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Original Paper

The analysis of serum mineral profile of cows before and after calving: A case study

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High-yielding dairy cows have several critical periods during lactation. These include the drying period, parturition, postpartum period and the first 100 days of lactation. The mineral profile displays the balanced feed ration appropriate for the category. Therefore, investigation of serum mineral profile of dry cows and cows in 12th week after calving was the aim of this study. In this work 12 high producing Holstein Friesian dairy cows from dairy farm were used. The analysed elements Ca^{2+}, P, Na^{+}, K^{+}, Mg^{2+} and chlorides (Cl^{-}) were determined at 4th week after drying and during 12th week after calving. The data obtained were compared with the standard for dairy cows. Compared to reference interval, before calving 8 and after calving 5 cows had hypocalcaemia. Hypophosphatemia was detected for 2 cows before calving and 3 after calving. For the other elements Na, K, Mg^{2+} and chlorides (Cl^{-}) no deviations from the reference intervals were found. In blood serum mineral profile between dry cows and cows in 12th week of lactation significant differences were found for Mg Cl^{-} (increase) and K (decrease). Results shown, that main problem of dry and lactating cows was the hypocalcaemia and partly the hypophosphatemia.

Keywords: metabolic test, mineral profile, blood serum, dairy cow

1 Introduction

Focusing on high efficiency of dairy cows constantly deviates the parameters of the internal environment out of the optimal standard. It is also thought that this may significantly affect immune function (Gross et al., 2011). In large dairy farms, metabolic disorders that cause significant losses often occurs. Highly produced dairy cows are most affected. Disorders are referred to production diseases where the causes are nutritional deficiencies, imbalance between energy intake and expenditure, unilateral feeding (Prodanovi et al., 2010), reduced biological value of feed (Šimko et al., 2009), abnormal rumen function (Hanušovský et al., 2017), etc. From the diagnosis point of view, individual disorders, clinical examination remains an important method in the conditions of field practice. However, this method is not sufficient for the overall etiopathological conclusion in production diseases. For a more thorough examination of the herd or individual animals, by taking biological samples is possible to detect production diseases. By analysing are used laboratory diagnostic methods, which are ranked among the metabolic profile test (MPT), we can determine

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the exact cause of production disorders (Bertoni et al., 2009). The metabolic profile test is an important diagnostic method for the detection of preclinical stages of metabolic disorders, especially in dairy farms (Kantíková and Balážik, 2003). The metabolic profile test provide the possibility to sensitively monitor changes in the internal environment of animals caused by various factors. Metabolic disorders can occur latently, especially in the initial period (Hofírek et al., 2009).

They cause serious economic losses in productivity, worsen the feed efficiency, negatively affect the reproductive process and the viability of young animals. The later clinical stage already has clear manifestations and is accompanied by culling of animals or death (Kraft, 2005). The selection of animals for the metabolic profile test should reflect the purpose for which the test is intended to be performed. According to (Kantíková and Balážik, 2003) the most stressful periods for dairy cows are dry period and during third month after calving. This study was therefore aimed to describing the changes in the serum mineral profile during this period.

2 Material and methods

The mineral profile in the blood serum of dairy cows at 4th week after drying and 12th week after calving was determined. In the experiment, 12 dairy cows of Holstein Friesian breed were randomly selected from the herd at VPP-Oponice (Slovak University of Agriculture in Nitra, Slovakia). Dairy cows were on their 4th lactation on average. Dairy cows were fed with a feed ration corresponding to the given category. During 4th week after drying diet composition was as follows (in original matter): 12.0 kg alfalfa silage, 7.0 kg maize silage, 3.0 kg barley straw, 1.0 kg rape seed meal, 0.2 kg mineral premix. During 12th week after calving diet composition was as follows (in original matter): 21.5 kg maize silage, 15.0 kg alfalfa silage, 9.0 kg concentrate feed mixture, 2.0 kg corn grain, 0.25 kg mineral premix. The mineral profile expresses the basic elements in the respective reference values of Ca^{2+}, P, Na, K, Mg^{2+} and chlorides (Cl^-). The blood of dairy cows was collected at 12th hour after morning feeding. Blood collection was performed by a veterinarian using Hemos (Gama Group, Czech Republic) collection kits from the vena caudalis mediana in an amount of 10 ml. After collection, the blood was cooled to 5 °C and processed within 24 hours of collection to obtain the serum. Serum was obtained by centrifuging the blood in a centrifuge (MPW 370, Poland), 2500-3000 rpm. for 10 minutes. The obtained serum was stored in "eppendorf" tubes at -20 °C in a freezer. Serum minerals were determined using biochemical kits according to manufacturer instruction (BIO-LA-TEST, Erba Mannheim). After thawing, blood serum was diluted with the appropriate reagent according to the methodology of the element to be measured. The colour change was measured with a spectrophotometer (UviLine 9400, Reasol). The results were compared with reference values according to the standard for dairy cows (Kahn, 2005), as well as between samplings (4th week after drying vs. 12th week after calving). Statistical processing and evaluation of the results were performed in Microsoft Excel and IBM SPSS v. 20. The significance of the differences in the mean values between the samplings was tested by *t*-test at a significance level of 0.05.

3 Results and discussion

Examination of blood serum from dry cows, at 4th week after drying, confirmed differences in calcium and phosphorus (Table 1), compared to reference interval published by Kahn (2005). The average value for calcium was 2.11 mmol/l, which not reached the down value of reference interval of cows. The highest concentration of serum calcium from all analysed dry cows was 2.56 mmol/l. Within the physiological range of serum calcium were only 4 dry cows. The average concentration of phosphorus was 1.79 mmol/l. Only two dry cows had phosphorus concentration under the physiological range. Concentration of other analysed serum minerals was within physiological interval. Blood serum mineral profile of the same cows was analysed also after calving, during 12th week of lactation (Table 1). Similar as in blood serum of dry cows, in serum of cows during 12th lactation week the deviation from physiological interval was detected for calcium and phosphorus. Serum calcium concentration under the physiological range had 5 lactating cows and the lowest calcium concentration was 1.96 mmol/l. On the other site, the highest serum calcium concentration of lactating cows was 2.82 mmol/l. On average, serum concentration of calcium was higher (P <0.05) in cows during 12th week of lactation. Serum phosphorus concentration had under the physiological range three from twelwe analysed lactating cows and the lowest concentration was 1.42 mmol/l. Difference in phosphorus concentration between sampling times was insignificant (P >0.05). Other analysed serum minerals of lactating cows were within the physiological range, with moderate change. Mg (P <0.01), Na (P >0.05) and Cl^- (P <0.05) concentration was higher in cows' serum at 12th week after calving, compared to serum of dry cows. Between serum of dry cows and cows at 12th week after calving a decrease was detected for K (P <0.05).

Table 1 Serum mineral profile of dry cows before and after calving (mmol/l)

	Physiological interval*	4th week after drying		12th week after calving		*P*-value
		mean ±*S.D.*	range	mean ±*S.D.*	range	
Ca	2.25–2.99	2.11 ±0.26	1.63–2.56	2.39 ±0.31	1.96–2.82	0.032
P	1.62–2.26	1.79 ±0.13	1.56–1.96	1.73 ±0.18	1.42–2.01	0.329
Mg	0.78–1.07	0.90 ±0.05	0.82–0.99	0.95 ±0.04	0.87–1.02	0.008
Na	130–159	145 ±3.30	139–151	148 ±3.24	142–153	0.109
K	4.0–6.0	4.83 ±0.28	4.20–5.20	4.50 ±0.33	4.00–5.00	0.019
Cl^-	96–109	101 ±1.98	97–104	103 ±1.70	100–106	0.015

*Physiological interval according to (Kahn, 2005); *P*-value indicate the significance of difference of mean values between 4th week after drying and 12th week after calving

Phosphorus is presented almost in all tissues, and similar as calcium provides transfer of nutrients on cellular level. Concentration of Ca and P is regulated by parathormone, thyrocalcitonin as well as by vitamin D. Parathormone directly affects the release of Ca from bones and P excretion by kidneys and has also influence on calcinemia. Thyrocalcitonin protect resorption from bones and so decreased the concentration of Ca and P in blood serum. Hypercalcinaemia is in animals rarely and if, is related to overdosage of vitamin D, or to oncological diseases. Hypocalcaemia set in rickets, osteomalation, milk fever, deficit of vitamin D and disorders of resorption in intestine. According to data from literature, the reference interval for phosphorus in cow's blood serum is 1.81 to 2.1 mmol/l (Kaneko, 2008; Blood and Radostis, 1994). In this study some cows had concentration of phosphorus under the lower value of reference interval. Hadžimusić and Krnić (2012) found significant effect of cow's reproductive cycle sage on the concentration of phosphorus, which is in discrepancy with results of this study. The presence of hypophosphatemia is common in time around calving. But Palmer and Eckles (1927) reported hypophosphatemia in animals fed in phosphorous-deficient regions. If occur hypophosphatemia, the muscle weakness, rickets and osteodynia is detected. Occurrence of hypophosphatemia is accompanied with metabolic alkalosis (Šamanc et al., 2010). Similar as in this study, Hadžimusić and Krnić (2012) found significant difference in magnesium concentration between dry cows and lactating cows. Other analysed parameters were within reference intervals published by other authors (Slanina et al., 1991; Aiello, 1998). Beside intake of minerals through feed, according to Hadžimusić and Krnić (2012) also season have significant effect on average values of cows serum mineral profile.

4 Conclusions

Results shown, that main problem of dry and lactating cows was the hypocalcaemia and partly the hypophosphatemia, from blood serum mineral profile point of view. For reduction of presence of hypocalcaemia and hypophosphatemia is important direct feeding and continual monitoring of cows from each group. In the future will be better to determine the mineral profile of also in urine and rumen fluid.

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