Short Paper

Monthly variation in milk serum magnesium concentration in industrial and semi-industrial dairy Friesian herds in Urmia, northeastern Iran

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Summary

Monthly variation of magnesium (Mg) concentration in milk serum was investigated in industrial and semi-industrial dairy herds of Urmia, northeastern Iran, in 2002–3. Total number of 1, 112 milk samples from 96 herds including 615 samples from 53 industrial herds and 497 samples from 43 semi-industrial dairy herds were examined. 10-ml milk samples were collected monthly up to 12 months from each herd in the milk factory. Milk fat was separated by centrifugation. Milk serum was then separated after casein was precipitated by 0.1 N HCl. Spectrophotometery was used to measure the milk Mg concentration, using Mg kit (Ziest Chimi, Iran). The overall mean ± SD of Mg concentration in milk serum in industrial and semi-industrial herds was 5.47 ± 1.15 and 5.35 ± 1.21 mmol/l, respectively. The differences in Mg concentration between breeding systems were significant ($P<0.05$). The highest monthly mean Mg concentration in industrial and semi-industrial dairy herds was 6.39 and 6.05 and the lowest mean was 4.29 and 4.02 mmol/l, respectively. The lowest monthly mean Mg concentration in industrial and semi-industrial dairy milk herds was observed in August; the highest in November. The concentration decreased from March to August and then increased gradually up to November. The mean Mg concentration in milk serum within industrial, semi-industrial herds and between two breeds had a significant ($P<0.001$) monthly variation—mainly in August and November ($P<0.05$). The lowest and highest mean seasonal milk Mg concentration in industrial (4.61, 5.83 mmol/l) and semi-industrial herds (4.53, 5.72 mmol/l) were observed in summer and winter. The mean Mg concentration in milk serum had a significant ($P<0.05$) seasonal variation—between summer and other seasons. Thus, it could be concluded that milk Mg concentration in industrial herds was higher than semi-industrial dairy herds. The lowest milk Mg concentration was observed in August that could be important to supplement magnesium in food of dairy herds in Urmia.

Keywords: Magnesium, Cow, Milk, Season, Subclinical hypomagnesemia

Introduction

Among the nutrients, magnesium (Mg) is necessary in daily intakes of ruminants. Its roles in skeletal system, physiological and enzymatic functions and in reproductive performance have been well-defined. The serum Mg concentration in calves and dairy cows depends on nutrition, milk yield, and serum calcium level, among other things (Radostits *et al*., 2000). Clinicopathological diagnosis are usually made on the Mg level in the cerebrospinal fluid (CSF), serum and bone and less attention has been paid to its concentration in urine and milk. Test of the Analysis CSF is reliable but is not a suitable method for diagnosis. Serum has been recommended but has still its own limitations with preparing the blood sample. Mg is not properly stored in the body, therefore, its variation in serum is mainly a function of absorption and excretion to the milk and urine. Thus, measuring the level of Mg in herd milk is a useful method for determination of herd Mg status as it is feasible and milk preparation without stressing the animals is much easier.

The Mg concentration in cows varies in

body fluids and is reported to be 0.8-1.4 mmol/l in serum (Radostits *et al*., 2000), 1.5 mmol/l in urine (Wittwer *et al*., 1997) and 3.7–5.3 mmol/l in milk (Mostaghni, 2000), ranging from 2 to 9.8 mmol/l. Variation in milk Mg concentration depends on Mg level in food, serum and systemic disorders. Ragheb *et al*., (1998) showed that milk Mg concentration decreases in fungi and mycoplasma mastitis. The similar result reported by Madej *et al*., (1994) in cattle leukemia. Heat stress in summer has been shown to decrease milk Mg concentration (Kume, 1992). Finally, high producing dairy cows had low milk Mg concentration (Gabris and Bajan, 1983). High milk Mg concentration is an appropriate factor for calcium absorption that protects calves from milk tetany (Bomba *et al*., 1993). Several reports show that there are numerous factors affecting milk Mg concentration in ruminants. High milk Mg concentration has not still been revealed any adverse affects on the milk quality. Therefore, to determine the herd nutritional management problems in regard to Mg supplementation, we conducted this study 1) to determine the Mg level in industrial and semi-industrial dairy milk produced under different nutritional management; 2) to detect the monthly and seasonal variation in milk Mg concentration between the two types of nutritional management; and 3) to assess the reliability of milk Mg level in diagnosis of susceptible herds to sub-clinical hypomagnesemia.

Materials and Methods

We studied the Urmia dairy herds located 45 km away from the city, northeastern Iran. Most of milk producers prefer to deliver their production to milk factory by their own car. These big producers are called “industrial dairy herds” because they have many dairy cows and have an official license from the Veterinary Organization and use advanced hygiene and nutritional program. Small milk producers deliver their milk to milk factory via milk collecting companies and call “semi-industrial dairy herds” due to lack of appropriate conditions mentioned before for industrial herds.

A total number of 1,112 milk samples from 96 herds including 615 samples from 53 industrial herds and 497 samples from 43 semi-industrial dairy herds were examined. Location and breeding type were also recorded. Cows were aged from two to seven years.

Ten-ml milk samples were taken from each herd in the milk factory. Milk samples obtained monthly up to 12 months in 2002–3. Number of samples in spring, summer, autumn and winter for industrial herds were 152, 159, 153, 151 and for semi-industrial herds were 125, 129, 123, 120, respectively. The rate of rainfall, humidity and temperature were also recorded monthly up to 12 months to consider the level of regional forage and roughage growth as part of ruminants ration. The ration in industrial dairy herds were included wet and dry lucerne, concentrate, corn and fruit silages supported by bran, straw, urea and salt. The ration in semi-industrial herds was mainly based on lucerne, hay, dry fruit meals and occasionally concentrates. There were however, some seasonal nutritional variations in ration in both breeding systems.

Milk fat was separated by centrifugation. Milk serum was then separated after casein precipitated by 0.1 N HCl. Spectrophotometery was used to measure milk Mg concentration using Mg kit (Ziest Chimi, Iran).

SPSS statistical program was used to establish mean, standard deviation (SD) and the range for data. One-way analysis of variance (ANOVA) and independent-samples Student’s t-test were used for the comparison of the magnesium between months in two different management. Paired samples Student’s t-test were used for the comparison between seasons in industrial and semi-industrial dairy herds.

Results

The overall mean ± SD Mg concentration of milk serum during 12 months in industrial and semi-industrial dairy herds was significantly ($P<0.05$) different. The highest mean monthly Mg concentration in milk of industrial and semi-industrial herds were 6.39 and 6.09 and the lowest mean were 4.29 and 4.02 mmol/l (Table 1). The lowest and highest mean

monthly Mg concentrations in milk of industrial and semi-industrial herds were observed in August and November. The concentration decreased from March to August and then increased gradually up to November. The mean milk Mg concentration between industrial and semi-industrial herds had a significant monthly varaition between the August and November ($P<0.05$).

The lowest and highest mean seasonal Mg concentrations in milk of industrial herds (4.61, 5.83 mmol/l) were in summer and autumn and in semi-industrial herds (4.53, 5.72 mmol/l) were in summer and winter. There was no difference in mean Mg concentration in milk between industrial and semi-industrial herds. There was a significant ($P<0.05$) difference in the mean milk Mg concentration between summer and other seasons in both industrial herds and semi-industrial herds.

Table 1: Monthly mean milk Mg concentration in industrial and semi-industrial dairy herds

Month	Industrial dairy Herds		Semi-industrial dairy Herds	
	n	Mean ± SD	n	Mean ± SD
January	51	5.85 ± 1.27	42	5.67 ± 1.52
February	49	6.08 ± 1.39	41	6.09 ± 1.35
March	49	6.20 ± 1.55	40	6.05 ± 1.93
April	49	5.80 ± 1.22	37	5.61 ± 1.16
May	53	5.31 ± 1.96	43	5.10 ± 1.26
June	53	4.99 ± 0.93	43	5.20 ± 0.80
July	48	4.47 ± 1.08	37	4.40 ± 1.27
August	52	4.29 ± 0.67	43	4.02 ± 0.91
September	53	5.36 ± 0.99	43	5.41 ± 0.71
October	53	5.74 ± 1.38	43	5.51 ± 1.32
November	53	6.39 ± 0.99	43	5.97 ± 1.19
December	52	5.20 ±1.22	42	5.04 ± 0.96
Overall	615	5.47 ± 1.15	497	5.35 ± 1.21

Discussion

To achieve an optimal production in dairy herds attention has been carried out on feeding minerals mainly calcium and magnesium. Results of studies on Mg in calves' serum (Asadi, 2002) and urine (Hashemi, 2002) revealed the possibility of hypomagnesemia among dairy industries in Urmia. Because milk and dairy products are some of the most widespread foods in human and calf diet, they contribute a large fraction of mineral intake. Therefore, international emphasis exists to define the range and amounts of Mg concentration in milk and factors affecting milk Mg concentration too. Milk Mg concentration is constant (Heis, 1989), whereas its amount varied by nutrition, season, heat stress and diseases. The Mg concentration in milk is 3.7 mmol/l (Mostaghni, 2000) and a value <2 mmol/l is considered as hypomagnesemia in cows. That was why this study assessed the reliability of milk Mg for determination of herd Mg status as it showed in 2 herds (0.02 and 1.32 mmol/l).

The results of milk Mg concentration reported in this study, supported by the findings of Fransson and Lonnerdal (1983), Pennington *et al*., (1987), Guzman and Gongora (1992) except in 2 herds in which it was less than the recommended values for milk. The same result was reported in goat milk too (Sawaya *et al*., 1984). That could be attributed to the low level of serum Mg and susceptibility of these herds to subclinical hypomagnesemia. However, significant high Mg concentration in milk of industrial herds was due to consumption of minerals by cows that was not probably the case in semi-industrial herds in which adverse results were found, according to Gabris and Bajan (1983). It means that Mg concentration in milk of high producing cows (industrial herds) should be less than low yielding cows as concluding by Gabris and Bajan (1983). We found that Mg supplements were provided in daily food of

industrial herds.

The role of milk Mg in calves has been well-defined. Calves are susceptible to milk tetany (Heis, 1989) when milk Mg does not meet the requirements. The effects will be more pronounced following post-weaning and rumination at four months of age (Radostits *et al*., 2000). For this reason, these reports refer to at least 2 mmol/l Mg in milk. In this study, calves in industrial herds start to acquire concentrate feeding two weeks after birth. This rarely happened in semi-industrial herds. Mg has also a role in the absorption of milk calcium (Ca). The amount of Ca in milk is ten times of Mg (Guzman and Gongora, 1992) but its absorption is equal to the amount of Mg amount in milk. The side effects of low Ca absorption include rickets and skeletal malformation (Mostaghni, 2000; Radostitis *et al*., 2000). However, in both industrial and semi-industrial herds there was an adequate amount of Mg in milk to prevent the mentioned disorders except in two herds with 0.02 mmol/l in a semi-industrial herd and 1.32 mmol/l in an industrial herd which was corrected by the administration of oral Mg supplementation.

No reports found in relation to monthly or seasonal variation in milk Mg concentration in two different breeds except a study on heat stress in summer by Kume (1992). Previous reports on milk Mg assessment were not designed regularly as it has been done in this study. Serial measurements of Mg concentration in milk of 96 herds over 12 months to establish the milk Mg variations, in different months, seasons and breeds were one of our objectives to find the reliability of this method in determination of Mg status in dairy cows. The presence of significant low Mg concentration in August and summer season indicates that application of milk Mg in detection of herd Mg could be reliable. Low level of milk Mg in August and summer season observed here could be attributed to milk yield, nutrition and heat stress (Heis, 1989). That was the reason to administer oral Mg supplementation in summer in Urmia dairy herds as was recommended by others too (Wittwer *et al*., 1995).

There are a variety of factors affecting the milk Mg in dairy herds. Mycoplasma and fungi mastitis (Ragheb *et al*., 1998), bovine leukemia (Madej *et al*., 1994), heat stress in summer (Kume, 1992) and high milk yield has shown to decrease Mg concentration in milk. These reports show that low milk Mg was more critical and important than that high milk Mg (Gabris and Bajan, 1983). In this study, there were herds with milk Mg levels over 9 mmol/l. In this study the herds were apparently healthy and any variations in milk Mg should be interpreted from a physiological point of veiw, milk yielding and low appetite in summer.

In conclusion, the results of this study showed that the majority of herds under study had an appropriate Mg concentration in milk, though with some variations between months and seasons. The lowest Mg concentration in milk was observed in August or summer season. Milk Mg concentration in two breeding systems varied significantly with the highest amount observed in industrial herds. The presence of low Mg concentration in milk of two herds indicates that this method could be a reliable method in detection of the Mg requirement of herds. Supplementation of oral Mg in summer for Urmia dairy herds is recommended.

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