ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LX 6 Number 1, 2012

CONTENT CHANGES OF SELECTED MINERAL NUTRIENTS IN MARE'S COLOSTRUM IN THE FIRST 72 HOURS AFTER FOALING

B. Gálik, M. Šimko, M. Juráček, D. Bíro, F. Buňka, D. Misař, S. Kráčmar

Received: December 19, 2011

Abstract

GÁLIK, B., ŠIMKO, M., JURÁČEK, M., BÍRO, D., BUŇKA, F., MISAŘ, D., KRÁČMAR, S.: *Content changes of selected mineral nutrients in mare's colostrums in the first 72 hours after foaling.* Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 1, pp. 45–48

The aim of this study was to monitor levels of minerals in mare's colostrum in the first 3 days after foaling. Colostrum samples from four warm-blood mares (in three repetitions) were analysed 2, 12, 24, 36, 48 and 72 hours *postpartum*. The samples were obtained by hand milking. Calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), potassium (K), zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) contents were analysed in each sample. Non-significant decrease of *postpartum* Ca and Na contents was found in the analysed samples. Significant differences ($P < 0.05$) in P content were detected between 2 and 36 hours *postpartum*. Content of Mg showed statistically significant differences ($P < 0.05$) during the period after foaling (2, 24, 36, 48 and 72 hours post foaling). Mg concentration reached its maximum (21.8 $g.kg^{-1}$ of dry matter) 2 hours *postpartum* and it dropped to its lowest level (5.27 $g.kg^{-1}$ of dry matter) 48 hours after foaling. Similarly, the highest K content (significant in relation to values obtained 36, 48 and 72 hours *postpartum*) was detected 2 hours after foaling while the lowest K level (37.96 $g.kg^{-1}$ of dry matter) was found 48 hours *postpartum*. As regards the microelements, Cu showed insignificant differences in its postpartum levels ($P > 0.05$). Besides growth of Fe levels, decrease of Zn and Mn ($P > 0.05$) was also observed.

horses, nutrition, macroelements, lactation, differences

Maternal milk is the main source of nutrients for the newborn foals. Normally, they begin to suck within 1 to 2 hours after birth (Kubiak *et al.* 1988, Houpt, 2002) and one-day old foals are nursed up to 10 times per hour (Smith-Funk and Crowell-Davis, 1992). Nutritional composition of the dam's milk is affected by both genetic (Domellhof *et al.*, 2004, Bujko *et al.*, 2009, 2010) and non-genetic factors, such as diet, lactation stage and health status of mammary glands, albeit the mammary glands have been proved to have a good capacity to regulate secretion of trace elements such as Zn, Fe, Cu into milk independently of maternal mineral status (Domellhof *et al.*, 2004). So far, only few studies concerned with the nutrient content in mare's milk (i.e. Gibbs *et al.*, 1982, Schryver *et al.*, 1986, Csapó-Kiss *et al.*, 1995, Csapó *et al.*, 2009) have been published.

MATERIALS AND METHODS

Animal housing and feeding

The aim of the experiment was to monitor the mineral content in mare's colostrum. Four warmblood mares born between 1987 and 1994 were selected for the study. They foaled in February or March. The mares were stabled individually in boxes and they were fed three times per day (25:25:50%) with feed rations formulated from mixture of whole oat (3.5–4 kg), meadow hay (7–9 kg) and mineral feed additives (50 g). The feed rations possessed following average nutritive values: 19.3 $MJ.kg^{-1}$ of digestible energy (DE), 179.8 $g.kg^{-1}$ of crude protein (CP) and 378.6 $g.kg^{-1}$ of crude fibre (CF). Tab. I shows contents of minerals in feed rations

I: *Average content of the mineral nutrients in the mare's diet*

	Ca	P	Mg	Na	K	Zn	Cu	Fe	Mn
	g.kg^{-1}					mg.kg^{-1}			
Oat	1.40	3.60	0.80	4.90	0.30	27.42	3.14	38.40	20.20
Hay	3.90	2.90	1.0	29.30	0.53	22.50	4.60	200.70	55.80
MFM	160	50	65	10	-	2500	400	2500	1800

*MFM: mineral feed mixture

II: *Changes in contents of macroelements in mare's colostrum (g.kg^{-1} of dry matter)*

H		DM	Ca	P	Mg	Na	K
2	Mean ± S.D.	255.3 ± 4.431	38.83 ± 9.378	24.93^{a} ± 9.176	21.8^{abcd} ± 9.224	29.96 ± 13.402	80.68^{abc} ± 20.100
12	Mean ± S.D.	230.4 ± 3.500	30.58 ± 2.156	20.47 ± 5.077	11.33 ± 2.109	20.975 ± 4.007	65.10 ± 3.559
24	Mean ± S.D	231.5 ± 7.801	37.01 ± 8.986	25.86 ± 4.660	8.225^{a} ± 1.735	17.89 ± 1.880	70.29 ± 12.602
36	Mean ± S.D.	187.5 ± 2.052	28.83 ± 10.281	13.0^{a} ± 4.494	6.15^{b} ± 1.015	18.95 ± 6.350	38.60^{a} ± 18.852
48	Mean ± S.D.	120.5 ± 3.320	29.47 ± 9.383	17.47 ± 10.603	5.27^{c} ± 0.551	22.52 ± 8.529	37.96^{b} ± 15.969
72	Mean ± S.D.	115.0 ± 2.130	34.53 ± 9.762	16.62 ± 4.056	10.7^{d} ± 3.223	23.65 ± 4.177	42.59^{c} ± 15.113

*H: hours, DM: dry matter, S.D.: standard deviation, the values with identical superscript in the column are significant at the P<0.05 level.

which were formulated according to daily nutrient requirements for lactating mares (NRC, 2007). The *ad libitum* water intake was provided by automatic feeding pumps. Any health problems or metabolic diseases were observed during the experiment.

Samples collection and laboratory analyses

Mare's colostrum was sampled manually 2, 12, 24, 36, 48 and 72 hours after foaling. Average samples were obtained from total daily colostrum production of each mare separately. After samples collection and relevant treatment to mares' colostrums by lyophilisation, the contents of calcium (Ca), phosphorus (P), magnesium (Mg), sodium (Na), potassium (K), zinc (Zn), copper (Cu), iron (Fe), and manganese (Mn) were analysed. Dry matter content of the samples was detected at the temperature of 103 ± 2 °C. Laboratory samples were mineralized using an APION apparatus. The mineralized samples of mare's colostrum were mixed with 2 ml of HNO_3 (HNO_3 and distilled water, 1:1). The contents of mineral nutrients were determined by a SPECTRAL AA 30 Varian apparatus (Australia) using graphite cuvettes. The determination of individual elements' content was based on the absorptions measured at the following wavelengths: Ca content was detected at 422.7 nm, P at 410.0 nm (phosphomolybdate yellow), Mg at 285.2 nm, Na at 589.0 nm, K at 766.5 nm, Zn at 213.9, Cu at 324.7 nm, Fe at 248.3 nm and Mn at 279.5 nm (AOAC, 2000).

All results were evaluated using the variation statistics; double-way ANOVA with analysis of variance and *t-test* were performed at the probability level lower than 0.05. Correlation matrices and regression functions were calculated according to Snedecor and Cochran (1967) using the statistical package SAS (SAS Inc., New York City, U.S.A.).

RESULTS AND DISCUSSION

Changes of macroelement contents in mare's colostrum throughout the first 72 hours after foaling are shown in Tab. II. The dry matter content decreased from colostrum to milk transformation. A drop in all macroelements content, especially of Mg and K levels, was detected. Similarly significant ($P < 0.05$) decrease of Mg and K contents was reported by Csapó *et al.* (2009). In mammals, K content decrease in both colostrum and milk is typical (Molina *et al.*, 1995). The highest content of Ca in colostrum (38.83 g.kg^{-1} of dry matter) was found 2 hours after foaling. Nonsignificant ($P > 0.05$) decrease of Ca content was detected since then. Similarly to the other macroelements, phosphorus (P) concentration reached its peak 2 hours post foaling (24.93 g.kg^{-1} of dry matter).The minimum of P content (13.0 g.kg^{-1} of dry matter) occurred 36 hours post foaling; these differences were significant ($P < 0.05$). Likewise, the highest Mg content was found 2 hours *postpartum*, while a significant ($P < 0.05$) fall of its content was detected during the first 48 hours after foaling (5.27 g.kg^{-1} of dry matter). Substantially different, that is lower levels of Mg have been reported by Sutton *et al.* (1977). Schryver *et al.* (1986) reported constant content of Na in mare's colostrum and milk, and insignificant differences in its concentration during the lactation. Schryver *et al.* (1986) found average levels of Na at 18 g.kg^{-1} of dry matter in colostrum and milk of mares during the first 3 months of lactation. We detected similar contents of Na ranging between 17.89 and 29.96 g.kg^{-1} of dry matter in mare's colostrum. The content of Na reached its maximum 2 hours *postpartum*; the changes in its levels were not significant ($P > 0.05$). The K content in colostrums showed significant changes ($P < 0.05$). Two hours after foaling, it reached its peak (80.68 g.kg^{-1} of dry matter). Later, 36, 48 and

III: *Changes in contents of microelements in mare's colostrum (mg.kg^{-1} of dry matter)*

H		DM	Zn	Cu	Fe	Mn
2	Mean ± S.D.	255.3 ± 4.431	0.37 ± 0.264	0.08^{a} ± 0.017	0.12 ± 0.038	0.03 ± 0.036
12	Mean ± S.D.	230.4 ± 3.500	0.14 ± 0.079	0.08 ± 0.017	0.16 ± 0.013	0.01 ± 0.007
24	Mean ± S.D.	231.5 ± 7.801	0.20 ± 0.047	0.07 ± 0.010	0.18 ± 0.047	0.01 ± 0.005
36	Mean ± S.D.	187.5 ± 2.052	0.11 ± 0.072	0.06^{a} ± 0.010	0.12 ± 0.010	0.01 ± 0.001
48	Mean ± S.D.	120.5 ± 3.320	0.12 ± 0.099	0.07 ± 0.006	0.14 ± 0.007	0.01 ± 0.001
72	Mean ± S.D.	115.0 ± 2.130	0.16 ± 0.078	0.10 ± 0.038	0.24 ± 0.089	0.01 ± 0.003

*H: hours, DM: dry matter, S.D.: standard deviation, the values with identical superscript in the column are significant at the P<0.05 level

72 hours post foaling, significant ($P < 0.05$) decrease was apparent. The same distribution trends, but different levels of K were also reported by Csapó *et al.* (2009), who studied nutritional composition of mare's colostrum and milk. Generally, the content of zinc (Zn) in colostrums and milk of mares is very low (NRC, 2007). Throughout the experiment with mare's colostrums, it decreased insignificantly ($P > 0.05$). Maximum Zn content in colostrums was detected 2 hours *postpartum* (0.37 mg.kg^{-1} of dry matter, Tab. III) and since then it decreased gradually. Identical results in Zn content in colostrum of mares during the lactation have been reported by Csapó *et al.* (2009), who observed a decrease of Zn content from 0.30 to 0.19 mg.kg^{-1} of dry matter during the first 24 hours after foaling. Similarly, Cieśla *et al.* (2009) detected significant decrease of Zn content in mare's colostrum during the lactation period. Csapó *et al.* (2009) found a specific continual decrease of Zn and Cu contents. However, our results did not confirm the abovementioned change. We detected a significant ($P < 0.05$) decrease of Cu content in mare's colostrum just up to 36 hours after foaling. The content of Fe grew during the first 24 hours *postpartum*. After a moderate decrease, an increase of Fe levels was observed again, but the above changes were not statistically significant ($P > 0.05$). Nevertheless, they were in accord with the tendencies reported by Csapó *et al.* (2009). Throughout our experiment, mare's colostrum did not show any significant differences in Mn content; its levels typically remained low. Our findings differed from the results of experiments implemented by Csapó-Kiss *et al.* (1994), who found increasing content of Mn in colostrum during the first 5 days after foaling.

SUMMARY

The study focused on the changes in mineral composition of mare's colostrums during the first 72 hours after foaling, namely on the variations in macro- and microelement levels. Significant differences in contents of macroelements such as P, Mg and K ($P < 0.05$) were detected. The highest levels of macroelements were found two hours *postpartum*. Regarding microelements contents, significant ($P < 0.05$) changes in Cu content were found throughout the experiment. Except for Fe the contents of microelements reached their maximum 2 hours after foaling. Significant changes were detected in contents of P, Mg, K and Cu in warm-blood mare's colostrums during the first 72 hours after foaling.

Acknowledgements

This study was supported by the Grant agency of Slovak Ministry of Education, Science, Research and Sport and Slovak Academy of Science No. 1/0662/11 and No. MSM 7088352101 which are financed by the Ministry of Education, Youth and Sports of the Czech Republic.

REFERENCES

AOAC, 2000: Official methods of analysis of AOAC International, 17th Ed. Gaithersburg: Maryland, ISBN 09-3-558-4544.

BUJKO, J., PJONTEK, J., ŽITNÝ, J., CANDRÁK, J., 2009: Optimalization of genetic improvement of milk production in population of Slovak spotted breed (in Slovak). Acta fytotechnica et zootechnica. Vol. 12, p. 4–6. ISSN 1335-258X.

BUJKO, J., PJONTEK, J., HRNČÁR, C., 2010: Genetic Improvement of Fat and Proteins Production in Selected Herds of the Slovak Spotted Breed. Lucrari siintifice Zootehnie si Biotehnologii. Vol. 43, No. 2, p. 217–220. ISSN 1221-5287.

CIEŚLA, A., PALACZ, R., JANISZEWSKA, J., SKÓRKA, D., 2009: Total protein, selected protein fractions and chemical elements in the colostrum and milk of mares. Archiv Tierzucht. Vol. 52, No. 1, p. 1–6. ISSN 0003-9438.

CSAPÓ-KISS, Z., STEFLER, J., MARTIN, T. G., MAKRAY, S., CSAPÓ, J., 1994: Protein content, amino acid composition, biological value and

micro- and macroelement content of mare's milk. Acta Alimentaria. Vol. 23, No. 2, p. 179–194. ISSN 0139-3006.

CSAPÓ-KISS, Z., STEFLER, J., MARTIN, T. G., MAKRAY, S., CSAPÓ, J., 1995: Composition of mare's colostrum and milk. Protein content, amino acid composition and contents of macro and microelements. International Dairy Journal. Vol. 5, No. 4, p. 403–415. ISSN 0958-6946.

CSAPÓ, J., SALAMON, S., LÓKI, K., CSAPÓ-KISS, Z., 2009: Composition of mare's colostrum and milk II. Protein content, amino acid composition and contents of macro- and micro-elements. Acta Universitatis Sapientiae Alimentaria. Vol. 2, No. 1, p. 133–148. ISSN 1844-7449.

DOMELLOF, M., LONNERDAL, B., DEWEY, K. G., COHEN, R. J., HERNELL, O., 2004: Iron, zinc and copper concentrations in breast milk are independent of maternal mineral status. American Journal of Clinical Nutrition. Vol. 79, No. 1, p. 111–115. ISSN 0002-9165.

GIBBS, P. G., POTTER, G. D., BLAKE, R. W., McMULLAN, W. C., 1982: Milk production of Quarter Horse mares during 150 days of lactation. Journal of Animal Science. Vol. 54, No. 3, p. 496–499. ISSN 1525-3163.

HOUPT, K. A., 2002: Formulation and dissolution of the mare-foal bond. Applied Animal Behaviour Science. Vol. 78, No. 2–4, p. 319–328. ISSN 0168-1591.

KUBIAK, J. R., EVANS, W., POTTER, G. D., HARMS, P. G., JENKINS, W. L., 1988: Parturition in the multiparous mare fed to obesity. Journal of Equine Veterinary Science. Vol. 8, No. 2, p. 135–140. ISSN 0737-0806.

MOLINA, P., MUELAS, R., FERNANDEZ, N., TORRES, A., CAJA, G., GALLEGO, L., 1995: Change of colostrum composition and factors affecting the level of production and composition of colostrum from dairy ewes. Journal of Dairy Science. Vol. 78, No. 1, p. 233. ISSN 1525-3198.

NRC. 2007: Nutrient requirements of horses, 6th Ed. Washington: National Academies Press, 341 p., ISBN 10-0-309-6696-3.

SCHRYVER, H. F., OFTEDAL, O. T., WILLIAMS, J., SODERHOLM, L. V., HINTZ, H. F., 1986: Lactation in the horse: the mineral composition of mare milk. Journal of Nutrition. Vol. 116, No. 11, p. 2142–2147. ISSN 1541-6100.

SMITH-FUNK, E. D., CROWELL-DAVIS, S. L., 1992: Maternal behavior of draft mares (*Equus caballus*) with mule foals (*Equus asinus* x *Equus caballus*). Applied Animal Behaviour Science. Vol. 33, No. 2–3, p. 93–119. ISSN 0168-1591.

SNEDECOR, G. W., COCHRAN, W. G., 1967: Statistical Methods. 6th Ed. Iowa State University Press. Iowa.

SUTTON, E. I., BOWLAND, J. P., RATCLIFF, W. D., 1977: Influence of level of energy and nutrient intake by mares on reproductive performances and blood serum composition of the mares and foals. Canadian Journal of Animal Science. Vol. 57, No. 3, p. 551–558. ISSN 1918-1825.

SAS Institute Inc: SAS User's Guide: Statistics, 5th Ed. Cary, NC: SAS Institute Inc., 1985.

Address

Ing. Branislav Gálik, PhD., doc. Ing. Milan Šimko, PhD., doc. Ing. Miroslav Juráček, PhD., prof. Ing. Daniel Bíro, PhD., Katedra výživy zvierat, Slovenská poľnohospodárska univerzita v Nitre, Tr. Andreja Hlinku 2, 949 76 Nitra, Slovenská republika, doc. Ing. František Buňka, Ph.D., Ústav technologie a mikrobiologie potravin, prof. Ing. Stanislav Kráčmar, DrSc., Ústav analýzy a chemie potravin, Univerzita Tomáše Bati ve Zlíně, nám. T. G. Masaryka 275, 762 72 Zlín, Česká republika, doc. Ing. Drahoslav Misař, CSc., Ústav chovu a šlechtění zvířat, Mendelova univerzita v Brně, Zemědelská 1, 613 00 Brno, Česká republika, e-mail: Branislav.Galik@uniag.sk; Milan.Simko@uniag.sk, Miroslav.Juracek@uniag.sk, Daniel.Biro@uniag.sk, bunka@ft.utb.cz, kracmar@ft.utb.cz