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THE INFLUENCE OF MINERAL MIXTURE WITH BUFFERING ACTIVITY ON MILK PRODUCTION, METABOLIC PROFILE AND RUMEN FLUID PARAMETERS IN COWS

Milan Adamović[1], Jovan Lemić[1], Milovan Jovičin[2], Goran Grubić[3], Ognjen Adamović[3], Bojan Stojanović[3], Mihailo Radivojević[4],

[1]Institute for Technology of Nuclear and other Mineral Raw Materials 11000 Belgrade,
[2]Scientific Institute for Veterinary Medicine "Novi Sad", Rumenački put 20, 21000 Novi Sad
[3]Faculty of Agriculture, Nemanjina 6, 11080 Zemun,
[4]Institute PKB Agroekonomik, 11213 Padinska Skela, Serbia

Summary. The experiment was conducted on two groups of Holstein cows (C – control and E – experimental). Both groups received diets based on lucerne hay, maize silage, concentrate (18% crude protein) and extruded soybeans. The mineral mixture with buffering activity (based on magnesium oxide, sodium bicarbonate, bentonite and organozeolite) was added as 1% in concentrate mixture experimental group. It had a positive influence on 4%FCM production (26.97:27.40 kg/day), milk fat content (3.29:3.58%), protein 2.90:3.03%) and dry solids in milk (11.62:11.99%). The differences were not statistically significant (P>0.05). The investigated mixture had no influence on the metabolic profile in cows and on rumen fermentation. Values for pH in blood, urine and feces were increased in cows on the experimental treatment (P>0.05).

Introduction

The change in pH values of the rumen fluid from optimal values (6.2 to 7) has negative influence on the development of microflora and rumen processes, which has harmful effects on production and composition of milk and in case of longer occurrence may affect health and fertility in cows. The reasons for disorders in rumen acidity are mostly in the intake of too moist and acid feeds, inadequate level of fiber in the diet, high amount of finely ground carbohydrate feeds, too few feedings in a day, which is followed by the lower salivation and as a result the acidity of rumen fluid is increased. In order to maintain the pH value in the rumen the additives are used which have ability to neutralize the increased acidity. Usually these are magnesium oxide, sodium bicarbonate, bentonite, zeolite and others. Magnesium oxide is an alkalizer that increases pH value in proportion of the added amount. Magnesium enhances the adsorption of acetic acid and prevents magnesium deficiency. Sodium bicarbonate induces the increase in feed dry matter intake, keeps the pH stabile in the rumen during the first six hours after intake, which is enabling higher production of milk and milk fat. Jovanović et al. (2002) cite the opinion of some authors that sodium bicarbonate stimulates animals to drink more water, which is diluting the rumen fluid and enables more starch to escape rumen fermentation. As a result the propionic and butyric acid production is slower, and they are usually the reason for acid indigestions in cows. Bentonites and zeolites have other (additional) beneficial effects. In the rumen they successfully adsorb mycotoxins, toxic metals, radionuclides, ammonia, carbon dioxide and methane. They have ability to bind water and to swell, which is increasing the volume of ingesta and helping in its more even passage through digestive tract, better digestion and nutrient utilization (Grubić and Adamović, 2003; Jovanović et al. 2002; Adamović et al. 2003; Magdalena Tomašević-Čanović et al. 2000 and 2003, Eng et al. 2002). The aim of this trial was to investigate the influence of the mineral mixture with buffering activity on the production and composition of milk, metabolic profile in cows, amount and ratio of volatile fatty acids in the rumen, pH values of blood, urine, feces and rumen fluid.

Material and methods

The experiment was done on two groups of 15 Holstein cows kept tied. It lasted 33 days in May and June 2003. Temperature between 12:00 and 16:00 h in the barn was at an average 32.6° C and was between 28 and 38° C. Both groups received diets shown in the Table 1. Cows that produced up to 30 kg milk per day received 1 kg and those above that production 2 kg of extruded soybean grains. Concentrate mixture for both groups was made from: maize and oat meal, sunflower meal (33 %CP), wheat middlings, dicalcium phosphate, chalk, salt and vitamin-mineral premix. In the concentrate for experimental group 1% of mineral mix, with buffering activity, was added. This mix was composed from magnesium oxide, sodium bicarbonate, bentonite and organozeolite (Patent 838/2000). The mix was produced in the Institute for technology of nuclear and other mineral materials in Belgrade.

Table 1. Composition and nutritive value of the diet

Feed, kg	**Control**	**Experiment**
DM feed in DM diet,%		
Lucerne hay	19.1	19.5
Maize silage (33.4% DM)	38.0	38.9
Extruded soybean	6.4	6.2
Concentrate, C 18% CP	36.5	-
Concentrate, E 18% CP	-	35.3
Nutritive parameters		
Dry matter, kg	21.80	21.28
NEL,MJ	150.47	146.78
Crude protein,%	16.78	16.63
Undegradable protein,% of CP	36.06	35.87
Crude fiber,%	18.57	18.70
ADF,%	20.82	21.15
NDF,%	34.03	34.59
Fat,%	3.62	3.57
Ca,%	0.82	0.83
P,%	0.45	0.45
K,%	1.10	1.11
Na,%	0.17	0.20
Mg,%	0.32	0.38
S,%	0.30	0.29

Feed intake in cows was controlled daily. Milk production control was done every ten days. At the same day the samples for milk analyses were collected. At the end of experiment, two hours after the morning feeding the samples were collected from five cows of rumen fluid and blood from jugular vein. The samples of urine were collected at the moment of urinating. In the rumen fluid the following analyses were done: pH and volatile fatty acids, while in blood serum the metabolic profile analyses and pH values were done. In urine and feces the pH value was analyzed. Chemical composition of milk was done with Milkoscan 133 equipment. Volatile fatty acids were analyzed with gas chromatography and metabolic profile analyses were done with standard methods.

Results and discussion

Milk production and composition

The inclusion of the investigated mineral mixture had positive effect on the milk production (Table 2). The increase in 4%FCM production in experimental compared to control treatment was 0.43 kg or 1.59%. The milk fat percent in experimental group was increased by 0.29 percent points. Because of that the production of milk fat was 54 g higher (5.44%) in the experimental group. Also, some increase in protein and dry matter content was observed. The differences were not statistically significant ($P>0.05$). Nikkhan et al. (2001) discovered that addition of zeolite or zeolite/sodium bicarbonate in diets with 66.7% concentrates, there was significant increase of 4%FCM production, by 1.75 or 2.25 kg. The milk fat content was increased by 0.12 or 0.26 percent points. Comparable results considering milk yield and composition, using similar additives were presented by Adamović et al. (2003), Garcia et al. (1992) and Thivierge et al. (1998). The feed conversion ratio for kg 4%FCM in this investigation was lower by 3.70%, which indicates the better nutrient utilization in cows which received investigated mixture.

Table 2. Amount and composition of milk and efficiency of utilization of dry matter

Parameter	**Control**	**Experiment**
4%FCM per cow kg/day	26.97	27.40
Milk fat, %	3.29	3.58
Protein,%	2.90	3.03
Lactose,%	4.73	4.68
Dry matter,%	11.62	11.99
Diet dry matter per kg 4%FCM	0.81	0.78

Volatile fatty acids and pH of the rumen fluid

The amount of acetic acid in the rumen fluid (Table 3) and its ratio with other acids was similar on both treatments. It was typical for the diets used. The pH values for rumen fluid was lower in the experimental group, but within optimal physiological values (P>0.05).

Table 3. Rumen fluid parameters (x± SD)

Parameter	Control	Experiment
pH	6.64 ± 0.15	6.50 ± 0.16
Acetic acid, %	62.31 ± 2.56	61.88 ± 1.51
Other acids, %	37.69 ± 2.57	38.12 ± 1.52
Ratio: acetic/other acids	1.65 ± 0.18	1.62 ± 0.11

Considering that feed digestion has dynamic flow, we can treat the obtained values only as representative for the time when samples were taken. Erdman et al. (1982) discovered that the smallest variation in pH value of rumen fluid (6.2-6.5) occurs within 10 hours after feeding in cows which received sodium bicarbonate (1%) and magnesium oxide (0.8%). The same authors found that in control group of cows, which had not received additives the variation of pH values was much bigger (5.6-6.5). Bergero et al. (1995) found that values for acetic acid were higher 5 hours post feeding compared to 0.5 h post feeding. In the same time pH value was increased from 6.82 to 6.90 and acetic acid from 58 to 61%. Nikkhan et al. (2001) discovered in cows which received zeolite and sodium bicarbonate the increase from 6.16 to 6.46 and from 0.3 to 0.4 pH units in urine. This results show that indicators of rumen activity can be very variable depending on many factors.

Metabolic profile and pH values of blood, urine and feces

Biochemical parameters of blood and pH value of blood, urine and feces (Table 4) were within physiologically normal values and differences between treatments were not significant (P>0.05). Newer investigations show that correlation between buffers, the metabolic profile and physiological acid-base parameters are small (Jovanović et al. 2002). Values for glucose and triglycerides were lower in experimental group which maybe indicates certain changes in energy metabolism. Higher values for blood, urine and feces pH in experimental group compared to control are similar to results published by other authors (Nikkhan et al. 2001). However, they discovered increased level of plasma glucose and concluded that the used additives increased the digestibility of starch. Eng et al. (2002) found that zeolite addition in fattening cattle diets induces higher pH value in rumen fluid by 0.2-0.3 pH units.

Table 4. Biochemical parameters in blood serum and pH of blood, urine and feces (x± SD)

Parameter	Control	Experiment
Glucose, mmol/L	3.28 ± 0.35	2.59 ± 0.27
Total protein, g/L	63.79 ± 3.29	62.12 ± 3.13
Total albumin, g/L	26.44 ± 3.21	21.96 ± 2.72
Globulin, g/L	37.35 ± 4.95	40.16 ± 2.88
Albumin/Globulin	0.72 ± 0.19	0.55 ± 0.09
Urea mmol/L	3.59 ± 0.24	3.55 ± 0.91
Triglycerides, mmol/L	0.40 ± 0.06	0.29 ± 0.01
Calcium, mmol/L	2.75 ± 0.16	2.69 ± 0.11
Phosphorus, mmol/L	1.47 ± 0.06	1.67 ± 0.13
Ca/P	1.57 ± 0.11	1.58 ± 0.15
Blood pH	7.38± 0.04	7.60± 0.00
Urine pH	7.42± 0.44	7.77± 0.14
Feces pH	6.74± 0.44	6.88± 0.26

Conclusion

The mineral mixture with buffering activity based on magnesium oxide, sodium bicarbonate, bentonite and organozeolite had positive influence on milk, milk fat, protein and dry matter production (P>0.05). The addition of the investigated mixture to the concentrate mixture had no bigger effect on acetic acid content and pH in rumen fluid, also on metabolic profile and pH values in blood, urine and feces (P>0.05).

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E-mail: m.adamovic@itnms.ac.yu