INFLUENCE OF DIETARY CATION-ANION BALANCE ON PH RUMEN FLUID IN LACTATING DAIRY CATTLE

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ABSTRACT

In the trial with eight dairy cows of Czech Fleckvieh breed was monitored the effect of addition of limestone to the diet on pH of the rumen fluid. Monitoring was performed using a probe for measuring and records of pH and of temperature within the rumen. Milk production was recorded every day. The daily ration TMR feeding limestone was added over a period of three weeks. The feeding intervention with 100g limestone was compared with the control. When feeding control, the average pH of 5.82 ± 0.178 (n = 1010) and after addition of limestone feed, the pH had to 5.85 ± 0.238 (n = 1010). There was also an increase in daily milk production - control 25.62 ± 6.39 liters of milk per day, feeding limestone - 25.83 ± 4.96 liters per day (n = 111). Regulation of dietary cation-anion balance may become a useful tool for changing pH and improving the performance of lactating dairy cattle. DACB result in the control group was 77.1meq/kg dry matter and in the group with limestone was DACB 89.2 meq/kg dry matter.

Key words: dairy cows, pH in the rumen, probe for measuring and records of pH, bolus, cation-anion diet

INTRODUCTION

Why do we bother to calculate DCAB and what does it mean to the animal? The direct answer is apparently quite simple. These four minerals are intricately involved in the acid base status of the animal; not rumen acids and bases, but systemic (blood) acids and bases. Sodium and K^+ are thought to be alkalogenic in that their metabolism and excretion leads to an elevation of blood buffering capacity via bicarbonate retention (HCO_3^-) and an increase of blood pH (acid). Metabolism of $Cl^-$and $S^=$ lead to a decrease of blood buffering capacity (lower HCO_3^-) and a reduced blood pH; therefore, $Cl^-$and $S^=$ are considered to be acidogenic. A high DCAB would, therefore, indicate that a feed or diet will promote a high blood buffering capacity and a low DCAB would promote a reduced blood buffering capacity. In the extreme case of a negative DCAB (Na + K) is less that (Cl + $S^=$) a mild acidosis can occur in the blood. The specific effects of DCAB on organs such as kidney, liver and bone and on enzyme and hormone functions appear to all be related back to this effect on acid-base status(Block, 2009). For example the rumen acidosis, mainly occurring as subacute rumen acidosis (SARA), is characterized by abnormally low rumen pH. SARA is a widely spread problem in high yielding dairy cows and also in grazing cattle (Kleen et al., 2003, Bramley et al., 2008). Measurements of pH in the rumen can contribute to the understanding of the microbiological activity and dynamics of fermentation (Broberg, 1957). The repeated collection of ruminal fluid to diagnose SARA is accompanied by potential risks for conditions such as peritonitis related to rumenocentesis due to a trocar and esophageal and ruminal injuries induced by oro-ruminal probe extraction. Moreover, the reliability of the data depends on the skill of the operator and the locations of the sampling sites within the rumen (Duffield et al. 2004). Problem solving how to measure the pH in the rumen is using indwelling bolus for monitoring ruminal pH. The sensor system benefits from the fact that data can be collected continuously. The sensor system was evaluated by a comparison with standardized pH-dilutions (pH 4, pH 7). The sensor system has proven to be an accurate and reliable instrument (r = 0.9984) and it represents an innovative system for answering scientific questions in terms of rumen physiology and rumen pathology (Schneider et al., 2010). In our experiment with dairy cows we monitored the changes of ruminal pH during day by using rumen boluses (smaXtec Animal Care, Austria).

MATERIAL AND METHODS

Eight dairy cows of Fleckvieh breed in the second lactation were chosen to monitoring pH. Cows were housed in groups of 35 heads. Housing was loose pit with bedding of straw. There were two automatic drinkers available. Feed was served on a feeding table twice a day as a total mixed ration (TMR). Composition of TMR followed: 22 kg maize silage, 12 kg alfalfa hay, wheat straw, 1.4 meadow hay, beet pulp 6 kg, 7 kg fresh barley grains and 9.2 kg production mixture. The total weight of TMR was 58.1 kg. Weights are indicated in the original matter. Determination of dry matter feed was 23.1 kg. Production mixture contained – 27 % corn, 35.7 % wheat, 11 % extracted rapeseed meal, 17 % soybean meal, 0.8 % natriumcarbonate, 0.4 % feed salt, 0.5 % urea compound, 3 % Megalac. Selected cows obtained adition of limestone 50 g twice a day (100 g per day).

Tab. 1 Content of anions and cations in the ration on the day following

Minerals	kation/ anion	molecular weight	konstant number	Content g/kg
Na^{+}	+	22,99	0,0434972	**2,78**
K^{+}	+	39,1	0,0255754	**11,74**
Mg^{++}	+	24,31	0,0822707	**3,5**
Ca^{++}	+	40,8	0,0490196	**10,62**
Cl^{-}	-	35,45	0,0282087	**1,7**
SO_4^{--}	-	32,06	0,062383	**2,38**
PO_4^{---}	-	30,97	0,0968679	**4,13**

Outside temperature was measured using thermohydrograph Comet brand. Cows were milked twice a day in the milking parlor. Every day was also recorded individual milk yield. DACB was calculated using the formula: DCAB (meq/kg dry matter) = (meq Na+ /kg dry matter + meq K+/kg dry matter) - (meq Cl -/kg dry matter + meq SO4 --/kg dry matter) (NRC, 1989).

The timetable for dairy cows

The diet was fed as a TMR and divided into two equal portions given at 5:00 a.m. and 5:00 p.m. At 6:00 a.m. cows were exaggerated in the parlor. They left the parlor at 7:00 a.m. around 9:00 a.m. is the stable normal bustle associated with moving the cows to milking. It is performed push feed at 1:00 p.m. At 6:00 p.m. dairy cows are transferred to the evening milking and at 7:00 p.m. they are back in the barn. At this time, is currently implementing the second push feed. At 9:00 p.m. starts peace in the barn, which is broken up at 4:30 a.m. with push feed. During the experiment this schedule was identic every day.

An indwelling measuring sensor (bolus smaXtec Animalcare) was used for continuous measurement of the ruminal pH-value. The wireless radio transmission system consisted of a pH sensor, a data measurement receiver, a mobile reader, and a personal computer (PC) with special software (smaXtec, Austria). Shape and size of the sensor allow oral placement of the system in adult cattle. The pH sensor weighs 219 g is in 132 mm length with diameter of 35 mm. It is attached to a small glass electrode on one side. We used a special balling gun to insert the smaXtec® pH Bolus into the rumen after activation and calibration. The resulting data (10 - minute measuring interval) were saved in a unit (A/D-converter, memory chip) and sent to an external receiver via ISM-band (433 MHz). This receiver unit was connected with an internet server, which analyzed data and created graphics with the help of a specifically created software.

Data were processed using MICROSOFT EXCEL® (USA) and STATISTICA.CZ Version 10.0 (Czech Republic).

RESULT AND DISCUSSION

The test objective was to determine the variation of the DACB adding lime and whether this influenced the addition of pH change. The experiment was changed DACB adding 100 g of limestone from 77.1 to 89.2 therefore 15.7%. We found the pH in the control group 5.82 ± 0.178 (n = 1010) and by adding limestone was found pH 5.85 ± 0.238 (n = 1010). This means that the change DACB 15.7% pH value changed by only 0.5%. We assume that the buffering capacity of the rumen could suppress the changes caused by mineral nutrition. The use of limestone increased positive numbers miliequivalent titration. Response in dairy cows was surprisingly lower. Buffering capacity of the rumen will probably eliminate changes in the feed ration. Calcium thus had a large influence on the change of pH. Submission of limestone brought great changes DACB but did not bring changes in the physical measurement of pH in the rumen.

Tab. 2 Comparison DACB with used limestone and control

Minerals	kation/ anion	molecular weight	konst number	Obsah g/kg	konst numb.	**Limestone**	**Control**
Na^{+}	+	22,99	0,0434972	2,78	1	**63,9**	**63,9**
Mg^{++}	+	24,31	0,0822707	3,5	0,30	**12,8**	**12,8**
Ca^{++}	+	40,80	0,0490196	10,62	0,38	**82,3**	**70,2**
Cl^{-}	-	35,45	0,0282087	1,7	1	**60,3**	**60,3**
SO_4^{--}	-	32,06	0,062383	2,38	0,25	**9,5**	**9,5**
DACB						**89,2**	**77,1**

CONCLUSIONS

Increasing the ratio of cation - anion balance has slightly increased alkalinity of the the diet, but the pH in the rumen has not changed. Probably consequently the rumen operates phosphate and carbonate buffers. Served amount of limestone was quite dramatic change and therefore would recommend the next time you try to increase the amount of limestone.

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