

CHANGES OF THE MINERAL PROFILE OF SERUM OF GOATS IN VARIOUS PHYSIOLOGICAL STATES

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Abstract

The aim of this work was to obtain comparative evaluation of the content of calcium (both the total and ionic forms), magnesium and phosphorus in the blood serum of goats during three physiological states characterized by much instability of the mineral balance.

The study involved 15 goats, divided into 3 groups in different physiological states (breeding season, pregnancy, lactation period). The study showed that the mean content of the ionic form of calcium (*A,D* – 1.210; *B,E* – 1.135; *C,F* – 1.115) and total calcium (*A,D* – 1.640; *B,E* – 2.075; *C,F* – 2.045) in all the groups was within the range reference concentrations. It can be thought that the low content of calcium was caused by its deficiency in fodder and unstable hormonal balance (pregnancy and lactation period).

The reason why the mean content of calcium did not reach the reference level for this species was a high content of P (*A,D* – 1.650; *B,E* – 2.040; *C,F* – 2.125) and Mg (*A,D* – 0.970; *B,E* – 1.415; *C,F* – 0.990) in blood serum.

Key words: goats, breeding season, pregnancy, lactation, macroelements.

ZMIANY PROFILU MINERALNEGO SUROWICY KÓZ W RÓŻNYCH STANACH FIZJOLOGICZNYCH

Abstrakt

Celem doświadczenia było porównanie stężeń wapnia (całkowitego i zjonizowanego), magnezu i fosforu nieorganicznego w surowicy kóz w trzech okresach aktywności fizjologicznej, tj. w czasie dużej chwiejności gospodarki mineralnej ustroju.

Badanie przeprowadzono na 15 kozach rasy saaneńskiej, podzielonych na 3 grupy, będących w różnych okresach fizjologicznych (stanówka, wysoka ciąża, laktacja).

Wykazano, że średnie wartości jonów wapnia (*A,D* – 1,210; *B,E* – 1,135; *C,F* – 1,115) oraz wapnia całkowitego (*A,D* – 1,640; *B,E* – 2,075; *C,F* – 2,045), w surowicy wszystkich badanych grup kóz, znajdowały się poniżej norm referencyjnych. Wy tłumaczeniem niskich poziomów wapnia może być jego nieodpowiednia podaż w pożywieniu, w okresie ciąży i laktacji, kiedy następuje rozchwianie gospodarki hormonalnej, i tym samym nie ma możliwości odpowiedniej regulacji zawartości wapnia w surowicy.

Przyczyną obniżenia ilości Ca nawet poniżej norm fizjologicznych może być także stosunkowo wysoka zawartość P (*A,D* – 1,650; *B,E* – 2,040; *C,F* – 2,125) i Mg (*A,D* – 0,970; *B,E* – 1,415; *C,F* – 0,990) w surowicy. Potwierdzeniem tego okazały się wyniki otrzymane w doświadczeniu.

Słowa kluczowe: kozy, stanówka, ciąża, laktacja, makroelementy.

INTRODUCTION

The largest instability of the organism's mineral balance is observed during the perinatal period. This period is also characterized by metabolic and hormonal disorders. Mineral disorders, usually short-lasting, are a natural phenomenon during the delivery and developing lactation. They usually disappear a few days after the kidding without any influence on the animal's health and fertility. If, however, they are compounded by deficiency of minerals in fodder or by lowered absorption, complications in the course of impregnation and impaired reproductive abilities may appear as well as various complications after the delivery (KRUCZYŃSKA, MOCEK 1997).

The level of daily mineral component requirements of animals, in this case goats, is important. The following factors play an important role as well: the animal's age, sex, physiological state or the type of breeding. Domesticated goats, kids or dairy goats have different requirements (KRUCZYŃSKA, MOCEK 1997).

Being ruminants, goats eat fodder containing very diversified levels of dry matter and organic matter. The content of calcium, magnesium and phosphorus in fodder used for goat feeding is usually sufficient. Goats with high milk yield, during lactation as well as kids have to be given mineral mixtures (KRUCZYŃSKA, MOCEK 1997).

One of the macroelements described in this paper is calcium, which is an element necessary for the proper growth and development. Goats' daily calcium requirement equals 11-17 g. Natural sources of calcium for every organism (both human and animal) are milk and milk products, nuts, sesame seeds, yeast and some types of cereal (WIERZBICKA 1996).

The organism's phosphorus requirement is strictly connected with its calcium demand. The optimal Ca to P ratio in a diet should be 1 mmol Ca to 1 mmol P. The indispensable amount of phosphorus for ruminants

is 0.3-0.4% in the dry matter of a fodder ration. The concentration of both P and Ca is strictly connected with the quality and value of the fodder since the content of these elements in plants decreases as their vegetation progresses (KRUCZYŃSKA, MOCEK 1992). Among natural sources of phosphorus which ruminants find in food are cereal grains (WIERZBICKA 1996).

Like calcium and phosphorus, magnesium is a component of bones (WIERZBICKA 1996). Simple nitro-compounds and potassium limit the absorption of magnesium (MADEJ et al. 1994), hence it is necessary to pay attention to the potassium-magnesium-calcium ratio in a dose. The absorption of magnesium from fodder is low, i.e. 25-30%. It is believed that the calcium-magnesium ratio should be 04:01. The determination of magnesium requirement standards depends mainly on the content of this bio-element and other elements (especially K and Ca) in fodder as well as on the animal's species, breed, age and physiological stadium (GABRYSZUK 1988).

This paper aims at the analysis of selected mineral components (total and ionized calcium, magnesium and inorganic phosphorus) of goats' blood serum depending on the physiological state of animals.

MATERIALS AND METHODS

The research comprised 15 Saanen goats. The animals came from a private farm in Świerznica near Rabin. The research was carried out in winter and spring (December 2002 – April 2003). All the animals were clinically healthy, maintained under identical zoohygienic conditions and fed with fodder rations according to the requirements of goat feeding (oats – 0.7 kg/a goat/daily, hay – at will, 20% high-protein concentrate for goats – 0.21 kg/a goat).

The goats were divided into two age groups depending on their year of birth. Three physiological states were distinguished in every group. Animals from every age group went through consecutive physiological states, during which their blood was taken for testing and elements were marked (letters *A* to *F*).

1. The goats born in 1999 (4 goats):
 - in breeding season (marked with letter *A*),
 - in advanced pregnancy (marked with letter *B*),
 - in lactation period (marked with letter *C*).
2. The goats born in 2000 (11 goats):
 - in breeding season (marked with letter *D*),
 - in advanced pregnancy (marked with letter *E*),
 - in lactation period (marked with letter *F*).

The test material was serum obtained after centrifugation of whole blood taken each time at 9.00 a.m. from the outer jugular vein.

The following biochemical determinations were carried out in the centrifuged blood of every tested animal:

- 1) the colorimetric analysis, without deproteinization, was used for marking total calcium. Methylene blue was the applied indicator;
- 2) an electrolyte analyser AVL 9180 was used for marking ionized calcium;
- 3) the colorimetric analysis, without deproteinization, was used for marking magnesium, with the application of an EGTA calmagite;
- 4) inorganic phosphorus was also marked by means of the colorimetric analysis without deproteinization. The determination method is based on formation of a phosphomolybdenum complex in the presence of a reductant (iron sulphate). All the results were submitted to statistical calculations with the application of Statistica 6.0 software.

RESULTS AND DISCUSSION

In the analysis of ionized calcium concentration in the blood serum, no significant differences were found in comparable test periods (cf. Table 1, Figure 1). The observed values differed from those accepted to be physiological standards. The level of total calcium in the goats' serum was much higher (Table 1, Figure 2).

Table 1

Ionized calcium concentration, total calcium concentration, magnesium concentration and inorganic phosphorus concentration in the blood serum

Group	Ionized calcium (mmol dm ⁻³)			Total calcium (mmol dm ⁻³)			Total magnesium (mmol dm ⁻³)			Inorganic phosphorus (mmol dm ⁻³)		
	A and D	B and E	C and F	A and D	B and E	C and F	A and D	B and E	C and F	A and D	B and E	C and F
<i>N</i>	15	15	15	15	15	15	15	15	15	15	15	15
<i>X</i>	1.210	1.135	1.115	1.640	2.075	2.045	0.970	1.415	0.990	1.650	2.040	2.125
SD	0.500	0.061	0.320	0.683	0.160	0.297	0.191	0.321	0.439	0.438	0.441	0.332
Maximum	1.290	1.200	1.210	2.446	2.336	2.521	1.310	1.892	1.134	2.267	2.722	2.563
Minimum	1.145	1.045	1.055	0.706	1.891	1.184	0.717	1.020	0.762	1.215	1.428	1.549

N – number of subjects

X – arithmetic mean

SD – standard deviation

A and *D* – goats in breeding season

B and *E* – goats in advanced pregnancy

C and *F* – goats in lactation period

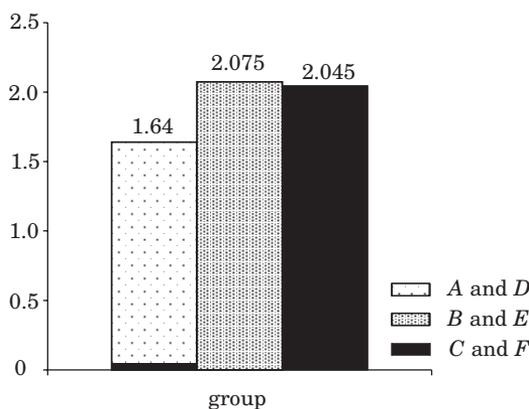


Fig. 1. The average values of ionized calcium concentration (mmol dm⁻³) in goats' blood serum

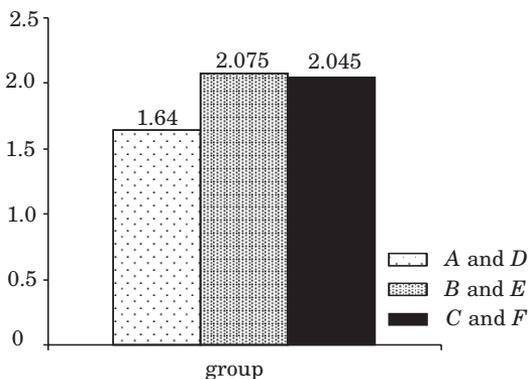


Fig. 2. The average values of total calcium concentration (mmol dm⁻³) in goats' blood serum

The low value of calcium concentration in the tested goats' blood serum can be explained by an inadequate supply of this element in fodder given to the pregnant goats, as pregnant and breastfeeding goats usually require more mineral components (KLATA et al. 2000). How much calcium ruminants require depends largely on their physiological state, but also on the animals' productivity, and the supply of calcium is optimum when its content in dry matter of a ration equals 0.4-0.8%. High calcium supply and a broad Ca : P ratio is especially unfavourable during advanced pregnancy, just like calcium deficiency is unfavourable at the beginning of pregnancy (KRUCZYŃSKA, MOCEK 1992). The supplementation of easily assimilable calcium compounds considerably improves the calcium balance in the postnatal period. The final positive ratio is influenced by a chloride ion, which lowers the pH of the gastric contents, thus having a stimulating effect on calcium absorption.

During the three physiological periods, the content of another tested element, magnesium, also changed. During the first period, the average level of this element for *A* and *D* was $0.97 \text{ mmol dm}^{-3}$. During pregnancy, there was a rapid increase of magnesium concentration – *B* and *E*: $1.415 \text{ mmol dm}^{-3}$. This was the largest increase in the content of this macroelement. After the kidding, at the beginning of lactation, magnesium concentration was similar in blood samples and the results were much lower for *C* and *F*: $0.99 \text{ mmol dm}^{-3}$ (Table 1, Figure 3). However, the results were within the standards (WINNICKA 2002).

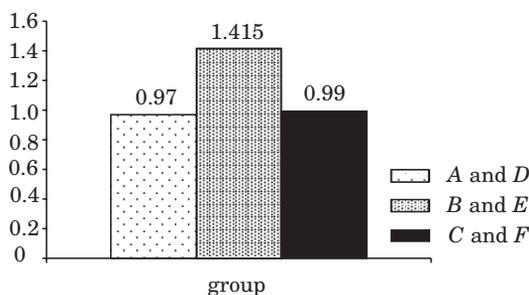


Fig. 3. The average values of magnesium concentration (mmol dm^{-3}) in goats' blood serum

The reason why magnesium level in the blood serum fell may have been the insufficient content of this element in grazing fodder characterized by a low content of dry matter. Lowered magnesium absorption, low assimilation of the macroelement from the skeleton and finally high milk yield are also important (GABRYSZUK 1988).

Inorganic phosphorus concentration showed slight differences (Table 1, Figure 4). Among the goats in their breeding season, it equalled: *A* and *D* – $1.65 \text{ mmol dm}^{-3}$, which was rather low. Among all the tested goats, an increase in the inorganic phosphorus content during pregnancy was observed:

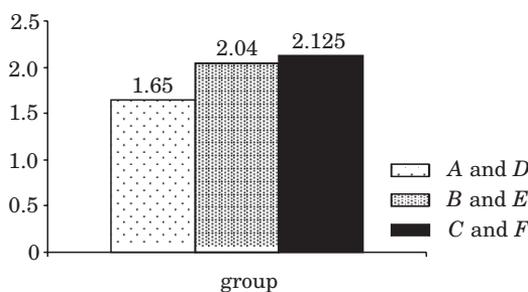


Fig. 4. The average values of inorganic phosphorus concentration (mmol dm^{-3}) in goats' blood serum

B and F – 2.04 mmol dm⁻³. In the lactation period, the values were as follows: C and F – 2.125 mmol dm⁻³. Disorders in the relations between calcium and inorganic phosphorus may be the result of worse quality fodder or wrong composition of the feeding dose. Simultaneously, in literature on ruminants, the deficiency of both elements occurring at the same time has rarely been reported, and an increase in the inorganic phosphorus concentration in fodder is usually accompanied by a decrease in calcium absorption (BRZEZIŃSKA et al. 1999).

Young animals as well as pregnant and breastfeeding females are especially sensitive to deficiency of mineral components. Milk yielding animals lose considerable amounts of mineral compounds, which have to be supplemented together with fodder (SABA et al. 2000).

Apart from protein and energy, mineral components play a very important role in the animals' growth, efficiency and physiological functions. The physiological activities are a sufficient reason for a considerable instability of the organism's mineral balance (KRUCZYŃSKA, MOCEK 1997).

CONCLUSIONS

1. In all the tested groups, the level of total and ionized calcium did not exceed the lowest reference value limit. The values of the other bio-element, magnesium, were in the lower normal range in all the tested groups. All the results concerning inorganic phosphorus in the blood serum were in the lower normal range.

2. On the basis of the research and reference data, a conclusion can be drawn that a simultaneous deficiency in calcium and inorganic phosphorus rarely occurs among ruminants, and increased inorganic phosphorus in fodder is usually accompanied by depressed calcium absorption and a considerable decrease of calcium in blood serum. This may result from using worse quality fodder or wrong composition of a feeding ration.

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