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DIAGNOSTICS OF METABOLIC DISORDERS IN THE COWS' ORGANISM BY BASIC BIOCHEMICAL BLOOD MARKERS: EVIDENCE FROM FP 'MRIIA' (RIVNE DISTRICT, RIVNE REGION, UKRAINE)

Sachuk R. M.

Research Epizootology Station of the Institute of Veterinary Medicine of the National Academy of Agrarian Sciences of Ukraine, Rivne, Ukraine, e-mail: sachuk.08@ukr.net

Summary. The purpose of the research was to determine the characteristics of metabolic disorders in dairy cows in the dry periods, calving, and after calving periods in FG 'Mriia' in Rivne district of Rivne region. Researches were conducted in FG 'Mriia' v. Velyka Omeliana of Rivne district, Rivne region on cows of Ukrainian black-rumped dairy breed. The presence of metabolic changes in the cows in dry period (n = 6), post-partum cows (n = 8), and cows 10 days after calving (n = 8) were determined by biochemical parameters (markers) in blood serum samples, which were tested by conventional biochemical methods using the 'Cobas c 311' analyzer, and the content of inorganic elements was determined using the 'C-115M1' atomic absorption spectrophotometer. According to the results of obstetric examination of sick animals, carried out in the dry season, such diseases as ketosis (8.9%), fatty liver syndrome (6.7%), and udder edema (5.6%) were determined. In cows, the level of ketone bodies was 2.0 ± 0.04 mmol/l. 75.0% of animals diagnosed with ketosis in the dry period were prone to develop other diseases such as ovarian cysts and postpartum endometritis. Idiopathic diseases averaged 12.2%. Among the concomitant pathologies, the detention of litter was detected — 32.2%. 25 cases (27.8%) of post-partum paresis were recorded out of 90 cows examined. The following metabolic disorders have been established by biochemical markers in animals of the respective groups, namely: in cows in the dry period — a decrease of the total protein level along with its globulin fraction, the decrease of glucose content relative to the reference values of these indicators; in cows in the calving group on the background of changes in the proteinogram — a decrease in total cholesterol was determined; and in cows 10 days after calving — a decrease in the content of albumin relative to the reference values of these indicators was determined. As a result of determining the content of inorganic elements, it has been established: in the cows in dry period group — lack of zinc, copper, manganese, selenium, iodine, and cobalt and excess of iron and nickel; in the group of calving cows — there is a lack of zinc, copper, selenium, and iodine and excess of iron; in the group of cows 10 days after calving — lack of zinc, manganese, selenium, and cobalt. The data obtained can be interpreted to diagnose metabolic disorders in other farms and to perform corrective measures

Keywords: metabolic disorders, diagnostics, cows, serum, biochemical markers, inorganic elements

Introduction. Metabolic diseases in cattle in modern conditions of animal husbandry occupy one of the dominant places in the structure of non-contagious pathology (Alekhin, 2011; Kovalenko et al., 2015; Urazaev et al., 1990). The detection of metabolic disorders, especially in highly efficient cows, will provide the basis for the creation of new means for increasing the general resistance of animals, the prevention and treatment of metabolic diseases, as well as current schemes of their application in the context of industrial livestock management (Sakhniuk, 2008; Bezukh, Chub and Nadtochii, 2011).

Laboratory markers of metabolic disorders in cows comprise a small number of biochemical parameters, which include the determination of various parameters reflecting the state of protein, carbohydrate, lipid and mineral metabolism, as well as the activity of some key serum enzymes. Evaluation of the results of biochemical blood testing, especially in the dynamics — in the process of disease development, has great diagnostic and prognostic value in many acute and chronic diseases of the internal organs.

The purpose of the research was to determine the characteristics of metabolic disorders in dairy cows in the dry periods, calving, and after calving periods in FG 'Mriia' in Rivne district of Rivne region.

Materials and methods. Researches were conducted in FG 'Mriia' (v. Velyka Omeliana of Rivne district, Rivne region) in cows of Ukrainian black-rumped dairy breed, aged 4–6 years, live weight 470–500 kg, productivity of 4,700–5,500 kg of milk per lactation, which were kept in the stall-pasture system.

Clinical examination of cattle (examination, thermometry, palpation) was performed by conventional methods (Levchenko et al., 2012).

The presence of metabolic changes in the body of cows in dry period (n = 6), post-partum cows (n = 8), and cows 10 days after calving (n = 8) were determined by

biochemical parameters (markers) in blood serum samples, which were tested by conventional biochemical methods (Pokrovskiy, 1969; Antonov, Fedotova and Sukhaya, 1989) using the biochemical analyzer 'Cobas c 311' (Roche Diagnostics, Switzerland) and the content of inorganic elements was determined using the atomic absorption spectrophotometer 'C-115M1' in the Laboratory of Experimental and Analytical Methods of the Research Epizootology Station of the Institute of Veterinary Medicine of the National Academy of Agrarian Sciences of Ukraine (Rivne, Ukraine).

Statistical processing of the results was performed by variation statistics using Statistica 6.0 (StatSoft, USA). Nonparametric research methods were used (Wilcoxon-Mann-Whitney test). The arithmetic mean (x), standard error of the mean (SE) was determined. The difference between the two averages was considered statistically significant when: * — $p < 0.05$, ** — $p < 0.01$, *** — $p < 0.001$.

Results and discussion. According to the results of obstetric examination of sick animals, carried out in the dry season, such diseases as ketosis (8.9%), fatty liver syndrome (6.7%), and udder edema (5.6%) were established. In cows, the level of ketone bodies was 2.0 ± 0.04 mmol/l. 75.0% of animals diagnosed with ketosis in the dry period were prone to develop other diseases such as ovarian cysts and postpartum endometritis. Idiopathic diseases averaged 12.2%. Among the concomitant pathologies, the detention of litter was detected — 32.2%. 25 cases (27.8%) of post-partum paresis were recorded out of 90 cows examined. During the analysis of clinical symptoms of post-partum paresis it was determined that cows had decreased appetite, reduced acts of urination and defecation; cows became weak, sluggish, disorders of movement coordination were observed, the body temperature was decreased (n = 15) within 35.4 ± 1.01 to 37.6 ± 1.13°C.

The analysis of the results of primary biochemical studies of cattle blood revealed that in the serum of cows in all physiological groups, the values of protein, hydrocarbon and fat metabolism, namely total protein, albumin, glucose, and total cholesterol were lower relative to the average levels (Motuzko, Nikitin and Gusakov, 2008). In the body of cows, the content of total globulins was reduced by 16.6% during the dry period. A similar trend is observed with the content of vitamin A, total calcium, and inorganic phosphorus.

In cows, on the 10th day after calving, the albumin content was reduced by 18.8% ($p < 0.01$) relative to the lower reference level. In addition, in post-partum cows, a decrease in the content of one of the most sensitive markers — total cholesterol by 13.5% ($p < 0.05$), and glucose content by 26.4% ($p < 0.05$) relative to the lower reference level (Table 1).

Table 1 — Biochemical parameters of blood of cows with different physiological state (M ± m)

Biochemical parameters	Serum of animals of different physiological groups			Reference level, adult animals (Motuzko, Nikitin and Gusakov, 2008)
	cows in dry period (n = 6)	cows after calving (n = 8)	cows 10 days after calving (n = 8)	
Indicators of protein metabolism				
Total protein, g/l	58.49 ± 1.53	67.28 ± 2.2*	68.19 ± 0.96	72.0–86.0
Albumin, g/l	37.70 ± 0.7	29.66 ± 0.59**	22.51 ± 0.92	27.5–39.4
Total globulins, g/l	24.14 ± 1.63	39.25 ± 2.51	46.29 ± 0.75	28.9–48.6
Urea, mmol/l	4.60 ± 0.42	5.34 ± 0.18	4.96 ± 0.26	3.5–6.0
Creatinine, μmol/l	99.65 ± 5.80	111.38 ± 4.07	121.86 ± 4.09	80.0–130.0
Carbohydrate metabolism rate				
Glucose, mmol/l	2.15 ± 0.09	1.84 ± 0.06*	2.71 ± 0.12	2.5–3.5
The index of fat metabolism				
Total cholesterol, mmol/l	3.22 ± 0.31	1.99 ± 0.07*	2.50 ± 0.08	2.3–4.5
The activity of hepatospecific enzymes				
ALT, mmol/h×l	0.55 ± 0.018	1.13 ± 0.019	1.21 ± 0.11	0.6–1.8
AST, mmol/h×l	1.73 ± 0.24	2.36 ± 0.16	2.41 ± 0.08	0.6–3.0
Indicators of vitamins and macronutrients				
Vitamin A, μg%	13.53 ± 1.14***	10.63 ± 0.93**	20.56 ± 0.36	Not less 25
Vitamin E, μg/ml	3.56 ± 0.19	2.81 ± 0.1*	5.0 ± 0.24	4.0–6.0
Total calcium, mmol/l	1.92 ± 0.03***	2.06 ± 0.07	2.76 ± 0.16	2.25–3.0
Inorganic phosphorus, mmol/l	1.32 ± 0.08	1.3 ± 0.13	1.03 ± 0.06	1.45–2.10
The ratio, Ca:P_n	1.8 ± 0.06**	2.71 ± 0.07	0.66 ± 0.09	1.43–1.55

Notes: * — $p < 0.05$; ** — $p < 0.01$; ** — $p < 0.001$ relative to the lower reference level.

According to the results of studies of inorganic elements in blood sera it has been established:

— in the group of cows in dry period — lack of zinc (7.8%), copper (18.6%), manganese (11.8%), selenium (50.9%), iodine (33.9%), and cobalt (26.8%) relative to the lower reference level and excess of iron (1.8 times) and nickel (0.9%) relative to the upper reference level. Due to the low content of total calcium, inorganic phosphorus, manganese cows are at high risk of postpartum paresis. The low content of total calcium, copper, iodine, and selenium poses risks of delayed litter and low content of cobalt — the risk of ketosis. Deficiency of total calcium, inorganic phosphorus, manganese, selenium, vitamins A and E during the dry season results in abortions and stillbirths;

— in the post-partum group, there was a shortage of zinc (4.95%), copper (3.3%), selenium (36.7%), and iodine (39.7%) relative to the lower reference level and excess of iron (1.8 times) relative to the upper reference level. In this physiological period, the lack of zinc, copper, selenium, vitamins A and E is one of the reasons for the decrease in the humoral level of the immune system, which creates a basis for the activation of conditionally pathogenic microflora and the development of postpartum sepsis;

— lack of zinc (12.4%), manganese (6.0%), selenium (29.2%), and cobalt (27.6%) in cows 10 days after calving is one of the reasons of delayed heat period and low fertility, followed by early embryonic mortality (Table 2).

As a result of the conducted studies and in accordance to 'Nutrient Requirements of Dairy Cattle' (NRC, 2001), the farm was recommended:

— to investigate the nutritional value of all feed used in cattle feeding to eliminate dietary imbalances, especially in protein, carbohydrate, lipid and mineral constituents;

— for correction of the lack of microelements in animals, it is necessary to enter in the rations of cattle preparations of zinc (zinc sulfate 60–70 mg/animal/day) for 7–14 days (further diet of animals should contain zinc in the amount of 30.0 mg/kg of dry matter) and manganese (manganese sulfate or chloride) at the rate of 40.0 mg of the element per 1 kg of dry matter; selenium preparations (the content of the element should be 0.1–0.3 mg/kg of dry matter);

— to introduce into the diet (or inject) vitamins A and E in therapeutic doses according to the instructions for use. A detailed correction of cattle mineral nutrition can also be achieved by introducing a blend containing the above trace elements, after examining their actual content in the diet;

— to examine the feed (especially mineral supplements) and water for their content to detect the source of the excess of iron;

— for timely identification of problematic points in the state of metabolism in the body of cattle, periodically (in spring and autumn) to examine blood samples from all age groups of animals (especially calves up to the age of 1 month, heifers, before first fertilization, cows, before changing conditions of keeping) content of glucose, total cholesterol, total protein, albumin, urea, creatinine, activity of indicator hepatospecific enzymes, content of vitamins A and E, content of inorganic elements.

Table 2 — Content of microelements in serum of cows in different physiological groups (M ± m)

Element	Different physiological groups			Reference level, adult animals (Motuzko, Nikitin and Gusakov, 2008)
	Cows in dry period (n = 6)	Cows after calving (n = 8)	Cows 10 days after calving (n = 8)	
Zinc, μg%	92.18 ± 0.88	95.06 ± 1.44	87.63 ± 1.24	100.00–220.0
Copper, μg%	65.13 ± 1.28	77.33 ± 1.15	114.16 ± 2.1	80.00–120.00
Iron, μg%	385.35 ± 11.41	200.41 ± 3.33	194.15 ± 16.15	85.00–210.00
Manganese, μg%	3.53 ± 0.19	4.16 ± 0.21	3.76 ± 0.09	4.00–6.00
Selenium, μg%	3.68 ± 0.38	4.75 ± 0.12	5.31 ± 0.21	7.50–10.00
Lead, μg%	Not found	Not found	Not found	–
Nickel, μg%	5.45 ± 0.068	5.15 ± 0.14	4.76 ± 0.19	2.80–5.40
Iodine, nmol/l	198.3 ± 0.11	181.1 ± 3.21	309.25 ± 2.66	300–500
Cobalt, μg%	1.83 ± 0.037	2.4 ± 0.009	1.81 ± 0.16	2.50–5.00

Conclusions. 1. The following metabolic disorders have been established by biochemical markers in animals of the respective groups, namely: in cows in the dry period — the decrease of the total protein level along with its globulin fraction, the decrease of glucose content relative to the reference values of these indicators; of cows in the calving group on the background of changes in the proteinogram — a decrease in total cholesterol was determined; and in cows 10 days after calving — a decrease in the content of albumin relative to the reference values of these indicators was determined.

2. According to the results of determination of the content of inorganic elements, it is established that in the body of cattle there is: in the group of dry cows — lack of zinc, copper, manganese, selenium, iodine, and cobalt and excess of iron and nickel; in the group of calving cows,

there is a lack of zinc, copper, selenium, and iodine and excess of iron; in the group of cows 10 days after calving — lack of zinc, manganese, selenium, and cobalt.

3. The data obtained can be interpreted to diagnose metabolic disorders in other farms and to take corrective action.

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