

The effect of betaine and rumen undegradable choline on growth rate and feed efficiency in calves

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ABSTRACT

The experiment was performed on 30 Black-and-White Lowland calves of 87.0-90.3 kg body weight. The animals were divided into three groups fed meadow hay and a control granulated concentrate – C, supplemented with 2.5% betaine – B (Betafin – Finnsugar Bioproducts, Helsinki, Finland) or with 2.25% choline chloride – CH (Prince Agri Products, Inc., Quincy, IL, USA), which was equivalent to about 0.5% of the rumen undegradable choline.

The daily body gain of animals fed the C diet and the B diet was the same, 0.849 ± 0.029 kg, but in calves of the CH group was 0.898 ± 0.029 kg. The concentrate efficiency ratio was 3.06 ± 0.097 , 3.13 ± 0.097 and 2.91 ± 0.097 kg in the C, B and CH group, respectively. The relative growth rate was higher ($P \leq 0.10$) in the CH group, reaching 131.7 ± 1.40 , 169.1 ± 2.71 and $210.6 \pm 4.84\%$ of the initial weight in the 5th, 10th and 15th weeks, respectively. The results achieved suggest that 0.5% rumen undegradable choline has a positive effect on production performance of half year old calves. In contrast, 2.5% betaine supplementation had no effect on production performance even though it was administered at 5-times higher levels than the rumen undegradable choline.

KEY WORDS: calf, betaine, choline, growth rate

INTRODUCTION

Deficiency of the essential sulphur-containing amino acids, methionine and/or cysteine, often limit ruminant production (Armentano et al., 1997; Campbell et al., 1997). Because betaine and choline are donors of free methyl groups their role in the organism is closely related to methionine and methylation processes (Barak et al., 1996). That is why they can positively influence the growth performance of

monogastric animals. They are not usually considered as essential nutrients but they are important in many metabolic pathways (Mitchell et al., 1979; Burnham et al., 1996; Holler et al., 1996; Shronts, 1997). Thus the objective of this study was to estimate the effect of betaine and rumen undegradable choline on growth rate and feed efficiency ratio in calves.

MATERIAL AND METHODS

The experiment was performed on 30 Black-and-White Lowland calves of 87.0 – 90.3 kg body weight. The animals were divided into three groups fed meadow hay and a control granulated concentrate – C, supplemented with 2.5% betaine – B (Betafin – Finnsugar Bioproducts, Helsinki, Finland) or with 2.25% choline chloride – CH (Prince Agri Products, Inc., Quincy, IL, USA), which was calculated to be about 0.5% of the rumen undegradable choline. The betaine supplement was approximately 5-times higher, because it was not protected against rumen degradation and we assumed 80% would be degraded in the rumen (unfortunately no rumen undegradable betaine was commercially available at the beginning of 1997). A two week adaptation period, when the calves were fed the control concentrate and meadow hay *ad libitum*, was followed by 15 weeks of regular experiment when the animals were offered restricted amounts of concentrates (Table 1). Feed intake was controlled daily and body gain weekly.

Multiple analysis of variance (group x sex x period) for data analysis was carried out and the Scheffe test was applied for comparison of means at $P \leq 0.05$ (Statgrafics software).

TABLE 1

The chemical composition of meadow hay and granulated concentrate

Item	Meadow hay	Control concentrate	Betaine concentrate	Choline concentrate
Dry matter, %	84.1	92.3	92.6	92.5
Organic matter, %	76.37	85.16	85.40	85.42
Net energy, MJ/kg	2.83	6.32	6.40	6.35
Crude protein, %	11.3	17.0	17.2	17.2
Crude fibre, %	31.15	4.66	4.50	4.51
Ether extract, %	2.02	2.79	2.79	2.74
Ash, %	7.73	7.14	7.20	7.08
Ca, g/kg	0.55	10.03	9.91	9.88
P, g/kg	0.27	9.84	9.90	9.86
Betafin, %	–	–	2.50	–
Choline chloride, %	–	–	–	2.25

RESULTS AND DISCUSSION

The initial and final body weights of the calves as well as the relative growth rates are presented in Table 2. The differences in relative growth rate were confirmed statistically ($P \leq 0.10$) despite the short duration of the trial and the low animal numbers. The relative increase in body weight was higher in the animals fed the diet with rumen undegradable choline. The calves in this group achieved 131.7 ± 1.40 , 169.1 ± 2.71 and $210.6 \pm 4.84\%$ of their initial weight in 5th, 10th and 15th weeks, respectively. The results observed suggest that 0.5% rumen unde-

TABLE 2

Initial weight, final weight and total gain of growing calves

Item	n	Initial weight, kg	Final weight kg	Relative growth rate, % of beginning weight		
				5 th week	10 th week	15 th week
Group						
control	10	90.3 \pm 5.61	177.9 \pm 8.53	128.6 ^{ab} \pm 1.40	161.9 ^a \pm 2.71	197.0 ^a \pm 4.84
betaine	10	90.3 \pm 5.61	178.0 \pm 8.53	127.5 ^a \pm 1.40	163.2 ^{ab} \pm 2.71	198.5 ^a \pm 4.84
choline	10	87.0 \pm 5.61	179.6 \pm 8.53	131.7 ^b \pm 1.40	169.1 ^b \pm 2.71	210.6 ^b \pm 4.84
Sex						
male	21	93.9 \pm 5.40	187.1 \pm 5.40	128.6 \pm 0.94	163.3 \pm 1.82	201.1 \pm 1.40
female	9	84.6 \pm 8.24	169.9 \pm 8.24	130.0 \pm 1.43	166.2 \pm 2.77	202.9 \pm 4.95
Total	30	89.2 \pm 4.93	178.5 \pm 4.93	129.3 \pm 0.86	164.7 \pm 1.66	202.0 \pm 2.96

means in columns with different superscripts, (a, b) are significantly different ($P < 0.05$)

gradable choline has a positive effect on production performance of half year old calves. The daily body gain of animals fed the C and B diet was the same – 0.849 ± 0.029 kg, but was higher in calves of the CH group – 0.898 ± 0.029 kg (Table 3). The concentrate efficiency ratio was 3.06 ± 0.097 , 3.13 ± 0.097 and 2.91 ± 0.097 kg in the C, B and CH groups, respectively. The 2.5% betaine supplementation had no effect even though it was 5-times higher than the addition of the rumen undegradable choline. Puchała et al. (1998) showed that duodenal infusion of betaine increased portal and jugular plasma concentration of methionine. Therefore the entire betaine was probably degraded in the rumen and none flowed into the duodenum. It was most probably metabolised to trimethylamine, methane and CO (Mitchell et al., 1979). There are reports that betaine improves the health and production performance of monogastric animals (Matthews et al., 1995, 1997; Emmert et al., 1996; Augustine et al., 1997). Hence it would be useful to examine the effect of rumen undegradable betaine in ruminants. We observed differences ($P \leq 0.05$) between the sexes in daily gain (0.903 ± 0.018 – males and 0.827 ± 0.028 kg –

TABLE 3

Daily gain, concentrate and hay efficiency ratio in growing calves

Item	n	Daily gain kg	Concentrate efficiency ratio kg/kg feed	Hay efficiency ratio kg/kg feed
Group				
control	30	0.849 ± 0.029	3.06 ± 0.097	1.24 ± 0.068
betaine	30	0.849 ± 0.029	3.13 ± 0.097	1.35 ± 0.068
choline	30	0.898 ± 0.029	2.91 ± 0.097	1.23 ± 0.068
Sex				
male	63	0.903 ± 0.018 ^a	3.00 ± 0.062	1.20 ± 0.043
female	27	0.827 ± 0.028 ^b	3.07 ± 0.094	1.34 ± 0.066
Period				
1	30	0.781 ± 0.029 ^a	2.74 ± 0.097 ^a	0.78 ± 0.068
2	30	0.886 ± 0.029 ^b	2.94 ± 0.097 ^a	1.28 ± 0.068
3	30	0.929 ± 0.029 ^b	3.42 ± 0.097 ^b	1.75 ± 0.068
Total	90	0.865 ± 0.017	3.03 ± 0.056	1.27 ± 0.039

means in columns with different superscripts (a,b) are significantly different (P<0.05)

females) and better feed efficiency during weeks 5-10 and weeks 10-15 of the experiment (0.886 ± 0.029 and 0.929 ± 0.029 kg) than in the first period (0.781 ± 0.029 kg).

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