EFFECT OF THE ADDITIVE INTAKE OF ZINC ON ITS CONTENT IN BLOOD PLASMA OF DAIRY COWS

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Introduction

The aim of this study was to assess the effect of adding zinc to food of diary cows for the period of three weeks before delivery on its content in the blood plasma in varying intervals *post partum.* In animal tissues, zinc is present in concentrations close to iron, i.e. usually higher that those of manganese and copper (Prasad *et al.,* 1974 in Bencko *et al.,* 1995). Majority of zinc is found in muscles, liver, bones and mammary gland (Suchý *et al.,* 1998). It is required for the activity of many enzymes (Prasad, 1991, Vrzgula *et al.,* 1990) which positively effect the processes of growing and development, development of bones, blood, reproduction abilities and transformation of proteins and saccharides (Sova *et al.,* 1981). Research studies show that its intake is important for proper functioning of the immune system (Conway, 1988). Zinc significantly reduces the after-effects of retardation of intrauterine development (Simmer *et al.,* 1991). In blood, zinc is by 75% bound in the blood plasma (mainly proteins), 22% in erythrocytes and 3% in leucocytes (Sollmann, 1957 in Bencko *et al.,* 1995). Utilisation of zinc is affected among other factors by its chemical form (Keyzer *et al.,* 1983 in Vrzgula *et al.,* 1990). From inorganic forms, the best is in zinc sulphate (15 - 40%). Digestibility of zinc from organic forms (proteinates, yeast, lactates, etc.) is many times higher (Suchý *et al.,* 1998). At present, a special emphasis is put on organically bound microelements in the form of chelate complexes (Sinovec and Jovanovic, 2002). Šimek *et al.* (2001) in his experiments identified a favourable effect of organic forms of mineral substances on the production of milk. Administration of organically bound zinc, copper, cobalt and manganese to diary cows significantly reduces insemination intervals (Campbell *et al.,* 1999).

Material and methods

The experiment was conducted on diary cows from a farm in the Southern Bohemia District. For the purpose of this experiment, two groups of diary cows were established: an experimental group which was saturated with inorganic zinc added to the dose of food above the recommended daily standard, and a control group to which no zinc supplement was administered. The intake of zinc to the experimental group was increased in the form of zinc oxide by 20%, i.e. 130 mg per head per day, administered in the form of capsules *per os* daily over the period of three weeks before expected calving. The diary cows had blood samples taken repeatedly from *vena jugularis* - before the supplement administration and then in the 1^{st}, 3^{rd}, 5^{th}, 6^{th} and 8^{th} month after delivery. The content of zinc in the blood plasma was determined by the method of atomic absorption spectrophotometry (AAS), using a UNICAM 969 AA spectrometer, and this was compared with a reference sample.

Results and discussion

The content of zinc in the blood plasma of diary cows before the commencement of the experiment (Table 1) is characterised by the following parameters: Experimental group: (n = 16): arithmetic mean 16.87 µmol/l, standard deviation 3.85 µmol/l, coefficient of variation (V%) 23, minimum 11.93, maximum 26.91, median 15.98 µmol/l; Control group (n = 16): arithmetic mean 16.75 µmol/l, standard deviation 2.84 µmol/l, coefficient of variation (V%) 17, minimum 11.01, maximum 21.41, median 16.97 µmol/l. The mean values of content of both groups are very even and within the framework of physiological limits of zinc content in blood plasma, i.e. 12.5 - 26.0 µmol/l (Slanina *et al.,* 1992), which demonstrates a corresponding level of the diary cows supplementation with zinc. Graph 1 illustrates the history of zinc content in blood plasma during the monitored period. Both groups show a similar tendency, until 2^{nd} month *post partum* showing a drop, from 2^{nd} month in the experimental group and 3^{rd} month in the control group until 6^{th} month an increase, with a peak in 6^{th} month, the experimental diary cows with intake of zinc supplement showing higher average values. However, the differences between the experimental and the control group during this period were below the level of statistical significance. The drop in the content of zinc during colostration feeding can be explained by an increased demand for it in the colostrum which contains 3 - 5 times as zinc as what is present in normal cow milk (Novák *et al.,* 1982), and the drop until 2^{nd} month *post partum* in the experimental group (and 3^{rd} month in the control group) can be ascribed to the upsurge of lactation. Unlike some other microelements, milk contains considerable quantity of zinc (Novák *et al.,* 1982) - on average 3.8 - 4.7 mg/kg (Reilly, 1991 in Kvasničková, 1998). The effect of long-term intake prior to delivery manifested itself not only by higher average content of zinc in plasma, but also by faster evening out and growth of its concentration in plasma (Graph 1) compared to the control zinc of the unsupplemented group. This can be explained by zinc getting released into the blood plasma from mobilised reserves (Bouda *et al.,* 1990), created at the time of its supplemented intake.

Conclusion

Supplemented zinc intake at quantity 130 mg per head per day over the period of three weeks prior to delivery was reflected in its increased presence in blood plasma in 3rd and 5th and/or 6th month *post partum* compared to the control group; however, this difference was statistically insignificant.

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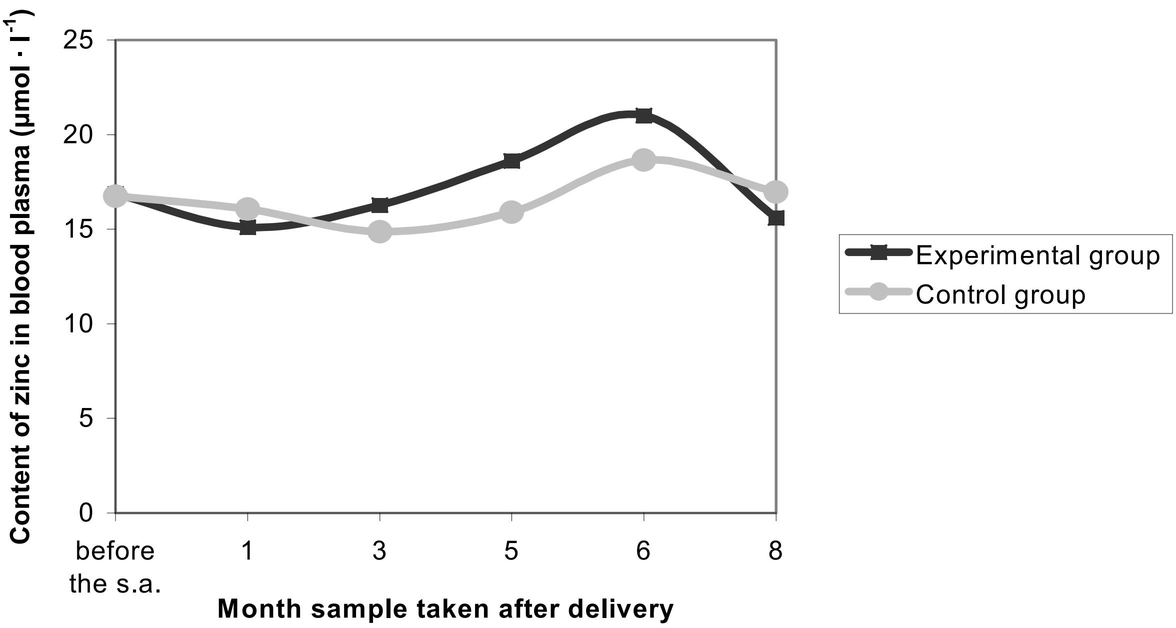
References

1. *Bencko, V., Cikrt, M., Lener, J.: Toxické kovy v životním a pracovním prostředí člověka. Grada Publishing, spol. s r. o., Praha, 2. vyd., 1995, 288 s.*
2. *Bouda, J., Klimeš, J., Jagoš, P., Doubek, J.: Metabolické poruchy u vysokobřezích krav a jejich vliv na kvalitu kolostra, vývoj a zdraví telat. Metabolické a produkční choroby skotu (Sborník). Kolektiv autorů.Dům techniky ČSVTS (Československá vědeckotechnická společnost), Brno, 1. vyd., 1990, 131 s., str. 43.*
3. *Campbell, M. H., Miller, J. K., Schrick, F. N.: Effect of Additional Cobalt, Copper, Manganese and Zinc on Reproduction and Milk Yield of Lactating Dairy Cows Receiving Bovine Somatotropin (ZP A0032). University of Tennessee, Knoxville TN. 1999. J. Dairy Sci. Vol. 82: 1019 - 1025*
4. *Conway, L. W.: Zinc supplements may affect immune response. Environ-Nutr. New York, N. Y., Environmental Nutrition, Inc. Sept 1988. v. 11 (9) p. 2.*
5. *Kvasničková, A.: Minerální látky a stopové prvky. Esenciální minerální prvky ve výživě. ÚZPI (Ústav zemědělských a potravinářských informací), Praha, 1. vyd., 1998, 128 s.*
6. *Novák, J., Kacerovský, O., Flíček, V., Kalous, J.: Výživa a krmení hospodářských zvířat I. Vysoká škola zemědělská, Praha, 1. vyd., 1982, 215 s.*
7. *Prasad, A. S.: Discovery of human zinc deficiency and studies in an experimantal human model. Am-J-Clin Nutr. Baltimore, Md., American Society for Clinical Nutrition. Feb 1991. v. 53 (2) p. 403 - 412.*
8. *Simmer, K., Lort-Phillips, L., James, C., Thompson, R. P. H.: A double-blind trial of zinc supplementation in pregnancy. Eur-J-Clin-Nutr. Basingstoke, The Macmillan Press Ltd. Mar 1991. v. 45 (3) p. 139 - 144.*
9. *Sinovec, Z., Jovanovic, N.: Significance of supplementing microelements in preventing metabolic disorders in cattle. 79 ref. Veterinarski glasnik (Yugoslavia). (2002). v. 56(3-4) p. 153-175.*
10. *Slanina, Ľ., Beseda, I., Hlinka, D., Illek, J., Kováč, G., Kroupová, V., Lehocký, J. et al.: Metabolický profil hovädzieho dobytka vo vzťahu k zdraviu a produkcii. ŠVŠ SR - Ústav veterinárnych informácií a osvety, Bratislava, 2. vyd., 1992, 116 s.*
11. *Sova, Z., Bukvaj, J., Koudela, K., Kroupová, V., Pješčak, M., Podaný, J.: Fyziologie hospodářských zvířat. Praha, SZN, 1981, 512 s.*
12. *Suchý, P., Suchý, P. Ml., Straková, E.: Mikroprvky ve výživě hospodářských zvířat. Krmiva @ Výživa, číslo 3 - 4, I. ročník. Vydává: Zdeněk Makovička, Vydavatelství ZT, prosinec 1998, str. 18 - 19.*

13. *Šimek, M. et al.: Organické zdroje minerálních látek a zatížení životního prostředí (zemědělské informace 22/2001). Ústav zemědělských a potravinářských informací, Praha, 2001, 40 s.*
14. *Vrzgula, L. et al.: Poruchy látkového metabolizmu hospodárských zvierat a ich prevencia. Bratislava, Príroda, 1990, 503 s.*

Graph 1: Content of zinc in blood plasma of diary cows during the monitored period



s.a. - suplement administration