Dynamics of Selected Haematological and Biochemical Parameters in Blood of Calves in Relation to Environmental Conditions

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Abstract
The health status of calves is very important for the future production of meat and dairy cattle. The aim of this thesis is to evaluate the dynamics of selected hematologic and biochemical parameters in blood plasma of calves reared in different environmental conditions.
Totally 120 blood samples of calves in age of 1 to 124 days were collected. The animals came from three different breeds with different ways of rearing. The total blood parameters tested in all observed groups were in the normal range.
Dynamics of selected hematologic and biochemical parameters in blood plasma of calves in all groups were relatively similar. It is evident that the calves, while preserving the basic animal hygiene conditions of livestock, can cope with the effects of different technologies of rearing and environmental conditions.

Keywords blood parameters, calves, dynamics, environmental conditions

1. Introduction

The count of white blood cells is different by species and varies under the influence of physiological changes. The leukocytosis occurs during stress, physical strain and inflammatory processes. Leucopenia occurs by the damage during the mitotic dividing of cells, by the exposure to toxins or lack of substances important for hematopoiesis (e.g. vitamin B12) [1]. Their concentration in cattle is 6.0 to 10.0 x 10⁹/l [2].
Erythrocytes contain 60% water, 40% is red blood pigment–hemoglobin composed of globin proteins and coloured non-protein component containing divalent iron, called hem. The hemoglobin binds oxygen in the lungs and thus oxyhemoglobin is formed [3]. In tissues oxygen is transmitted to cells and oxyhemoglobin is reduced back to hemoglobin. Physiological values of hemoglobin in cattle are 90-140 g/l⁻¹ [2, 4]. Haematocrit value specifies the ratio of the volume of red blood cells to total blood volume [1].
Haematocrit values of domestic animals move in cattle around 0.38% [4]. Blood glucose level differs in various animal species [1]. The range of values for cow is 2.2 to 4.4 mmol.l⁻¹, for calf 4.4 to 6.6 mmol.l⁻¹ [5]. In calves blood glucose depends significantly on age. It is low at birth, increases after receiving colostrum with culminating the 14th to 21st day and then stabilizes gradually with the development of fore stomach at the age 2-3 months [6].
Urea is the most important final product of protein metabolism. Its synthesis takes place in the liver. Urea of blood plasma is a very good indicator of

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the uptake and metabolism of nitrogen. The concentration of urea in blood serum determines several factors (nutrition, physiological status, age etc. [7]. In all species of animals the urea concentration of urea depends on food intake of proteins. Decreased levels may also occur in severe liver diseases, starvation of animals or kidney diseases. Increased levels are found when food intake is rich in proteins, while increased protein breakdown (e.g. in feverish conditions, trauma, bleeding or when dehydrated), furthermore, they manifest kidney diseases or damage of the urinary tract [8].

Physiological level of urea in blood plasma of cattle ranges from 1.66 to 4.00 mmol.l⁻¹ [5], according to other authors between 3.0 and 5.0 mmol.l⁻¹ [2].

Alkaline phosphatase is an enzyme that is found in almost all organs and tissues [8]. Average values are 0.3-5 μkat.l⁻¹ [1]. Increased values are a sign of liver damage or disease [8]. The average normal range is 0.1 to 0.6 μkat.l⁻¹ [1] 0.2 to 0.5 μkat.l⁻¹ [2].

Cholesterol is present in the organism as free cholesterol (30-40%) and then in the form of fatty acid esters (60-70%). The sum of both is called a total cholesterol. It is related to blood proteins and probably also calcium and magnesium [9]. Normal physiological level of cholesterol in the blood plasma in cattle is reported to be between 2.6 to 4.6 mmol.l⁻¹ [8], sometimes between 2.6 to 5.2 mmol.l⁻¹ [2].

In the overall quantity of plasma proteins are more than 100 individual proteins which can be divided into albumins and globulins. Globulins constitute 40% of plasma proteins, they are the basic building components of lipoproteins, proteins, binding of components, enzymes and enzyme inhibitors. Albumin is the most involved in osmotic pressure in the transport of thyroxine, fatty acids, bilirubin and medicaments [1]. Physiological value is reported in the range of 65 to 75 g.l⁻¹ [8].

Lipids are carriers of electrons, of substrates in enzymatic reactions; they are components of biological membranes. They serve directly as an energy source, but also potentially in the form of stored fat deposited in the body. The total lipid content in the blood plasma depends on the age of animal, on the composition of the feed ration, on working or production activity. The increase of lipids occurs when a lack of energy and by mobilization of stored fat [1].

In blood, zinc is contained in blood plasma, in erythrocytes, leukocytes and thrombocytes. Concentration of zinc in blood and plasma reacts to the changes in the content of zinc in food intake. It is primarily part of some enzymes and other enzymes are activated by zinc. Zinc positively affects via enzymes the growth, development, bone formation, blood, fertility, transformation of proteins and saccharides [4]. Natural physiological level of zinc in cattle is 12.2 to 26.0 μmol.l⁻¹ [3, 10].

Copper is an essential element for formation of pigments, elastin or collagen, it influences bone metabolism, reproductive functions, haematopoiesis, keratinization of hair and nervous system activity. It is part and activator of many enzymes and metalloproteins. Concentration of copper in the blood plasma of cattle is between 12-16 μmol.l⁻¹ [1], 12.6 and 18.9 μmol.l⁻¹ [2].

Phosphorus is contained in plasma in both organic and inorganic form. In ruminants, phosphorus is necessary for the fermentation processes in the stomach. It is an important growth factor of rumen bacteria, because it is essential for the formation of microbial enzymes, TMK, microbial protein and vitamins of B group [1, 3]. The average values of phosphorus are from 1.60 to 2.26 mmol.l⁻¹ [2].

Calcium enables contractility of smooth, striated and cardiac muscle. It keeps muscle tonus and activates phosphorylation enzymes that ensure energy conversion in muscle fibers. In blood, calcium is contained in blood plasma and it is also an activator of blood coagulation [8]. Its concentration in plasma in a mammal is of 2.25-3 mmol.l⁻¹ [1, 2].

The magnesium concentration in blood plasma depends on the intake of magnesium in food and on the level of resorption [1, 9]. Magnesium is essential for bone formation, acts as a synergist of calcium and an antagonist of phosphorus. On the contrary in the process of blood coagulation magnesium has the opposite function than calcium. Concentration of magnesium in blood plasma is from 0.9 to 1.2 mmol.l⁻¹ [4], or e.g. 0.80 to 1.07 mmol.l⁻¹ [2].
2. Materials and methods

In the experiment calves from three farms located in the same region were involved. At one of the farms Czech Pied cattle were bred, at the other two farms cows of the Holstein. To a comparison we used only the blood of calves placed in outdoor individual boxes. Calves were transported to open individual boxes in two hours after calving. Feeding with milk mixture in winter was carried out twice a day, in summer three times daily. During the whole day calves had a free access to clean water and to a starter of a good quality. Blood sampling was conducted after the fixation of the animal by an assistant, who also put on a tourniquet to the animal. Responsible staff then took a sample of blood from the jugular vein of calf by a syringe needle into the prepared glass with three drops of heparin. After the blood withdrawal the injection site was disinfected. Totally we collected and analyzed 120 samples in 7 sampling days. Age range of calves was from 1 to 124 days. The sample analyzes were performed in the laboratory of the Faculty of Agriculture in Czech Budejovice, always just the next morning after the withdrawal. For the sample analysis of haematocrit, erythrocytes, leucocytes, glucose, urea, AF, GGT, cholesterol, triglycerides and total proteins we used the hematological and biochemical analyzer from DIALAB Ltd. Praha with the usage of standard sets. For further measurements blood was poured into glass tubes and in a centrifuge blood elements were separated. Blood plasma was aspirated into clean containers and prepared for the analysis of zinc, copper, phosphorus, calcium and magnesium by using an atomic absorption spectrometry [AAS]. The results were processed in MS Excel 2007 and by using a statistical software STATISTICA 7.0 transferred in the charts.

3. Results and discussion

Haematocrit values at the observed groups ranged from 0.21 to 0.34 %, which is a slight decrease in comparison with the data reported in the literature [9; 11]. Decreased content of hemoglobin might be caused by anemia, fluid overload, hemoglobinuria or deficiency of proteins in the feed ration. Decreased haematocrit can be attributed also to the young age of animals. The dynamics of erythrocytes in tested calves was growing until the 10th day and then it was relatively stable. Extreme decline of values in one group of calves with average age of 20 days can be attributed to a current worse feed ration or to a lack of proteins, which corresponds with the findings in calves of other authors [2]. The content of glucose in the blood significantly depended on age. It was low immediately after the birth and increased after the adoption of colostrum, culminating in the 14th to 21st day. In the following days the curve showed lower blood glucose, which may be due to lack of prompt energy in the feed ration or hunger strike [6]. The urea concentration in blood plasma of calves showed considerable variability. Low values in 46th and 57th day could relate with reduced intake of protein (milk). In total, curve slope roughly corresponds to the reference values [2, 5]. According to the curve slope of alkaline phosphatase, we can state that a growth of values was visible from the 20th day of age. Increase of AF occurs in the growing period of calves [8]. Further stabilization of the curve is caused by the transition to plant nutrition. After the birth higher level of GMT was found due to colostrum intake. Later the level declined and stabilized after the 46th day. The cholesterol level in the tested animals was very low in the first measurements. In the next period the values moved in ideal range of reference values [2, 5] and were relatively balanced. Dynamics of total proteins in the monitored calves were relatively balanced. In the first six days of age the values slightly increased, which can be attributed to colostrum intake. The measured values were in accordance with the recommended reference values [8], but at a lower margin. The value of triglycerides was fluctuating in the early days of monitoring, which could be related with the use of energy supplies from body sources of animals. Average values were within the reference range. According to the literature [6] the largest zinc deficiency in calves should occur between 6 and 10 weeks, which our survey data do not confirm. Nevertheless, all measured values were within the range of the natural reference values [2]. The concentration of copper increased gradually in the first days of life of calves, in the next period it was relatively stable. The concentration of
Copper in blood plasma is related with the intake of this element in the feed ration [1]. The copper content in the monitored calves corresponds to reference values [2]. The values of inorganic phosphorus in plasma correspond to the reference values. Decreased level of phosphorus in the 53 days of age of calves related to the termination milk feeding of calves and to the adaptation to plant nutrition.

Dynamics of calcium is rising in the first 10 days and then stable. In the group of calves with an average age of ten days an extremal decrease of calcium level was found at one of the farms, which could be most probably caused by a mistake in giving them milk. Overall, the calcium content in tested calves was at lower limit reference values [1, 2]. This may be justified by a lower content of calcium in the feed ration.

The values of magnesium in the taken samples were relatively balanced and corresponding with reference values [2, 3, 11]. Extreme values increase on 11th day in calves at one of the farms had only a secondary importance and could be caused by higher intake of magnesium in the feed ration, which is also described in the literature [6].

Conclusions

At 120 of calves aged from 1 to 124 days hematological and biochemical profile of blood was observed. Based on the analysis of blood samples taken during the rearing calves in different breeding systems it was found that most of the observed parameters were in the range of reference values given in the work cited authors. Haematocrit values observed in the groups ranged at the lower limit of the recommended values similarly as erythrocytes and leukocytes partly. The reason could be either a worse nutrition after page of the protein content, or a higher exhaustion of the organism and stress in calves during the rearing period. Blood glucose concentration during the first days of calves’ life is connected with ontogenetic development and corresponds to generally applicable physiological regularities in cattle. The content of total proteins in blood plasma was above the lower limit of the recommended values and it indicates rather a lower supply of the organism with proteins from feed, which suggests also relatively low and stable level of urea. Obtained values of alkaline phosphatase and glutamyl transpherase correspond to the normal development of the calves’ organism. The cholesterol level in the tested animals was balanced, with light fluctuations, but on the stable level. It balanced also in the ideal range of reference values. The content of triglycerides in the blood plasma corresponds to physiological processes in pups. It means an increase in the first days of their life and then a subsequent stabilization. From the zinc and copper values we can read only a slight variation within the reference values. Similarly, it is possible to evaluate also the dynamics of calcium, magnesium and phosphorus.

Generally, we can conclude, that the blood parameters tested in all observed groups moved within the usual range. The exceptions occurred in several cases, where apparently principles of correct nutrition were violated, especially after page of sufficient milk giving to calves, or possibly a submission of feeding with a lower content of proteins. These situation, however, were recorded in individual groups and only once. Dynamics of selected hematological and biochemical blood plasma parameters in calves was relatively similar in all observed groups, and therefore it is evident that the calves may cope with various effects of rearing technologies and environmental conditions while keeping the basic animal hygiene conditions.

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