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STUDY ON THE INTER-SEASONAL SERUM VALUE OF MAGNESIUM AND ITS RELATIONSHIP WITH SOME BIOCHEMICAL PARAMETERS IN HOLSTEIN DAIRY COWS IN AZADSHAHR

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ABSTRACT

Calcium, phosphorus and magnesium are the main mineral elements of body which have many function in dairy cattle especially high producing ones. The aim of present study was to survey on the inter-seasonal serum value of magnesium and its relationship with some biochemical parameters in Holstein dairy cows. In this study, 100 blood samples from apparently healthy hybrid and non-pregnant cows were obtained using venoject tubes from jugular vein. Serum values of magnesium, calcium, total protein, albumin, total bilirubin and glucose was measured by Randox commercial kits (Zeist Shimi) and spectrophotometry method. Data showed that there is significant correlation between Mg, P, Alb, bilirubin and Glu serum values in animals in different seasons. But, there is no significant correlation between Mg and calcium serum levels.

Keywords: Mg, Ca, P, Alb, Bilirubin, Glu, Serum, Cow

INTRODUCTION

The most common reason to assess the trace mineral status of ruminants is because performance is below expectation. Accordingly, the assessment is done to determine the presence or prevalence of nutrient deficiencies (or toxicities) within a population. Assessment also is done to evaluate efficacy of dietary supplementation or to compare available supplements. A critical part of assessment is the determination of the most appropriate measurement criteria. Physiological functions are progressively affected by deficiencies. For example, loss of pigmentation occurs with intakes of Cu that are sufficient for pregnancy maintenance and hemoglobin formation. Pregnancy is not maintained by intakes of Cu that prevent anemia. Furthermore, the disruption to Fe metabolism caused by Cu deficiency does not occur until after most other clinical signs have appeared **[1]**. However, economically important effects on performance and health of animals can be affected by trace element deficiencies even before clinical signs are evident. Thus, the assessment will fail if inappropriate criteria are selected. The purpose of this paper is to review various methods of assessment for trace element status of ruminants.

Calcium, phosphorus and magnesium are the main mineral elements of body which have many function in dairy cattle especially high producing ones. A dietary deficiency or disturbance in metabolism of calcium, phosphorus or vitamin D including imbalance of calcium- phosphorus ratio is the principle cause of osteodystrophies and periparturient hypocalcemia **[2]**. Magnesium deficiency causes lactation tetany in adult dairy cows and hypomagnesemic tetany of calves. Dairy cows during lactation absorb 1.71 g calcium in turn of each gram phosphorous absorption. Body calcium store during gestation and especially in last two months of pregnancy decreases to a very low level. Each kilogram of milk with 4% fat approximately has 1.22 g calcium **[3]**. Then pregnancy and lactation were the most important causes of hypocalcemia in dairy cattle. Amount of phosphorous in dairy cow's feed must be very high because of following reasons: 1- losing high amount of endogenous phosphorous in feces, 2- absorption of phosphorous from alimentary tract is approximately low, 3- high concentration of phosphorous in milk. In contrast to calcium there was not any mechanism for transfer of bone phosphorous to blood stream **[4]**. According to NRC, daily requirement of a 450 kg dairy cow with 18 kg milk production is 4 grams **[5]**. The aim of present study was to survey on the inter-seasonal serum value of magnesium and its relationship with some biochemical parameters in Holstein dairy cows.

MATERIALS AND METHODS

In this study, 100 blood samples from apparently healthy hybrid and non-pregnant cows were obtained using venoject tubes from jugular vein. Samples were transferred to the laboratory in ice packs. Samples were centrifuged and serum was prepared. Then, serum values of magnesium, calcium, phosphorus, total protein, albumin, total bilirubin and glucose was measured by Randox commercial kits (Zeist Shimi) and spectrophotometry method. Data obtained from measurement of serum values was compared each other using SPSS software and ANOVA statistical analyzing method. Also, we used correlation test to indicate relationship between variables.

RESULTS

Based on data given in **Table 1**, it shown that serum value of magnesium in spring, summer, autumn and winter was 3.13±0.62, 3.37±0.78, 2.56±0.53 and 2.73±0.35, respectively. Based on F=26.15 and p=0.000 at 99% confidential level, difference observed between serum value of magnesium in different seasons is statistical significant in which the value in summer was higher than other seasons (P<0.001).

Based on data given in **Table 2**, it shown that serum value of calcium in spring, summer, autumn and winter was 9.906±1.41, 10.08±1.36, 9.207±1.45 and 9.19±1.46, respectively. Based on F=6.21 and p=0.000 at 99% confidential level, difference observed between serum value of calcium in different seasons is statistical significant in which the value in summer was higher than other seasons (P<0.001).

Based on data given in **Table 3**, it shown that serum value of phosphorus in spring, summer, autumn and winter was 5.93±0.89, 6.22±1.32, 5.66±1.44 and 5.34±0.57, respectively. Based on F=5.12 and p=0.002 at 97% confidential level, difference observed between serum value of phosphorus in different seasons is statistical significant in which the value in summer was higher than other seasons (P<0.01).

Based on data given in **Table 4**, it shown that serum value of albumin in spring, summer, autumn and winter was 2.88±0.26, 2.701±0.26, 3.37±0.36 and 3.21±0.27, respectively. Based on F=63.06 and p=0.000 at 99% confidential level, difference observed between serum value of albumin in different seasons is statistical significant in which the value in autumn was higher than other seasons (P<0.001).

Based on data given in **Table 5**, it shown that serum value of total protein in spring, summer, autumn and winter was 7.49±0.53, 7.13±0.55, 8.22±0.76 and 7.99±0.57, respectively. Based on F=36.85 and p=0.000 at 99% confidential level, difference observed between serum value of total protein in different seasons is statistical significant in which the value in autumn was higher than other seasons (P<0.001).

Based on data given in **Table 6**, it shown that serum value of bilirubin in spring, summer, autumn and winter was 0.09±0.03, 0.07±0.05, 0.18±0.08 and 0.15±0.05, respectively. Based on F=38.37 and p=0.000 at 99% confidential level, difference observed between serum value of bilirubin in different seasons is statistical significant in which the value in autumn was higher than other seasons (P<0.001).

Based on data given in **Table 7**, it shown that serum value of Glucose in spring, summer, autumn and winter was 47.84±7.38, 49.18±8.28, 36.27±8.76 and 41.90±12.19, respectively. Based on F=29.54 and p=0.000 at 99% confidential level, difference observed between serum value of Glucose in different seasons is statistical significant in which the value in summer was higher than other seasons (P<0.001).

Based on table 8 and pearson's Correlation index revealed that there is no significant correlation between Mg and Ca serum values so that correlation index was r=0.109 and p=0.085 and confidential level 95%.

Based on **Table 9** and pearson's Correlation index revealed that there is significant correlation between Mg and P serum values so that correlation index was r=0.196 and p=0.002 and confidential level 97%.

Based on **Table 10** and pearson's Correlation index revealed that there is significant and indirect correlation between Mg and Alb serum values so that correlation index was r=-0.311 and p=0.000 and confidential level 99%.

Based on **Table 11** and pearson's Correlation index revealed that there is significant and indirect correlation between Mg and bilirubin serum values so that correlation index was r=-0.342 and p=0.000 and confidential level 99%.

Based on **Table 12** and pearson's Correlation index revealed that there is significant and direct correlation between Mg and Glu serum values so that correlation index was r=0.388 and p=0.000 and confidential level 99%.

Table 1: Comparison Serum Value of Magnesium in Term of Seasons (mg/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	3.13±0.62	8.92	0.34	26.15	0.000
Summer	50	3.37±0.78				
Autumn	100	2.56±0.53				
Winter	50	2.73±0.35				
Total	250	2.87±0.66				

Table 2: Comparison Serum Value of Calcium in Term of Seasons (mg/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	9.906±1.41	12.74	2.05	6.21	0.000
Summer	50	10.08±1.36				
Autumn	100	9.207±1.45				
Winter	50	9.19±1.46				
Total	250	9.52±1.47				

Table 3: Comparison Serum Value of Phosphorus in Term of Seasons (mg/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	5.93±0.89	7.268	1.41	5.12	0.002
Summer	50	6.22±1.32				
Autumn	100	5.66±1.44				
Winter	50	5.34±0.57				
Total	250	5.76±1.21				

Table 4: Comparison Serum Value of Albumin in Term of Seasons (g/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	2.88±0.26	6.079	0.096	63.06	0.000
Summer	50	2.701±0.26				
Autumn	100	3.37±0.36				
Winter	50	3.21±0.27				
Total	250	3.108±0.41				

Table 5: Comparison Serum Value of Total Protein in term of seasons (g/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	7.49±0.53	15.537	0.422	36.85	0.000
Summer	50	7.13±0.55				
Autumn	100	8.22±0.76				
Winter	50	7.99±0.57				
Total	250	7.81±0.77				

Table 6: Comparison Serum Value of Bilirubin in Term of Seasons (mg/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	50	0.09±0.03	0.167	0.004	38.37	0.000
Summer	50	0.07±0.05				
Autumn	100	0.18±0.08				

Winter	**50**	**0.15±0.05**				
Total	**250**	**0.13±0.07**				

Table 7: Comparison serum Value of Glucose in Term of Seasons (mg/dl)

Season	No	Mean	Mean square between groups	Mean square within groups	F	P
Spring	**50**	**47.84±7.38**	**2515.12**	**85.13**	**29.54**	**0.000**
Summer	**50**	**49.18±8.28**				
Autumn	**100**	**36.27±8.76**				
Winter	**50**	**41.90±12.19**				
Total	**250**	**42.29±10.69**				

Table 8: Correlation Index Between Mg and Ca Serum Values

variables	Mg
Ca	**R= 0.109** **P= 0.085** **N= 250**

Table 9: Correlation Index Between Mg and P Serum Values

variables	Mg
P	**R= 0.196** **P= 0.002** **N= 250**

Table 10: Correlation Index Between Mg and Alb Serum Values

variables	Mg
Alb	**R= -0.311** **P= 0.000** **N= 250**

Table 11: Correlation Index Between Mg and Bilirubin Serum Values

variables	Mg
bilirubin	**R= -0.342** **P= 0.000** **N= 250**

Table 12: Correlation Index Between Mg and Glu Serum Values

variables	Mg
Glu	**R= 0.388** **P= 0.000** **N= 250**

DISCUSSION AND CONCLUSION

Blood measures are frequently used in assessment because they are significantly correlated to nutritional status of some trace elements **[1, 6, 7]**, and blood is less invasive to sample than liver. However, there are several limitations to blood analyses. Because red blood cells in cattle have a life span of about 160 d **[8]**, concentrations of minerals in whole blood often change slowly.

Homeostatic control mechanisms can limit changes in concentrations of some trace minerals in plasma until endogenous reserves are substantially depleted **[9]**. Also, careful handling of blood samples is needed to prevent hemolysis and contamination of plasma.

[10] conducted a study with the objectives to examine the influence of dietary calcium on calcium homeostasis and absorption during the prepartum period, on magnesium and phosphorus metabolism, and on calcium, magnesium, and phosphorus in blood. A total of 16 dry Holstein cows were assigned four diet groups combining either 0.2 or 2.1%. The 86 day experiment started 84 days prepartum and completed 2 days postpartum. Magnesium and phosphorus utilizations improved with low diet calcium. Treatment had no significant effect on serum mineral content. Serum calcium decreased by 12%, 2 days postpartum. High calcium diets produced better results when a positive balance was maintained for magnesium and phosphorus.

[11] randomly assigned a salt treatment upon calving to each of 20 Holstein cows. Salt was fed ad libitum. All animals were maintained on a balanced ration of corn silage fed ad libitum and concentrate fed in the barn in a ratio of 0.45 kg concentrate per 1.36 kg milk production. Blood plasma concentrations of calcium, magnesium, sodium, potassium, chloride, phosphorus and total serum protein were monitored throughout lactation and gestation. Calcium and magnesium concentrations were high in younger animals compared with mature animals during much of the lactation period. Magnesium concentration was high in cows fed mineralized salt.

[12] collected data from 1021 calvings of non-paretic Holstein cows, in 14 Quebec dairy herds and described calcium metabolism after calving in healthy cows. Serum calcium, phosphorus, magnesium, potassium, albumin, and glucose were measured first and seventh days post-calving. The distributions were compared between the first and seventh day postpartum. Serum calcium and phosphorus values were low on the first day postpartum compared to a week later, whereas it was the opposite for magnesium, and potassium. No significant difference was observed in albumin values. It was concluded that postpartum hypocalcemia was an event to be expected, especially for the older cow and biochemical profiles near at and after calving could be used to better assess the cow's health.

[13] estimated levels of calcium, inorganic phosphorus and magnesium in 10 healthy buffaloes during late pregnancy, 30, 15 days and 7 days before calving, within 12 h after calving and 7, 15, 30, 45 and 60 days after calving. The almost constant serum concentrations of calcium and phosphorus throughout the study period indicated that these buffaloes need to utilize only a little of their endogenous mineral resources.

[14] conducted a study to determine the serum mineral and electrolyte concentrations in pregnant Murrah buffaloes kept at Livestock farm, Adhartal, India. The mean serum calcium concentration was 11.83±1.17 mg/dl, phosphorus concentration was 4.84±1.44 mg/dl, while mean magnesium concentration was 1.88±0.26 mg/dl and potassium concentration was 31.20±1.59 mg/dl. Sodium was observed to be 247.91±2.91 mg/dl and chloride concentration was 25.56±5.60 m.eq/l while copper and iron concentrations were 21.83±1.54 μg/dl and 93.80±10.36 μg/dl, respectively.

[15] collected blood samples from a total of 131 buffaloes affected with periparturient reproductive and metabolic disorders for the determination of serum calcium, inorganic phosphorus, magnesium, blood glucose and total proteins. For each disorder 10 control samples were also collected. Serum calcium level was found to be low in cases of retention of fetal membranes, uterine prolapse and milk fever. Mean blood glucose level was significantly low in buffaloes with retention of fetal membranes. Magnesium and total protein concentrations were almost the same compared with controls in the cases of milk fever and retention of fetal membranes. It was concluded that the altered metabolic profiles could be the predisposing factor for most of the periparturient disorders in the buffaloes.

[16] collected blood samples from a total of 12 buffaloes for determination of serum calcium, inorganic phosphorus and magnesium. Six sampled buffaloes were affected with uterine prolapse and six with normal parturition as control. The mean serum calcium and phosphorus concentrations were significantly low in buffaloes on the day of prolapse. No significant difference was recorded in the mean magnesium concentrations compared with controls.

[17] conducted a study with the objective to determine monthly variations in serum glucose, cholesterol, total protein (TP), urea, albumin, globulin, albumin/globulin ratio, calcium, phosphorus and magnesium in Nguni, Bonsmara and Angus beef steers raised on sweetveld. Twenty-five Nguni, 15 Aberdeen Angus and 15 Bonsmara 8-month old steers were studied from June 2006 until March 2007. There was a breed x month interaction on calcium, albumin and phosphorus concentrations. Breed had no effect on total protein, urea and globulin concentrations. Breed and month differences obtained could be attributed to changes in environment temperature and nutrient content of the forage **[18]**.

Magnesium exist in the grass used by animals differ between seasons and age of grass. Based on data obtained from present study it shown that decrease in magnesium serum value in different seasons does not relate to serum value of protein.

In the present study, it was found that the mean serum value of magnesium in under study dairy cows is varied in different seasons and serum magnesium levels have been reduced by decreasing the temperature.

So that in the autumn (cold seasons) have been measured at their lowest levels that based on ANOVA statistically difference between the seasons was observed ($P<0.001$). Decreased serum magnesium in winter is due to poor diet that animals fed. Magnesium in the diet, especially in the grass, consider as the main source of animal daily requirement supplier. Because there is indirect relation between grass age and its palatability as well as magnesium concentration in the forage being reduced with its hardness thus, decrease in the magnesium serum value can be attributed to its low content in the grass in the winter so absorption of element is decreased **[2]**.

Also, increase in basal metabolism, decreases serum levels of minerals, especially magnesium. In addition, excessive consumption of straw which is poor of magnesium, especially in the cold season, it could cause a significant decrease in serum magnesium level **[19]**. Higher intake of straw in cold seasons causes increase in salivation which is full of Potassium. Since potassium is one of the main opponents of magnesium absorption from the rumen, so, it yields to increase in excretion of magnesium from the gastrointestinal tract. There is a direct relationship between low magnesium serum value and weather changes and when it is cold, the magnesium level is at its lowest level **[20]**.

In this connection should be noted that when the animal is forced to use fat for energy storage, magnesium intake being increased and therefore causes hypomagnesaemia.

Serum value of Calcium and phosphorus were other factors considered in this study which were in the highest and lowest levels in summer and winter, respectively.

The effect of magnesium on the structure and metabolism of parathyroid hormone and 1,25(OH)2D3 has direct role in homeostasis of calcium and phosphorus in the body, so in case of magnesium deficiency, hypocalcemia and hypophosphatemia are likely to occur **[21]**.

In cows decreased serum magnesium in the body decreases the amount of calcium mobility and considering the role of magnesium in the secretion of parathyroid hormone and activation of vitamin D in the body, so, decrease in serum calcium in cold seasons which is associated with serum magnesium reduction could be significant.

Total bilirubin was another parameter that measured in this study which was at higher and lower levels in cold and hot seasons, respectively.

Due to role of the magnesium in strength and stability of red blood cells membrane, there is an increase in serum bilirubin value in case of magnesium deficiency.

Glucose was another parameter that measured in this study which was at higher and lower levels in hot and cold seasons, respectively. Based on pearson's Correlation index revealed that there is significant and direct correlation between Mg and Glu serum values in which, glucose being increased by increasing the serum value of magnesium **[22]**.

Because of important role of magnesium in the structure of many enzymes that are involved in the Krebs cycle, reduction in serum magnesium interrupting this cycle and yields to decrease in serum glucose.

In present study, it was revealed that serum values of total protein and albumin was higher in cold seasons in compared with hot seasons. So, it can be concluded that decrease of serum magnesium in cold seasons does not relate to serum protein changes.

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