MJAVL

Manas Journal of Agriculture Veterinary and Life Sciences

ISSN 1694-7932 | e-ISSN 1694-7932

Volume 12 (Issue I) (2022) Pages 88-92 https://doi.org/10.53518/mjavl1116266

Determination of Potassium Levels in Dairy Cows in the Periparturient Period

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ABSTRACT

Detection and prevention of hypokalemia which causes economic losses and metabolic diseases in dairy cows had great importance. For this reason, the first objective of this study is to determine the level of blood potassium in dairy cows during the periparturient period and the second objective is to the determination of the relationship between metabolic diseases and blood potassium levels. A total of 60 cows were used in the study. Forty cows of them (Group I; 20 and group II;20) were pregnant and multiparous, and 20 of them with metabolic diseases (ketosis, displacement of abomasum). Blood samples of healthy cattle were taken from v.jugularis twice, 10 ml each time. The first blood sample was taken two weeks before calving, and the second blood sample was taken within two weeks after calving. Blood samples of 20 cattle with metabolic diseases were taken from v.jugularis once, 10 ml. Serum samples were analyzed for Na, K, Cl, Creatinine, AST, LDH, Mg, P, and CPK parameters. The mean potassium level of group I and II healthy cattle after calving was 2.35 ± 0.17 mmol/l and 2.71 ± 0.12 mmol/l, respectively. However, the mean potassium level of cattle with metabolic diseases was also 2.53 ± 0.06 mmol/l. However, the mean potassium level of cattle with metabolic diseases was also 2.53 ± 0.06 mmol/l.

In conclusion, development of negative K balance in dairy cows after birth were detected. Additionally, cattle with displaced abomasum and ketosis were also found hypokalemic.

ARTICLE INFO

Research article
Received: 13.05.2022
Accepted: 12.06.2022

Keywords:
Cattle, Hypokalemia, Potassium

INTRODUCTION

Potassium is the most abundant cation in the intracellular fluid and it plays a vital role in the maintenance of normal cell functions. However, serum potassium concentration is a poor indicator of the potassium status of the animal. An animal with a normal appetite usually has a normal serum potassium concentration (Başpınar et al. 2006). Hypokalemia may occur as a result of decreased dietary intake, increased renal excretion, abomasal stasis, intestinal obstruction and enteritis, and repeated administration of corticosteroids with mineralocorticoid activity (Sattler et al. 1998; Coffer et al. 2006; Batmaz 2011). Animals with hypokalemia have generalized muscle weakness, depression, and muscle fasciculations. Severely affected animals are unable to stand or lift their head from the ground (Constable et al. 2017). A serum potassium concentration <2.5 mEq/L reflects severe hypokalemia; most animals will be weak, and some will be recumbent. A serum potassium concentration of 2.5–3.5 mEq/L reflects moderate hypokalemia (Constable 2017). Hypokalemia (defined as serum or plasma potassium concentration <3.9 mEq/L) is common in lactating dairy cows with leftdisplaced abomasum (LDA), right displaced abomasum (RDA), abomasal volvulus (AV), abomasal impaction, clinical mastitis, dystocia, retained placenta, and hepatic lipidosis (Peek and Dives 1998; Constable 2003; Wittek et al. 2005). Hypokalemia in cattle is commonly encountered secondary to anorexia as well as a number of primary conditions of the gastrointestinal and urinary systems (Smith et al. 2001; Kalaitzakis et al. 2010; Constable et al. 2013). Hypokalemia has also been documented as a potential cause of muscleweakness in cattle of varying ages (Constable 2003). A low serum potassium concentration is a significant predictor of nonsurvival in cattle

To Cite: Toprak Çınar Z, Şen I 2022. Determination of Potassium Levels in Dairy Cows in the Periparturient Period, MJAVL Sciences. 12 (1) 88-92

undergoing surgical correction of LDA or treatment of hepatic lipidosis (Grunberg et al. 2006). The first objective of this study is to determine the level of blood potassium in dairy cows during the periparturient period, and the second objective is to the determination of the relationship between metabolic diseases and blood potassium levels.

MATERIALS AND METHOD

Animal Materials

Two farms were selected for the study. Animals were equally divided into three groups (Healthy cattle; Group I and II, and cattle with metabolic disease; group III), and each group included 20 dairy cattle, and a total of 60 dairy cows were used.

Method

In this study, two different farms were selected to determine the levels of potassium and other parameters before and after calving in healthy pregnant cows feding with different rations.

I. Group: There were 300 dairy cattle on the farm, and selected 20 Holstein cattle, multiparous, between 3 and 5 ages.

II. Group: There were 1200 dairy cattle on the farm, and selected 20 Holstein cattle, multiparous, between 3 and 7 ages.

III. Group: The group were consisted of 20 cattle with metabolic diseases (3 ketosis and 17 displacements of Abomasum) brought to the clinic for treatment, based on routine physical examination results, complete blood count, and serum biochemistry profiles.

Collecting of Blood Sample

Blood samples for biochemical analyses (tubes without anticoagulant) were collected from the vena jugularis before one week from birth time and within two weeks after birth from cattle in groups I and II.

Blood samples were collected only once at admision from cattle with metabolic diseases in group III. Tubes without anticoagulant were kept at room temperature and coagulated. Serum removed by centrifugation for 15 min at 5000 g. Serum samples were stored at -20 ˚C until analyzed.

Serum Na, K and Cl levels were analysed by an automated analyser (BS-200, Mindray, China) using electrod tecnique. Serum AST, Creatinin, CPK, LDH, Magnezium and phosphor leves were analysed by an automated analyser (BS-200, Mindray, China).

Statistically Analyses

All data were presented as mean and standard error of mean (Mean ± SEM). Duncon and wilcoxon test were used to assess the significance of the differences between the groups. The SPSS software program (Version 18.0, SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

RESULTS

Clinical symptoms related to hypokalemia and metabolic diseases in healthy groups I and II were not observed in the study. There was also no decrease in milk production and appetite. Serum potassium levels of healthy groups were mild-moderate decreased (Table 1) after birth compared to before birth values. While serum potassium levels before birth in groups I and II had 2.98±0.14mmol/l and 3.13±0.18 mmol/l respectively (Table 1), serum potassium levels after birth in group I and II cows had 2.35±0.18 mmol/l and 2.71±0.12mmol/l, respectively (Table I). After birth potassium levels were decreased in groups I and II compared to before birth.

Hypokalemia had observed in cows with the displacement of abomasum and ketosis (Group III). The cows also had anorexia, weakness, and decreased milk production. Mean serum potassium levels had 2.53 ± 0.06 mmol/l in cows with metabolic diseases (Table 1).

Serum AST, P, and LDH levels in after birth cows of groups I and II were increased, and serum Na concentration decreased compared with before birth cows of groups I and II (Table 1). While serum creatinine, Mg, and P were decreased, AST, CPK, LDH, and Na were increased in cows with metabolic disease. There was statistically importance among those parameters (Table 1).

Table 1. *Biochemical parameters before and after the birth of healthy cows (Group I and II II) and cows with metabolic diseases (Group III).*

	Group I(n:20)	Group II (n:20)	Group III (n:20)	**P**

		($S \pm S_x$)	($S \pm S_x$)	($S \pm S_x$)		
Creatinine(mg/dl)	BB	0.95±0.05b	0.83±0.04b	1.58±0.09a	0.00	*
	AB	0.86±0.05b	0.78±0.03b	1.58±0.09a	0.00	*
Mg(mg/dl)	BB	2.54±0.09a	2.69±0.13a	1.91±0.14b	0.00	*
	AB	2.44±0.13a	2.36±0.11a	1.91±0.14b	0.01	*
AST (U/L)	BB	48.65±1.52b	50.80±3.26b	206.95±17.96a	0.00	*
	AB	73.84±5.58b	93.00±17.74b	206.95±17.96a	0.00	*
P(mg/dl)	BB	4.97±0.18ab	5.72±0.22a	4.65±0.44b	0.04	*
	AB	5.96±0.29a	5.34±0.26ab	4.65±0.44b	0.03	*
LDH(U/L)	BB	1724.85±61.42b	1752.90±68.82b	2150.45±161.59a	0.01	*
	AB	2083.26±77.59a	1845.63±64.63a	2150.45±161.59a	0.14	
CPK(U/L)	BB	160.65±20.10b	272.90±92.75b	790.20±104.61a	0.00	*
	AB	176.32±28.62b	323.26±90.55b	790.20±104.61a	0.00	*
Na(mmol/l)	BB	100.82±4.91b	103.47±5.45b	139.05±1.19a	0.00	*
	AB	80.11±7.12c	93.66±3.75b	139.05±1.19a	0.00	*
K(mmol/l)	BB	2.98±0.14a	3.12±0.18a	2.53±0.06b	0.01	*
	AB	2.35±0.18a	2.71±0.12a	2.53±0.06a	0.15	

zBB; Before birth, AB; After birth.

a,b,c; differents letter in same columns point significantly importance differences ($p<0.05$) * *;indicates statistically importance

DISCUSSION

Serum potassium concentration is a poor indicator of the potassium status of the animal. The primary source of potassium is the forage portion of the normal ruminant diet. An animal with a normal appetite usually has a normal serum potassium concentration. Hypokalemia in cattle is commonly encountered secondary to anorexia and many primary conditions of the gastrointestinal and urinary systems (Peek et al. 2000). In the meantime, hypokalemia occurs commonly in lactating dairy cows with left displaced abomasum (LDA), right displaced abomasum, abomasal volvulus, abomasal impaction, clinical mastitis, retained placenta, and hepatic lipidosis (Smith et al. 2001; Wittek et al. 2005; Grünberg et al. 2006; Kalaitzakis et al. 2010; Constable et al. 2014). In the present study, healthy cows in the group I and II had mild-modarete hypokalemia after birth (within two weeks). There were also observed hypokalemia in modarete level in cows with metabolic diseases (17 displacement of abomasum and 3 ketosis). Possible causes of low potassium level in cows may be related to loss of appetite and milk yield after birth. We know that lactating cows excrete a significant amount of potassium with milk. Therefore cows in early lactation are in negative K balance (Harrison et al. 2011). Potassium deficiency may be observed in healthy cattle after the decrease in the amount of potassium and urine flow in skeletal muscles (Shalit et al. 1991). A serum potassium concentration <2.5 mEq/L indicate severe hypokalemia; most animals would be weak, and some would be recumbent. A serum potassium concentration of 2.5–3.5 mEq/L indicate moderate hypokalemia, and some cattle would be recumbent or seen weak with depressed GI motility (Grünberg et al. 2006; Constable et al. 2017). In the present study, cows with the metabolic disease had anorexia, weakness, and decreased milk production, but all cows were standing. Serum potassium levels of those cows' mean were 2.53±0.06. Serum potassium levels of healthy groups (group I and II) were mild-moderate decreased (Table 1) after birth. However, those cows have not observed clinical symptoms of hypokalemia. It could be said that all groups of cows had mild-moderate hypokalemia (Table 1) after birth.

Milk yield in dairy cows and the quality of dairy products may be related to diet cation anion balance (DCAD). The minerals constituting the cation-anion balance are Na^+, K^+, CI^-, ve S^{-2}(DCAD: Na+K-Cl+S) (Sweeney 1999). In cases where Na and K concentrations increase in ration, pH in body fluids increases and alkalosis is seen in animals. Hypokalemia often occurs due to metabolic alkalosis due to alkalemia or hyperglycemia (Svendsen 1969; Sattler 1998; Günberg et al. 2006, Constable et al. 2013; Schneider et al. 2016). The existence of the relationship between metabolic alkalosis and hypokalemia in dairy cattle was also emphasized by various researchers **(**Sielman et al. 1997; Sattler et al. 1998; Peek et al. 2000). Hypokalemia commonly occurs due to a compartmental shift of K from the extracellular to intracellular space in cattle with hyperinsulinemia due to hyperglycemia or alkalemia due to metabolic alkalosis (Svendsen 1969; Grünberg et al. 2006; Constable et al. 2013). In the present study, hypokalemia was determined in cattle with metabolic diseases (17 displacements of the abomasum, 3 ketosis) (Table 1). The results of this study showed similarities with the results of those researchers. It could be said that hypokalemia can be seen in cows with the displacement of abomasum and ketosis.

Serum biochemical analysis is required to confirm a suspected diagnosis of hypokalemia. In addition to measurement of serum potassium concentration, measurement of serum concentrations of chloride, sodium, calcium, and phosphorus, and serum activities of AST and CK can be very helpful in guiding treatment (Constable 2017). Sattler et al. (1998) stated that 10 of the 14 cases with hypokalemia were found to have increased hyperglycemia, AST and CK activities as alkalosis and other laboratory findings. In another study, Peek et al. (2000) emphasized that serum AST increase in hypokalemic cows was caused by hepatic lipidosis. In the study, serum AST, CPK, and LDH levels were increased in cows with metabolic disease, but not in cows of groups I and II. Increased serum AST could be related to the fatty liver. AST can be also related with the diseases related clinical syptoms. Increased CPK and LDH might be also related to muscle damage in cows with metabolic diseases. Sattler and Fecteau (2014) stated that there was a relationship between hypokalemia an muscle damage.

CONCLUSION

The results of the study have shown that negative K imbalance might be seen in cows with metabolic diseases, and early lactation of cows. It would be beneficial a little more potassium addition to ration in late pregnancy and early lactation of cows.

ACKNOWLEDGEMENT

This manuscript has been produced from master thesis of Zeynep TOPRAK CINAR.

ETHICAL STATEMENT

During the writing process of the study titled " Determination of Potassium Levels in Dairy Cows in the Periparturient Period", scientific rules, ethical and citation rules were followed; No falsification has been made on the collected data and this study has not been sent to any other academic media for evaluation. This study was aproved by ethics committee of the Faculty of Veterinary Medicine, University of Selcuk (permit number: SÜVFEK 2016/82).

CONFLICT OF INTERESTS

The authors declared no conflict of interest.

AUTHORS CONTRIBUTION

All authors contributed equally.

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