Japanese Journal of Veterinary Research 58(3&4): 171–177, 2010

NOTE

Effects of feeding buffering mineral mixture on subacute rumen acidosis and some production traits in dairy cows

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Received for publication, April 20, 2010; accepted, September 16, 2010

Abstract

This trial was designed in order to evaluate the incidence of subacute rumen acidosis (SARA) during early lactation and to investigate the possibilities for its prevention by use of a buffering mineral mixture. On the beginning of the trial it was found that the pH value of rumen fluid in 4 animals was lower than normal ($pH < 6.0$) and that 20% of animals have had SARA. The control and the experimental group of cows were fed the same meal with exception of concentrated feed which in the experimental group contained the mineral mix with buffering activity in amount of 1%. Continuous addition of buffering mineral mixture in the amount of 1% in concentrated feed for early lactation cows successfully prevents SARA formation and leads to increased milk production, as well as increased milk fat and protein content.

Key words: buffers, cow, milk, prevention, rumen acidosis

Different forms of rumen acidosis have the same initial mechanism, but differ in the mechanisms of regulation after low pH is achieved [21)]. Decrease of rumen fluid pH from 6.4 to 5.5 mostly starts with ingestion of feeds that are rich in energy. Easily digestible

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carbohydrates (starch or sugars) represent a source of easily adoptable energy[17,20]. Ingestion of a meal poor in fibres and rich in energy in a period when rumen micro organisms are not yet fully able to ferment feeds properly is deemed to be responsible for subacute rumen acidosis (SARA) initialisation. Respectively two factors i.e. the rumen which is not adapted to concentrated feed and the possibly for increased ingestion of concentrated feed in a period before calving altogether can lead to SARA formation in the postpartum period. The problem of rumen adaptation is well described. SARA in this period can be usually controlled by proper feeding management and by providing successive meal transition between the dry period and onset of lactation; this assures a better adaptive ability of the reticulo-ruminal compartment[20].

Beside other symptoms, decrease of milk fat percent in SARA and other forms of rumen acidosis were reported by numerous researchers[2,3,20,21]. Since it usually affects singular animals, decrease in milk fat content stays undetected when cumulative milk samples from lacto freeze are tested[10,19].

Addition of buffering matters in concentrated feeds has restored higher rumen fluid pH and detained milk fat decrease[13,22,23,26]. Kennelly *et al.*[12] have concluded that supplementation of buffering matters prevents formation of trans C 18:1 unsaturated fatty acids which are believed to inhibit milk fat synthesis. There are no data concerning milk protein percent and influence of SARA on it. Having in mind the above mentioned we have aimed to investigate the effects of buffering mineral mixture on productive parameters of high producing dairy cows.

The trial was done on a total number of 20 cows Holstein–Friesian breed. The animals were divided into two groups (control $n = 10$ and experimental $n = 10$) on Kovilovo farm, PKB Corporation, Belgrade. Cows were introduced into the trial 5 to 7 days after calving, and were randomly assigned to one of the treatment groups (control or experimental). The cows were on average 4–6 years old, weighing 587.1 ± 28.25 kg. Average milk yield of all cows embraced by this trail was (7524.2 ± 287.25 l calculated over a period of 305 days) in the previous 3 lactations. All cows (control and experimental group) were kept in tie-up stalls in barn housing. The trial lasted for 90 days. All cows were fed according to farm standard procedure (Table 1) and the experimental group was fed the same way like the control group of cows with the exception that concentrated feed was added with 1% of buffering mineral mixture. Buffering mineral mixture composed of benthonite, zeolite, magnesium oxide and sodium bicarbonate produced at the Institute for Technology of Nuclear and Mineral Raw Materials, Belgrade (commercial name Mix Plus®) contained: Mg 13.50%, Na 6.50%, Ca 1.20%, Sulphur 0.01%, Iron 900 mg/kg, Copper 900 mg/kg, Manganese 160 mg/kg, Zinc 20 mg/kg, Cobalt 12 mg/kg and Chromium 26 mg/kg. Mixing of the above mentioned four compounds was done in a turbo mixer at 3000 rpm for 3 minutes. Final granulation of the mixture was < 50 μm.

Rumen fluid samples were collected on day 0, 30, 60 and 90 with rumen probe model according to Zwick and Klee[28] (Hamburg, Germany). Samples of rumen fluid were collected 2 to 4 hr after morning feeding. In order to minimise the impact of saliva contamination on sample 2 litres of fluid were collected. Blood samples (6 ml of blood) were taken from the jugular vein using vacutainer (LH 102 IU, Vacuette®, Germany). Milk samples were collected at morning milking by use of Milko-Scope MKII® (DeLaval AB, Sweden) from each animal in the amount of 100 ml. On the same day when milk samples were collected the quantity of daily produced milk was measured. After the collection pH value was determined by pH-meter (*WTW 330 i*) in samples of rumen fluid and blood. Chemical composition of milk (content of fat and proteins) was determined with *Milko-*

Table 1. Meal composition and calculative analyses for the control and experimental group of cows

Feed	Group	
	Control (kg/day)	*Experimental (kg/day)*
Lucerne hay	4.00	4.00
Corn silage, whole plant (33% DM)	22.00	22.00
Full fat extruded soybean	1.50	1.50
Concentrate (18% crude protein)	9.50	-
Concentrate (18% crude protein) with added 1 % buffering mineral mixture	-	9.50
Sodium bicarbonate	0.050	0.050
Total	37.05	37.05
Calculative analysis		
Dry matter (*kg/day*)	19.37	19.38
NEL (MJ/kg DM)	6.48	6.47
Protein (% DM)	17.89	17.88
ADF (%)	19.76	19.74
NDF (%)	26.05	26.03
Fat (% DM)	2.29	2.28
Ca (% DM)	0.77	0.79
P (% DM)	0.45	0.45
Na (% DM)	0.49	0.51
Mg (% DM)	0.17	0.23
K (% DM)	0.81	0.80
S (% DM)	0.21	0.21

DM: Dry Matter
NEL: Net Energy of Lactation
ADF: Acid Detergent Fibre
NDF: Neutral Detergent Fibre

scan (Fosselectric 130 Type 10900, Denmark). The amount of produced milk was measured by DeLaval milk meter MM6 (DeLaval AB, Sweden).

Statistical analysis of intergroup differences of means was performed by ANOVA, Tukey test and student's *t*-test (Snedecor and Cochran[25]). Software package Prism Pad v. 4.0 was used for statistical calculation. Data were expressed as means ± standard deviation (Mean ± SD). Differences with $p < 0.05$ were considered statistically significant.

On the beginning of the trial it was found that pH value of rumen fluid in 16 cows ranged from 6.0 to 6.80, in 4 cows values were in between 5.50 and 6.0 or that 20% of animals introduced into the trial have had SARA (Fig. 1). Kleen[14] and Krajcarski-Hunt *et al.*[15] have investigated the occurence of SARA in dairy herds and based on these data estimate that one third of all dairy herds has more that 40% of animals with sub acute rumen acidosis. In our country SARA presents a significant health problem since 10 to 30% of animals are affected[24]. Data of SARA incidence in our trial are similar to ones presented by other authors[5,9,24].

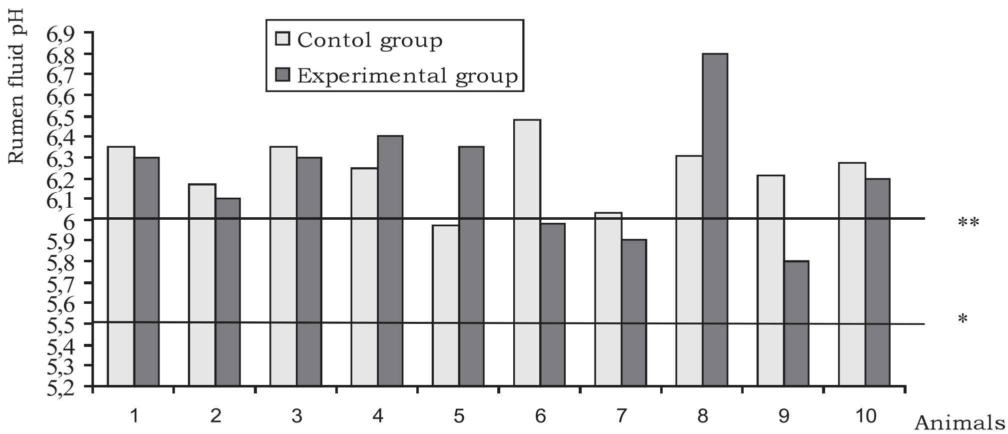

Fig. 1. pH of rumen fluid at the beginning of the trial.
*lower limit of rumen fluid pH in cows affected with SARA
**upper limit of rumen fluid pH in cows affected with SARA

Table 2. Average pH values of rumen fluid and blood in the control and experimental group of cows during the trail

Samplings (day)	Groups	Mean ± SD	
		Rumen fluid pH	Blood pH
0	Control	6.24 ± 0.15	7.29 ± 0.04
	Experimental	6.21 ± 0.29	7.31 ± 0.07
30	Control	6.45 ± 0.26	7.33 ± 0.06
	Experimental	6.65 ± 0.29	7.32 ± 0.07
60	Control	6.22 ± 0.18[a]	7.38 ± 0.10[c]
	Experimental	6.77 ± 0.23[a]	7.47 ± 0.09[c]
90	Control	6.31 ± 0.16[b]	7.28 ± 0.09[d]
	Experimental	6.68 ± 0.29[b]	7.39 ± 0.12[d]

[a, b, c, d] Values with the same superscripts differ significantly ($p < 0.05$).

pH values of rumen fluid and blood with statistical significance are shown in Table 2.

At the beginning of the experiment (day 0.) the average rumen fluid pH in the control and experimental group of cows was mostly the same and did not statistically differ, this was the case on day 30, as well. These findings are contradictory to findings of *Šamanc et al.*[24]. This can steer to a conclusion that planned feeding of cows at the beginning of lactation and use of buffers should be preceded by a transitional period in which the digestive organs and rumen microflora could adapt to large amounts of concentrated feed. This is supported by the fact that average values of rumen fluid pH on day 60 and 90 did significantly differ ($p < 0.01$). These data are in accordance with blood pH results on day 60 and 90 ($p < 0.05$) and with findings of other authors[4,9].

For maintaining rumen pH and creation of conditions for optimal development and function of rumen microflora buffers (which have the ability to neutralise increased acidity) are often used[11–13]. Those are general preparations based on mineral raw materials like benthonite, zeolite, magnesium oxide and sodium bicarbonate, and are added into feed mixtures in an amount of 1 to 2%[1,6,7,16,27]. Beside the fact that these substances regulate the acidity of rumen fluid they have other positive effects. Magnesium

Table 3. Daily produced amount of milk (l/day calculated on 3.6% milk fat), milk fat and protein content during the trial

Sampling (day)	Groups	Mean ± SD		
		Milk (l/day)	Milk fat (%)	Milk protein (%)
0	Control	23.29 ± 2.45	2.73 ± 0.53	2.90 ± 0.19
	Experimental	23.03 ± 4.94	2.81 ± 0.82	2.80 ± 0.08
30	Control	23.00 ± 3.55[a]	2.81 ± 0.43	2.89 ± 0.11
	Experimental	27.26 ± 6.01[a]	3.09 ± 0.58	2.85 ± 0.10
60	Control	23.52 ± 3.84[b]	2.71 ± 0.43	2.93 ± 0.17
	Experimental	30.19 ± 7.44[b]	3.26 ± 0.96	3.09 ± 0.35
90	Control	25.36 ± 4.66	2.86 ± 0.29[c]	2.93 ± 0.15[d]
	Experimental	28.93 ± 6.17	3.34 ± 0.50[c]	3.13 ± 0.13[d]

[a, b, c, d] Values with the same superscripts differ significantly ($p < 0.05$).

oxide improves the absorption of acetic acid. Benthonite and zeolite bind micotoxins, excess ammonia, metals and radionuclides, excessive water and other. Benthonite beside the above mentioned reduces feed passage trough the digestive system, thus contributing to better digestion and utilisation of nutrients.

Results of daily produced amount of milk (in liters) with milk fat and protein content altogether with statistical significance are given in Table 3. From the obtained results it can be clearly seen that addition of the buffering mixture (Mix Plus®) had positive effects on the amount of produced milk. Average daily produced amount of milk was significantly higher on day 30 and 60 in the experimental compared to the control group of cows ($p < 0.05$). The situation with fat and protein content did significantly differ but this was not noticeable until day 90 of the trial ($p < 0.05$ for fat and $p < 0.01$ for proteins). Results achieved in this trial concerning the amount of milk produced and chemical composition of milk (fat and proteins) are similar to the one which other authors[1,8,18] have achieved by using similar additives with buffering activity. Šamanc *et al.*[24] have found that average daily milk production (corrected on 3.9% milk fat) was for 11.19% higher in the experimental compared to control group of cows. This, as well as findings in our trial, can lead to the conclusion that addition of 1% of buffering mineral mixture provides optimal conditions for rumen microflora activity and as result of that increased the average daily amount of milk, as well as milk fat and proteins could be expected.

Based on the results obtained in this trial we have drawn the following conclusions:

Average values of rumen fluid pH in 20% of cows, embraced by the trail, in early lactation, were below the physiological minimum, thus these animals were in sub acute acidosis.

Planned feeding of cows at the beginning of lactation and the use of buffers should be preceded by a transitional period in which digestive organs and rumen microflora could adapt to large amounts of concentrated feed.

Use of concentrated feed supplemented with buffering mineral mixture for a longer period (over 90 days), has significantly positive effects on increased milk fat and protein content.

Acknowledgement

This work was supported by Grant No. 6807b from The Ministry of Science and Technology of Serbia.

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