EFFECT OF DISINFECTION SOLUTIONS AND ENVIRONMENTAL FACTORS ON CLAW HORN COPPER AND ZINC CONTENT IN DAIRY COWS

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SUMMARY

The purpose of the study was to investigate claw horn contents of zinc and copper n dairy cows and the influence of some environmental factors, such as manure and hoof disinfectants on these trace element concentrations. Claw horn specimens were obtained from the soles of clinically healthy cows, with no signs of lameness. Copper and zinc contents of sole horn were assayed, and then the samples were placed into cattle manure for 4 days and analysed once again. By the end of the study, claw horn was placed in 5% $CuSO_4$, 5% $ZnSO_4$ solutions and in a commercial hoof disinfectant. It was established that claw horn copper content was low and varied between 2 and 5 mg/kg; the manure had no effect on its concentrations. Under the effect of $CuSO_4$, horn copper attained 216.35 mg/kg. The zinc content of horn was substantially higher – 97.22 mg/kg, and under the influence of manure it decreased up to 79.12 mg/kg. The treatment of hooves with $ZnSO_4$ resulted in significant increase of zinc levels up to 205.26 mg/kg. The effect of the tested commercial hoof disinfectant consisted in extremely high elevation of horn copper content (881.41 mg/kg) and at a lesser extent – of horn zinc concentration (127.31 mg/kg). The results of study demonstrated that hoof disinfectants influenced the chemical composition of claw horn in dairy cows.

***Key words**: claw horn, manure, zinc, copper, disinfectant*

Introduction

The lameness in dairy cows as a clinical sign of hoof and claw pathology is an important problem in cattle husbandry. The losses due to lameness are substantial and together with infertility and mastitis, among the commonest causes for culling of animals and poor economic results at the farms (Esslemont and Kosaibati, 1997). Numerical estimation of losses because of lameness demonstrates the following proportions: reduced milk production from affected cows – 40%, increased treatment costs – 34% and lower conception rates – 26% (Olechnowicz and Jaskowski, 2011).

The strength and resistance of claw horn are essential for the onset of lameness. Claw horn strength depends on selection, feeding, the environment and its chemical composition. According to some researchers, the content of zinc (Zn) and copper (Cu) are closely relayed to higher resistance and strength of hooves (Rodin, 1985; Lukyanovskii and Gorshkov, 1985; Lukyanovskii, 1988; 1997). According to authors, foot baths with $ZnSO_4$ and $CuSO_4$ solutions have an astringent effect on claw horn and improve its density. Furthermore, copper is important for the buildup of disulfide bonds of keratin molecules, thus increasing claw horn strength (Underwood, 1981; Baggott et al., 1988). Zinc, on the other hand, participates in synthesis of horn keratin DNA (Baggott et al., 1988).

The purpose of the study was to investigate claw horn contents of zinc and copper in dairy cows and the influence of some environmental factors, such as manure and hoof disinfectants on their concentrations.

Material and methods

For the purpose of the study, claw horn was obtained from the soles of hooves of clinically healthy cows. Specimens were cut into pieces from 0.5 to 1.0 cm of size.

A part of samples were shredded into fine flakes, which were then analysed for determination of baseline Zn and Cu contents. Some of claw horn pieces were placed in cattle manure mass, with faeces to urine ratio of 2:1 (v:v) for four days. After removal from the MM, horn samples were washed with deionised water, shredded into fine flakes, and assayed for Cu and Zn content. The

other part of pieces was removed from the manure mass, washed with deionised water and divided into three groups. One group was placed in 5% $CuSO_4$ solution, the second group – in 5% $ZnSO_4$ solution and the third one – in a solution of commercial hoof disinfectant. The duration of stay in these solutions was 4 days. After removal, they were washed with deionised water, shredded into fine flakes and submitted to chemical analysis.

Shredded flakes of horn walls, were dried to constant weight and digested with a mixture of 22.5 ml HCI and 7.5 ml HNO_3. The analysis was performed by electrothermal atomic absorption spectrometry (ETAAS), in compliance with modern trends for analysis of macroelements in biological samples − electrothermal atomic absorption spectrometry (ETAAS), inductively coupled plasma optical emission spectrometry (ICPOES) and mass spectrometry (ICP-MS) (Dospatliev et al., 2011; Dospatliev et al., 2011).

The statistical processing of data was done by means of STATISTICA 6 software, by calculation of least square means (LSM) with repeated measures ANOVA.

Results and discussion

Fig. 1 presents the mean concentrations of Cu (mg/kg) at the beginning of the experiment (environment 0), after placement in manure (environment 1) and $CuSO_4$. It was established that claw horn Cu content did not change after the stay in manure, but considerably increased after the stay in $CuSO_4$. These findings suggested that claw horn was able to absorb copper from its environment. This most probably would influence the health of hooves and supports the use of $CuSO_4$ solutions for feet disinfection.

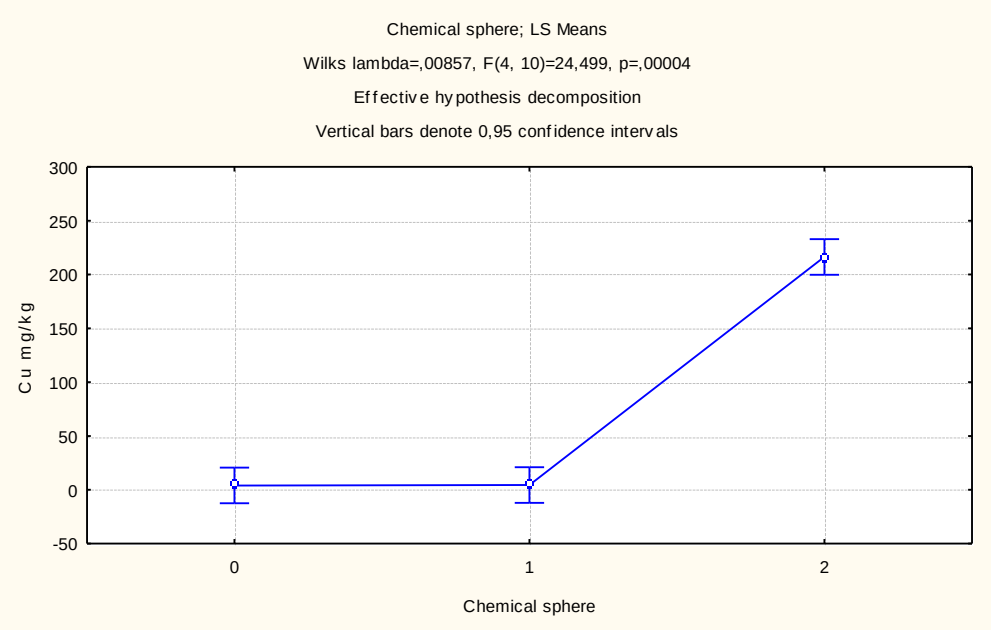

Fig 1. LS-means of claw horn Cu at the beginning (0), after stay in manure (1) and after the stay in $CuSO_4$ (2)

Figure 2 demonstrates that the Zn content of claw horn was significantly higher that that of copper. After the stay in manure, the Zn concentrations decreased from 97.22 mg/kg to 79.12 mg/kg which indicated that manure, as a constant factor of the cattle farm environment had a negative effect on claw horn zinc content and therefore, on its strength. This requires using disinfectants containing $ZnSO_4$, at farms in order to maintain the level of this trace element in hooves. According to the recommendations for hoof disinfection of Borissov et al. (2010), the used preparations should be alternated. This way, the onset of resistant is avoided and also, the chemical balance of the hoof

is probably maintained. This is confirmed by the results shown on Fig. 2 i.e. that after the stay in zinc sulfate solution, Zn levels attained 205.26 mg/kg.

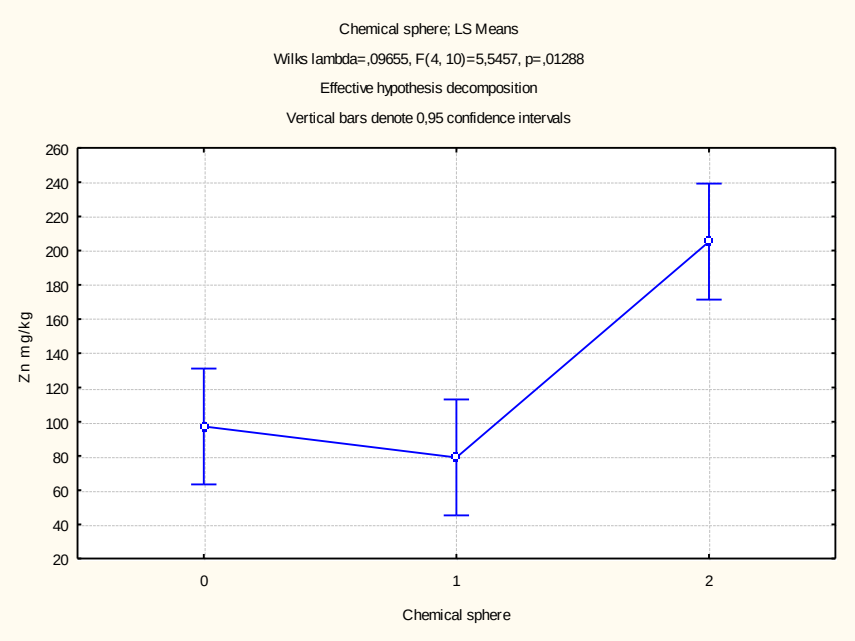

Fig 2. LS-means of claw horn Zn at the beginning (0), after stay in manure (1) and after the stay in $ZnSO_4$ (2)

Fig. 3 depicts the average content of copper in claw horn and its changes after the stay in either manure or commercial disinfectant solution. It becomes clear that under the influence of the tested disinfectant, copper content in claw horn increased considerably up to 881.41 mg/kg, which was more than levels determined after the stay of hooves in $CuSO_4$ solution. The copper concentration in the commercial product is higher than 5%, aiming at saturating the horn with this trace element.

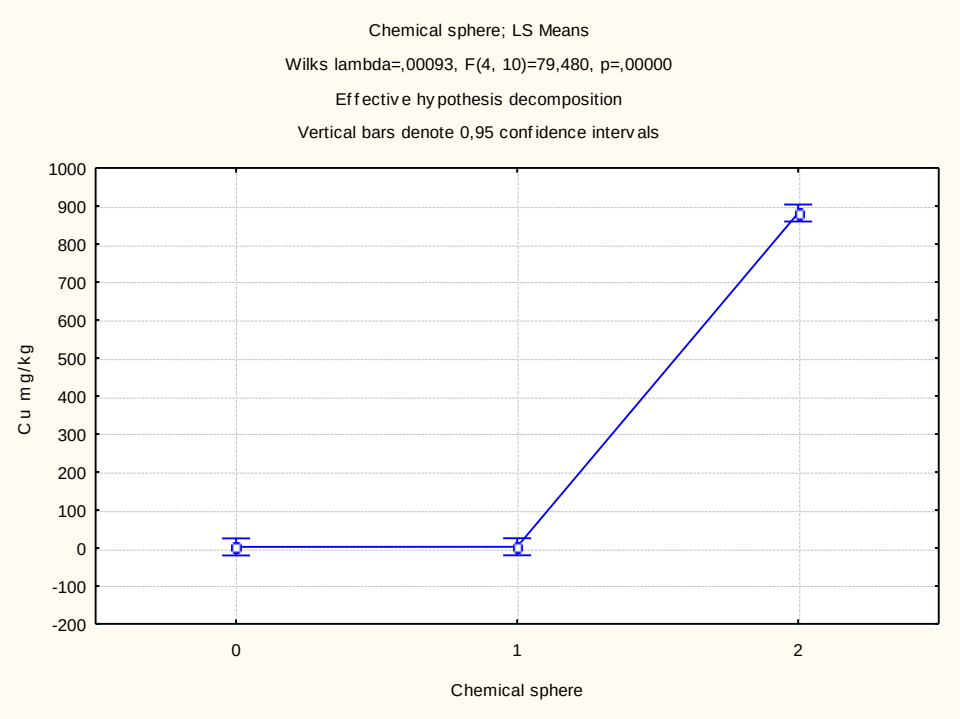

Fig 3. LS-means of claw horn Cu at the beginning (0), after stay in manure (1) and after the stay in the commercial disinfectant (2)

Fig. 4. shows average zinc levels in claw horn and its changes after the 4-day stay in manure and the disinfectant. It could be seen that zinc content of hooves decreased after the stay in manure, but after removal of samples from the disinfectant solution, exceed the baseline values.

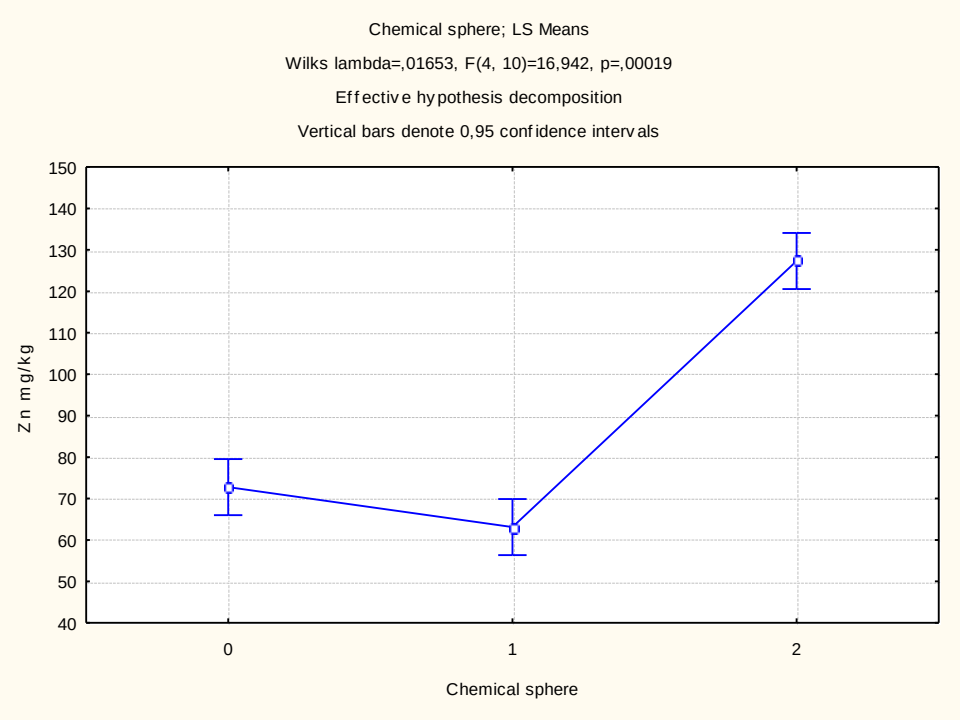

Fig 4. LS-means of claw horn Zn at the beginning (0), after stay in manure (1) and after the stay in the commercial disinfectant (2)

Thus, it could be concluded that the product contained a significant amount of zinc apart copper as it was able to increased horn zinc content up to 127.31 mg/kg. With this regard, the disinfectant had a similar effect as $ZnSO_4$, but it was superior as copper content is concerned.

Conclusion

The results of study demonstrated that copper and zinc sulfate baths increased the concentrations of copper and zinc in claw horn of dairy cows. Manure, being a constant environmental factor of the dairy farm, had no substantial effect on horn copper levels. Under the influence of manure, zinc content of claw horn is reduced, which requires a periodical treatment with zinc-containing disinfectant solution. The tested commercial hoof disinfectant increased at a higher extent claw horn copper concentrations and at a lesser extent – zinc concentrations. Under the influence of the product, the levels of both trace elements in the horn increased vs the baseline values.

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