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Study of changes in total proteins, hemoglobin, oxygen capacity (O_2CT) and total carbon dioxide (TCO_2) in cows of different motor activity and physiological condition

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Abstract

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The purpose of this study is to monitor changes in total protein, hemoglobin and oxygen capacity (O_2CT), and total carbon dioxide (TCO_2) levels in free-range cows during their dry period and depending on the degree of their phisical activity, and physiological state. The study was conducted with three groups of cows from the breed Bulgarian Black and White cattle.

Animals from the control group were kept free-ranged in indoor building sand were fed inside the building. They were also given access to a yard for a walk. Animals from the first experimental group were grown in the same way with an additional daily 2 km walk, and those from the second experimental group - under the same conditions with an additional daily walk of 4 km. All groups were grown in the same building. Blood samples were taken in dynamics form 5 cows from each group: - on their dry period, 7-5 days before calving and 5-7 days after calving. Blood samples were taken from the same animals during the different periods.

It was found that the total protein increased with pregnancy and it slightly decreased before birth. Excessive physical exercise (over 4 km) kept the protein synthesis. Hemoglobinleves also increased with pregnancy until the time of delivery, and then slightly decreased. Moderate physical exercise (up to 2 km) stimulated hematopoiesis. The level of total carbon dioxide in the blood remains in its physiological range regardless of the physiological state of the cows and their physical exercise. Oxygen capacity of the blood in animals with moderate exercise is increased with pregnancy and postpartum.

Key words: cows; physical activity; total protein; hemoglobin; oxygen capacity; total CO_2

Introduction

Blood is one of the most important systems of the animal organism. It performs an intimate, mediating role between different tissues and organs and reflects all changes, both physiological and pathological (Moscovina et al, 2011; Shaposhnikova, 2009). With extreme physiological stress, such as lactation and pregnancy, changes in blood are almost pathological. According to Naneashev et al (2008) this is an obstacle for gathering accurate conclusions.

The lactation period of cows corresponds with different stages of fetal development. The lactation and development of the fetus overloads all organs and systems, making animals susceptible to any change in diet, breeding, and exploitation. All of this causes changes in the metabolism and immunological resistance of the animals, meaning - disorders of the mechanisms ensuring the homeostatic equilibrium of

the "mother-fetus" system (Gergovska et al., 2001; Danilov, 2010, Yudin, 2001, Safonov et al., 2008). The major cause of impaired metabolism of proteins, fats, carbohydrates and minerals is the change in the alkaline-acid balance of the body, which may cause more or less serious illnesses (Jean-Luc Riond, 2001).

The importance of active movement for industrially grown animals is generally known. Forced movement, however, further exhaust the cow's organism, which leads to changes in the gas exchange. According to Petritza (1974), the ventilation of the lung depends on the speed of movement, the most sensitive changes occur in the first 30 minutes of the active load. Increased ventilation of the lung in physical exercise is mainly due to the higher frequency of respiratory movements, which are about 23-25% deeper than those in a calm state.

Taking all this into account, we have set ourselves the goal of monitoring the changes in total protein, hemoglobin and oxygen capacity (O_2CT), and total carbon dioxide (TCO_2) levels in free-range cows during their dry period and depending on the degree of their phisical activity, and physiological state.

Materials and Methods

For the purpose of this study we monitored three groups of cows of the breed Bulgarian Black-Whait Cattle. Animals from the control group were kept free-ranged in indoor buildings and were fed inside the building. They were also given access to a yard for a walk. Animals from the first experimental group were grown in the same way with an additional daily 2 km walk, and those from the second experimental group -under the same conditions with an additional daily walk of 4 km. All groups were grown in the same building.

The active movement was organized in a special built-in circular track with maximum speed of 2-3 km/h. The feeding of all groups of cows was the same, both during lactation and during the dry period. The dry period coincided with the spring-summer season, and calving coincided with autumn season. The trial included animals with a dry period of no more than 70 and no less than 50 days.

Blood samples were taken in dynamics form 5 cows from each group: - on their dry period, 7-5 days before calving and 5-7 days after calving. Blood samples were taken from the same animals during the different periods. Hemoglobin (Hb) was determined by the cyanomethohemoglobin method, the common protein was determined using tests form the company Boehringer and blood sugar was determined by the orthotholoid method (Angelov et al., 1998). The blood was taken by puncture of V. jugularis in the morning, before feeding. For the monitoring of oxygen capacity and total carbon dioxide we used an Astrup -ABL-3 (Radiometer) apparatus.

The results were statistically processed with the Statistica for Windows (1994) program.

Results and Discussion

Proteins in the mother's organism are used not only for building material, but also for the conception and formation of all organs and systems of the fetus, as well as in its feeding and breathing (Vasilenko et al, 2011).

The results of our experiment show (Table 1) that the common protein in blood serum, at the end of the lactation period, in the control and in the second experimental group exceeds the acceptable reference values (Angelov et al., 1998). Vassilenko et al. (2011) and Semerunchik (2013) suggest that the progression of pregnancy, the accelerated vital processes of the body and the processes in the mammary gland are the cause for an increased protein and overall metabolism. The calving time of our cows has lowered the protein level by about 12-14 g/l in the control and by about 30 g/l in the second test group. This state was maintained during the first days after birth in the two groups with different physical activity, while in the control group the total protein increased during the same period. Chilov et al. (1959) believe that this increase is a result of the increased synthesis of globulins. Therefore, we assume that the additional physical activity negatively affects the synthesis of common proteins, including globules.

Blood proteins maintain the persistence of pH in the blood (buffer substances) as well as the level of cations by the formation of non-diffusible compounds (Chilov et al., 1959). Into

Table 1. Level of total protein depending on the mode of movement of the Black-and-White type cows(g/L)

Groups	Number of animals n	Physiological periods			
		Drying (7 months pregnant) x ± Sx	8 months pregnancy x ± Sx	5-7 days before calving x±Sx	5-7 days after calving x±Sx
Control group	5	90.8±2.2	86.5±4..0	77.9±2.2	82.8±3.6
Group I	5	86.8±4.0	94.3±4.1	82.5±5.4	78.2±1.7
Group II	5	113.6±4.1	96.4±3.8	83.6±4.7	80.2±4.9

Table 2. Hemoglobin level in Black-and-White type cows depending on the mode of movement and their physiological state (g L)

Groups	Number of animals n	Physiological periods			
		Drying (7 months pregnant) x±Sx	8 months pregnancy x ± Sx	5-7 days before calving x±Sx	5-7 days after calving x±Sx
Control group	5	139.6±2.3	144.8±1.6	150.2±4.8	141.0±5.5
Group I	5	140.2±5.7	152.3±9.2	156.2±5.8	146.2±3.5
Group II	5	133.0±4.3	143.2±4.8	148.6±10.4	143.0±6.4

the venous portion of the capillaries, sodium is released from the sodium salts of the proteins to bind with the cellular acid metabolites, especially carbonic acid, and in the capillaries of the lungs, sodium is again combined with the proteins.

The total protein level increased with pregnancy and it slightly decreased before birth (Table 2). The ongoing active metabolism carried out in the mother and in the fetus, is accompanied by the release of all toxic products from the metabolism. The amount of these products increases in parallel with the physical activity, which in its turn leads to an increase in lung ventilation, respiratory rate, pulse rate (Petritza, 1974), erythrocyte count and hemoglobin content. The increase in physical activity in the second group of animals (with a walk of up to 4 km) does not lead to an increase in Hb, on the contrary, its content slightly decreases. We and Nachev et al. (1963) assume that this is due to the increased erythrocyte biconcavity (increase in their active surface). In the event of forced short-term or prolonged muscular activity the available reserves are released from the blood depots and not only the erythrocytes and Hb increase, but also the volume of the circulating blood.

As pregnancy progresses, the hemoglobin content increases and, in parallel, the total amount of oxygen in the blood, presented as dissolved oxygen and as oxyhemoglobin, also increases (Table 3). After birth the oxygen capacity in the control group gradually returned to the baseline of non-pregnant animals. In the case of animals with physical activity, the oxygen capacity increases even after birth, especially in animals with a daily walk of 2 km. However, the excessive increase in animal activity reduces the absorption of oxygen and reduces its capacity (Petritza, 1974). According to the same author, the maximum ventilation of the lung and the absorption of oxygen occur not at the end of the physical activity, but after 30 - 60 minutes from its beginning.

Physical activity leads to the exchange of K, PO_4 and Ca from the muscles to the blood and connective tissue, and exchange of Na and Cl from the blood to the muscles. The loss of K from the tired muscle hinders the glycogen resynthesis and restricts the muscle from supply material use for energy (Chilov et al., 1959). Therefore, the problem of muscle fatigue should not be accepted as a disrupted general nutrient exchange but as a result of disrupted mineral exchange.

Table 3. Level of O_2CT (oxygen capacity) depending on the mode of movement of Black-and-White type cows(mmol/L)

Groups	Number of animals n	Physiological periods			
		Drying (7 months pregnant) x±Sx	8 months pregnancy x ± Sx	5-7 days before calving x±Sx	5-7 days after calving x±Sx
Control group	5	9.04±0.67	11.42±0.68	15.10±0.56	12.10±0.99
Group I	5		12.03±1.44	13.62±0.66	14.68±0.86
Group II	5		11.48±0.78	12.77±1.34	12.27±0.66

Table 4. Level of TCO_2 (Total CO_2) depending on the mode of movement and physiological state in Black-and-White type cows (mmol/L)

Groups	Number of animals n	Physiological periods			
		Drying (7 months pregnant) x±Sx	8 months pregnancy x ± Sx	5-7 days before calving x±Sx	5-7 days after calving x±Sx
Control group	5	27.71±0.46	30.16±1.20	27.12±1.14	29.63±0.82
Group I	5		27.30±1.33	30.76±0.32	30.04±1.59
Group II	5		30.86±1.27	27.47±1.18	30.30±0.85

Animals from the test and control groups, with different physiological status and physical activity, retained the level of total carbon dioxide within the range of the physiological rate (Table 4).

Conclusions

The total protein level increases with pregnancy and it slightly decreases before birth. Excessive physical activity (over 4 km) keeps protein synthesis.

Hemoglobin level increases with pregnancy and it slightly decreases after birth. Moderate physical activity (up to 2 km) stimulates hematopoiesis.

The level of total carbon dioxide in the blood remains in its physiological range regardless of the physiological state of the cows and their physical activity.

Oxygen capacity of the blood in animals with moderate activity increases with pregnancy and postpartum.

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