

Effect of Selected Factors on Hematological and Trace Blood Traits of Cows

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Abstract

The objective of the present study was to evaluate the influence of altitude, season of year, management system, and breed on hematological markers and micromineral concentrations in cows. The highest haemoglobin concentration was at the altitude 550 m (128.48 g.L⁻¹) (P<0.001). The lower levels of haemoglobin and haematocrit (102.27 g.L⁻¹ and 0.28 L.L⁻¹) in the spring 2006. Differences among breeds were significant (P<0.001). The highest count of leucocytes was found in Spring 2006 and the lowest in Spring 2005 (9.94 G.L⁻¹ and 6.15 G.L⁻¹). Differences among Breeds were also significant (P<0.01). The percentage of lymphocytes and neutrophils differed (P<0.001) in Factors Altitude and Breed, the content of monocytes differed significantly in the factors Altitude and Season of Year only (P<0.05, P<0.001). The lowest percentage of eosinophiles was found at the altitude 550 m (4.45 %) and the highest at the altitude 910 m (14.34) (P<0.001). The highest value of phagocytose index was recorded at the altitude 550 m (21.34 %) and the lowest value at the altitude 910 m (14.73 %) (P<0.001). The highest copper and zinc concentrations were found at the altitude 550 m (13.42 µmol.l⁻¹ and 18.18 µmol.l⁻¹) and the lowest at the altitude 910 m (copper 10.17 µmol.l⁻¹; P<0.001) and 675 m above sea (zinc 12.77 µmol.l⁻¹; P<0.001). Similarly, the highest values of copper and zinc were recorded at the Fall 2005 (14.63 µmol.l⁻¹ and 16.31 µmol.l⁻¹). The lower concentration of the copper (7.54 µmol.l⁻¹) was found at the Spring of 2005. The highest values were found in Holstein breed (13.73 µmol.L⁻¹ and 17.55 µmol.L⁻¹) (P<0.001). We found higher concentrations in non-ecological system in both parameters (13.25 µmol.L⁻¹ and 16.25 µmol.L⁻¹ vs. 9.81 µmol.L⁻¹ and 14.65 µmol.L⁻¹).

Keywords: copper ,hematology, sheep, zinc.

1. Introduction

Mineral deficiencies, and in some cases imbalances, cause metabolic disturbances and can produce specific deficiency diseases [1] [2]. Microcytic hypochromic anemia is the one of the outcomes of copper deficiency and may perform several functions in the immune system of which the direct mechanism of action is not clear. Phagocytic activity of neutrophils was increased when copper was administered to deficient calves [3]. Dietary deficiency changes the count of circulating neutrophils and has been linked to a

variety of clinical signs [4]. Zinc is characterized by a number of catalytic, structural and regulatory functions. Both these microelements ranking among substances with biological activity in intermediate metabolism. They get into the organism mainly as components of animal diet. The level of absorption and retention of microelements is modulated by their actual levels in the organism and their concentrations in the diet and is generally higher for intake of their organic forms [5].

The efficiency of cattle is obviously dependent on the health and the well-being. More information is needed on their micromineral requirements in relation to nutrition, toxicology, and physiological status of the animal. Appropriate trace mineral

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supplementation is essential for maintaining optimum level of growth and performance of the animal [6] [7].

2. Materials and methods

The cows were kept in four herds, two systems, and four altitudes. Blood samples were divided according to factors altitude (400 m above sea level, n=120; 550 m, n=60; 675 m, n=82; 910 m, n=40), seasons of the year (spring 2005, n=38; fall 2005, n=58; spring 2006, n=101; fall 2006, n=105), system (ecological, n=40, non-ecological, n=262), and breed (Angus, n=85; Czech Pied cattle, n=73; Holstein, n=145).

Feed intake was monitored daily in each observation for 3 days. Blood samples were collected in the third day of observation by jugular venipuncture into heparinized tubes and placed on ice immediately after collection, then stored at -24°C until processing.

The haematological parameters were determined as follows: leukocytes count was determined using a Bürker chamber, the content of haemoglobin was estimated photometrically at 540 nm by using a spectrometer UV/VIS Unicam 5625. The haematocrit value was determined by capillary microhaematocrit method according to Janetzki. The phagocytic activity of cattle was determined via phagocytosis percentage using by microsferic hydrophilic particles.

The concentration of copper and zinc in blood plasma, and in dry matter of a diet was analysed by flame atomic absorption method using an AA Spectrometer Unicam 969. The data were analysed with a statistical package STATISTIX, Version 8.0.

Herd 1 was localized 400 m above sea level with the majority of Holstein breed (65 %) and Czech Pied cattle (35 %). Non-ecological beef herd (2) was localized in the hilly region (675 m above sea level). During the grazing season, the cows and calves (90 heads of beef cattle majority of Aberdeen Angus breed (70 %) and Simmental breed (30 %) were grazed in the paddock grazing system. A suckler ecological herd (3) of 210 beef cows and calves (Czech Pied cattle and their crosses with Hereford, Charolais, and Galloway) was kept on pasture (910 m above sea level). Conventional, non-ecological dairy herd (4) was localized 550 m above sea level. There were 350 of dairy cows with the majority of Czech Pied

cattle (60 %) and Holstein breed (40 %). Animals were fed ad libitum by Total Mixed Ration.

3. Results and discussion

The lowest haemoglobin concentration was at the altitude 400 m ($113.40\pm 1.12\text{ g.L}^{-1}$) and the highest at the altitude 550 m ($128.48\pm 1.58\text{ g.L}^{-1}$) ($P<0.001$). Differences among individual altitudes were significant. The highest content of haematocrit was recorded in the breeds 2 and 1 ($120.08\pm 1.74\text{ g.L}^{-1}$ and $119.88\pm 1.63\text{ g.L}^{-1}$), the lowest level was recorded in the breed 3 ($112.46\pm 1.22\text{ g.L}^{-1}$). Differences among breeds were significant ($P<0.001$). Similarly, the lowest value was found in the breed 3 ($0.31\pm 0.01\text{ L.L}^{-1}$).

The highest count of leucocytes was found in the altitude 2 and the lowest in the altitude 3 ($8.93\pm 0.37\text{ G.L}^{-1}$ and $6.64\pm 0.31\text{ G.L}^{-1}$; $P<0.001$). The great differences were recorded in factors season of year ($P<0.001$). The highest count was found in spring 2006 and the lowest in spring 2005 ($9.94\pm 0.28\text{ G.L}^{-1}$ and $6.15\pm 0.45\text{ G.L}^{-1}$). Differences among breeds were also significant ($P<0.01$), the highest count was found in breed 2 ($8.25\pm 0.37\text{ G.L}^{-1}$) and the lowest one in breed 1 ($6.46\pm 0.35\text{ G.L}^{-1}$).

The percentage of lymphocytes differed ($P<0.001$) in factors altitude and breed. The highest values were found in altitude 2 ($69.34\pm 1.17\%$) and breed 1 ($68.48\pm 1.15\%$). Similarly, the content of neutrophils had significant differences in factors altitude and breed. The highest values were found in altitude 1 ($35.31\pm 0.93\%$) and breed 3 ($33.75\pm 0.85\%$), and the lowest in altitude 3 ($21.29\pm 1.09\%$) and breed 1 ($21.89\pm 1.11\%$).

The lowest percentage of eosinophiles was found at the altitude 550 m ($4.45\pm 0.55\%$) and the highest at the altitude 910 m ($14.34\pm 0.67\%$) ($P<0.001$). We found the lowest content in the Holstein breed ($4.82\pm 0.39\%$) and the highest in the Czech Pied cattle ($10.41\pm 0.55\%$) ($P<0.001$). Phagocytosis index significantly differed in the factor of altitude, the highest value was recorded at the altitude 550 m ($21.34\pm 0.91\%$) and the lowest value at the altitude 910 m ($14.73\pm 1.17\%$) ($P<0.001$). Differences were found also in the factors of season of year and system.

At the present study, the highest haemoglobin concentration was at the altitude 550 m. Our

presumption about the highest content in the highest location 910 m above sea was not confirmed. The effect of altitude on erythrocytic values has been studied by many authors. They affirmed well known fact that reduced oxygen tension in mountains leads to an increased erythropoiesis as a coping or adaptive mechanism to low oxygen level in such an environment. According to Storz [8], modifications of haemoglobin function typically play a key role in mediating an adaptive response to chronic hypoxia.

The lower levels of haemoglobin and haematocrit, and the highest count of leucocytes were found in the spring 2006. There is not much information in available literature about it. We suppose that the higher leucocytes count was caused by higher content of copper in dry matter during spring 2006 in herds 1, 2, and 3. Dietary copper deficiency increases namely the accumulation of circulating neutrophils in the lung microcirculation [9]. Our results on significant differences among breeds were confirmed former findings of Kirk and Davis [10], and Steinhardt [11]. They showed some individual, breed and age specificity of haemoglobin in dairy cows. Such factor as management system did not seem to affect appreciably the haemoglobin content of the blood. The percentage of lymphocytes and neutrophils differed in factors altitude and breed. Eosinophils were found highest in the blood of cattle at the altitude of 910 m, but values at the other altitudes or breeds were not low enough to be deemed typical symptoms of stress [12].

The highest value of phagocytose index was recorded at the altitude 550 m and the lowest value at the altitude 910 m above sea level. This might be attributed to an aggravated adaptation of the organism on the mountainous environment. Copper is an essential trace mineral which plays an important role in immune response of the animal. Both cell-mediated and humoral immunity were greatly [3], reduced by copper deficiency. The results of Lominadze [9] suggest a proinflammatory effect of copper deficiency on mechanisms of neutrophils.

The highest Cu and Zn concentrations were found at the altitude 550 m ($13.42 \pm 0.41 \mu\text{mol.l}^{-1}$ and $18.18 \pm 0.49 \mu\text{mol.l}^{-1}$) and the lowest at the altitude 910 m (Cu $10.17 \pm 0.51 \mu\text{mol.l}^{-1}$; $P < 0.001$) and 675 m above sea (Zn $12.77 \pm 0.42 \mu\text{mol.l}^{-1}$; $P < 0.001$). Similarly, the highest values of Cu and Zn were

recorded at the fall 2005 ($14.63 \pm 0.42 \mu\text{mol.l}^{-1}$ and $16.31 \pm 0.49 \mu\text{mol.l}^{-1}$). The lower concentration of the copper ($7.54 \pm 0.52 \mu\text{mol.l}^{-1}$) was found at the spring of 2005.

In the both microminerals, there were the highest values found in Holstein breed ($13.73 \pm 0.29 \mu\text{mol.L}^{-1}$ and $17.55 \pm 0.32 \mu\text{mol.L}^{-1}$) ($P < 0.001$). We found higher concentrations in non-ecological system in both parameters ($13.25 \pm 0.25 \mu\text{mol.L}^{-1}$ and $16.25 \pm 0.28 \mu\text{mol.L}^{-1}$ vs. $9.81 \pm 0.64 \mu\text{mol.L}^{-1}$ and $14.65 \pm 0.73 \mu\text{mol.L}^{-1}$).

The highest Cu and Zn concentrations were found at the altitude 550 m and the lowest at the altitude 910 m (Cu) and 675 m above sea (Zn). Cu content in the cows under study was not marginal, we did not find the deficiency in herds with possible exception of herd 3 during spring 2005 observation (5.1 mg.kg^{-1} in dry matter), just exactly at the altitude of 910 m. However, the trace mineral status of animals depends not only on dietary allowance, but also on the efficiency of digestion and storage, which both can be affected by interactions with other food constituents.

In available literature there is no information about data concerning clear optimal level of Zn and Cu added in organic forms in rations for cows. However, different contents of these elements in feed could develop intake differences. They get into the organism mainly as components of animal diet. The improving of biological functions in high yielding cows increased the interest in different forms of minerals applied in feed rations. However, Cope [13] concluded that supplementation of Zn in the diet of dairy cows was not effective in improving the milk composition, health condition, or blood hematology.

The level of absorption and retention of microelements is modulated by their actual levels in the organism and their concentrations in the diet and is generally higher for intake of their organic forms [5] [14]. Hence, trace elements deficiencies are often veterinary suspected and deficient status is considered as the likely cause of disorders [15]. The lowest Zn content in blood plasma was at the altitude 675 m, where really dry matter feed contained the lowest amount of Zn (average of 28.5 mg.kg^{-1}).

Values of these elements in blood plasma were similar to those reported in most other studies. Cu and Zn liver levels increased progressively with soil levels, and the pattern was especially marked

for Cu [16] [17]. The seasonal variations in forages can have impact on microelements [18]; [19] [20]. Our results of variable impact of seasonal changes on the concentration of minerals in the blood and feed resources suggests the need for supplementation of deficient minerals like Cu, Zn in the available forms.

According to consumption feeds and minerals there were actually the lowest contents of Cu in herd 3 (ecological system). However, we did not recorded low content of Zn. There have been many reports of interactions between Cu and other elements in cattle [21] [22].

The content of minerals in different plant fodders given to cattle could be diversified. Therefore, their deficiency or imbalance in the feed could lead to disturbances, decreasing production and lowest concentration of minerals in blood. Cu deficiency in grazed animals is detected mostly in the spring and summer, when there is the lowest ratio of Cu culminating plants on pastures. In rainy periods, Cu is washed out from soil. Other, a number of factors, such as breed, diet, and the concentration of Cu antagonists may affect responses of cattle to supplemental Cu. The supply of Zn improves performance, fertility, health, and immune function [23].

Conclusions

At the present work were found higher concentrations in non-ecological system in both parameters (Cu, Zn). The mineral supplementation of feed rations is generally well done in dairy herds, but is much less practiced in beef herds.

This finding is supported also by our results, contents of Cu and Zn were balanced during seasons of year in dairy herds 1 and 4. We can conclude that hematological markers and trace minerals may be impacted of altitude, season of year, breed, and management system in cows

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