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EFFECT OF ENVIRONMENTAL AND MANAGEMENT FACTORS ON HEMATOLOGICAL AND TRACE BLOOD ELEMENTS OF COWS

M. ŠOCH[1], J. BROUČEK[2]*, P. VYDROVÁ[3], J. TRÁVNÍČEK[1], M. RAABOVÁ[1], M. UHRINČAŤ[2]

[1]University of South Bohemia in Ceske Budejovice, Czech Republic; [2]Animal Production Research Centre, Nitra, Slovak Republic; [3]Czech Beef Breeders Association, Praha, Czech Republic

ABSTRACT

The aim 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, phagocytose index, and copper and zinc concentrations were at the altitude 550 m ($P<0.001$). The lowest percentage of eosinophiles was found at the altitude 550 m and the highest at the altitude 910 m ($P<0.001$). The lowest copper and zinc contents were recorded at the altitude 910 m. We found higher concentrations in non-ecological system in both parameters (13.25 µmol.L^{-1}; 16.25 µmol.L^{-1} vs. 9.81 µmol.L^{-1}; 14.65 µmol.L^{-1}). Differences among seasons of year and breeds were significant in almost parameters. Results indicated that the imbalance in the diet could lead to differences in observed parametres. We can conclude that hematological markers and trace minerals may be impacted of altitude, season of year, breed, and management system in cows.

Key words: dairy cow; hematology; copper; zinc; altitude; season; breed

INTRODUCTION

Mineral deficiencies cause metabolic disturbances. Microcytic hypochromic anemia is the one of the outcomes of copper (Cu) deficiency and may perform several functions in the immune system of which the direct mechanism of action is not clear (Spears, 2003). Phagocytic activity of neutrophils was increased when Cu was administered to deficient calves (Solaiman et al., 2007). Both cell-mediated and humoral immunity can be reduced by Cu deficiency. Dietary Cu deficiency changes the count of circulating neutrophils (NE) and has been linked to a variety of clinical signs (Underwood and Suttle, 2001; Heidarpour Bami et al., 2008). Zinc (Zn) is characterized by a number of catalytic, structural and regulatory functions. As a biomembrane component plays an essential role in RNA, DNA and ribosome stabilization; it is also present in a number of transcription factors, stabilizes some complexes of hormones and their receptors, and antioxidant effects (O'Dell, 2000).

Cu and Zn are 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 (Cao et al., 2000; Massanyi et al., 2001).

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 supplementation is essential for maintaining optimum level of growth and performance of the animal (Solaiman et al., 2006; Šrejberová et al., 2008).

***Correspondence**: E-mail: broucek@cvzv.sk
Jan Brouček; Animal Production Research Centre Nitra,
Hlohovecká 2, 941 51 Lužianky, Slovak Republic
Tel. +421 37 6546280 Fax: +421 37 6546483

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MATERIAL AND METHODS

The aim 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 kept in a mountainous region.

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).

Animals were fed to meet daily requirements of cattle according to nutrient requirements. Ad libitum access to water was maintained throughout the study. Mineral treatments were provided at a single location in each pasture in free-choice mineral feeders. Feed intake was monitored daily in each observation for 3 days. Feed samples were dried and ground in a mill to pass through a 1 mm mesh screen. The amount and source of microelements in daily rations are presented in Table 1. Health parameters were obtained in the each three days observation. 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.

Table 1: Consumption of feeds and mineral content in dry matter

Herd	Season	Pasture kg	Hay kg	Haylage kg	Straw kg	TMR kg	Copper $mg.kg^{-1}$	Zinc $mg.kg^{-1}$
1	Spring 2005					16.9	10.7	65.0
	Fall 2005					17.5	10.1	51.7
	Spring 2006					16.4	12.6	88.3
	Fall 2005					15.7	9.8	86.4
2	Spring 2005	13.0					10.4	45.1
	Fall 2005	10.4					24.9	26.8
	Spring 2006	9.5		8.0			30.4	11.8
	Fall 2005	10.2	2.8				9.5	30.4
3	Spring 2005	13.5					5.1	75.1
	Fall 2005	13.5					13.4	76.9
	Spring 2006	10.7	2.8				11.2	33.5
	Fall 2005	13.2					17.9	61.6
4	Spring 2005					16.2	28.1	99.4
	Fall 2005					15.8	21.8	141.2
	Spring 2006		4.0	11.8	1.5		23.2	114.3
	Fall 2005		1.8			14.0	18.7	78.1

The haematological parameters were determined as follows: leukocytes count (Lc) was determined using a Bürker chamber, the content of haemoglobin (Hb) was estimated photometrically at 540 nm by using a spectrometer UV/VIS Unicam 5625. The haematocrit (HEM) value was determined by capillary microhaematocrit method according to Janetzki. The phagocytic activity of cattle was determined via phagocytosis percentage using by the MSHP kit „microsferic hydrophilic particles for determination of the blood leucocytes phagocytic activity in vitro“(code RK 031; Artim s.r.o., Praha). The phagocytosis percentage was determined as a ratio of phagocytized NE (which absorbed more then 5 particules) and the total LC counts, multiplied by 100. Phagocytic index (PI) was calculated as a ratio of particules sum and NE sum.

The concentration of Cu and Zn 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. The normal distribution of data was evaluated by Wilk-Shapiro/Rankin Plot procedure. Among-group comparisons were analysed using a General linear model ANOVA (General AOV/AOCV). Values are expressed as means ± s.e. Significant differences among means were tested by Bonferroni´s test.

Herd 1 was localized 400 m above sea level with the majority of Holstein breed (65 %) and Czech Pied cattle (35 %). There are 470 dairy cows with the average milk production 5700 kg per year (non-ecological system). Cows were kept in free-stall housing and tie-stall housing and artificially inseminated. Animals were fed ad libitum twice a day to meet daily requirements.

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 outdoors on pasture throughout the year without any shelter and were supplementary fed by locally produced hay and haylage. During winter, animals had access to a stone cowshed with clay floor and straw bedding and there were fed locally produced hay. Breeding period was beginning by artificially insemination at April and continued from May to June by the naturally mating.

A suckler ecological herd (3) of 210 beef cows and calves (Czech Pied cattle and their crosses with beef breeds Hereford, Charolais, and Galloway) was kept on pasture (910 m above sea level). Cows were together with bulls. It was switchback grazing system used. Cattle were grazed outdoors on pasture throughout the year without any shelter.

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 %) with the annual production of milk 4600 kg. Cows are kept in free-stall housing with straw bedding. The cows were milked twice a day. Cows were artificially inseminated throughout the year. Animals were fed ad libitum by Total Mixed Ration.

Table 2: Red blood cells

Distribution	Haemoglobin $g.L^{-1}$				Haematocrit $L.L^{-1}$			
	N	$\bar{x}$ **± SE**	**p**		**N**	$\bar{x}$ **± SE**	**p**	
				Altitude				
1	120	113.40±1.12	0.0000***	1:2***	120	0.32±0.01	0.0000***	1:2,3,4***
2	60	128.48±1.58		2:3***	60	0.35±0.01		
3	83	117.48±1.34		2:4**	83	0.35±0.01		
4	39	120.49±1.96		1:4*	39	0.35±0.01		
				Season of Year				
1	39	124.86±1.96	0.0000***	3:1,2,4***	39	0.36±0.01	0.0000***	3:1,2,4***
2	58	122.82±1.61		2:4**	58	0.38±0.01		1:2**
3	100	102.27±1.22			100	0.28±0.01		
4	105	129.91±1.19			105	0.36±0.01		
				Breed				
1	83	119.88±1.63	0.0002***	1:3***	83	0.35±0.01	0.0000***	1:3***
2	72	120.08±1.74		2:3**	72	0.33±0.01		2:3**
3	147	112.46±1.22			147	0.31±0.01		
				System				
1	39	119.62±2.92	0.3803		39	0.35±0.01	0.0256*	
2	263	116.86±1.13			263	0.33±0.01		

*P<0.05; **P<0.01; ***P<0.001
Interactions:
Hb - Season of Year*System=0.0037**

Altitude: 1: 400 m, 2: 550 m, 3: 675 m, 4: 910 m
Season of Year: 1=spring 2005, 2=fall 2005, 3=spring 2006, 4=fall 2006
Breed: 1=Angus, 2=Czech Pied cattle, 3=Holstein
System: 1=ecological, 2=non-ecological

RESULTS

The lowest HB concentration was at the altitude 400 m (113.40±1.12 g.L^{-1}) and the highest at the altitude 550 m (128.48±1.58 g.L^{-1}) (P<0.001). Differences among individual altitudes were significant (Table 2). Significant differences were in factor season of year in consequence of lower levels of HB and HEM (102.27±1.22 g.L^{-1} and 0.28±0.01 L.L^{-1}) in the spring 2006. The highest content of HEM was recorded in the breeds 2 and 1 (120.08±1.74 g.L^{-1} and 119.88±1.63 g.L^{-1}), the lowest level was recorded in the breed 3 (112.46±1.22 g.L^{-1}). Differences among breeds were significant (P<0.001). Similarly, the lowest value of HEM was found in the breed 3 (0.31±0.01 L.L^{-1}). Interactions were recorded only in HB between season of year*system (P<0.01).

The highest count of LC (Table 3) was found in the altitude 2 and the lowest in the altitude 3 (8.93±0.37 G.L^{-1} and 6.64±0.31 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±0.28 G.L^{-1} and 6.15±0.45 G.L^{-1}). Differences among breeds were also significant (P<0.01), the highest count was found in breed 2 (8.25±0.37 G.L^{-1}) and the lowest one in breed 1 (6.46±0.35 G.L^{-1}).

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

The percentage of monocytes differed significantly in the factors altitude and season of year only (P<0.05,

Table 3: White blood cells

Distribution	Leucocytes G.L^{-1}				Lymphocytes %			
	N	$\bar{x}$ ± SE	p		N	$\bar{x}$ ± SE	p	
				Altitude				
1	120	6.77±0.26	0.0000***	1:2***	118	56.02±0.97	0.0000***	3:1,2***
2	60	8.93±0.37		2:3***	60	57.38±1.36		3:4***
3	83	6.64±0.31		2:4*	85	69.34±1.17		
4	39	7.29±0.45			40	53.92±1.67		
				Season of Year				
1	39	6.15±0.45	0.0000***	3:1,2***	49	55.07± 1.51	0.0445*	1:2,3,4*
2	58	7.15±0.37		3:4***	58	60.62±1.39		
3	100	9.94±0.28			93	60.93±1.09		
4	105	6.40±0.27			103	60.04±1.04		
				Breed				
1	83	6.46±0.35	0.0010**	1:2,3**	85	68.48±1.15	0.0000***	1:2,3***
2	72	8.25±0.37			73	54.03±1.24		2:3*
3	147	7.90±0.26			145	58.41±0.88		
				System				
1	39	7.35±0.53	0.7521		40	53.72±1.83	0.0002***	
2	263	7.53±0.20			263	61.19±0.71		

*P<0.05; **P<0.01; ***P<0.001
Interactions:
Lc - Season of Year*System=0.3910
Ly - Season of Year*Breed=0.3441

Altitude: 1: 400 m, 2: 550 m, 3: 675 m, 4: 910 m
Season of Year: 1=spring 2005, 2=fall 2005, 3=spring 2006, 4=fall 2006
Breed: 1=Angus, 2=Czech Pied cattle, 3=Holstein
System: 1=ecological, 2=non-ecological

P<0.001). The highest value was found in the 550 m above sea and the spring 2005 (2.92±0.24 %; 4.24±0.26 %) and the lowest in and the lowest in altitude 3 at 675 m above sea and the spring of 2006 (1.94±0.19 %; 1.53±0.19 %). Interactions were recorded between season of year*system (P<0.05).

The lowest percentage of eosinophiles (EO) was found at the altitude 550 m (4.45±0.55 %) and the highest at the altitude 910 m (14.34±0.67) (P<0.001). We found the lowest content of EO (Table 5) in the Holstein breed (4.82±0.39 %) and the highest in the Czech Pied cattle (10.41±0.55) (P<0.001). PI significantly differed in the factor of altitude, the highest value was recorded at the altitude 550 m (21.34±0.91 %) and the lowest value at the altitude 910 m (14.73±1.17 %) (P<0.001) (Tab. 5). Differences were found also in the factors of season of year and system. There were higher PI in the spring of 2005 (20.03±1.07) and in the non-ecological system (18.33±0.50) (P<0.05).

The highest Cu and Zn concentrations (Table 6) were found at the altitude 550 m (13.42±0.41 μmol.l^{-1} and 18.18±0.49 μmol.l^{-1}) and the lowest at the altitude 910 m (Cu 10.17±0.51 μmol.l^{-1}; P<0.001) and 675 m above sea (Zn 12.77±0.42 μmol.l^{-1}; P<0.001). Similarly, the highest values of Cu and Zn were recorded at the fall 2005 (14.63±0.42 μmol.l^{-1} and 16.31±0.49 μmol.l^{-1}). The lower concentration of the copper (7.54±0.52 μmol.l^{-1}) was found at the spring of 2005.

In the both microminerals, there were the highest values found in Holstein breed (13.73±0.29 μmol.L^{-1} and 17.55±0.32 μmol.L^{-1}) (P<0.001). We found higher concentrations in non-ecological system in both parameters (13.25±0.25 μmol.L^{-1} and 16.25±0.28 μmol.L^{-1} vs. 9.81±0.64 μmol.L^{-1} and 14.65±0.73 μmol.L^{-1}). Interactions were calculated in Cu between season of year*system (P<0.001).

Table 4: Contents of neutrophiles and monocytes

Distribution	Neutrophiles %				Monocytes %			
	N	$\bar{x}$ ± SE	p		N	$\bar{x}$ ± SE	p	
Altitude								
1	118	35.31±0.93	0.0000***	3:1,2***	118	2.56±0.17	0.0470*	2:3*
2	60	34.29±1.30		3:4**	60	2.92±0.24		
3	85	21.29±1.09		4:1,2*	85	1.94±0.19		
4	40	28.44±1.59		2:3*	40	2.55±0.29		
Season of Year								
1	49	31.99±1.44	0.4685		49	4.24±0.26	0.0000***	1:2,3,4***
2	58	28.33±1.33			58	2.27±0.24		
3	93	29.63v1.05			93	1.53±0.19		
4	103	29.37±0.99			103	1.93±0.18		
Breed								
1	85	21.89±1.11	0.0000***	1:2,3***	85	2.24±0.22	0.9291	
2	73	32.53±1.20			73	2.27±0.23		
3	145	33.75±0.85			145	2.17±0.17		
System								
1	40	28.52±1.80	0.3457		40	2.67±0.31	0.1157	
2	263	30.35±0.70			263	2.14±0.12		

*P<0.05; **P<0.01; ***P<0.001
Interactions:
Mo - Season of Year*System=0.0198*

Altitude: 1: 400 m, 2: 550 m, 3: 675 m, 4: 910 m
Season of Year: 1=spring 2003, 2=fall 2003, 3=spring 2004, 4=fall 2004
Breed: 1=Angus, 2=Czech Pied cattle, 3=Holstein
System: 1=ecological, 2=non-ecological

DISCUSSION

The blood markers can be critical for improving of the physiological, nutritional and pathological status of cattle organism. No doubt that physiological values of different blood parameters are influenced by a number of factors such as altitude, age, sex, breed, season, climatic conditions, and nutrition. At the present study, the highest HB concentration was at the altitude 550 m. Our presumption about the highest HB 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 knows 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 (Herrera et al., 2007; Storz and Moriyama, 2008). According to Storz (2007), modifications of HB function typically play a key role in mediating an adaptive response to chronic hypoxia. Relationships of mammalian HB and their physiological role in oxygen transport are known, however the study of HB variations and their polymorphism in high-altitude mammals are need for better understanding the nature of adaptation.

Effect of season on erythrocytic values and leucocytes counts has been identified. The lower levels of HB and HEM, and the highest count of LC were found in the spring 2006. There is not much information in available literature about it. We can only suppose that the higher LC count was caused by higher content of Cu in dry matter during spring 2006 in herds 1, 2, and 3 (table 1). Dietary Cu deficiency increases namely the accumulation of circulating NE in the lung microcirculation (Lominadze et al., 2004). These authors also support the theory that dietary Cu deficiency has proinflammatory effects on both neutrophils and the microvascular endothelium that

Table 5: Eosinophiles content and phagocytose index

Distribution	Eosinophiles %				Phagocytose index			
	N	$\bar{x} \pm SE$	p		N	$\bar{x} \pm SE$	p	
Altitude								
1	118	5.22±0.39	0.0000***	4:1,2,3***	72	19.11±0.74	0.0008***	2:4***
2	60	4.45±0.55		2:3*	48	21.34±0.91		2:3**
3	85	6.57±0.46			47	17.10±0.92		1:4*
4	40	14.34±0.67			29	14.73±1.17		
Season of Year								
1	49	7.48±0.61	0.4700		35	20.03±1.07	0.0216*	1:4*
2	58	8.04±0.56			58	17.97±0.83		
3	93	7.09±0.44						
4	103	7.97±0.42			103	16.21±0.62		
Breed								
1	85	6.48±0.51	0.0000***	1:2***	47	1 7.14±0.92	0.0000***	2:3***
2	73	10.41±0.55		2:3***	50	1 5.97±0.89		1:3**
3	145	4.82±0.39		1:3*	99	21.09±0.63		
System								
1	40	14.30±0.68	0.0000***		29	15.18±1.21	0.0169*	
2	263	5.48±0.26			167	18.33±0.50		

*P<0.05; **P<0.01; ***P<0.001
Interactions:
FI – Season of Year*System=0.0371*

Altitude: 1: 400 m, 2: 550 m, 3: 675 m, 4: 910 m
Season of Year: 1=spring 2003, 2=fall 2003, 3=spring 2004, 4=fall 2004
Breed: 1=Angus, 2=Czech Pied cattle, 3=Holstein
System: 1=ecological, 2=non-ecological

promote neutrophil-endothelial interactions.

Our results on significant differences among breeds confirmed former findings of Kirk and Davis (1970) and Steinhardt et al. (1994). They showed some individual, breed and age specificity of HB in dairy cows. Such factor as management system did not seem to affect appreciably the HB content of the blood.

The percentage of LY and NE differed in factors altitude and breed. EO 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 (Broucek and Kovalcik, 1989). We can only suppose that the higher EO percentage in highlands was caused by adaptation.

The highest value of PI index was recorded at the altitude 550 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. Cu is an essential trace mineral which plays an important role in immune response of the animal (Spears, 2003). Effects of Cu on immune responses in cattle are well documented. Phagocytic activity of NE was increased when Cu was administered to Cu deficient calves. Both cell-mediated and humoral immunity were greatly reduced by Cu deficiency (Solaiman et al., 2007). The results of Lominadze et al. (2004) suggest a proinflammatory effect of Cu deficiency on mechanisms of neutrophiles. The changes in some indicators of cellular and humoral imunity indicate that the feeding of pollutants from the Cu and Zn can have immunosupressive effects in the ruminants.

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

Table 6: Copper and zinc concentrations

Distribution	Copper µmol.l^{-1}				Zinc µmol.l^{-1}			
	N	$\bar{x}$ ± SE	p		N	$\bar{x}$ ± SE	p	
Altitude								
1	120	12.59±0.29	0.0000***	2:4***	120	16.99±0.34	0.0000***	3:1,2***
2	60	13.42±0.41		1:4**	60	18.18±0.49		4:2***
3	82	11.75±0.35		2:3*	82	12.77±0.42		4:1,3*
4	40	10.17±0.51			40	14.93±0.59		
Season of Year								
1	38	7.54±0.52	0.0000***	1:2,3,4***	38	14.34±0.61	0.0000***	4:1,3***
2	58	14.63±0.42		2:3***	58	16.31±0.49		
3	101	11.66±0.32		3:4***	101	14.79±0.37		
4	105	14.12±0.31			105	17.44±0.37		
Breed								
1	82	11.61±0.39	0.0000***	3:1,2***	82	13.02±0.42	0.0000***	1:2,3***
2	73	11.61±0.41			73	15.94±0.45		
3	147	13.73±0.29			147	17.55±0.32		2:3*
System								
1	40	9.81±0.64	0.0000***		40	14.65±0.73	0.0431*	
2	262	13.25±0.25			262	16.25±0.28		

*P<0.05; **P<0.01; ***P<0.001
Interactions:
Cu - Season of Year*System=0.0000***

Altitude: 1: 400 m, 2: 550 m, 3: 675 m, 4: 910 m
Season of Year: 1=spring 2003, 2=fall 2003, 3=spring 2004, 4=fall 2004
Breed: 1=Angus, 2=Czech Pied cattle, 3=Holstein
System: 1=ecological, 2=non-ecological

3 during spring 2005 observation (5.1 mg.kg^{-1} in dry matter) (table 1), 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 of Zn and Cu added in organic forms in rations for cows. However, different contents of these elements in feed could develop intake differences. Both microelements ranked among substances with biological activity in intermediate metabolism. They get into the organism mainly as components of animal diet. The improving of biological functions in cattle increased the interest in different forms of minerals applied in feed rations (Kottferova and Korenekova, 1997). However, Mandal et al. (2008) and Cope et al. (2009) concluded that supplementation of Zn in the diet of dairy cows was not effective in improving the milk composition, health condition, or blood hematology.

An important factor that affects both the absorption and utilization of trace elements is their chemical form (Kottferova and Korenekova, 1995). Improvements in animal performance have been observed in several other studies when complexed trace minerals have replaced inorganic trace minerals, even though the diet was fortified at levels well in excess of nutritional requirements (Kellogg et al., 2003). 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 (Cao et al., 2000). Hence, trace elements deficiencies are often veterinary suspected and deficient status is considered as the likely cause of disorders (Massanyi et al., 2003; Enjalbert et al., 2006). 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}) (table 1).

The highest values of Cu and Zn were recorded at the fall 2005. The lower concentration of the Cu (7.54 ±0.52 μmol.l^{-1}) was found at the spring of 2005, when the average of Cu content in dry matter was really 13.6 mg.kg-1 (table 1). The highest values were measured in Holstein breed.

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 (Lopez et al., 2000; Lopez et al., 2004). The seasonal variations in forages can have impact on microelements. Our results of variable impact of seasonal changes on the concentration of minerals in the blood and feed resources suggest the need for supplementation of deficient minerals like Cu, Zn in the available forms.

At the present work were found higher concentrations in non-ecological system in both parameters. According to consumption feeds and minerals (table 1) there were actually the lowest contents of Cu in herd 3 (ecological system). However, we did not recorded low content of Zn. Mineral deficiencies, and in some cases imbalances, cause metabolic disturbances and can produce specific deficiency diseases. There have been many reports of interactions between Cu and other elements in cattle (Rajcakova et al., 2003). Blanco et al. (2006) showed the interaction between Cu and iron, related to haemoglobin synthesis. Other interactions have been reported with cadmium and Zn with high cadmium levels leading to Cu deficiency. Three-way interactions between Cu, molybdenum and sulphur have also been reported (Underwood and Suttle, 2001), so that the daily Cu requirements of cattle are strongly dependent on molybdenum and sulphur levels in the diet.

The mineral supplementation of feed rations is generally well done in dairy herds, but is much less practiced in beef herds (Čermák et al., 2006). 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. This finding is supported also by our results, contens of Cu and Zn were balanced during seasons of year in dairy herds 1 and 4 (table 1). 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 (Kellogg et al., 2004; Arthington, 2005).

This study has been based on a data set of analysis in four dairy and beef herds over two years. We can conclude that hematological markers and trace minerals may be impacted of altitude, season of year, breed, and management system in cows. Results indicated that the imbalance in the diet could lead to differences in observed parametres.

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