EFFECT OF MANURE MASS ON CALCIUM AND PHOSPHORUS CONTENT OF CLAW HORN IN DAIRY COWS

T. Penev*

**Agricultural Faculty, Trakia University, Stara Zagora*

ABSTRACT

The present study was conducted to determine the content of calcium and phosphorus in three claw horn areas – walls, soles and heels – of dairy cows. Hoof samples were obtained from first-lactation heifers at a slaughterhouse in the Stara Zagora region and placed in manure mass for 28 days. The content of calcium and phosphorus was determined before placement of specimens in manure and at 7-day intervals. The purpose was to establish the changes occurring in claw horn during its stay in manure for 28 days as a possible explanation of horn softening. During the experimental period, the changes in calcium and phosphorus content in the three areas did not show a tendency which could explain the changes in their hardness, but exactly the reverse. During the stay of hooves in manure mass and parallelly to occurring softening, the content of calcium tended to increased in walls and soles, and with some small exceptions – in heels. In most instances, phosphorus content has decreased. This supported the hypothesis that the changes in claw horn during its stay in manure are due to the loss of fat.

Key words: *claw horn, manure mass, chemical composition*

Abbreviations: *manure mass – MM, calcium – Ca, phosphorus – P, electrothermal atomic absorption spectrometry – ETAAS*

INTRODUCTION

The investigation of causes and effects of lameness in dairy cows is closely related to physical properties and chemical composition of claw horn. The horn hardness is largely dependent on selection for healthy hooves, but also on housing environment conditions. The environment influences the chemical composition of hooves as well as the content of specific elements and fats (Ministry of Agriculture and Foods of the Republic of Belarus, 2011). That is why, the chemical content of horn has been investigated by numerous researchers, which assume that calcium (Ca) content is essential for claw horn resistance. It is proved that in lame cows, Ca concentration is lower compared to healthy cows (Bodurov et al., 1981; Lukyanovski and Filippov, 1984; Baggott et al., 1988). The content of calcium in the different claw horn areas (walls, soles and heels) also differs, with highest concentrations in the region of walls (Bodurov et al., 1981; Lukyanovski and Filippov, 1984; Baggott et al., 1988) – the hardest part of the hoof (Penev et al., 2013). Seasonal variations in claw horn calcium content have been reported, with increase in the autumn and reduction in spring (Lukyanovski and Filippov, 1991; Lukyanovski, 1992). The lowest claw horn calcium concentrations were established during the dry period, explaining the lower hoof hardness during that period.

Phosphorus (P) is also a very important element of claw horn resistance. The phosphorus content of hind limb hooves of lame cows is higher as compared to sound animals (Bodurov et al., 1981; Lukyanovski and Filippov, 1987; Baggott et al., 1988). According to these studies, the higher phosphorus concentrations in claw horn of cows was related to lower resistance and hence, predisposition to lameness.

Manure mass is an environmental factor, influencing the health and hardness of cows' feet. Due to its alkaline nature, manure mass (MM) provokes a reduction in horn fat content and thus, makes is susceptible to penetration of water, swelling and softening (Kalinihin, 1982; Gregory, 2004; Gregory et al., 2006; Higuchi et al., 2009; Penev et al., 2013).

The purpose of the present investigation was to establish the effect of manure mass on calcium and phosphorus content in three zones of cattle claw horn (walls, soles and heels) as a factor for development of lameness.

MATERIAL AND METHODS

Twenty hind limb hooves were collected from first-lactation heifers in a slaughterhouse from the Stara Zagora region. Two specimens were obtained from the three zones of each hoof – walls, soles and heels – with a size 30x15x6 mm according to the method of Baggott et al. (1988) (Fig. 1).

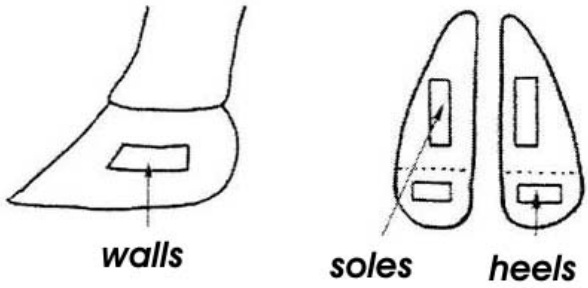

Fig 1. Claw horn areas (walls, soles, heels) included in the investigation (Baggott et al., 1988)

All claw horn samples were placed in cattle MM, with faeces to urine ratio of 2:1 (v:v). Manure mass was replaced twice weekly. At 7-day intervals, the hardness of one group of horn samples was tested by the Shore A method, and the other group served for determination of calcium and phosphorus contents. After being removed from the MM, horn samples were washed with deionised water, dried, part of them was shredded into fine flakes, and afterwards samples were replaced in manure. The procedures lasted over 28 days.

Shredded flakes of horn walls, soles and heels were dried to constant weight and digested with a mixture of 22.5 ml HCI and 7.5 ml HNO_3 (aqua regis).

The analytic method was selected in compliance with modern trends for analysis of macroelements in biological samples – Uv-Vis spectrophotometry, electrothermal atomic absorption spectrometry (ETAAS), inductively coupled plasma optical emission spectrometry (ICP-OES) and mass spectrometry (ICP-MS) (Dospatliev et al., 2010; Dospatliev et al., 2010).

Claw horn calcium content was assayed by AAS, whereas the phosphorus content – spectrophotometrically.

The statistical processing of data was done by means of STATISTICA 6 software, by calculation of least square means (LSM) of Ca and P concentrations over the 28-day experimental period with repeated measures ANOVA.

RESULTS AND DISCUSSION

Fig 2 and 3 present the LS means of calcium and phosphorus content of hoof wall areas. The Ca concentration of this zone increased until the 14th day, then decreased until the 21st day and slightly went up until the 28th day. The lowest calcium content was established on the 21st day of horn stay in MM. The differences between baseline and experimental values indicated that during the stay in manure, a considerable amount of calcium has accumulated in this hoof zone and according to literature data, an improved hardness could be anticipated, which practically has not been observed (Penev et al., 2013). According to authors, the hardness of hoof walls was most intensively reduced until the 14th day of the study, when horn calcium concentrations were higher.

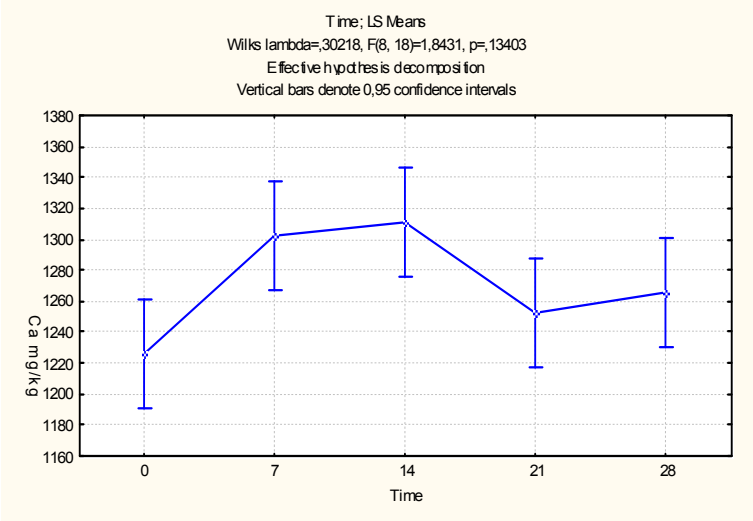

Fig 2. LS means of calcium concentrations in claw horn in the hoof wall region

Phosphorus content of claw horn walls increased substantially after 7 days stay in manure. Afterwards, they decreased by the 14th and the 21st day and almost attained baseline concentrations. There was a slight increase in P content of hoof walls between experimental days 21 and 28.

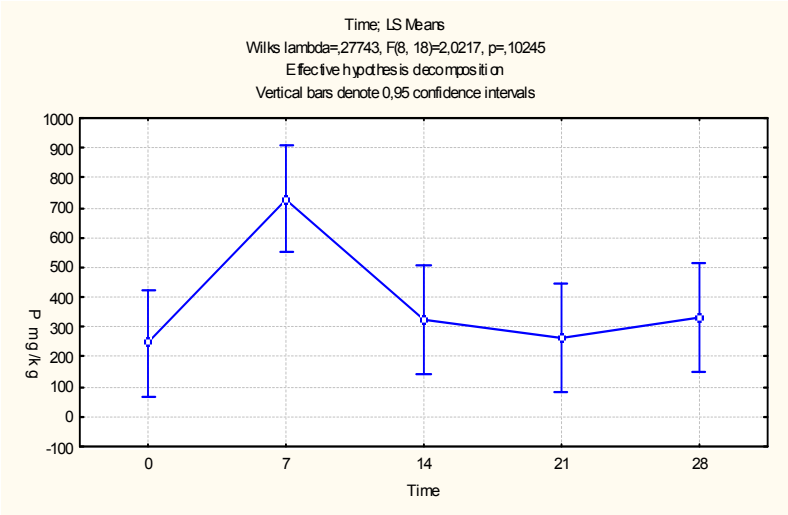

Fig 3. LS means of phosphorus concentrations in claw horn in the hoof wall region

These data, as well as hoof calcium concentrations shown on Fig 2 demonstrated that MM had not an effect on Ca and P contents which could explain the softening, observed over the same period by Penev et al. (2013). The authors suggested that the softening of this horn zone was due to the loss of fat and penetration of water into the horn.

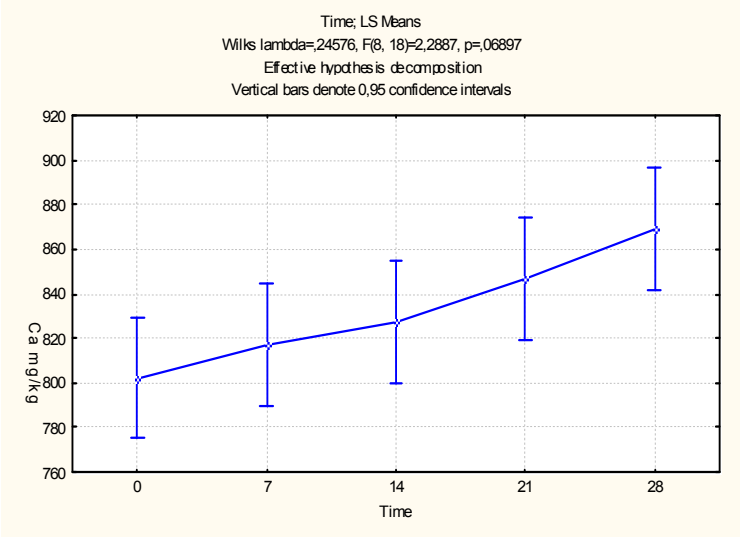

Fig 4. LS means of calcium concentrations in claw horn in the sole region.

Fig 4 presents calcium content of claw horn in the region of soles. This macroelement increased steadily during the entire experimental period, with most significant increase after the 14th day. The results of Penev et al. (2013) for claw horn hardness in the soles' region reported softening during the entire 28-day period with two peaks: one until the 14th day and another peak of strong softening – after the 21st day. These findings come to support the earlier thesis that manure influences other claw horn ingredients, namely fats, and that calcium concentrations could not be a reliable indicator of strength in such investigations.

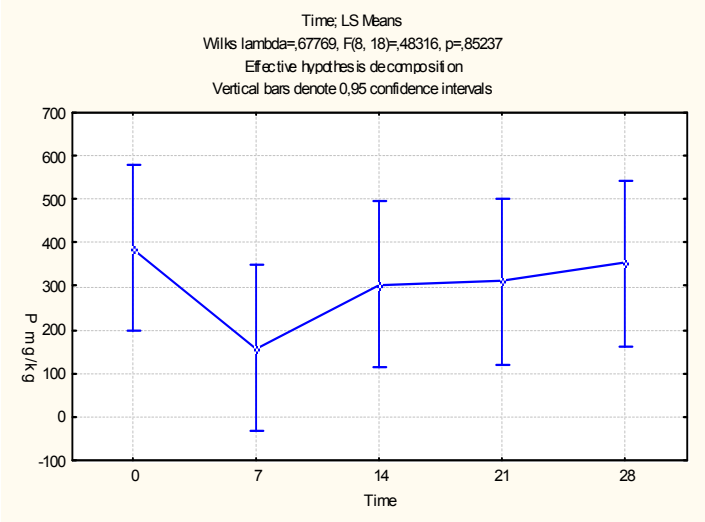

Fig 7. LS means of phosphorus concentrations in claw horn in the sole region

The analysis of phosphorus content (Fig 5) did not exhibit any consistent relationship between claw horn hardness reported in the study of Penev et al. (2013) and the concentrations of this macroelement in horn. Contrary to Baggott et al. (1988), the P content of diseased and softer hooves were higher. Higher phosphorus concentrations in the hooves of lame cows established by Baggott et al. (1988) were probably due to impaired metabolism rather that to diffusion of this element from the manure mass.

Fig 6 presents the LS means of calcium in claw horn heels. The analysis of calcium in this zone supported the already discussed thesis that the hardness of the hoof after its stay in manure

was not related to its calcium content. During the period of strongest claw horn softening (until the 7th day) as observed by Penev et al. (2013), this macroelement increased, regardless of the affirmations of Lukyanovski and Filippov (1991) and Lukyanovski (1992) that higher content was a parameter of high resistance and hardness of claw horn.

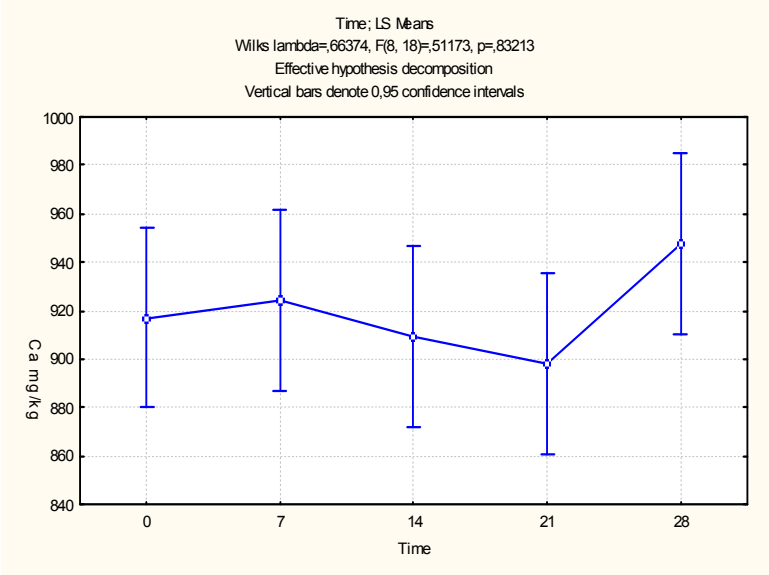

Fig 6. LS means of calcium concentrations in claw horn in the heel region

The established LS means of horn phosphorus content in the region of heels were rather inconsistent (Fig. 7). Its concentrations varied during the different periods of the study, with alternating increase and reduction. This supports our earlier hypothesis.

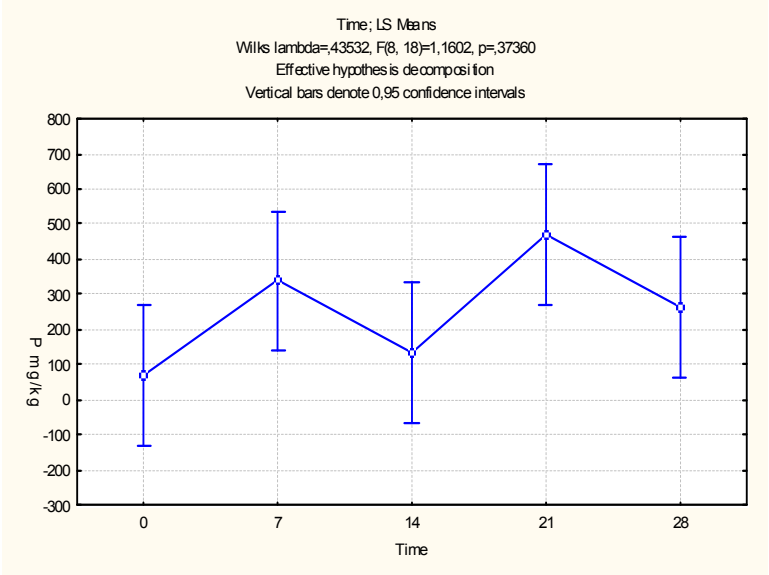

Fig 7. LS means of phosphorus concentrations in claw horn in the heel region

CONCLUSION

The analysis of calcium and phosphorus concentrations in claw horn of dairy cows could be objective indices for the metabolism, and for health and strength of claw horn, respectively. The concentration of these macroelements was not influenced by manure – a constant factor of dairy

farm environment, which exerts its aggressive effects on claw horn only through extraction of horn fat, increased water content of hooves and reduction of their hardness.

REFERNCES:

1. Baggott, D. G., K. J. Bunch and K. R. Gill, 1988. Variations in some inorganic components and physical properties of claw keratin associated with claw disease in the British Friesian cow. The British Veterinary Journal, 144: 534-542.

2. Bodurov, N., O. Neychev, K. Binev, Zh. Filipov, 1981. Physico-chemical properties of claw horn of high-production dairy cows with healthy and diseased hooves. Veterinary Science (Sofia), 8; №3: 46-52.

3. Dospatliev, L., G. Mihaylova, M. Varbanov, 2010. Estimate of macroelement content and their reciprocal ration in mountain grassland, Journal of Mountain Agriculture on the Balkans, 13: 244-254.

4. Dospatliev, L., G. Mihaylova, M. Varbanov, 2010. Use of Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) to Determine the Macro in the Cow's Milk and Cheese, Ecology and Future, 9, (3-4): 17-19.

5. Gregory, N. G., 2004. Swelling of cattle heel horn by urine. Australian Veterinary Journal, 82: 161-163.

6. Gregory, N., L. Craggs, N. Hobson, C. Krogh, 2006. Softening of cattle hoof soles and swelling of heel horn by environmental agents. Food Chem Toxicol, 44:1223-1227.

7. Higuchi, H., H. Kurumado, M. Mori, A. Degawa, H. Fujisawa, A. Kuwano, H. Nagahata, 2009. Effects of ammonia and hydrogen sulfide on physical and biochemical properties of the claw horn of Holstein cows. The Canadian Journal of Veterinary Research, 73: 15-20.

8. Kalinihin, V., 1982. Method for improvement of claw horn of cows at industrial keeping methods. Dairy and Meat Animal Husbandry, № 12, 19-20.

9. Lukyanovski, V. A., 1992. Biophysical and biochemical analysis of claw horn in dairy cows reared under various industrial production systems. Agricultural Science Newspaper, T2: 92-96 ISSN 0206-6335.

10. Lukyanovski, V. A., Y. I. Filippov, 1984. calcium and inorganic phosphorus content of claw horn of black-and-white and Ayrshire cattle. Functional morphology and pathology of locomotory organs of domestic livestock: 96-97.

11. Lukyanovski, V. A., Y. I. Filippov, 1987. Inorganic phosphorus and calcium content of claw horn in cows with Rusterholz ulcer. Morphology of locomotory organs of domestic livestock reared under different industrial production systems: 80-82.

12. Lukyanovski, V. A., Y. I. Filippov, 1991. Macro- and microelements in the claw horn of dairy cows reared under various industrial production systems. Agricultural Science Newspaper, T1: 133-135.

13. Ministry of Agriculture and Food of the Republic of Belarus, 2011. Technological requirements of veterinary service, therapy of large ruminants and prophylaxis of surgical pathology at industrial dairy farms. Recommendation, p. 24.

14. Penev, T., A. Iliev, Ch. Miteva, Y. Mitev, P. Valkova, K. Uzunova, 2013. Investigation of manure-induced physicochemical changes of the claw horn in dairy cattle. Journal of The Faculty of Veterinary Medicine Istanbul University – in press.