VETERINARSKI ARHIV 81 (1), 1-11, 2011

Comparison of blood serum macromineral concentrations in meat and dairy goats during puerperium

Marko Samardžija[1]*, Tomislav Dobranić[1], Marija Lipar[2], Ivica Harapin[3], Nikica Prvanović[1], Juraj Grizelj[1], Gordana Gregurić Gračner[4], Vesna Dobranić[5], Berislav Radišić[2], and Dražen Đuričić[6]

[1]*Clinic of Obstetrics and Reproduction, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[2]*Clinic of Surgery, Orthopaedics and Ophthalmology, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[3]*Clinic of Internal Diseases, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[4]*Department of Biology, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[5]*Department of Hygiene and Technology of Animal Origin and Food Staff, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[6]*Veterinary Practice d.o.o. Đurđevac, Đurđevac, Croatia*

SAMARDŽIJA, M., T. DOBRANIĆ, M. LIPAR, I. HARAPIN, N. PRVANOVIĆ, J. GRIZELJ, G. GREGURIĆ GRAČNER, V. DOBRANIĆ, B. RADIŠIĆ, D. ĐURIČIĆ: Comparison of blood serum macromineral concentrations in meat and dairy goats during puerperium. Vet. arhiv 81, 1-11, 2011.

ABSTRACT

The goal of this research was to determine the breed, parity and litter size influence on macromineral levels during puerperium in Boer goats and crossbreeds of German Fawn-improved goats. Twenty Boer goats (8 primiparous and 12 pluriparous) and 10 crossbreeds of German Fawn-improved goats (5 primiparous and 5 pluriparous) between 2 and 6 years old were used in this research. Blood samples were taken every four days, starting on the third day until day 40th of puerperium. Potassium, magnesium, sodium and chloride serum concentrations were determined. These were within physiological ranges in Boer goats and in crossbreeds, without significant differences according to parity and the litter size. Boer goats had significant higher ($P<0.05$) calcium serum level in comparison to crossbreed of German Fawn-improved goats. Phosphorous levels were significantly higher in crossbreed ($P<0.05$) in comparison to Boer goats. Both production goat types had significantly higher ($P<0.05$) phosphorous level in primiparous in comparison to pluriparous goats. It was determined that German Fawn-improved goats had average serum calcium level 2.12 ± 0.05 mmol/L (primiparous) and 2.15 ± 0.05 mmol/L (pluriparous), that is below normal ranges (2.3 to 2.9 mmol/L) whereas Boer goat (meat breed), regardless of parity and the litter size, had significantly higher ($P<0.05$) levels of serum

*Corresponding author:

Prof. Dr. Marko Samardžija, PhD, MSc, DVM, Clinic of Obstetrics and Reproduction, Faculty of Veterinary Medicine, University of Zagreb, Heinzelova 55, 10000 Zagreb, Croatia, Phone: +385 1 2390 169; E-mail: smarko@vef.hr

ISSN 0372-5480
Printed in Croatia

calcium 2.29 ± 0.04 to 2.38 ± 0.02 mmol/L. In our research, crossbred German Fawn-improved goats during puerperium suffered from moderate hypocalcemia.

Key words: Boer goats, macrominerals, number of kids, puerperium

Introduction

Metabolism of macrominerals plays a significant role in the regulation of physiological functions during pregnancy and lactation. All animals require minerals for growth, reproduction and lactation, and they serve as the structural part or components of enzymes and regulate many chemical reactions in the body (AHMED et al., 2000; KRAJNIČAKOVA et al., 2003). The changes in blood concentrations of the minerals have been observed in newly absorbed minerals from the intestine, and redistribution from endogenous stores (PICCIONE et al., 2007). The need for calcium increases at the beginning of lactation. Calcium mobility from the bones and resorption from the gastrointestinal system reaches maximal level due to haemostasis in the body. Calcium metabolism is controlled by hormone calcitonin and parathyreoid hormone (PTH) and vitamin D (1,25-dihydroxivitamine D) (PEREZ et al., 2008). Dairy goats respond promptly to calcium needs, unlike sheep and as a result goats are more often used as research models for cows (LIESEGANG, 2008). The calcium and phosphorous ratio is controlled by numerous ions and hormones in the guts, kidneys and bones. Bones contain 78% of the total phosphorous, and 99% of total calcium, and only 1% of calcium is in the extracellular fluid and soft tissues. Blood levels of calcium and phosphate vary in daily rhythms that have to be considered from urinary excretion rhythm, hormonal control, and bone remoulding processes together with the intestinal absorption rhythms (PICCIONE et al., 2007).

Pasture quality and quantity or well-balanced food enriched by vitamin and mineral additives (JOHNSON and POWLEY, 1990) are the basic preconditions for normal macro and micro-physiological profile in goat serum during puerperium that is variable depending on milk production (KHALED et al., 1999; ZUMBO et al., 2007), the number of kids, parity, season (KRAJNIČAKOVA et al., 2003; YOKUS et al., 2006; SOWANDE et al., 2008; OUEDRAOGO et al., 2008), health condition (TANRITANIR et al., 2009), climate region (DARAMOLA et al., 2005; NDOUTAMIA and GANDA, 2005). Analysis of plasma biochemical parameters in small ruminants is helpful to confirm clinical diagnosis, metabolic disorders and diseases (YOKUS et al., 2006; TANRITANIR et al., 2009). Biochemical parameter interpretation is demanding. Comparison of biochemical results with physiological ranges is complex, because values depend on many factors such as: species, breed, sex, age, nutrition, physiological conditions (pregnancy and lactation), illness and seasonal variations (YOKUS et al., 2006). The Boer goat is well-known for fecundity. In the north-western part of Croatia, there were 32.98% (n = 96) Boer does with singles, 54.64% does with twins (n = 159), 9.97% with triplets (n = 29), 2.41% with quadruplets (n = 7) and one doe had quintuplets (ĐURIČIĆ et al., 2009). The normal macro-mineral ranges in Boer goats during

puerperium in intensive meat production are not well known. In sheep, the concentration of calcium varied during the milking period with the highest values in the late, and the lowest in the mid milking period, however they were always within the reference values. Phosphorus values were significantly higher in the early milking periods with respect to the mid or late milking periods. The values of magnesium were constant during the milking period in dairy sheep (MAŠEK et al., 2007).

The aim of the study was to determine breed, parity and litter size (number of sucklings) influence on macromineral serum levels during puerperium in two different production types and breeds of goats: Boer goats and crossbreeds of German fawn-improved goat.

Materials and methods

Twenty Boer goats (8 primiparous and 12 pluriparous) and 10 crossbred of German fawn-improved goats (5 primiparous and 5 pluriparous) between 2 and 6 years old were used in this research. In the Boer goats, body weight was 60 to 85 kg and in crossbred goats, body weight was 50 to 80 kg. Milk production was measured in the morning and in the evening on the 16th and the 32nd day of puerperium. Suckling kids were separated during the evening suckling on the 15th day after kidding. Milk production was not measured because suckling kids were kept together with their mothers from the 1st to the 15th day post partum. Both groups of goats were living together. According to standard farming practice, the animals had free access to good quality hay and drinking water. Concentrate (700 g per animal per day) (40% corn, 18% soya bean with 44% crude proteins, 15% oats, 15% barley, 9% wheat flour and 3% mineral and vitamin supplement) was provided, every day at the same time, twice a day. Blood samples were taken by vacutainer from the jugular vein every four days, starting on the third and ending on the 40th puerperium day. Blood samples were stored for about 30 minutes at room temperature and centrifuged for 15 minutes at 700 g. In 15 minutes the post-centrifuged serum were separated and serum samples stored at -20 °C until they were analysed. Serum biochemistry tests were done to show the ranges of calcium, phosphorous, potassium, magnesium, sodium and chloride. These tests were performed at the Internal diseases clinic laboratory at the Faculty of Veterinary Medicine Zagreb, Croatia. An Olympus AU 600 analyser (Olympus Diagnostica GMBH, Hamburg, Germany) was used and the standard method of absorptive spectrophotometry. All results were statistically analysed by ANOVA and Tukey tests of post-hoc analysis. Correlation of macroelement ranges, breed, litter size and parity was determined. Statistically significant results were $P<0.05$.

Results

The serum calcium level in Boer goats was between 0.80 mmol/L to 3.33 mmol/L, the average range was 2.35 mmol/L, and S.E.M. was 0.02 mmol/L. The highest serum phosphorous level was 4.53 mmol/L, and the lowest serum phosphorous level was 0.54 mmol/L. The average serum phosphorous level was 2.17 mmol/L, and S.E.M. was 0.05 mmol/L. Serum sodium level was between 122.7 mmol/L and 166.1 mmol/L, the average range was 147.61 mmol/L, and S.E.M. was 0.54 mmol/L. The highest serum potassium level was 6.85 mmol/L, and the lowest serum potassium level was 3.17 mmol/L. The average serum potassium level was 4.84 mmol/L, and S.E.M. was 0.04 mmol/L. The serum chloride level was between 94.20 mmol/L and 130.00 mmol/L, the average range was 108.17 mmol/L, and S.E.M. was 0.37 mmol/L. The highest serum magnesium level was 1.59 mmol/L, and the lowest serum magnesium level was 0.81 mmol/L. The average serum magnesium level was 1.21 mmol/L, and S.E.M. was 0.01 mmol/L. In crossbred German fawn-improved goats the serum calcium level was 1.26 mmol/L to 2.97 mmol/L, average range was 2.14 mmol/L, and S.E.M. was 0.04 mmol/L. The highest serum phosphorous level was 4.18 mmol/L, and the lowest serum phosphorous level was 0.84 mmol/L. The average serum phosphorous level was 2.68 mmol/L, and S.E.M. was 0.09 mmol/L. The serum sodium level was 120.80 mmol/L to 167.60 mmol/L, the average level was 147.54 mmol/L, and S.E.M. was 0.94 mmol/L. The highest serum potassium level was 6.42 mmol/L, and the lowest serum potassium level was 3.37 mmol/L. The average serum potassium level was 4.88 mmol/L, and S.E.M. was 0.07 mmol/L. The serum chloride level was 91.40 mmol/L to 130.00 mmol/L, the average range was 106.55 mmol/L, and S.E.M. was 1.20 mmol/L. The highest serum magnesium level was 1.55 mmol/L, and the lowest serum magnesium level was 0.88 mmol/L. The average serum magnesium level was 1.23 mmol/L and S.E.M. was 0.02 mmol/L. Average milk production measured on the 16th day from puerperium in Boer goats was 1.40 kg and in crossbred German fawn-improved goats 1.95 kg. In Boer goats, on the 32nd day of puerperium, the average milk yield/day was 1.80 and in crossbred German improved goats 3.20 kg. Litter size in primiparous Boer goats was 1.75 in comparison to pluriparous where it was 2.00 kids per goat. German-fawn improved goats had 1.6 kids per goat regardless of parity.

Table 1. Mean values (± SEM) of macromineral levels (mmol/L) according to the groups

	Boer (n = 20)		Crossbred (n = 10)	
	Primiparous (n = 8)	Pluriparous (n = 12)	Primiparous (n = 5)	Pluriparous (n = 5)
Ca	2.29 ± 0.03[a]	2.39 ± 0.02[a]	2.13 ± 0.05[b]	2.15 ± 0.05[b]
P	2.31 ± 0.08[a]	2.07 ± 0.06[b]	2.79 ± 0.13[c]	2.56 ± 0.12[d]
Na	147.82 ± 0.89[a]	147.46 ± 0.69[a]	148.69 ± 1.19 [a]	146.39 ± 1.44[a]
K	4.88 ± 0.08[a]	4.81 ± 0.06[a]	4.92 ± 0.09[a]	4.86 ± 0.09[a]
Cl	107.70 ± 0.67[a]	108.48 ± 0.43[a]	105.77 ± 0.97 [a]	107.33 ± 0.20[a]
Mg	1.19 ± 0.01[a]	1.22 ± 0.01[a]	1.23 ± 0.02[a]	1.24 ± 0.02[a]

Values with different superscripts in the same lines differ significantly (P<0.05)

Table 2. Correlations between calcium (Ca) and phosphorous (P), sodium (Na), potassium (K), magnesium (Mg), chloride (Cl) levels in primiparous and pluriparous Boer goats and German fawn crossbreed goats

	Ca			
	Boer goats		Crossbreds of German fawn-improved goats	
	Primiparous	Pluriparous	Primiparous	Pluriparous
P	r = -0.22; P>0.05	r = 0.17; P>0.05	r = -0.14; P>0.05	r = -0.16; P>0.05
Na	r = -0.14; P>0.05	r = -0.16; P>0.05	r = -0.13; P>0.05	r = -0.09; P>0.05
K	r = -0.01; P>0.05	r = 0.25; P>0.05	r = -0.04; P>0.05	r = -0.08; P>0.05
Mg	r = -0.22; P>0.05	r = -0.21; P>0.05	r = -0.14; P>0.05	r = -0.06; P>0.05
Cl	r = -0.26; P>0.05	r = -0.11; P>0.05	r = -0.12; P>0.05	r = -0.15; P>0.05

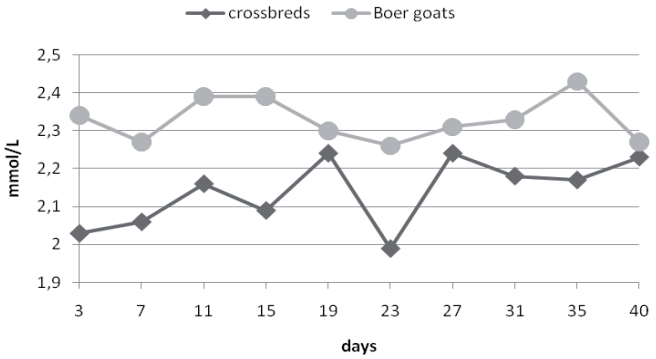

Fig. 1. Serum calcium levels in Boer (n = 20) and crossbred German fawn improved goats (n = 10) during puerperium

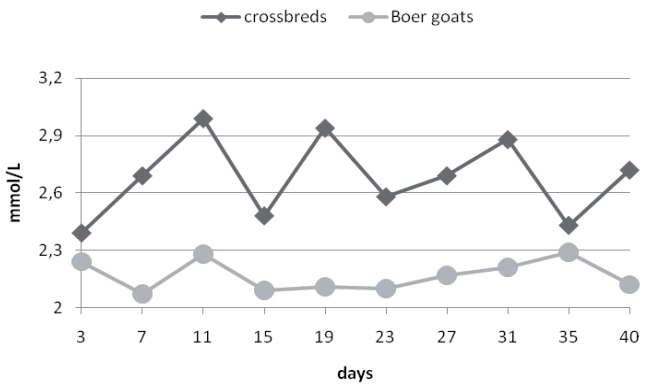

Fig. 2. Serum phosphorous levels in Boer (n = 20) and crossbred German fawn improved goats (n = 10) during puerperium

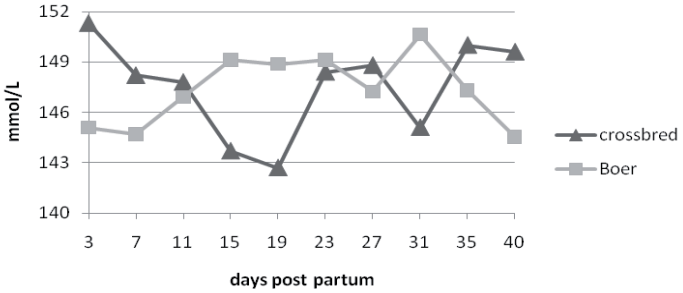

Fig. 3. Serum sodium levels in Boer (n = 20) and crossbred German fawn improved goats (n = 10) during puerperium

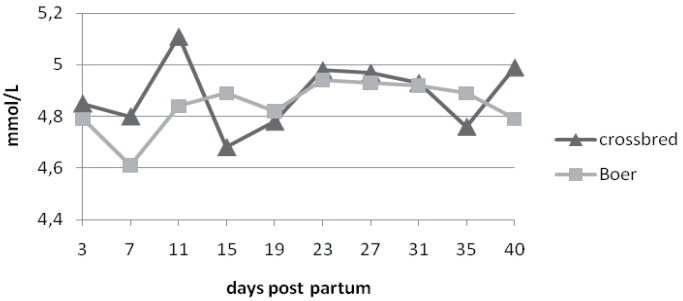

Fig. 4. Serum potassium levels in Boer (n = 20) and crossbred of German fawn improved goats (n = 10) during puerperium

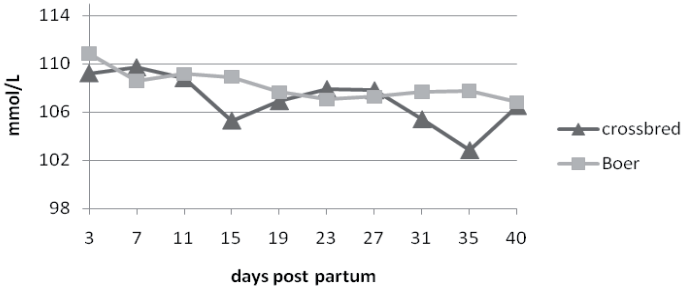

Fig. 5. Serum chloride levels in Boer (n = 20) and crossbred of German fawn improved goats (n = 10) during puerperium

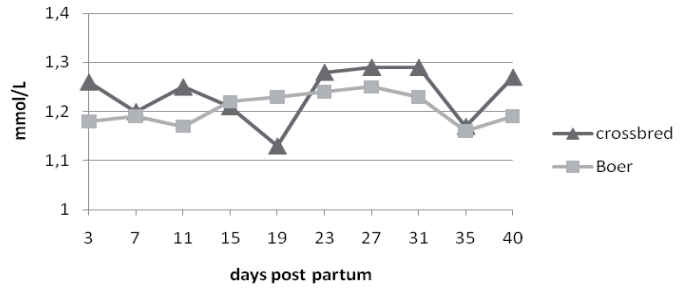

Fig. 6. Serum magnesim levels in Boer (n = 20) and crossbred of German fawn improved goats (n = 10) during puerperium

Discussion

All animals require minerals for growth, reproduction and lactation (AHMED et al., 2000; KRAJNIČAKOVA et al., 2003). After parturition, at the beginning of lactation, the need for calcium increases. Average serum calcium levels in ruminants during puerperium decreases. Calcium levels in serum are reversely proportional to milk production (IVANOV et al., 1990).

According to AHMED et al. (2000), KRAJNIČAKOVA et al. (2003), DARAMOLA et al. (2005), ZUMBO et al. (2007), OUEDRAOGO et al. (2008) and TSCHUOR et al. (2008) all dairy goats during early puerperium suffer from moderate hypocalcaemia. In our research it was determined that German fawn-improved goats had average serum calcium levels of 2.12 ± 0.05 mmol/L (primiparous) and 2.15 ± 0.05 mmol/L (pluriparous), which is below normal ranges (2.3-2.9 mmol/L) according to KANEKO et al. (2008). Furthermore,

KRAJNIČAKOVA et al. (2003) and ĐURIČIĆ (2008) established that hypocalcaemia in the puerperium may been connected to litter size or the number of suckling kids. In contrary to these authors we found no correlation between hypocalcaemia and litter size or the number of suckling kids. In our research litter size in Boer goats was significantly higher ($P<0.05$) (1.90) in comparison to German fawn-improved goats (1.6), and in pluriparous Boer goats (2.00) in comparison to primiparous Boer goats (1.75). Furthermore, we determined that serum calcium levels were equal in primiparous and pluriparous dairy goats (crossbreeds of German fawn-improved goats). In contrast to our results AHMED et al. (2000) found that calcium levels were lower in primiparous Nubian goats at the beginning of lactation. Whereas Boer goats (meat breed) had significantly higher ($P<0.05$) levels of serum calcium: 2.29 ± 0.04 mmol/L in primiparous and 2.38 ± 0.02 mmol/L in pluriparous Boer goats, in comparison to German fawn-improved goats. Nonetheless, for both breeds the levels were within the physiological ranges (KANEKO et al. 2008).

According to our data, in meat and dairy goats, serum phosphorous levels were significantly higher ($P<0.05$) in primiparous in comparison to pluriparous goats. Average serum phosphorous levels in German fawn-improved goats were significantly higher in our research ($P<0.05$) 2.68 ± 0.09 mmol/L in comparison to Boer goats (2.17 ± 0.05 mmol/L). In Maltese goats, ZUMBO et al. (2007) and PICCIONE et al. (2007) found similar phosphorous levels (2.31 ± 0.71 mmol/L and 2.26-2.34 mmol/L respectively). In this research, potassium, phosphorous, magnesium and chloride serum levels were within the physiological ranges in both groups of goats without significant differences due to parity, age and litter size. Furthermore, in goats of various breeds KRAJNIČAKOVA et al. (2003), AHMED (2000), DOBRANIĆ et al. (2008) and ĐURIČIĆ et al. (2008) potassium, phosphorous and magnesium levels were found to be within the physiological ranges. KRAJNIČAKOVA et al. (2003) determined biochemistry parameters in Boer goats during puerperium and also determined sodium levels that decreased significantly until the 28th day of puerperium. At that time sodium levels were 144.0 ± 1.26 and that level did not change until the end of puerperium. This is similar to sodium levels in our research (146.39 ± 1.44 to 148.69 ± 1.19 mmol/L). However, in our research there was no significant decrease in sodium levels in Boer or German fawn-improved goats during puerperium. We determined that potassium concentrations did not change significantly from 4.81 ± 0.06 to 4.92 ± 0.09 mmol/L during puerperium, as mentioned by KRAJNIČAKOVA et al. (2003) 4.68 ± 0.22 to 5.23 ± 0.16 mmol/L, in their research. TSCHUOR et al. (2008) found haematological and biochemical parameters in more than one hundred goats after parturition in Switzerland. They determined the average level of macrominerals in goats which were similar to our results in Boer goats and consisted for sodium 152 mmol/L, potassium 4.7 mmol/L, chloride 108 mmol/L, calcium 2.5 mmol/L, phosphorous 2 mmol/L and magnesium 1.1 mmol/L.

Boer goats had higher calcium serum levels in comparison to dairy (crossbred German improved-fawn) goats, while phosphorous levels were lower in Boer goats. Both production goat types had higher phosphorous levels in primiparous in comparison to pluriparous goats. German fawn-improved goats had average serum calcium levels below the physiological ranges. Analysis of macromineral serum levels in small ruminants during puerperium is helpful for diagnostic purposes of some metabolic disorders in goats.

References

AHMED, M. M. M., A. KHALID SIHAM, M. E. S. BARRI (2000): Macromineral profile in plasma of Nubian goats as affected by physiological state. Small Rumin. Res. 38, 249-254.

DARAMOLA, J. O., A. A. ADELOYE, T. A. FATOBA, A. O. SOLADOYE (2005): Haematological and biochemical parameters of West African Dwarf goats. Livestock Res. Rur. Dev. 7.

DOBRANIĆ, T., M. SAMARDŽIJA, D. ĐURIČIĆ, S. VINCE, D. GRAČNER, N. PRVANOVIĆ, J. GRIZELJ, LJ. BEDRICA, R. RESANOVIĆ (2008): The metabolic profile of boer goats during puerperium XVI. (FeMeSprum). Congress of Mediteranean Federation for Health and Production of Ruminant, Zadar, Croatia, 403-408.

ĐURIČIĆ, D., T. DOBRANIĆ, M. SAMARDŽIJA, I. HARAPIN, S. VINCE, J. GRIZELJ, N. PRVANOVIĆ, D. GRAČNER, LJ. BEDRICA, D. CVITKOVIĆ (2008): Analyse der Ovarienaktivität der Burenziegen im Puerperium mit Hilfe des Stoffwechsel- und Hormonprofils. Tierärztl. Umschau 63, 370-376.

ĐURIČIĆ, D., T. DOBRANIĆ, M. SAMARDŽIJA, S. VINCE, J. GRIZELJ (2009): Fruchtbarkeitsmerkmale der Burenziegen im nordwestlichen Teil Kroatiens. Tierärztl. Umschau 64, 384-388.

IVANOV, I., I. RAJIČ, M. J. JOVANOVIČ, M. LALIĆ (1990): Concentration of calcium in the blood serum in high-pregnant and lactating cows in intensive breeding. Vet. glasnik 44, 359-364.

JOHNSON, C. L., G. POWLEY (1990): Magnesium metabolism in lactating goats fed on grass diets differing in mineral contents. J. Agr. Sci. 114, 133-138.

KANEKO, J. J., W. HARVEY, M. L. BRUSS (2008): Clinical Biochemistry of Domestic Animals, 6th edition Academic Press, San Diego London Boston New York Sydney Tokyo Toronto.

KHALED, N. F., J. ILLEK, S. GAJDUSEK (1999): Interactions between nutrition, blood metabolic profile and milk composition in dairy goats. Acta Vet. Brno 68, 253-258.

KRAJNIČAKOVA, M., G. KOVAČ, M. KOSTECKY, I. VALOCKY, I. MARAČEK, I. ŠUTIAKOVA, L. LENHARDT (2003): Selected clinico-biochemical parameters in puerperal period of goats. Bull. Vet. Inst. Pulawy 47, 177-182.

MAŠEK, T., Ž. MIKULEC, H. VALPOTIĆ, S. PAHOVIĆ (2007): Blood biochemical parameters of crossbred Istrian × East Friesian dairy ewes: relation to milking period. Ital. J. Anim. Sci. 6, 281-288.

LIESEGANG, A. (2008): Influence of anionic salts on bone metabolism in periparturient dairy goats and sheep. J. Dairy Sci. 91, 2449-2460.

NDOUTAMIA, G., K. GANDA (2005): Détermination des paramètres hématologiques et biochimiques des petits ruminants du Tchad. Revue Méd. Vét. 156, 202-206.

OUEDRAOGO, G. A., M. BARRY, B. A. KANWÉ, G. J. SAWADOGO (2008): Variations des profils métaboliques lors de gestation a terme et d'avortement chez des chevres Mossi au Burkina Faso. Revue Méd. Vét. 159, 112-118.

PÉREZ, A. V., G. PICOTTO, A. R. CARPENTIERI, M. A. RIVOIRA, M. E. PERALTA LÓPEZ, N. G. TOLOSA DE TALAMONI (2008): Minireview on regulation of intestinal calcium absorption. Emphasis on molecular mechanisms of transcellular pathway. Digestion 77, 22-34.

PICCIONE, G., A. ASSENZA, F. FAZIO, F. GRASSO, G. CAOLA (2007): Serum concentration of calcium, phosphate and 1,25-dihydroxyvitamin D_3 in goats (*Capra hyrcus*): daily rhythms. J. Appl. Biomed. 5, 91-96.

SOWANDE, O. S., E. B. ODUFOWORA, A. O. ADELAKUN, L. T. EGBEYALE (2008): Blood minerals in WAD sheep and goats grazing natural pasture during wet and dry seasons. Arch. Zootec. 57, 275-278.

TANRITANIR, P., S. DEDE, E. CEYLAN (2009): Changes in some macro minerals and biochemical parameters in female healthy Siirt hair goats before and after parturation. J. Anim. Vet. Adv. 8, 530-533.

TSCHUOR, A. C., B. RIOND, U. BRAUN, H. LUTZ (2008): Hämatologische und klinisch-chemische Referenzwerte für Ziegen und Schafe. Schweiz. Arch. Tierheilk. 150, 287-295.

ZUMBO, A., R. DI ROSA, S. CASELLA, G. PICCIONE (2007): Changes in some blood haematological parameters of Maltese goats during lactation. J. Anim. Vet. Adv. 6, 706-711.

YOKUS, B., D. U. CAKIR, Z. KANAY, G. TOPRAK, E. UYSAL (2006): Effects of seasonal and physiological variations on the serum chemistry, vitamins and thyroid hormone concentrations in sheep. J. Vet. Med. A 53, 271-276.

Received: 11 January 2010
Accepted: 9 July 2010

SAMARDŽIJA, M., T. DOBRANIĆ, M. LIPAR, I. HARAPIN, N. PRVANOVIĆ, J. GRIZELJ, G. GREGURIĆ GRAČNER, V. DOBRANIĆ, B. RADIŠIĆ, D. ĐURIČIĆ: Usporedba razina makroelemenata u krvnom serumu mliječnih i mesnatih pasmina koza u puerperiju. Vet. arhiv 81, 1-11, 2011.

SAŽETAK

Cilj istraživanja bio je odrediti razine makroelemenata u puerperiju mliječnih i mesnatih pasmina koza te usporediti vrijednosti u odnosu na proizvodni tip, dob, paritet i broj jaradi po kozi. Pretraženo je 20 burskih koza (8 primiparnih i 12 pluriparnih) te 10 križanih u tipu njemačke srnaste koze (5 primiparnih i 5 pluriparnih) u dobi od 2 do 6 godina. Uzorci krvi uzimani su svaka četiri dana počevši od trećeg do 40. dana puerperija. Razine kalija, magnezija, natrija i klora bile su u fiziološkim granicama podjednake kod burskih i kod križanih koza, bez značajnih razlika u odnosu na paritet, dob i broj jaradi po kozi. Burske koze, bez obzira na paritet i broj jaradi u leglu, imale su značajno višu ($P<0,05$) prosječnu razinu kalcija u serumu nego koze križane u tipu njemačke srnaste. Prosječna razina fosfora kod križanki u tipu njemačke srnaste koze bila je značajno veća ($P<0,05$) nego

kod burskih. U oba proizvodna tipa mliječnih i mesnih koza, značajno je bila veća (P<0,05) razina fosfora u primiparnih nego u pluriparnih koza. Kod križane koze u tipu njemačke srnaste, mliječne pasmine, prosječna razina kalcija iznosila je 2,12 ± 0,05 mmol/L (primiparne) i 2,15 ± 0,05 mmol/L (pluriparne), što je ispod fiziološke granice (2,3 do 2,9 mmol/L), dok burske (mesni tip) koze, bez obzira na paritet i veličinu legla, imaju značajno višu (P<0,05) razinu kalcija 2,29 ± 0,04 do 2,38 ± 0,02 mmol/L. U ovom istraživanju kod križanki u tipu njemačke srnaste koze određena je umjerena hipokalcemija za vrijeme puerperija.

Ključne riječi: burske koze, makrominerali, broj jaradi, puerperij