

# THE INFLUENCE OF PREGNANCY AND LACTATION ON THE MAGNESIUM AND CALCIUM CONCENTRATION IN GOATS' BLOOD SERUM

**Maria Brzezińska, Monika Krawczyk**

**Chair of Physiology  
University of Szczecin**

## Abstract

The aim of this work was to trace differences in magnesium and calcium concentrations (both total and ionic form) between goats which were in late pregnancy and lactating goats.

The study involved 30 goats. Blood samples were taken three times from each goat. Total concentrations of magnesium and calcium were determined with the colorimetric method and (A – 1.581 mmol dm<sup>-3</sup>; B – 2.052 mmol dm<sup>-3</sup>; C – 2.112 mmol dm<sup>-3</sup>). Ionic form of calcium based on using ion-selective analysis (A – 1.219 mmol dm<sup>-3</sup>; B – 1.126 mmol dm<sup>-3</sup>; C – 1.123 mmol dm<sup>-3</sup>).

The study showed that mean value of both the total of calcium from each goat did not reach the reference level for this species. Ionic form of calcium was within the lever limit of the physiological norm.

The content of magnesium in all the groups was within the range of reference concentrations (A – 1.051 mmol dm<sup>-3</sup>; B – 1.165 mmol dm<sup>-3</sup>; C – 1.117 mmol dm<sup>-3</sup>).

Key words: goats, pregnancy, lactation, macroelements.

## WPŁYW CIĄŻY I LAKTACJI KÓZ NA STĘŻENIE MAGNEZU I WAPNIA W SUROWICY

## Abstrakt

W pracy przedłożono różnice stężeń magnezu i wapnia (całkowitego i zjonizowanego) między kozami będącymi w ciąży a kozami laktującymi.

Badaniem objęto 30 kóz. Krew od zwierząt pobierano 3-krotnie. Stężenie magnezu i wapnia  $\text{Ca}^{2+}$  oznaczono metodą kolorymetryczną, natomiast stężenie wapnia zjonizowanego – metodą jonoselektywną.

Stwierdzono, że średnia zawartość wapnia  $\text{Ca}^{2+}$  w badanych grupach kóz nie osiągnęła norm referencyjnych dla tego gatunku (A –  $1,581 \text{ mmol dm}^{-3}$ , B –  $2,052 \text{ mmol dm}^{-3}$ , C –  $2,112 \text{ mmol dm}^{-3}$ ). Poziom zjonizowanych form wapnia był korzystniejszy u wszystkich objętych badaniem kóz, choć jego wartości znajdowały się w dolnych granicach referencyjnych (A –  $1,219 \text{ mmol dm}^{-3}$ , B –  $1,126 \text{ mmol dm}^{-3}$ , C –  $1,123 \text{ mmol dm}^{-3}$ ). Wyniki stężeń wapnia w surowicy krwi nie zawsze stanowiły dobre odzwierciedlenie stopnia pokrycia zapotrzebowania zwierząt na ten pierwiastek, ponieważ podlega on stosunkowo precyzyjnej regulacji homeostatycznej. Dlatego optymalny poziom  $\text{Ca}^{2+}$  w surowicy krwi nie jest równoznaczny z dostateczną jego ilością w organizmie. Niższy od norm świadczy jednak o jego niedoborze.

Poziom magnezu u wszystkich badanych kóz podczas  $\text{Ca}^{2+}$  okresu doświadczenia mieścił się w normie (A –  $1,051 \text{ mmol dm}^{-3}$ , B –  $1,165 \text{ mmol dm}^{-3}$ , C –  $1,117 \text{ mmol dm}^{-3}$ ), co może świadczyć o dostatecznym doborze pokarmu pod względem zapotrzebowania zwierząt w ten makroelement.

Słowa kluczowe: kozy, ciąża, laktacja, makroelementy.

## INTRODUCTION

Magnesium is the fourth most common and the second (next to potassium) most abundant intracellular cation in organisms (PASTERNAK 1999). This element plays an important role in the regulation of many significant biological processes, and especially in enzymatic reactions. Magnesium balance is maintained in the organism via the intestinal absorption processes and precisely controlled renal excretion. Magnesium absorption from food in the alimentary tract is very low in comparison with absorption of other elements. Magnesium absorbed in the blood in the form of  $\text{Mg}^{2+}$  enters a pool from which it is later accumulated in bones and other tissues. Under proper conditions, part of magnesium assimilated by tissues returns to the blood pool, from which it is excreted through the intestine with faeces (so-called endogenous magnesium) and through the kidneys with urine. A considerable amount of magnesium absorbed from food and released from tissues into the blood is excreted together with milk during intensive lactation, which predisposes lactating females to hypomagnesaemia. Determination of magnesium requirement is difficult and raises many objections. It depends mainly on the amount of magnesium absorbed in the alimentary tract and excreted with urine. Magnesium requirement increases, for example, during pregnancy and lactation (GABRYSZUK 1992).

Magnesium ions are physiological antagonists of calcium ions. Calcium in organisms can be divided into two pools: an easily exchangeable calcium pool and a much bigger pool of non-exchangeable calcium. The former is responsible for the regulation of  $\text{Ca}^{2+}$  concentration in the blood plasma, the latter – for the resorption of calcium from bones and its re-incorporation.

Calcium stored in the bone tissue is an important reserve used in times of deficiency and that is why in physiological conditions its concentration in the blood remains at a steady level, because whenever calcium in food is deficient, it permeates from the bones into the blood. From 30% to 80% of calcium provided with food is absorbed. Calcium is absorbed during the active transportation of  $\text{Ca}^{2+}$  ions in the upper part of the small intestine, where there is also some calcium absorption through passive diffusion. Calcium absorption is adjusted to the organism's requirements. It increases when there is a deficiency of  $\text{Ca}^{2+}$  ions, and decreases when there are too many of these ions (BARANOW-BARANOWSKI et al. 2001). Regarding calcium requirements of animals, their physiological state should be considered. During pregnancy and lactation, for example, calcium requirement is high. Calcium requirement grows rapidly right after the delivery, which is connected with the excretion of considerable amounts of this element with milk (GABRY-SZUK 1992).

This paper aims at the determination of differences in magnesium and calcium (total and ionized) concentration in pregnant goats and lactating goats maintained on the same feeding regime. Another objective was to compare and interpret the results for the purpose of their application in breeding.

## **MATERIALS AND RESEARCH METHODOLOGY**

The research was carried out on 30 Saanen goats from a private farm in Ćwierznica near R<sup>1</sup>bin. All of the animals were clinically healthy, kept under identical hygienic conditions and fed identical fodder doses (oats – 0.7 kg/a goat/a day, hay – *ad libitum*, 20% high-protein concentrate for goats – 0.21 kg/a goat). The research material was the venous blood which was taken three times:

group 1 – blood taken on 16.12. 2002 – pregnant goats, the second half of pregnancy,

group 2 – blood taken on 06.02.2003 – goats in the initial lactation period,

group 3 – blood taken on 02.04.2003 – goats in the advanced lactation period.

The following biochemical marking was carried out in the blood serum:

- 1) the colorimetric analysis without deproteinization was used to determine the total magnesium concentration; Bio-Merieux reagents and calmagite EGTA as an indicator were applied;
- 2) the colorimetric analysis without deproteinization was also used for determination of the total calcium concentration; Bio-Merieux reagents and methylene blue as an indicator were applied;
- 3) ionized calcium concentration was marked by means of the ion-selective method with the application of the electrolyte analyser AVL 9180.

Table 1 and Figures 1-3 present the results of the research: arithmetic means and standard deviations as well as the results of a comparison of the arithmetical means obtained with an aid of Statistica 6.0 software.

Table 1

Magnesium and calcium concentration in the blood serum

Group	Total magnesium (mmol dm <sup>-3</sup> )			Total calcium (mmol dm <sup>-3</sup> )			Ionized calcium (mmol dm <sup>-3</sup> )		
	1	2	3	1	2	3	1	2	3
N	10	10	10	10	10	10	10	10	10
X	1.051	1.165	1.117	1.581	2.052	2.112	1.219	1.126	1.123
SD	0.23	0.17	0.03	0.69	0.22	0.32	0.05	0.07	0.06
Maximum	1.52	1.42	1.16	3.14	2.44	2.56	1.31	1.21	1.25
Minimum	0.70	0.85	1.08	0.69	1.78	1.65	1.13	1.02	1.04
Reference value	0.74-1.62			2.20-3.05			1.12-1.32		
Statistically significant differences	-			1:2 >0.01 1:3 >0.01			1:2 > 0.01 1:3 > 0.01		

N – number of subjects, X – arithmetic mean, SD – standard deviation, 1 – goats in advanced pregnancy, 2 – goats in initial lactation period, 3 – goats in advanced lactation period

## RESULTS AND DISCUSSION

In this research, magnesium concentration in the blood serum in all of the tested goat groups was within the standard limits accepted for the species; it is presented in Table 1 and Figure 1. In the first test, the average magnesium concentration was 1.051 mmol dm<sup>-3</sup>, in the second test: 1.165 mmol dm<sup>-3</sup>, and in the third test: 1.117 mmol dm<sup>-3</sup>. There were no statistically significant differences between the average magnesium concentrations during comparable testing periods. It may be assumed that the goats' physiological state had little influence on the level of magnesium in the blood serum, which was probably owing to the proper feeding during the entire pregnancy and in the preceding period. The assessment of magnesium requirement on the basis of its content in fodder is possible only conditionally, since it is the effective use of magnesium that plays a decisive role in this respect. Magnesium absorption can be lower when there is too much K<sup>+</sup> (KRUCZYŃSKA, MOCEK 1997, BARANOW-BARANOWSKI et al. 2001). Magnesium requirement increases, for instance, during pregnancy and lactation. Magnesium deficiency can occur in ruminants fed with large amounts of low magnesium fodder or with fodder containing much of magnesium antagonists (KANIA 1998).

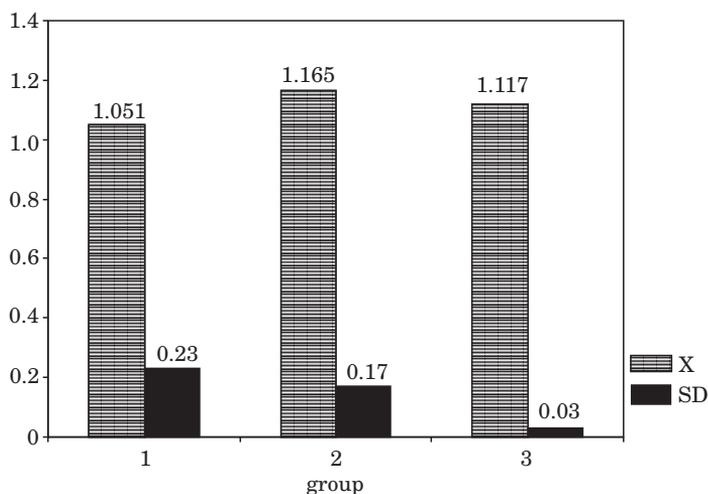


Fig. 1. Magnesium concentration ( $\text{mmol dm}^{-3}$ ) in blood serum

Both the level of total calcium and ionized calcium in the animals' blood was tested. Total calcium concentration showed considerable fluctuations in all tested groups; it is presented in Table 1 and Figure 2. None of the average values of total calcium in the comparable tests was within the reference value limits (WINNICKA 2002). The results indicate total calcium deficiency in the pregnant goats' blood serum. The average total calcium value was the lowest during pregnancy – group 1.

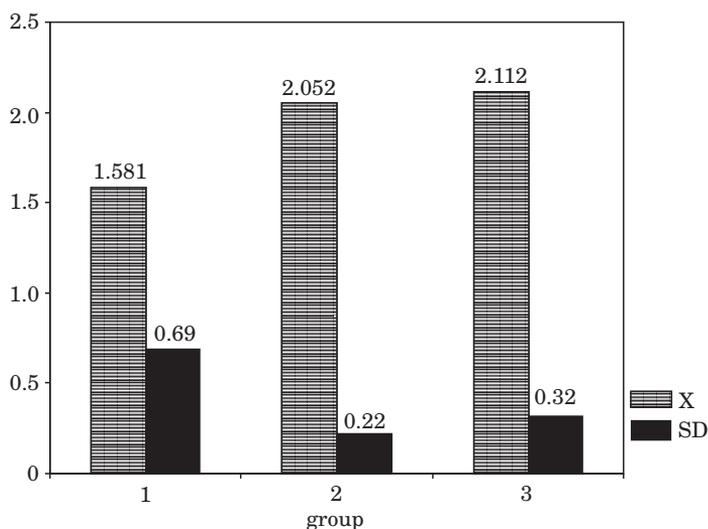


Fig. 2. Total calcium concentration ( $\text{mmol dm}^{-3}$ ) in blood serum

The average values of ionized calcium concentration were even lower (Table 1, Figure 3). Ionized calcium concentration in the first test was on average  $1.219 \text{ mmol dm}^{-3}$ , in the second test:  $1.126 \text{ mmol dm}^{-3}$ , and in the last test:  $1.123 \text{ mmol dm}^{-3}$ . It is probable that the decrease in the ionized calcium level was the result of progressing lactation. The results of Ca concentration in the blood serum do not always correspond well to the degree to which the animals' calcium requirement is covered because it is the subject to a relatively precise homeostatic regulation. Thus, the optimum calcium level in the blood serum is not equivalent to its sufficient amount in the organism. If it is lower than the reference values, it proves calcium deficiency (KLATA et al. 2000). It should be remembered that it is not recommended to enrich a feeding dose with calcium a few weeks before the delivery because increased supply and absorption of calcium activates a mechanism inhibiting the release of endogenous calcium. However, immediately before the delivery, at the time of activation of the lactiferous gland, it is necessary to introduce changes in feeding and add calcium preparations (GABRYSZUK 1988). Such high levels of calcium supply should be maintained until the end of the lactation period because towards the end of this period calcium absorption from a dose increases considerably (GABRYSZUK 1992).

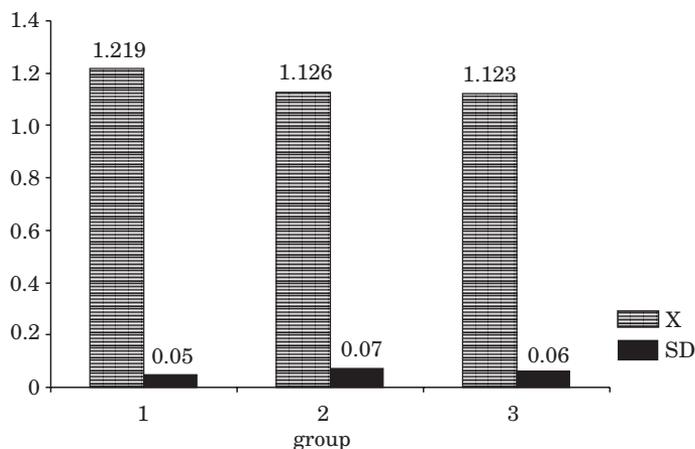


Fig. 3. Ionized calcium concentration ( $\text{mmol dm}^{-3}$ ) in blood serum

## CONCLUSIONS

1. In the evaluated physiological periods, the average content of total magnesium in goats' blood serum was proper. No significant fluctuations were observed in this respect, which can prove that the magnesium requirement was covered.

2. The average total calcium concentration in the goats' blood serum in the evaluation periods was below the reference values accepted for this species.

3. Calcium concentration in pregnant goats was the lowest and statistically significant, which may indicate a deficiency of this element in the diet, especially noticeable during pregnancy.

4. On the basis of the available literature, it can be assumed that ionized calcium concentration in goats is strictly related to total calcium concentration. The level of this biologically active form was more favourable in all of the evaluation periods, which may prove a more effective homeostasis mechanism of the biologically active forms of calcium in periods of increased requirement (pregnancy, the peak lactation period).

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