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COPPER AND ZINC CONCENTRATIONS IN SOIL, PASTURE SWARD AND BLOOD PLASMA OF BEEF CATTLE

STĘŻENIE MIEDZI I CYNKU W GLEBIE, MURAWIE PASTWISKA ORAZ W OSOCZU KRWI BYDLĘCEJ

Abstract: The objective of this study was to compare concentrations of copper and zinc in soil, pasture sward and blood plasma of extensive reared Aberdeen Angus bulls and heifers on a farm in the foothills of the Orlicke Mountains. We sampled soil, pasture sward from pasture areas and blood from 22 bulls and 22 heifers in the period from birth to weaning at regular intervals (81, 151, 189 and 273 days of age). Concentrations of copper and zinc were analysed. Significant relationships ($p < 0.05$) was noted between soil and pasture copper concentrations ($r = 0.74$), pasture and blood plasma copper concentration ($r = 0.29$). No other significant correlation between monitored parameters was found.

The indicators determined in this study can be used to specify the health and nutritional status of animals reared in the extensive suckling cows systems more detailed.

Keywords: beef cattle, iron, copper, zinc, soil, pasture, blood plasma

Among different environmental factors, soil plays a vital role in cattle production and health because cattle appease their nutrient needs from the feed and fodder, which in turn obtain nutrients from the soil. The role of soil and nutritional quality of plants with respect to the health and production of livestock is very important and varies from place to place [1]. Plants are the basic and potential source of food for animals; ultimately the nutritional values of plants are of central importance in determining the plants and human health. Herbs are an important source of delivering minerals to grazing livestock in extensive and low-input situations. At the same time mineral deficiencies can depress forage digestibility and herbage intake and ultimately decrease livestock production efficiency [2]. The uptake of minerals and particularly trace minerals by plants can provide important information on environmental contamination and requirements of

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ruminants [2, 3]. Plants absorb minerals from soil as well as from surface deposits on parts of plants exposed to polluted areas [2]. Information on mineral levels of forages are very important to identify what measures should be taken to improve the nutritional status of grazing livestock. Seasonal variation affects livestock seasonal production in different regions of the world by affecting forage dry matter accumulation [4, 5].

Because trace elements that constitute an important part of animal nutrition have unique roles in mammals, their deficiencies can adversely affect animal health [6]. Copper, one of the trace elements, is involved in numerous physiological functions such as hemoglobin formation, iron metabolism, and connective tissue metabolism [7]. Copper deficiency is associated with numerous clinical signs, including anaemia, severe diarrhoea, weight loss or diminished weight gain, epiphyseal enlargement, change in hair colour, neonatal ataxia, and infertility [8]. Several biochemical and physiological changes have been reported in Zn deficient animals, including an early decrease in serum alkaline phosphatase, then a loss of appetite, followed by poor growth and reduced feed efficiency [9, 10].

The objective of this study was to characterize the mineral status of soil and forage system in relation to blood minerals concentration of grazing beef cattle.

Materials and methods

The experiment was conducted in pasture areas in the foothills of the Orlicke Mountains (Czech Republic). The elevation in this area is around 500 m a.s.l., and the total annual precipitation is on average 728 mm per year. Twenty-two grazing bull and heifers were selected for observation from birth to weaning. Sampling of soil, forage and blood plasma were provided at regular intervals (81, 151, 189 and 273 days of the animals age). The representative soil and forage samples were collected randomly. Composite forage samples weighing about 400 g were made from combined clippings from a sampling position. Soil samples were taken from below the clipped swards at 0–30 cm depths, using a soil sampler.

The soil samples were extracted in 2 mol · dm^{-3} HNO_3 according to [11]. Forage samples were dried in an oven at 60 ^{o}C and decomposed in the microwave system Ethos 1 (Milestone, Italy) in the mixture of nitric(V) acid and hydrogen peroxide. The contents of Zn and Cu were determined on high resolution continuum source atomic absorption spectrometer ContrAA 700 (Analytik Jena, Germany) by using flame atomization. Blood plasma concentration of Cu and Zn was measured on an XT20i automatic analyser (Thermo Fisher Scientific, Finland) using common commercial sets (Biovendor-Laboratorní medicína, Czech Republic).

Statistical analysis of the obtained data was performed using the STATISTICA 8.0 programme. Single-factor analysis of variance was used for factor time. ANOVA was followed by post-hoc Fisher's LSD test for pair-wise comparisons, when appropriate. Evaluation of the interdependence between the soil, forage and animals minerals concentration was conducted using a correlation coefficient at the level of probability ($p < 0.05$).

Results and discussion

The mean soil copper concentration was much higher than the critical level of 0.3 $mg \cdot kg^{-1}$ as stated by some of authors [12, 13]. Winter season copper level in soil was significantly higher than summer season level. In all pastures, the soil Cu level was lower during summer than winter season, according to [2]. Most of the soil samples form pastures had zinc levels higher than the critical level 2.5 $mg \cdot kg^{-1}$ [13]. The effect of season on soil zinc level was not profound and variation was minor. Forage copper and zinc contents rose significantly ($p < 0.05$) with the aging of forage plants from spring to summer season, corresponding to [2]. Soil concentrations of those elements were found to be high, but in forage was determined low content, especially first half of monitoring, compared with [14]. It could be due to antagonism among other mineral elements such sulphur, calcium etc., in the uptake of copper and zinc by forage [2]. Also [12] suggest cattle requirements of zinc between 20 and 40 $mg \cdot kg^{-1}$. Copper concentrations in blood plasma of bulls and heifers changed slightly during the survey. Significant increasing was found at the end of experiment. The average values fluctuated between 8.09 and 13.21 $\mu mol \cdot dm^{-3}$. Significant decreasing of plasmatic zinc concentrations were determined in bulls and heifers from beginning to end of observation. The range of average values was between 9.39 and 15.18 $\mu mol \cdot dm^{-3}$. Copper and zinc blood plasma concentration were in physiological range according to [15].

In our study significant relationships ($p < 0.05$) was noted between soil and pasture copper concentrations ($r = 0.74$), pasture and blood plasma copper concentration ($r = 0.29$). Also [16] found high correlation between soil and fodder ($r = 0.823$) and between fodder and cattle ($r = 0.885$). Contrary those authors, we did not record significant correlation between forage and blood plasma zinc content.

Table 1

Soil-forage-cattle blood plasma correlation of copper and zinc concentrations

Mineral		Soil-forage	Forage-blood plasma	Soil-blood plasma
Cu	correlation value	**0.74**	**0.29**	0.54
	P value	< 0.05	< 0.05	0.092
Zn	correlation value	0.37	0.58	0.34
	P value	0.335	0.273	0.181

Conclusion

Evaluation of copper and zinc in the forage or other diet for ruminants has limited diagnostic value. It can be concluded, from the results of the present study, that cattle reared under extensive production system in foothills of the Orlicke Mountains were not deficient in Cu and Zn minerals. The present study established some relationship between soil, forage, and cattle.

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References

[1] Abdel Rahman MM, Kincaid RL, Elzubeir EA. Mineral deficiencies in grazing cattle in Kardofan and Darfur regions in the eastern Sudan. Trop Anim Health Prod. 1998;30(2):123-135.
[2] Khan ZI, Ashraf M, Valeem EE et al. Pasture concentration of minerals in relation to the nutrient requirements of farm livestock. Pakistan J Bot. 2007;39(6):2183-2191.
[3] Yusuf AA, Arowola TA, Bamgbose O. Cadmium, copper, and nickel levels in vegetables from industrial and residual areas of Logos City, Nigeria. Food Chem Toxicol. 2003;41:375-378.
[4] Arizmendi-Maldonado D, McDowell LR, Sinclair TR et al. Mineral concentrations in four tropical forages as affected by increasing daylength. II. Microminerals. Comm Soil Sci Plant Anal. 2002;33(11-12):2001-2009.
[5] Khan ZI, Hussain A, Ashraf M et al. Seasonal variation in soil and forage mineral concentrations in a semiarid region of Pakistan. Pakistan J Bot. 2004;36(3):635-640.
[6] Karapinar T, Dabak M, Demirci Y et al. Copper defficiency in feedlot cattle. Bull Vet Inst Pulawy. 2007;51(1):135-138.
[7] Hays VW, Swenson MJ. Minerals and bones., In: Dukes' Physiology of Domestic Animals. Swenson MJ, Reece WO editors. London: Cornell University Press, Ithaca; 1993.
[8] Maas J, Smith BP. Copper deficiency in ruminants. In: Large Animal Internal Medicine. Smith BP editor. St Louis-London-Philadelphia-Sydney-Toronto: MosbyInc; 2002.
[9] Hambidge KM. Zinc. In: Trace elements in human and animal nutrition. Mars W editor, vol 2, fifth edition. Orlando, FL: Academic Press, Inc; 1986.
[10] Engle TE, Nockels CF, Hossner KL et al. Marginal zinc deficiency affects biochemical and physiological parametres in beef calves. Amer J Anim Sci. 1997;10(5):471-477.
[11] Zbíral J. Analyses of soils II. Central Institute for Supervising and Testing in Agriculture, Methodology. Brno, Czech Republic; 2003.
[12] McDowell LR, Conrad JH, Ellis GL et al. Minerals for growing ruminants in tropical regions. Gainesvill, FL, USA: Department of animal science, University of Florida, Buletin; 1983.
[13] Rhue RD, Kidder G. Analytical procedures used by the IFAS extension soil laboratory and the interpretation of results. Gainesville, FL: Soil Science Department, University of Florida; 1983.
[14] NRC. Nutrient requirements of domestic animals. Washington, DC: National Academy of Sciences--National Research Council; 1984.
[15] Slavik P, Illek J, Zeleň T. Zinc and copper status of beef cattle in the Sumava Region, Czech Republic. Acta Vet Brno. 2006;75(4):485-488.
[16] Kumaresan A, Bujarbaruah KM, Pathak KA et al. Soil–plant–animal continuum in relation to macro and micro mineral status of dairy cattle in subtropical hill agro ecosystem. Trop Anim Health Prod. 2010;42(4):569-577.

STĘŻENIE MIEDZI I CYNKU W GLEBIE, MURAWIE PASTWISKA ORAZ W OSOCZU KRWI

Abstrakt: Celem pracy było porównanie stężenia miedzi i cynku w glebie, runi pastwiskowej oraz osoczu krwi buhajów i jałówek rasy Aberdeen Angus, hodowanych w gospodarstwie u podnóża Gór Orlickich. Badano glebę, murawę pastwisk oraz krew 22 byków i 22 jałówek w okresie od urodzenia do odsadzenia w regularnych odstępach czasu (81, 151, 189 i 273 dni życia). W pobranych próbkach oznaczono stężenie miedzi i cynku. Istotne korelacje ($p < 0,05$) zaobserwowano pomiędzy stężeniem miedzi w glebie i w paszy ($r = 0,74$) oraz w paszy i w osoczu krwi ($r = 0,29$). Nie stwierdzono żadnych innych istotnych korelacji pomiędzy monitorowanymi parametrami. Parametry określone w tym opracowaniu mogą być używane do bardziej szczegółowego określenia stanu zdrowia i odżywienia zwierząt hodowanych.

Słowa kluczowe: bydło, żelazo, miedź, cynk, gleba, pastwiska, osocze krwi