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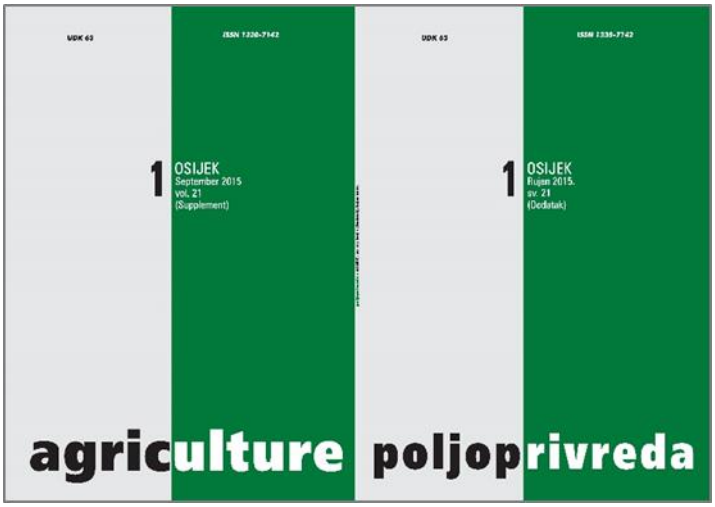
**Poljoprivreda/Agriculture**

ISSN: 1848-8080 (Online)
ISSN: 1330-7142 (Print)

http://dx.doi.org/10.18047/poljo.21.1.sup.13

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ISSN 1330-7142
*UDK: 636.2:636.061*
DOI: 10.18047/poljo.21.1.sup.13

# EFFECT OF BREED AND SAMPLING PLACE ON THE MINERAL CONTENT OF CATTLE HAIR

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Original scientific paper

***SUMMARY***

***Mineral intake is important for high production level. Estimation of exact mineral intake is difficult in grazing and/or group housed animals like cattle. Accessing of long term mineral status seems to be possible using hair mineral analyses. However, several factors can affect the results. Therefore, the aim of this study was to test the effect of sampling location and breed on the mineral content of beef cows' hair fed the same feeding regime. Ten Hungarian Simmental and ten Charolais cow were selected from the same farm. Coloured hair samples free of visible contamination were obtained from the withers, side and quarter of the cows. Hungarian Simmental samples were used to test the effect of sampling location. Since it did not show significant effect, Charolais samples were analysed as pooled. Samples were mineralized using nitric acid and hydrogen peroxide using ultrasonic cleaning unit. Calcium, magnesium, sodium, copper, selenium and zinc content were determined by ICP-OES (Perkin-Elmer, Optima 3300 DV). Statistical analyses were carried out by SAS (SAS Institute Inc., Cary, NC) GLM procedure. Significant breed differences were detected in the case of calcium, magnesium and copper. The measured values were above or around the normal ranges, suggesting that the mineral status of the herd was adequate. Sampling location of short hairs had no influence on the mineral profile.***

***Key-words: cattle, mineral content, hair analyses***

## INTRODUCTION

Minerals play various roles in the living organisms. Due to the increase of production potential and level of farm animals, the proper mineral supplementation has high importance. The actual amount of metabolically available minerals depends on many factors: mineral intake, chemical form of mineral supplementation, age, mineral interactions, phytase enzyme supplementation, etc. Therefore, it has a practical importance to monitor the actual mineral status. Analysing the plasma or urine mineral content to check the mineral status is an obvious option. However, the plasma mineral content is quite variable due to the stage of intestinal absorption (absorption and plasma level is increasing as the partly digested feed reaches the place of absorption, but decreases when available substrate is decreased) and/or mineral mobilization from stores. Therefore, plasma or urine mineral content represent limited information about the overall mineral supply (Gabryszuk et al., 2010). For that reasons, researchers were looking for other biological samples, which can give information about the mineral status of longer period. It is proven that in the course of hair development minerals are accumulated from blood into the cortex of hair (Combs, 1987). Developed hair became isolated from the continuously changing metabolic processes. Therefore, hair mineral content can represent the average mineral supplementation of a longer period. The first applications of hair mineral analyses were to detect and prove mineral poisoning of famous humans, like Bonaparte Napoleon (Kintz et al., 2007). However, in such a case only the detection of presence is required, while in case of farm animals the connection of intake and hair mineral content should be established. The research results are controversial regarding to the precision and interpretation of hair mineral analyses (Namkoong et al., 2013; Darsch and Roider, 2002; Combs, 1987). For the practi-

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cal application we need to establish reference values and gain information about the factors influencing the hair mineral content (Mikulewicz et al., 2013; Combs, 1987). It is known that hair mineral content of animals originating from different farms and genotypes can be different (Gabryszuk et al., 2010; Patkowska-Sokola et al., 2009). The obvious reason is the various feeding regimes applied on the different farms. Information is still lacking on the hair mineral content of different breeds of cattle having the same feeding regime. Body location of sampling and the contamination of hair samples can also alter the measured mineral content (Fisher et al., 1985). Therefore, the aim of our study was to investigate the effect of breed (Hungarian Simmental and Charolais) and hair sampling place on the hair mineral content of beef cattle.

## MATERIAL AND METHODS

Ten Hungarian Simmental (beef type) and ten Charolais cows were randomly selected from the herd of the Derecske Petőfi Agricultural Ltd. (Derecske, Hungary). The sampling was carried out in March. The animals received the same feeding regime consisting of meadow hay and concentrate. Coloured hair samples free of visible contamination were obtained from the withers, side and quarter of the Hungarian Simmental cows using bended scissors. As results did not show any sampling site effect, Charolais cows were sampled by the same method, but hair samples were mixed and analysed like that. Results of the mixed samples served to test breed differences. From the samples calcium (Ca), magnesium (Mg), sodium (Na), copper (Cu), selenium (Se) and zinc (Zn) content were analysed. Organic contamination was removed by washing with ethyl-alcohol (96%, Sigma-Aldrich). Dried samples were mineralized by 2 ml nitric acid (distilled, Sigma-Aldrich) in ultrasonic cleaning unit at 60°C for 30 min. After cooling 2 ml of 30% hydrogen peroxide (Sigma-Aldrich) were added and samples were mineralized for 90 min at 100°C. After mineralization solutions were filled up to 10 ml with distilled water and filtered throughout MN 619 G ¼ (155 mm diameter) filter paper. Measurement of solutions was carried out with ICP-OES (Perkin-Elmer, Optima 3300 DV). Statistical analyses were conducted by SAS (SAS Institute Inc., Cary, NC) GLM procedure at $P=0.05$ level.

## RESULTS AND DISCUSSION

Calcium content of Hungarian Simmental cows was higher than Charolais, but both fell within the reference range (Table 2). Calcium is the most abundant mineral in the body. Despite that, its majority can be found in bones. It has several important functions in soft tissues as well. Ca is transported in ionized form in the plasma, and its level regulated in narrow limits (Georgievskii, 1982). This can be the reason that researchers found out only week correlation between calcium intake and hair content, making hair analyses limited value for assessing Ca supply (Combs, 1987). The evaluation is further complicated by the interaction with other elements. Anke (1966) reported that dietary Ca had an antagonistic effect on hair P and Zn level. Kornegay et al. (1981) reported that hair of pigs fed a reduced P diet contained higher amount of Zn and Mn. It is known that Ca and P compete for transport mechanisms during intestinal absorption, and P in a form of phytic acid binds other minerals. These mechanisms can be the reasons of such observations. However, it is still not explained why we detected breed differences in spite of the similar nutrition. Since experimental animals were adult, differences in metabolic activity due to different growth rate cannot be suspected as a reason. Furthermore, it is very interesting that Gabryszuk et al. (2010) found only 25-30% Ca level in cattle hair kept on organic farms, showing deficient Ca supply. These cows were grazing and, depending on pasture yield and availability of other feeds, the feeding ration was supplemented only with hay, straw, silage and cereals. The large differences in hair Ca content suggest that in spite of well controlled blood Ca level, hair Ca level can respond to certain factors, needed to be identified.

Magnesium level of Hungarian Simmental cow's hair was significantly higher than found in Charolais (Table 1). However, both values are much higher than the suggested normal level. Despite that, Holstein Friesian cows from organic farms expressed levels quite below the reference values (Gabryszuk et al., 2010). Increasing the level of Mg in the diet induced higher Mg content in cattle hair (Anke, 1966). Fisher et al. (1985) demonstrated that Mg content in hair samples were depended on the Mg content of pasture where cattle grazed. They also stated that higher Mg content of hair does not necessary mean sufficient supply because hair can be contaminated by manure rich in magnesium (especially in case of tail switch hair). However, in our case this likely have not been the responsible factors, as samples originated from uncontaminated short haired body parts and were washed before analysis. Therefore, we can conclude that the Mg supply of the experimental animals were more than adequate. Blood plasma analyses could confirm that conclusion (Fisher et al., 1985). Fisher et al. (1985) demonstrated that black hair can contain markedly higher amount of magnesium, compared to lightly coloured hair samples. The breed differences we found can be attributed to the different pigment content of Charolais and Hungarian Simmental coloured hair.

No breed effect was found in the case of sodium. Unfortunately we could not find any research suggesting normal Na levels of cattle hair. However, the values we found were about 13 times higher than in cows kept on organic farms (Gabryszuk et al., 2010). In our case the cows had free access to salt blocks. Gabryszuk et al. (2010) do not mention salt supplementation of their experimental cows. Based on that we can suspect that

hair Na level reflects the salt supply of cattle. However, the determination of normal values needs further investigations.

Unlike to Ca and Mg, Charolais cows had higher copper level in their hair samples (Table 1). Early research results demonstrated that hair copper level relates liver copper reserves when the level is below 20 $\mu$g/g (Kellaway et al., 1978). The values were found are around the lower end of the normal range. However hair samples of organic cattle showed deficient supply again (Gabryszuk et al., 2010). Suttle and McMurray (1983) developed an assessment system for cattle and sheep based on three criteria. According to that system, if cattle hair contains less than 4 mg/g copper it shows prolonged deficiency with probable production drop. When this low hair copper value is coupled with plasma tither higher than 0.59 it shows infection or stress.

Both tested breed had statistically similar selenium content in their hair. The measured values are far above the normal range, suggesting an oversupply of Se in the tested herd. Olson (1969) concluded that Se concentrations of 5 to 10 ppm in cattle hair may indicate selenium toxicity. Acute selenium toxicity can be caused by consuming large amount of high seleniferous accumulating plants during grazing or by accidental overdosing supplementation. Signs of toxicities include laboured breathing, abnormal movement and posture, prostration and diarrhoea followed by death in few hours. The acute selenosis is not a frequent problem, since grazing animals avoid accumulator plants if possible (NRC, 2005). In spite of the high hair Se level in this study, no signs of acute or chronic selenosis had been observed on the animals. One reason can be that overdosing inorganic Se supplements not always result in toxicities, but maybe reflected in hair. It has to be stressed out that selenium deficiency is more frequent in farm animals, in spite of the fact that the importance of selenium was discovered throughout its toxic effect (NRC, 2005).

Zn level in the examined population did not show breed differences (Table 1). The values somewhat below the normal range, suggest zinc deficient feeding. Nevertheless, animals in organic farms developed much lower levels (Gabryszuk et al., 2010). Zn is widely distributed in the body; highest levels were detected in bone, liver, skin, and hair (Georgievskii, 1982). Early studies summarized by Combs (1987) demonstrated that dietary Zn intake correlated with hair levels. In cattle and goat, hair reflects more sensitively to the differences in Zn intake than any other tissue (Miller, 1970). Contrary, it has been also concluded that the severity and duration of Zn deficiency cannot be determined (Combs, 1987). Studies with animal hairs used hair samples from unshaved body parts. As hair/wool length approaches its final length, the growth and mineral accumulation slows down. This can be a reason of variable results. Therefore, the adequacy of mineral nutrition should be evaluated based on hair samples collected from the previously shaved skin surfaces.

**Table 1. The effect of breed on the mineral content of cattle hair**

| Breed | Minerals (mg/kg) | | | | | | Source |
|---|---|---|---|---|---|---|---|
| | Ca | Mg | Na | Cu | Se | Zn | |
| Charolais | 1722 | 650.8 | 4916 | 7.58 | 7.02 | 80.7 | this trial |
| Hungarian Simmental | 2406 | 912.2 | 4165 | 5.66 | 9.20 | 84.4 | this trial |
| RMSE** | 376 | 180 | 1300 | 1.21 | 3.06 | 16.6 | |
| P | 0.0007 | 0.0045 | 0.2131 | 0.0023 | 0.1283 | 0.6233 | |
| Holstein Friesian (organic farms) | 587 | 63 | 368 | 2.26 | 0.91 | 37.6 | Gabryszuk et al., 2010 |
| Normal values | - | - | - | 7 | - | 129 | Haenlein and Anke, 2011 |
| Normal values | 1000-2500 | 130-455 | - | 6.7-32 | 0.5-1.32 | 100-150 | Puls, 1994 |
| Normal values | - | 25-30; 100-125* | - | 8.7 | - | - | Fisher et al., 1985 |

*For non-coloured and black hairs; **root mean square error

Hair growth of most species occurs in phases. The length and season of active hair growth periods depends on species, season and body location (Combs, 1987). In the case of cattle body hair has shorter growth and rest periods than tail switch. Furthermore, hair contamination can markedly alter the concentration of some mineral in hair. In that sense, body hair is more suitable than tail switch for analyses. The results of this study demonstrate that the sampling site on the short haired body parts has no influence on mineral composition (Table 2).

**Table 2. The effect of sampling place on the mineral content of Hungarian Simmental cattle hair**

| Sample origin | Minerals (mg/g) | | | | | |
|---|---|---|---|---|---|---|
| | Ca | Mg | Na | Cu | Se | Zn |
| withers | 2402 | 920.5 | 4166 | 5.69 | 9.20 | 84.6 |
| side | 2406 | 907.7 | 4154 | 5.72 | 9.19 | 82.5 |
| quarter | 2410 | 908.7 | 4175 | 5.58 | 9.22 | 86.3 |
| RMSE* | 472 | 217 | 814 | 0.54 | 3.65 | 22.0 |
| P | 0.9992 | 0.9893 | 0.9983 | 0.8333 | 0.9999 | 0.9291 |

*root mean square error

## CONCLUSION

Breed differences exist in Ca, Mg and Cu of hair mineral content even in case of similar nutrition ($P<0.05$). This may reflects metabolic differences. Sampling site of short haired body parts has no influence on hair mineral content. Results of hair analyses showed that the herd had satisfactory mineral status.

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(Received on 1 May 2015; accepted on 3 August 2015)