ISSN 1644-0714
ISSN 2300-6145 (online)
www.asp.zut.edu.pl

SCIENTIARUM POLONORUM ACTA *Acta Sci. Pol. Zootechnica 14(3) 2015, 37–48*

INFLUENCE OF LACTOSE SUPPLEMENTATION IN MILK REPLACER ON THE BLOOD PLASMA LEVELS OF SELECTED MICRO- AND MACROELEMENTS IN CALVES

Alicja Dratwa-Chałupnik[1], Katarzyna Michałek[1], Andrzej Olszewski[2]

[1]West Pomeranian University of Technology, Szczecin, Poland
[2]National Research Institute of Animal Production, Kołbacz, Poland

Abstract. Milk replacer overfeeding increases lactose supply, which leads to osmotic diarrhea. Changes in the status of selected micro- and macroelements are observed in calves with diarrhea caused by various pathogenic factors. There is very few data on changes in various blood parameters in calves in response to lactose administration. The primary aim of this study was to search for plasma mineral management indicators that could be used to make a rapid diagnosis of the cause of diarrhea. The experiment was carried out on 8 Polish Holstein-Friesian var. Black-and-White male calves at age two and three weeks. Calves were fed milk replacer. The diet was twice supplemented with lactose in the amount of 1 g $\cdot$ kg^{-1} of body weight. The plasma concentrations of calcium, phosphorus, magnesium, zinc, copper and iron were measured before and after lactose was added. In both age groups, milk replacer with lactose addition most likely increased the passage of the gastric contents and additional water loss in feces. In conclusion, our studies demonstrate that zinc may be considered as a potential diagnostic indicator of the cause of diarrhea. A decrease in plasma zinc concentrations accompanied by an increase in plasma copper values have been observed in response to excessive lactose supply. A decrease in plasma zinc concentrations in two- and three-week-old calves during diarrhea, along with relatively stable values of other micro- and macroelements, may indicate an excess of lactose in milk replacer or an oversupply of milk replacer.

Key words: calves, micro- and macronutrients, neonatal period, transient diarrhea

---

Corresponding author: Corresponding author: Alicja Dratwa-Chałupnik, Department of Physiology, Cell Biology and Proteomics, West Pomeranian University of Technology, Szczecin, Doktora Judyma 6, 71-466 Szczecin, Poland, e-mail: alicja.dratwa-chalupnik@zut.edu.pl

INTRODUCTION

Mortality during the first month of a calf's life high mortality is remarkable. One of the most important causes is diarrhea [Singh et al. 2009]. In calf diarrhea, caused by either infectious and non-infectious factors, loss of water and electrolyte through the gastrointestinal tract is observed, which in turn may lead to water and electrolyte imbalance, and finally to death.

Milk replacer overfeeding increases administration of lactose, osmotically active disaccharide present in the milk of all mammals. Undigested lactose accumulates in the gastrointestinal tract, what leads to water retention and results in osmotic diarrhea [Dratwa-Chałupnik et al. 2012]. Moreover, in calves, the lactose digestive ability depends on lactase activity, that decreases with age. The highest mean jejunal mucosal lactase activity (180 IU) is observed during the first three days of calves life and it is followed by a significant decrease to the value of 100 IU on the fifth day. From the 7th till the 21st day of life the activity of this enzyme remains relatively stable (40–80 IU) [St. Jean et al. 1991].

Changes in the status of selected micro- and macroelements are observed in calves with diarrhea caused by various pathogenic factors [Ranjan et al. 2006, Seifi et al. 2006, Tajik and Nazifi 2013]. There exist a very few data concerning changes in different parameters in calves blood in response to lactose administration [Gutzwiller and Blum 1996, Hugi et al. 1997].

The primary aim of this study was to search indices of mineral metabolism in the blood plasma of calves, that could be used to make a rapid diagnosis of the cause of the diarrhea. Moreover, information concerning above-mentioned plasma minerals changes may be helpful in healing newborn calves from diseases elicited by excessive amount of lactose in milk replacer (or an oversupply of milk substitute preparation). In addition to water and electrolytes administration during healing from diarrhea, it might be worth considering providing these electrolytes which concentration was considerably diminished during diarrhea caused by excessive lactose administration.

To achieve this goal we measured the blood plasma concentrations of calcium, magnesium, zinc, copper, iron and phosphorus in two and three week old calves before and after short-lived lactose addition at an amount of 1 g $\cdot$ kg^{-1} body weight to the milk replacer.

MATERIAL AND METHODS

The experiment was carried out on 8 Polish-Friesian var. Black-and-White male calves during the second (from 13th to 16th day of life) and the third week of life (from 20th to 23rd day of life). From the 4th day of life, animals were fed with the commercial milk replacer twice a day, in amount of 10% of animal body weight. Milk replacer (Mlekovit Imupro®, Poland) contained 23% crude protein, 16% crude fat, 0.1% crude fibre, 45% lactose, 7.5% crude ash, 1.7% lysine, 0.42% methionine 0.9% calcium, 0.7% phosphorus. Furthermore, the monohydrate lactose (Pharma Cosmetic) in amount of 1 g $\cdot$ kg^{-1} of body weight was added twice into the milk replacer: on the 13th and 20th day of life (during the evening feeding) and on the 14th and 21st day of life (during the morning feeding). The use and handling of animals for this experiment was approved by the Local Commission of Ethics for the Care and Use of Laboratory Animals (Resolution No. 3/2010).

Blood was drawn from the jugular vein into the heparin tubes before evening feeding. The samples were centrifuged (15 minutes, 4°C, 3000 rpm) and the harvested plasma was stored at –80°C until processing.

The plasma samples were mineralized in 5 ml of 65% nitric acid (Suprapure, Merck, Darmstadt, Germany) and 0.5 ml of 30% hydrogen peroxide (Suprapure, Merck) in an Anton Paar Multiwave Sample Preparation System (Anton Paar Ltd., Hertford, UK) that allows for temperature and pressure control in the vessels during mineralization. The oven programme was as follows: 0–5 min., generator power increased linearly from 100 to 600 W; 5–10 min., power kept constant at 600 W; 10 min., power increased to 1000 W and kept constant until 20 min. (provided that pressure and temperature did not reach the threshold limit values of 75 MPa and 300°C, respectively); 15 min., the system was cooled.

The prepared samples were analyzed by inductively coupled plasma optical emission spectrometry (ICP-OES) using an Optima 2000 DV spectrometer (Perkin Elmer Inc.). Measurements were made along the plasma in axial direction. The elements were quantified using calibration curves plotted from multi-element standard solution (ICP Multi-element Standard IV, Merck). Yttrium was used as an internal standard.

Mean values and standard deviations were calculated. The resulting data were analyzed using an ANOVA with repeated measurements. The significance of differences was tested with the Duncan post hoc test at the significance level $P \leq 0.05$ (Statistica, StatSoft Inc., Tulsa, OK, USA).

RESULTS

The results obtained from this experiment are shown in Table 1. The concentration of calcium in the blood plasma of two-week-old calves before the administration of lactose was 2.78 mmol $\cdot$ l^{-1}and was statistically significantly higher than that observed in three-week-old calves: 2.56 mmol $\cdot$ l^{-1}. In both experimental groups there was no change in the concentration of this macroelement after lactose administration with the milk replacer.

Table 1. Mean concentration of calcium, phosphorus, magnesium, zinc, copper and iron in the blood plasma of two and three week old calves before and after supply of lactose

Tabela 1. Średnia koncentracja wapnia, fosforu, magnezu, cynku, miedzi i żelaza w osoczu krwi dwu- i trzytygodniowych cieląt przed i po podaniu laktozy

Mineral Pierwiastek	Specification Wyszczególnienie	Two week old calves Dwutygodniowe cielęta				Three week old calves Trzytygodniowe cielęta			
		before przed	after supply of lactose po podaniu laktozy			before przed	after supply of lactose po podaniu laktozy		
			12 h	36 h	60 h		12 h	36 h	60 h
Calcium Wapń	x̄, mmol · l^{-1}	2.78*	2.76	2.75	2.75	2.56#	2.49	2.50	2.50
	SD	0.10	0.10	0.11	0.12	0.09	0.09	0.14	0.08
Phosphorus Fosfor	x̄, mmol · l^{-1}	3.65	3.74	3.79	3.76	3.57	3.56	3.57	3.48
	SD	0.19	0.19	0.27	0.26	0.20	0.19	0.19	0.09
Magnesium Magnez	x̄, mmol · l^{-1}	0.96	0.99	0.98	0.97	0.95	0.94	0.94	0.93
	SD	0.01	0.06	0.04	0.06	0.03	0.01	0.05	0.03
Zinc Cynk	x̄, µmol · l^{-1}	21.04[a]	20.09[a,b]	18.80[b]	18.75[b]	19.78[a]	18.61[a,b]	18.16[a,b]	16.67[b]
	SD	2.46	1.90	1.38	2.41	4.42	2.24	2.90	3.31
Copper Miedź	x̄, µmol · l^{-1}	13.28[a]	13.77[a,b]	14.07[b]	14.53[c]	13.72	13.11	13.54	13.35
	SD	1.78	2.11	2.05	1.70	2.46	2.66	2.89	2.95
Iron Żelazo	x̄, µmol · l^{-1}	22.49	24.01	24.76	24.40	22.61	22.75	23.92	23.79
	SD	9.72	6.59	7.10	9.69	10.99	11.38	12.16	12.25

Different symbols (*#) indicate significant changes in concentrations of parameters with age at $P \leq 0.01$.
Different letters indicate significant differences between concentrations of parameters within age group at $P \leq 0.05$.
Różne symbole (*#) wskazują istotne różnice w koncentracji pierwiastków pomiędzy wiekiem $P \leq 0{,}01$.
Różne litery wskazują istotne różnice w koncentracji pierwiastków w obrębie grup wiekowych $P \leq 0{,}05$.

The concentration of copper in the blood plasma of two-week-old calves before the administration of lactose was 13.28 µmol · l^{-1}. After supply of lactose there was a statistically significant increase in the concentration of this microelement. The initial concentration of copper in the three-week-old calves was 13.72 µmol · l^{-1} and there was no change observed in the concentration of this microelement after administration of lactose in the diet.

The levels of phosphorus, magnesium and iron remained contrast during the two weeks of experiment and no changes after administration of lactose have been observed.

After administration of lactose with milk replacer, in all calves studied a soft stool was observed with a delicate sour odor with small green, mucus streaks, which could indicate a change in the rate of passage of gastric contents.

DISCUSSION

Varying levels of Ca, Mg, Zn, Cu, P, and Fe in the blood of healthy neonatal calves have been reported in different studies (Table 2). In addition, there are few studies describing, apart from electrolytes, also changes in the concentration of macro- and microelements in the blood of calves during diarrhea [Dratwa-Chałupnik et al. 2012]. Moreover, during diarrhea, various changes in the concentration of electrolytes and minerals are observed, most likely because various infectious factors are the cause of their occurrence [Bartels et al. 2010]. The current study describes the effect of lactose induced diarrhea on the concentration of micro- and macro- elements, in the blood of calves.

Average value of calcium concentration in the blood of two-week-old calves was 2.76 mmol $\cdot$ l^{-1}, and three-week-old calves was 2.51 mmol $\cdot$ l^{-1}. Similar levels of this parameter as in the current work were also observed in the studies by Jagoš et al. [1981] in 14- and 21-day-old calves and their mothers, and by Lepczyński et al. [2011] in two-week-old calves, while much lower values were observed by Mohri et al. [2007] in 14- and 28-day-old calves. A decrease of the calcium concentration with age in the blood plasma of the test calves is confirmed by other studies [Birgele and Ilgaza 2003, Mohri et al. 2007, Mohammad 2009, Eshratkhah et al. 2010]. By contrast, Jagoš et al. [1981] showed higher concentration of this macroelement in blood of 21-day-old calves when compared to 14-day-old calves (Table 2). According to Lepczyński et al. [2011], a decrease in the concentration of this macroelement is higher in calves fed milk replacer than in calves fed with mother's milk. Calcium ions are a substrate for many biochemical and physiological processes occurring in cells (tissues), and above all are important in the mineralization of bones [Hunt et al. 2008]. High demand for this macroelement during the growth of the animals may be the cause of its decrease in the blood of calves.

In the present study, there was no change in the calves plasma calcium concentration before and after lactose administration. Tajik and Nazifi [2013] showed hypocalcaemia in calves with diarrhea, and the average concentration of calcium in the blood serum of these animals was 1.297 mmol $\cdot$ l^{-1}. These authors also observed that animals with bloody diarrhea had significantly higher concentrations of Ca in the blood.

Phosphorus is a major component of bones and teeth where it is responsible for maintaining the correct structure of these tissues. It also plays an important role in the growth and restoration of damaged tissues, and energy transmission. The average value of total phosphorus in two-week-old calves was higher than that observed in the three-week-old calves (Table 2). A decrease in the concentration of inorganic phosphorus in the blood between 14th and 21st day of life of calves was

Table 2. Mean concentration of calcium, phosphorus, magnesium, zinc, copper and iron in the blood plasma of two and three week old healthy calves observed in different studies and the current study

Tabela 2. Średnia koncentracja wapnia, fosforu, magnezu, cynku, magnezu i żelaza w surowicy krwi dwu- i trzytygodniowych cieląt w badaniach własnych i innych badaniach

Minerals Pierwiastki		Age, weeks Wiek, tyg.	Mean concentration of minerals observed in: Średnia koncentracja pierwiastków w: this study badania własne	other studies inne badania
Calcium Wapń	mmol · l^{-1}	2	2.76	2.23 Mohri et al. [2007] – Mohri i in. [2007] 2.59 Jagoš et al. [1981] – Jagoš i in. [1981] 2.77 Mohammad [2009] 2.85 Eshratkhah et al. [2010] – Eshratkhah i in. [2010] 2.93 Lepczyński et al. [2011] – Lepczyński i in. [2011]
		3	2.51	2.61 Mohammad [2009] 2.70 Jagoš et al. [1981] – Jagoš i in. [1981]
Phosphorus Fosfor	mmol · l^{-1}	2	3.73	2.56 Jagoš et al. [1981] – Jagoš i in. [1981] 2.57 Mohri et al. [2007] – Mohri i in. [2007] 2.57 Mohammad [2009]
		3	3.54	2.48 Mohammad [2009] 2.70 Jagoš et al. [1981] – Jagoš i in. [1981]
Magnesium Magnez	mmol · l^{-1}	2	0.97	0.56 Eshratkhah et al. [2010] – Eshratkhah i in. [2010] 0.80 Jagoš et al. [1981] – Jagoš i in. [1981] 0.92 Mohammad [2009] 0.95 Mohri et al. [2007] – Mohri i in. [2007] 1.16 Lepczyński et al. [2011] – Lepczyński i in. [2011]
		3	0.94	0.79 Jagoš et al. [1981] – Jagoš i in. [1981] 0.93 Mohammad [2009]
Zinc Cynk	µmol · l^{-1}	2	19.67	8.01 Eshratkhah et al. [2010] – Eshratkhah i in. [2010] 14.20 Mohammad [2009] 17.33 Lepczyński et al. [2011] – Lepczyński i in. [2011] 26.32 Jagoš et al. [1981] – Jagoš i in. [1981]
		3	18.30	14.10 Mohammad [2009] 21.97 Jagoš et al. [1981] – Jagoš i in. [1981]
Copper Miedź	µmol · l^{-1}	2	13.91	14.60 Mohammad [2009] 14.69 Lepczyński et al. [2011] – Lepczyński i in. [2011] 14.90 Jagoš et al. [1981] – Jagoš i in. [1981] 15.92 Eshratkhah et al. [2010] – Eshratkhah i in. [2010]
		3	13.43	15.10 Mohammad [2009] 16.39 Jagoš et al. [1981] – Jagoš i in. [1981]
Iron Żelazo	µmol · l^{-1}	2	23.91	14.00 Mohri et al. [2007] – Mohri i in. [2007] 21.40 Mohammad [2009] 39.19 Jagoš et al. [1981] – Jagoš i in. [1981]
		3	23.27	23.10 Mohammad [2009] 37.77 Jagoš et al. [1981] – Jagoš i in. [1981]

reported by Jagoš et al. [1981], and these levels were higher than those observed in the mothers of those calves.

In the present study, we found no significant changes in plasma phosphorus concentrations after lactose administration in both age groups. However, Walker et al. [1998] observed elevated serum phosphate levels of 3–7-day-old calves with diarrhea. Moreover, Guzelbektes et al. [2007] showed that in calves, the serum phosphorus concentration increases with the degree of dehydration.

There is a correlation between the concentration of calcium and phosphorus in the blood plasma. This relationship was not observed in the current study due to a stable concentration, falling within physiological norms, of both mineral in the blood.

Magnesium is an activator of many enzymes and plays an important role in the organism's growth and skeletal development. Mohammad [2009] observed in calves a decrease of this parameter with age, suggesting that this may be associated with the use of magnesium in the process of bone mineralization. In our study, there was a slight decrease observed in the level of this element in calves with age. Similar observations were made in the study by Jagoš et al. [1981] where 14-day-old calves had 0.80 mmol $\cdot$ l^{-1} Mg in the blood plasma and 0.79 mmol $\cdot$ l^{-1} Mg in 21-day-olds (Table 2). By contrast, Mohri et al. [2007] observed higher concentration of magnesium in the blood of four-week-old calves compared to two-week-olds. Higher concentration of this element was reported by Eshratkhah et al. [2010] in 1–2-month-old calves compared to 1–14-day-olds.

In the study of Tajik and Nazifi [2013], the average level of magnesium in calves with diarrhea was 0.8145 mmol $\cdot$ l^{-1}, which fell within the normal range observed in adult individuals. In the present study, there was no change in the concentration of this element in the blood, in both age groups of animals during the experiment. However, in two-week-old calves at 12 hours after administration of lactose there was a slight increase in the concentration of magnesium in the blood, which then gradually decreased in the following days of the experiment. No significant changes in plasma magnesium concentrations after a short-term lactose administration at the amount of 1 g $\cdot$ kg^{-1} of body weight were observed in both age groups.

Zinc plays a vital role in the proper functioning of the skin and hair, enzymes, and immune system as well as the metabolism of proteins, lipids and sugars. In the current study, the concentration of zinc in blood plasma of 13-day-old calves (21.04 µmol $\cdot$ l^{-1}) was higher than that observed by Lepczyński et al. [2011] in calves of the same age, fed a milk replacer (17.33 µmol $\cdot$ l^{-1}), and much higher than that observed by Mohammad [2009] in 14-day-old calves: 14.2 µmol $\cdot$ l^{-1}. On the 20th day of life of calves studied, a lower concentration of this microelement was noted, i.e., 19.78 µmol $\cdot$ l^{-1}. Jagoš et al. [1981] in calves fed milk replacer, also demonstrated a decrease of the level of zinc in blood plasma between 14th and 21st day of life. Further, Eshratkhah et al. [2010] showed higher concentration of zinc in 1–2-month-old calves compared with 1–14-day-olds (Table 2).

In the present study, in both groups of animals, there was a statistically significant decrease in the concentration of zinc in the blood plasma of calves, most likely due to the loss of this element through gastrointestinal tract during diarrheas observed after the supply of lactose. These observations are confirmed by the findings of Ranjan et al. [2006] in calves aged from 15 to 30 days. These authors reported a significantly lower concentration of zinc in the blood of calves with diarrhea compared to healthy calves. Ranjan et al. [2006] explained low levels of zinc in the blood with reduced bone resorption, loss of this element in the GI tract and the increased demand for zinc of the immune system as well as the use of tissue zinc resources for the synthesis of antioxidant enzymes.

Copper is a cofactor of many enzymes involved, e.g., in the biosynthesis of hemoglobin, iron metabolism, immune response or protection against free radicals. Similar copper level to that observed in the present study in two-week-old calves was also showed by Lepczyński et al. [2011] and by Jagoš et al. [1981]. Level of this microelement was lower in our experiments than in the study of Jagoš et al. [1981] in three-week-old calves. In the present study, in contrast to Jagoš et al. [1981], no age-related change was observed in the copper concentration in the blood of calves (Table 2).

In two-week-old calves on day 3 and 4 of the experiment, there was a statistically significant increase in the copper level in the blood plasma, which was accompanied by diarrhea caused by the lactose administration. However, in three-week-old calves no change in the concentration of this element was detected. Lower copper level in the blood of calves with diarrhea was averagely observed by Tajik and Nazifi [2013]: 10.86 μmol $\cdot$ l^{-1} than that observed in the present experiment. Furthermore, these authors demonstrated a negative correlation between the concentration of copper in the serum and the packed cell volume (PCV). Based on the results obtained, Tajik and Nazifi [2013] considered copper supplementation during the treatment of long-term diarrhea in calves.

Changes in the level of zinc in blood plasma result in the alterations of copper concentration [Lepczyński et al. 2011]. This relationship was observed in the two-week-old calves, in which after lactose administration, a decrease in the zinc concentration has been demonstrated that was accompanied by an increase in the copper blood level.

Iron is an important component of proteins (hemoglobin, myoglobin) involved in the transport and storage of oxygen. This mineral is a part of many enzymes responsible, among others, for energy production, metabolism and proper functioning of the immune system. Higher concentration of iron in the blood plasma of calves compared to results of the present study was obtained by Jagoš et al. [1981]. These authors observed a decrease in the level of this microelement in the blood plasma between 14th and 21st day of life of calves (Table 2). By contrast, Mohri et al. [2007] showed a lower level of iron in the blood and an increase of the concentration of this microelement in the blood with age. In our experiment, the concentration of iron remained at the same level in two- and three-week-old calves. The inconsistencies in changes of blood plasma iron concentrations, observed by different authors (Table 2) are mainly due to large variability in its dietary level and its body storage.

The average concentration of iron in calves with diarrhea in the study of Tajik and Nazifi [2013] was 10.03 μmol · l^{-1} and was lower than the value observed by Mohri et al. [2007] in healthy calves. In the present study, there was no decrease in the level of this element in the blood, after the administration of lactose. On the contrary, an increasing trend was noted. The highest concentration of iron in the blood was obtained in calves on the 3rd day of the experiment when all animals had symptoms of diarrhea. Most studies presents minerals level in the blood of calves during diarrhea cased by pathogenic factor [Ranjan et al. 2006, Seifi et al. 2006, Tajik and Nazifi 2013]. It is commonly known, that iron is involved in the immune response during infection [Cassat and Skaar 2013]. In the current study, we observed no significant changes in mean plasma iron concentrations in calves after lactose administration. It seems that the major cause of the observed phenomenon is the fact that the diarrhea in our calves was evoked by excessive lactose administration.

The results show that short-lived lactose addition at an amount 1 g · kg^{-1} body weight to the milk replacer caused the occurrence of diarrhea in both two- and three-week-old calves. This process was accompanied by a decrease in the concentration of zinc in blood plasma. Moreover, caused by lactose transient diarrhea increased the blood plasma copper concentration however, only in the group of younger animals.

CONCLUSIONS

In conclusion, our studies demonstrate that zinc may be considered as a potential diagnostic indicator to determine the cause of diarrhea. A decrease in plasma zinc concentrations accompanied by an increase in plasma copper values are observed in response to excessive lactose administration. A decrease in plasma zinc concentrations in two- and three-week-old calves during diarrhea, along with relatively stable values of the other micro- and macroelements may indicate on excessive amount of lactose in milk replacer or an oversupply of milk substitute preparation.

ACKNOWLEDGEMENTS

This work was supported by scientific grant from National Centre of Science, Poland, 2011–2013 (Project No. N N311 016239).

REFERENCES

Bartels, C.J., Holzhauer, M., Jorritsma, R., Swart, W.A., Lam, T.J. (2010). Prevalence, prediction and risk factors of enteropathogens in normal and non-normal faeces of young Dutch dairy calves. Prev. Vet. Med., 93, 162–169.

Birgele, E., Ilgaza, A. (2003). Age and feed effect on the dynamics of animal blood biochemical values in postnatal ontogenesis in calves. Vet. IR Zootech., 22, 5–10.

Cassat, J.E, Skaar, E.P. (2013). Iron in Infection and Immunity, Cell Host Microbe., 13, 509–519.

Dratwa-Chałupnik, A., Herosimczyk, A., Lepczyński, A., Skrzypczak, W.F. (2012). Calves with diarrhea and a water-electrolyte balance. Med. Weter., 68, 5–8.

Eshratkhah, B., Sadaghian, M., Dianat, V. (2010). Variations in some plasma macro and micro elements concentrations during different ages of Iranian Sarabi calves. Global Veterinaria, 5, 35–38.

Gutzwiller, A., Blum, J.W. (1996). Effects of oral lactose and xylose loads on blood glucose, galactose, xylose, and insulin values in healthy calves and calves with diarrhea. Am. J. Vet. Res., 57, 560–563.

Guzelbektes, H., Coskun, A., Sen, I. (2007). Relationship between the degree of dehydration and the balance of acid-based changes in dehydrated calves with diarrhea. Bull. Vet. Inst. Pulawy, 51, 83–87.

Hugi, D., Bruckmaier, R.M., Blum, J.W. (1997). Insulin resistance, hyperglycemia, glucosuria, and galactosuria in intensively milk-fed calves: dependency on age and effects of high lactose intake. J. Anim. Sci., 75, 469–482.

Hunt, J.R., Hunt, C.D., Zito, C.A., Idso, J.P., Johnson, LK. (2008). Calcium requirements of growing rats based on bone mass, structure, or biomechanical strength are similar. J. Nutr., 138, 1462–1468.

Jagoš, P., Dvořák, V., Bouda, J. (1981). Levels of mineral in the blood plasma of cows and their calves fed from buckets. Acta Vet. Brno, 50, 33–41.

Lepczyński, A., Herosimczyk, A., Dratwa-Chałupnik, A., Ożgo, M., Michałek, K., Malinowski, E., Skrzypczak, W.F. (2011). Comparative study of selected blood biochemical components in milk or milk-replacer fed calves during the second week of life. Folia Biol. (Kraków), 59, 175–181.

Mohammad, M.A. (2009). Mineral status in blood serum of newborn calves in Assiut Governorate. Bs. Vet. Med., 19, 51–56.

Mohri, M., Sharifi, K., Eidi, S. (2007). Haematology and serum biochemistry of Holstein dairy calves: age related changes and comparison with blood composition in adults. Res. Vet. Sci., 83, 30–39.

Ranjan, R., Naresh, R., Patra, R.C., Swarup, D. (2006). Erythrocyte lipid peroxides and blood zinc and copper concentrations in acute undifferentiated diarrhea in calves. Vet. Res. Commun., 30, 249–254.

Seifi, H.A., Mohri, M., Shoorei, E., Farzaneh, N. (2006). Using haematological and serum biochemical findings as prognostic indicators in calf diarrhea. Comp. Clin. Pathol., 15, 143–147.

Singh, D.D., Kumar, M., Choudhary, P.K., Singh, H.N. (2009). Neonatal calf mortality - an overview. Intas Polivet, 10, 165–169.

St. Jean, G.D., Schmall, L.M., Rings, D.M., Hoffsis, G.F., Hull, B.L. (1991). Jejunal mucosal lactase activity from birth to three weeks in conventionally raised calves fed an electrolyte solution on days 5, 6 and 7 instead of milk. Can. J. Vet. Res., 55, 86–88.

Tajik, J., Nazifi, S. (2013). A preliminary study of the correlations of serum concentrations of electrolytes and trace elements with clinical signs in diarrheic dairy calves. Pak. Vet. J., 33, 5–8.

Walker, P.G., Constable, P.D., Morin, D.E., Drackley, J.K., Foreman, J.H., Thurmon, J.C. (1998). A reliable, practical, and economical protocol for inducing diarrhea and severe dehydration in the neonatal calf. Can. J. Vet. Res., 62, 205–213.

WPŁYW DODANIA LAKTOZY DO PREPARATU MLEKOZASTĘPCZEGO NA STĘŻENIE WYBRANYCH MIKRO- I MAKROELEMENTÓW W OSOCZU KRWI CIELĄT

Streszczenie. Przekarmianie preparatem mlekozastępczym zwiększa podaż laktozy, która powoduje występowanie biegunki osmotycznej. U cieląt z biegunkami wywołanymi różnymi czynnikami patogennymi obserwuje się zmiany w stężeniu mikro- i makroelementów w ich krwi. Sporadyczne są dane na temat zmian różnych parametrów krwi cieląt w odpowiedzi na podawanie laktozy. Głównym założeniem pracy było poszukiwanie wskaźników mineralnych osocza krwi mogących pomóc w zdiagnozowaniu przyczyny obserwowanej biegunki u cieląt noworodków. Badania przeprowadzono na ośmiu cielętach, buhajkach rasy polskiej holsztyno-fryzyjskiej odmiany czarno-białej w pierwszym i drugim tygodniu życia. Cielęta żywione były preparatem mlekozastępczym. Ponadto, dwukrotnie do preparatu mlekozastępczego dodano laktozę jednowodną w ilości 1 g $\cdot$ kg^{-1} masy ciała. W osoczu krwi oznaczono stężenie wapnia, fosforu, magnezu, cynku, miedzi i żelaza przed i po dodaniu laktozy. W obu grupach wiekowych zwierząt dwukrotne podanie do preparatu mlekozastępczego laktozy przyczyniło się do przyśpieszonego pasażu treści pokarmowej i dodatkowo utraty wody wraz z kałem. Badania wykazały, że cynk można uznać za potencjalny wskaźnik diagnostyczny do określenia przyczyny biegunki. W odpowiedzi na podaż nadmiaru laktozy w diecie obniżeniu się stężenia cynku towarzyszyć może wzrost stężenia miedzi w osoczu krwi cieląt noworodków. Obniżenie stężenia cynku w osoczu krwi dwu- i trzytygodniowych cieląt podczas biegunki, przy względnie stabilnym stężeniu pozostałych mikro- i makroelementów może wskazywać na nadmierną ilość laktozy w preparacie mlekozastępczym lub na nadmierną podaż preparatu mlekozastępczego.

Słowa kluczowe: cielęta, mikro- i makroelementy, okres neonatalny, krótkotrwała biegunka

Accepted for print: 24.06.2015

For citation: Dratwa-Chałupnik, A., Michałek, K., Olszewski, A. (2015). Influence of lactose supplementation in milk replacer on the blood plasma levels of selected micro- and macroelements in calves. Acta Sci. Pol. Zootechnica, 14(3), 37–48.