid; and 3) ACE: basal diet added with 16.5 g/kg DM of acetic acid. The basal diet was formulated with dry (non-fermented) ingredients, so the effect of the organic acids can be evaluated without bias. Water was added to all TMR to reach 550 g/kg of DM content. The TMR ingredients were mixed by hand twice daily, immediately before each feeding at 0800 and 1330 h. Cows were milked in a milk parlor twice daily at 0630 and 1530 h. Data were analyzed using the Mixed procedure of SAS (v. 9.4, SAS Inst. Inc., Cary, NC). Significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P \leq 0.10$.

RESULTS AND DISCUSSION

Eating time, meal frequency, meal size, meal duration, and eating rate were unaffected by treatment (Table 1). However, BUT increased ruminating time and, consequently, increased chewing time (min/d) and tended to increase chewing per kg DM. All TMR had a similar physical structure, with no difference in TMR sorting index at the feed bunk (data not shown). The mechanism underlying the increased rumination observed with BUT supplementation warrants further investigation; however, effects of BUT on rumen papillae development and the clearance of volatile fatty acids, as well as rumen motility, may be involved. Additionally, ACE decreased and BUT tended to decrease the duration of the first meal, likely due to the pungent odor of acetic and butyric acids, which may alter intake pattern via olfaction (Daniel *et al.*, 2013).

Several studies have reported negative relationships among n-butyric or acetic acid and DMI by multivariate or correlation analysis. However, the occurrence of collinearity among variables prevents the establishment of cause and effect (e.g., high concentrations of n-butyric and acetic acids in poorly fermented silages containing other potentially hypophagic compounds). In studies where pure n-butyric acid was supplemented its effect on DMI was equivocal, whereas the sole effect of acetic acid on DMI depends on its concentration in diet. Gerlach *et al.* (2021) demonstrated in a meta-analysis that concentrations of acetic acid greater than 17.3 g/kg of diet DM depressed DMI, whereas lower concentrations had negligible effect. In the current study, adding 10.0 g/kg of n-butyric acid or 16.5 g/kg of acetic

Tab. 1: Feeding behavior of dairy cows fed TMR added with n-butyric and acetic acid

Item	Treatments[1]			SEM[2]	P-value
	CON	BUT	ACE		
Eating, min/d	302	301	299	13.7	0.983
Ruminating, min/d	537[b]	577[a]	538[b]	9.0	0.011
Chewing, min/d	838[y]	877[x]	837[y]	13.9	0.043
Chewing, min/kg DM	39.9[xy]	41.4[x]	39.7[y]	0.83	0.060
Eating rate, g DM/min	70.0	70.4	70.8	2.75	0.966
Meal frequency, /d	6.56	7.22	7.11	0.517	0.526
Meal size, kg DM/meal	3.33	3.04	3.16	0.205	0.617
Meal duration, min	48.6	42.7	44.7	2.80	0.332
First meal duration, min	108[a]	94.4[ab]	90.0[b]	6.67	0.045

[1]CON: control; BUT: 10.0 g/kg DM of n-butyric acid; ACE: 16.5 g/kg DM of acetic acid. [2]Standard error of the mean. [a,b]Tukey test ($\alpha = 0.05$). [x,y]Tukey test ($\alpha = 0.10$)

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acid to TMR (DM basis) did not affect the DMI (Table 2). Milk yield, feed efficiency, milk fat, lactose, and MUN did not differ among treatments, whereas BUT slightly increased milk protein concentration. The greater rumination time may have improved the ruminal environment, thereby increasing the intestinal flux of microbial amino acids that were subsequently utilized for milk protein synthesis. Further studies are needed to confirm this hypothesis. As expected, blood β-OH-butyrate tended to increase in cows fed BUT compared to CON or ACE, due to the conversion of butyrate to β-OH-butyrate mainly in the rumen epithelium (Kristensen and Harmon, 2004). All milk samples tested negative for the presence of alcohol.

Tab. 2: Performance of dairy cows fed TMR added with n-butyric and acetic acid

Item	Treatments1			SEM[2]	P-value
	CON	BUT	ACE		
DMI[3], kg/d	21.1	21.7	21.2	0.59	0.421
ECM[4], kg/d	24.2	25.4	25.6	1.33	0.139
Fat, g/kg	41.5	43.3	42.1	1.92	0.412
Protein, g/kg	31.9b	32.8a	32.7a	0.36	0.027
Lactose, g/kg	45.6	45.7	45.7	0.41	0.976
MUN[5], mg/dL	15.1	14.9	14.7	0.62	0.681
ECM/DMI	1.15	1.18	1.20	0.054	0.206
Milk alcohol test, %	0	0	0	–	–
Blood β-OH-butyrate, mmol/L	0.644^{y}	0.744^{x}	0.622^{y}	0.0449	0.098

[1]CON: control; BUT: 10.0 g/kg DM of n-butyric acid; ACE: 16.5 g/kg DM of acetic acid. [2]Standard error of the mean. [3]Dry matter intake. [4]Energy-corrected milk. [5]Milk urea nitrogen. [a,b]Tukey test (α = 0.05). [x,y]Tukey test (α = 0.10)

CONCLUSION

Adding 16.5 g/kg of acetic acid or 10.0 g/kg of n-butyric acid to TMR (DM basis) did not affect total DMI and performance of late lactating cows.

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