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Analysis of the metabolic profile of dairy cows

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Abstract

The metabolic profile is a diagnostic procedure that determines the concentrations of certain biochemical blood parameters to obtain data on the balance of organic and inorganic substances and the functional state of certain organs important in the metabolism of high-milk cows. The goal of the research was to determine, through biochemical parameters, the state of energy metabolism, protein metabolism, and mineral substances, as well as the state of certain organs important of high-milk cows. Research was conducted on the farm "Milošević" in Katun on a group of pregnant heifers 30 days before and 30 days after calving. The number of cows included in this research is 21 cows of high-bred heifers of the Simmental (n=7), Holstein (n=7) breed and their hybrids (n=7), as well as 45 cows of high-milk Simmental (n=15), Holstein (n=15) breed and their hybrids (n=15). After taking blood from the tail vein, laboratory tests of serum, Ca, P, ratio Ca:P, Ca++, Mg, Protein, Albumin, Globulin, Urea, Glycemia were performed and compared with reference values. The obtained data were statistically processed and the mean values, standard deviation, and coefficient of variation were determined. The obtained results indicate that at the time of blood sampling, the animals were energetically stable with mild hypoproteinemia in the whole calf as a result of hypogammaglobulinemia, which can lead to a decrease in milk yield and milk quality in the colostrogenesis phase, disturbances in the immunological status of newborn calves, as well as increased mobilization of Ca from bones.

Key words: metabolism, dairy cows, serum

INTRODUCTION

Genetic predisposition and every liter of milk produced requires greater and greater monitoring of highly milking cows, especially Holstein Friesian breed, in order to preserve the health of the animals and fulfill their genetic potential. The creation of a metabolic profile and its correct interpretation in order to correct the diet is a necessary auxiliary tool used to take care of the health of high-milk cows on farms. Determining the metabolic profile is of particular importance on farms with high milk cows (the number of cows is not a limiting factor because the number of animals that will be included in the metabolic profile is adjusted to the total number of milking cows) where, in order to achieve the highest possible milk production, the metabolism of those animals burdens beyond the ultimate physiological limits, which very often leads to an imbalance between the body's needs for a certain stage of lactation and the intake of nutrients. Then a disturbance of the body's homeostasis occurs and metabolic diseases occur in subclinical and clinical form. What is very important to emphasize is that the creation of a metabolic profile should be a preventive diagnostic tool. In this case, the metabolic profile is important because changes in the composition of the blood can be determined before the clinical symptoms of the disease appear and there is a drop in milk production. When problems arise on the farm, it is already too late because the owner has suffered losses in terms of milk yield, milk quality, losses in higher feeding costs, losses due to treatment of clinical cases of metabolic diseases, death and economic exploitation of animals due to low milk production (Call et al. 1987).

The metabolic profile is a diagnostic procedure that determines the concentrations of certain biochemical blood parameters in order to obtain data on the balance of organic and inorganic substances and the functional state of certain organs important in the metabolism of high-milk cows. It is most often done by after taking blood from the tail vein (rarely v. jugularis). Biochemical analyzes are performed from serum except for glucose, for which it is recommended to use vacutainer with fluoride (prevents erythrocytes from consuming glucose). Glucose can also be separated from the serum, but then the time that elapses between drawing blood from the cows and sedimentation of the serum needs to be shortened. Less commonly, biochemical parameters can be determined from urine, milk, rumen contents and hair (Van Dorland et al. 2009).

The metabolic profile is a group test and it makes sense to perform it only if we work on a large number of animals from one production category. The mean value of a biochemical parameter whose coefficient of variation is not greater than 30% represents the value for that biochemical parameter of an entire production category. The lower the coefficient of variation and the larger the number of animals in the group, the greater the uniformity of the group in terms of a certain biochemical parameter (Ferguson et al. 1993).

The selection of animals for the creation of a metabolic profile should represent the average of that production category of cows in terms of age, milk production in the current and previous lactation. Cows should be clinically healthy and not under hormone or antibiotic therapy. When creating a metabolic profile, our goal is to determine the state of energy metabolism, protein metabolism, and mineral matter as well as the state of certain organs important in the metabolism of high-milk cows through the biochemical parameters we work on. The parameters we most often use in clinical practice are β hydroxy butyric acid, non-esterified fatty acids - NEFA, glucose (parameters of energy status), urea, total proteins, albumins and globulins (parameters of protein status), calcium and phosphorus (parameters of mineral status) and total and direct bilirubin (parameters of the functional state of the liver) (Ferguson et all. 1994). What is important to emphasize is that when feeding cows, we must not lose sight of the fact that the cow is a ruminant and that when preparing the meal we primarily feed the microorganisms of the rumen.

Metabolism in cattle goes through lower fatty acids (butyric, acetic and propionic). Glucose, which is synthesized in the process of gluconeogenesis in the liver from propionic acid, is used primarily in the mammary gland and in the nervous system, while all other organ systems use lower fatty acids for their energy needs. (Kida et al. 1999).

This method of timely diagnosis should recognize the metabolic problem (it is believed that for one clinical case of metabolic disease there are 12 more subclinical problems in different stages of their development) in order to: prevent the appearance of clinical symptoms of the disease (reduce treatment costs, uncertainty regarding treatment), prevent reduction of milk production (profitability of production), prevented a negative impact on reproductive parameters (absence of the first fertile cycle, embryonic death of the fetus), prevented a drop in immunity (immunosuppression), optimized meal costs (surplus of protein in the meal, lack of energy in the meal), used the maximum genetic the individual's potential (optimal meal for a certain phase lactations). It is a well-known fact that for the metabolism of viscoproductive cows, the most critical transition is the dry period of early lactation. One of the characteristics of high pregnancy is a positive energy balance, and this fully applies to the final stage of lactation (Kida et al. 2002). During this period, animals consume a larger amount of energy than what their body really needs, so the excess energy is deposited. This phenomenon is recognized by the increase in the body weight of animals. When the positive energy balance lasts longer, as is the case in low-fertile cows with a long service period, the positive energy balance results in obesity.

Depending on their genetic predisposition and way of feeding, highly pregnant cows achieve smaller or larger changes in body condition. It is desirable that cows deposit sufficient amounts of energy in body fat depots, but not excess fat tissue as an excessive reserve of energy that will be consumed during early lactation. The surplus in energy at the end of lactation and during drying is the main reason for a more pronounced positive energy balance, which results in fattening condition of the animals. In addition, excess energy stored in body depots due to excessive and uncontrolled lipomobilization is one of the main reasons for the appearance of subclinical and clinical disorders of the body (Bertoni et al 2009). The first stage of lactation, which lasts up to three months after calving, is the most critical stage in the production cycle. Namely, with the establishment of lactation, the organism of high-milk cows is burdened to the extreme physiological limits (40-60 percent of the total milk production is produced in the first 120 days of lactation). It is also characteristic for this stage of lactation that cows physiologically consuming a smaller amount of food, so that by the second week of calving, they can consume only 10 to 11 kilograms of dry matter per day. After that, food intake gradually increases and reaches optimal possibilities between the second and third months of lactation (18-21 kilograms of dry matter per day). This practically means that in the first weeks of lactation there is a negative energy balance, because the total energy needs are far greater than can be provided from alimentary sources. Therefore, in the early stage of lactation, the energy balance is negatively correlated with the change in body weight of animals. It has been estimated that a third of the energy that is lost through the secretion of milk in the first month of lactation comes from the body's body reserves. At the same time, it should be borne in mind that after calving, when milk production begins, energy turnover increases by about 100 percent within just a few days (Kessel et al., 2008).

It was found that the total energy turnover of cows in early lactation is 175 MJ, of which an average of 78 MJ is spent on milk components that partly come from glucogenoplastic compounds (Butler et al., 2003). In the period around calving, there are sudden changes in the energy balance, and with the onset of lactation, the energy deficit increases sharply. Cows, especially good milking cows, lose body weight in the first third of lactation due to negative energy balance and increased lipomobilization, which often affects their health. Until a balance is established between the amount of energy entered and the amount of milk produced (from the 8th to the 10th week after calving), the resulting difference is compensated from the organism's body reserves, thanks to compensatory mechanisms, the organism tries to reduce the energy imbalance by the process of mobilizing fat from body depots. Therefore, fats are the most important source of energy, which is necessary and needed to fully express the genetic potential of animals (Carlson et al., 2006). However, at the same time, it represents a great possibility for the disruption of the metabolic balance and the formation of fatty infiltration and degeneration of liver cells. It seems that the genetic predisposition of cows to high milk yield can result in the secretion of milk in unfavorable energetic conditions, at the expense of intensifying the metabolism of other organic compounds, until a diseased state occurs (Šamanc et al., 1996, 2000, 2003).

The goal of the research in this work was to determine the state of energy metabolism, protein metabolism, mineral matter as well as the state of certain organs important in the metabolism of high-milk cows, which affect the assessment of body condition in cows, through the analysis of biochemical parameters.

MATERIAL AND METHODS

Location: Experimental research was conducted on the farm "Milošević" in Katun on a group of cows and pregnant heifers, three weeks before calving.

Animals: This research includes: 66 heads of cows (n=45) and heifers (n=21) of different racial composition. In the herd of heifers there were Holstein breeds (n=7), Simmental breeds (n=7) and crossbreeds of Simmental and Holstein breeds (n=7), aged 17 months.

In the herd of cows there were: Holstein breed (n=15), Simmental breed (n=15) and crossbred Simmental and Holstein breed (n=15), aged 5 years. Cows and heifers were housed in the barn on short beds tied with Grabner chains.

Nutrition: During the experimental period, the animals were treated as one group and fed with the same nutrients, corn silage, alfalfa hay and concentrated feed.

Statistical analysis: After taking blood from the tail vein, laboratory tests of serum, Ca, P, Ca:P ratio, Ca++, Mg, Protein, Albumin, Globulin, Urea, Glycemia, VNVA, OTK were performed and compared with reference values, and in order to determine the energy stability of the examined cows. The obtained data were statistically processed and the mean values, standard deviation and coefficient of variation were determined.

RESULTS AND DISCUSSION

The diversity of the racial composition on the “Milošević” farm complicates the interpretation of metabolic parameters due to risks in homeoretic mechanisms. The animals that were the subject of research at the time of blood sampling were energetically stable. This stability was ensured by nutrients rich in carbohydrates. The obtained test results in high-bred heifers, which are shown in table 1, indicate that in the drying phase, it is necessary to reduce the amount of Ca in the meal in order to prepare the animals more easily and better for the upcoming lactation and the mobilization of Ca from the bones (Grubić and Adamović, 2003).

Table 1. Results of blood analysis in high- bred heifers, three weeks before calving

		Number samples	Ca mmol/l	P mmol/l	Ca:P	Ca^{++} mmol	Mg mmol/l	Proteins g/l	Albumins g/l	Globulins g/l	Urea mmol/l	Glycemia mmol/l
Referential values			2,0-3,0	1,4-2,7	1-1,5:1	1,08-1,60	0,7-1,3	58-81	21-40	29-49	2,0-4,5	3,3-4,2
High pregnant heifers	S	7	2,86	1,82	1,57	1,16	0,92	59,55	40,94*	18,61	3,53	5,03
	H	7	2,73	2,14	1,28	1,17	0,98	43,79	37,16	6,63*	4,27	4,35
	M	7	2,93	2,22	1,32	1,18	0,97	44,79	41,77	3,02*	4,18	4,10
∑		21	2,84	2,06	1,39	1,17	0,96	49,37	39,95	9,42	3,99	4,49
Sd			0,14	0,06	0,03	0,00	0,01	0,71	3,26	2,55	0,06	0,18
$C_{(x)}$			5,00%	2,59%	2,40 %	0,17%	0,73%	1,60%	8,26%	52,90%*	1,51%	4,18%

* *Racial composition, S - Simental, H - Holstein, M - crossbreed Simmental x Holstein*

Also, by analyzing the results from the table, a large percentage of globulin is observed, which can be defined as a consequence of hypogammaglobulinemia, that is, a violation of the immune system. A damaged immune system increases the risk of possible infections due to a reduced number of antibodies. These results primarily warn of the possibility of immunological problems in newborn calves, that is, in cows in the colostral phase, as shown in their works by Nafikov and Beitz (2007).

Table 2. Results of blood analysis in cows three weeks before calving

		Number samples	Ca mmol/l	P mmol/l	Ca:P	Ca^{++} mmol	Mg mmol/l	Proteins g/l	Albumins g/l	Globulins g/l	Urea mmol/l	Glycemia mmol/l
Referential values			2,0-3,0	1,4-2,7	1-1,5:1	1,08-1,60	0,7-1,3	58-81	21-40	29-49	2,0-4,5	3,3-4,2
Cows	S	15	2,96	2,12	1,40	1,34	0,82	56,30	34,25	7,95*	3,08	3,82
	H	15	2,31	1,42	1,63	1,00	0,92	50,04	32,25	14,85	3,32	3,53
	M	15	2,64	1,77	1,51	1,20	0,87	53,17	33,30	20,93	3,20	3,68
∑		45	2,63	1,76	1,50	1,21	0,88	53,16	33,40	14,57	3,21	3,68
Sd			0,46	0,49	0,16	0,10	0,07	4,43	1,34	7,34	3,08	0,18
$C_{(x)}$ (%)			17,46	27,96	10,78	15,84	8,13	8,33	4,03	50,66*	15,52	5,53

* *Racial composition, S - Simental, H - Holstein, M - crossbreed Simmental-Holstein*

The results of blood analysis in high-milk cows in the pre-calving period show, in addition to a high percentage of globulin, a high percentage of urea, calcium and phosphorus. The parameters obtained indicate the possibility of the occurrence of hypocalcemia, which causes the decline of differentiated receptors in the intestines of cows and poor metabolism. Similar results were obtained by Grubić and Adamović in their research (2003). Of the protein fractions, only gammaglobulins showed a tendency to increase compared to the reference values. Similar results were presented by Piccione et al. (2011) in their research. By using the indicators shown in tables 2 and 3, related to the evaluation of the metabolic status of high-pregnant heifers and cows, they should be used when assessing whether cattle production is economical enough, which was also shown in their works by a large number of scientific workers (Reist et al. , 2002; Kida, 2003; Kirovski et al., 2010).

CONCLUSION

The groups of examined cows, S, H, M, showed an average level of calcium in the blood (2.63±0.48 mmol/L). No statistically significant differences were found between the groups. The groups of examined cows, S, H, M, showed an average level of phosphorus in the blood (1.76±0.49 mmol/L). No statistically significant differences were found between the groups. The groups of examined heifers, S, H, M, showed an average level of calcium in the blood (2.84±0.14 mmol/L). No statistically significant differences were found between the groups. The groups of examined heifers, S, H, M, showed an average level of phosphorus in the blood (2.06±0.06 mmol/L). No statistically significant differences were found between the groups. The groups of examined cows, S, H, M, showed an average blood glucose level (2.68±0.18 mmol/L). No statistically significant differences were found between the groups. The groups of examined cows, S, H, M, showed an average level of globulin in the blood (14.57±7.34 mmol/L). The analysis revealed a statistically significant difference between the groups. The first group S showed a low globulin level compared to groups H and M and significant deviations from the reference values. The groups of examined heifers, S, H, M, showed an average blood glucose level (4.49±0.18 mmol/L). No statistically significant differences were found between the groups. The groups of examined cows, S, H, M, showed an average level of globulin in the blood (9.42±2.55 mmol/L). The analysis revealed a statistically significant difference between the groups. The first group S showed a higher globulin level compared to groups H and M and significant deviations from the reference values. The obtained results show that the groups of examined cows, S, H, M, are at a low level of energy stability, which indicates problems in the way of feeding and hints at reduced milk production. The obtained results show that the groups of examined heifers, S, H, M, are not at the medium level of energy stability, which indicates problems in the way of feeding and hints at reduced milk production, while reduced albumin and globulin values will significantly affect the protein level in milk, which will be at the disposal of the calves. Based on the conducted analysis, it can be concluded that it is necessary to monitor the metabolic state of animals in order to achieve better results.

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