

# THE INFLUENCE OF PRESENCE OF CADMIUM AND ARSENIC IN FEEDMEAL ON PRODUCTION AND REPRODUCTION TRAITS OF GOATS\*\*

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**Abstract:** Animals require microelements in small quantities, and they play a role in virtually all physiological and biochemical processes. The role of microelements is important role from bone structure to maintaining the structure of proteins and lipids. Microelements are provided to animals in food, by special supplementation (premixes), or in water. In addition to essential minerals, which are regularly used in goat nutrition, there are 10 other elements present in traces (mg/kg or ppm) which are also indispensable for the goat's organism, as follows: Fe, J, Cu, Zn, Mn, Co, Mo, Se, Cr, F. In addition to these, following elements have also been identified in goats' tissues: Al, B, Ge, Cd, As, Pb, Hg, Ru, and Nb, however their significance for the organism of goats has still not been established. Their lack in goat nutrition may to a large extent contribute to lower yields and bad health.

**Key words:** the goat, minerals, production traits

## Introduction

Animals need microelements in small quantities, and these microelements play an important role in virtually all physiological and biochemical processes, from bone structure to maintaining the structure of proteins and lipids. Microelements are provided to animals in food, by special supplementation (premixes) or in water. In intensive production, their addition is obligatory, since this is the only way to provide them in sufficient quantities required for optimum health and production results (*Memiši et al.* 2004).

Minerals activate enzymes, are essential co-factors of metabolic reactions, function as carriers of proteins, regulate digestion, respiration, water balance,

muscle reaction, nerve transmission, skeletal strength, pH balance, even mental balance, protect against diseases, are antagonists or synergists of other elements and play a vital role in resistance, adaptation and evolution of new breeds and strains (*Lamand, 1981; Anke et Szentmihalyi, 1986; Haenlein, 1987; Kessler, 1991*).

Regardless of the fact that certain microelements are present in sufficient quantities in food, subclinical or clinical signs of their deficit appear, because their availability varies, or the microelement is present in a form that can not be used. It was established that the presence of certain substances in food (phytic acid and oxalic acid), as well as interaction with other nutrients in the digestive tract influences resorption mechanisms. Resorption of microelements does not depend only on their content in food, but also on the animal's age, on electrochemical reactions in the intestine, and on the form of the microelement. Salts of minerals are most frequently used, namely oxides, carbonates, chlorides, and sulfates. Today, in addition to inorganic forms of minerals, the use of so-called "chelate" forms, i.e. organically bonded microelements is becoming more frequent.

## **Goat requirements in Cadmium and Arsenic**

In feedmeals for goats belonging to various categories, care must be taken to satisfy a specific relationship between various minerals. The quantity of a certain mineral in food is not as important as its availability for the animal. This availability varies to a high degree, depending on numerous factors such as: their form in the food, the phase of development of plants, the presence of other minerals and components in the foods which bind them and make them unavailable, as well as the age and sex of the animal, etc. In order to prevent deficit of mineral elements in goat nutrition, there are various possibilities and certain procedures and methods to prevent this, primarily: treating fodder with various preparations, addition of elements when preparing land for fodder production, use of a premixed and complete mineral mixture in nutrition, and ultimately bodily reserves of the animal – goat can also be increased by using slow release or sustained release injections or capsules.

Research throughout the world has indicated that certain countries vary relevant to the presence of individual minerals in the soil, either as deficit or surplus, which can be used to channel and design programs to resolve the issue. Such surveys of land and plants should be linked to specific characteristics of metabolism of various animal species, and it is accepted that analysis of animal tissues is definitively the real diagnostic measure, although various tissues have different affinity for macro- and microelements, and some lack any affinity whatsoever, therefore their value as indicators differs (Table 1). Thus, the status

or providing of Arsenic can best be tested in goats in milk or blood, while hair is one of the best indicators for the presence of this element. In addition to milk, good indicators for the presence of this microelement can also be internal organs (liver, kidneys, skeletal muscles, brain, lungs, etc.), while the heart muscle and pancreas least react to Arsenic deficit in the feedmeal (*Anke et al.*, 1988). Content below 10 mcg As/kg DM of the liver, kidney or testicles in an adult goat indicates a deficit of this element in food. For kids the limit is around 25 mcg As/kg DM.

**Tabela 1. Razlike u sadržaju Arsena u tkivima koza sa izbalansiranim obrocima i onih koje su imale deficit ovog minerala u ishrani (*Anke i sar.*, 1988).**

**Table 1. Significant differences As in tissue contents in goats (*Anke i sar.*, 1988).**

	Kontrolna grupa <sup>1</sup> (n=131)/ Controls	Ogledna grupa <sup>2</sup> (n=113)/ As deficient
<b>Sadržaj As u pojedinim organima, mcg/kg SM- Organ contents, mcg As/kg DM</b>		
Kolostrum / Colostrum	10	7,8 NS
Mleko / Milk	24	15 **
Jetra / Liver	25	4,8 **
Bubreg / Kidney	28	5,8 **
Srčani mišić / Cardiac muscle	32	26 NS
Testisi / Testicles	14	3,2**
Skeletni mišići / Skeletal muscle	29	11 **
Slezina / Spleen	41	12 **
Dlaka / Hair	86	39 **
Mozak / Brain	25	12 **
Pankreas / Pancreas	35	20 NS
Pluća / Lungs	27	16 **

<sup>1</sup>Normalna ishrana mg/kg SM <sup>2</sup>Deficitarna ishrana mg/kg SM

Since goats to a large extent browse on brush, shrub, and trees, as well as weeds not belonging to grasses and not studied to any greater extent, it is indispensable to know their chemical composition (*Devendra*, 1990). When browse from lower quality grasses is used for goat nutrition, one should keep in mind that many plants have limited value due to one or more inhibitors, that can bind, or in some other way prevent utilization of nutrients (primarily minerals) contained in them. This fact forms the basis for obligatory supplementation of minerals in the nutrition of domestic animals (goats included), which has to a large extent resulted in better milk yield, reproduction, food intake, and reduced stress due by heat and other reasons (*Mc Dowell et al.* 1983; *Harris*, 1991).

Based on concrete experiments on goats the formulation of minerals depends to an ever decreasing degree on experiments carried out on sheep and cattle (*Haenlein, 1987; Kessler, 1991*) (Table 2).

**Tabela 2. Donji minimum potreba koza u mikroelementima (Kessler,1991; Haenlein, 1987).**

**Table 2. The latest minimum mineral requirements of goats (Kessler,1991; Haenlein, 1987).**

Mineralni elementi/ Minerals	
<b>Fe</b>	30 - 40 - 100 mg/kg SM/dan - DM/day
<b>Cu</b>	8 - 10 - 23 mg/kg SM/dan - DM/day
<b>Co</b>	0.1 - 0.15 mg/kg SM/dan - DM/day
<b>J</b>	0.1 - 0.4 - 0.6 - 0.8 mg/kg SM/dan - DM/day
<b>Mn</b>	20 - 40 mg/kg SM/dan - DM/day
<b>Zn</b>	10 - 50 mg/kg SM/dan - DM/day
<b>Se</b>	100 - 200 mcg/kg SM/dan - DM/day
<b>Mo</b>	100 mcg/kg SM/dan - DM/day
<b>Ni</b>	300 - 350 mcg/kg SM/dan - DM/day
<b>V</b>	10 - 25 mcg/kg SM/dan - DM/day
<b>Cd</b>	50 mcg/kg SM/dan - DM/day
<b>As</b>	50 mcg/kg SM/dan - DM/day
<b>Li</b>	> 2 mcg/kg SM/dan - DM/day

Cadmium is an essential mineral element for goat nutrition (*Anke et al., 1987b*). In research by *Anke et al., (1986a)* during a period of 10 years, on 2 groups of goats, experimental animals (79 goats) fed feed meals with lower Cadmium levels (below 15 mcg Cd/kg DM feed meal), compared to the control group of goats, had no significant differences in food consumption. However, the lower levels of this mineral in feed meals resulted in hindering and decreasing animal growth, decreased milk yield, shorter life span, and slower growth of kids in the suckling period which was also manifested by pronounced mortality (Table 3).

In addition, there were manifest problems of fertility and reproduction parameters in experimental goats. Conditions improved by adding 300 mcg Cd/kg DM. Symptoms of Cd deficit in goat nutrition are generally not expected in Europe, because research on numerous farms has shown that goats get sufficient quantities of this element in nutrition. Minimum Cd requirements for goats are around 50 mcg/kg DM of feed meal (*Anke et al., 1987b*).

**Tabela 3. Efekti nedostatka Cd u ishrani koza (Anke i sar., 1986; 1987b ).**  
**Table 3. Effects of As deficiency in goats nutrition (Anke i sar., 1986; 1987b ).**

	Kontrolna grupa (n=71) / Controls group	Ogledna grupa (n=79) / As deficient
<b>Koncepcija, % / Conception rate, %</b>		
prvi servis / 1 <sup>st</sup> service	73	46 **
Ukupni / Overall	85	72 NS
Servis/koncepcija / Services/conception	1.2	2,2 **
Pobačaj,% / Abortion rate, %	0	12 ** (1)
Veličina legla / Litter size	1,4	1,6 NS
Jarad/ broj odgajanih jaradi po kozi do 91 dana / Kids/kidded doe at 91 days	0,65	0.41 **
<b>Mleko - Milk</b>		
Prinos mleka, kg/dan / Milk yield, kg/day	1,01	0,73 **
Mlečna mast, % / Fat, %	3,45	3,15 *
Protein, % / Protein, %	2,77	3,01 *
<b>Mortalitet - Mortality</b>		
Odrasle koze,% / Adult goats, %	30	41 *
Jarad, % / Kids, %	8	43 *

(1) Tokom 4-og i 5-og meseca bremenitosti / Mostly at 4th - 5th month of pregnancy.  
 (Anke i sar., 1986; 1987b).

Arsenic also belongs to the group of essential microelements. Research by the same group of authors during a period of 13 years (*Anke et al.*, 1980a; 1987c), showed that nutrition containing less than 35 mcg As/kg DM of feedmeal, did not reduce food intake in 113 experimental goats, but did result in decreased growth, mainly intrauterine and after weaning, lower conception, lower milk yield, and higher mortality, both in kids and in adult animals (Table 4). Authors state that As secretion in milk of control goats did not differ from the level in milk of goats that did not have a deficit of As in feedmeals. It is their opinion that there is an apparent blood/udder barrier that can be crossed only by high As contents in feedmeals. None of the goats with As deficit in feedmeals survived to the second lactation. Control kids formed considerably higher depots of As in their organs, especially in kidneys, than adult control goats. In addition to hair, good indicators of As availability to adult animals can be the liver, kidneys, and testicles (*Anke et al.*, 1987c). Calculated that minimum As requirements for goats are 50 mcg/kg DM feedmeal/day, but it is considered that the majority of feeds and waters in Europe fulfill this requirement. Fish meal can be a good source of this mineral, and can contain 2 to 19 mcg As/kg DM, followed by algae, and mussels which can contain even 10 times higher concentrations, while water sources can vary to a great extent,

with some thermal springs that can be exceptionally rich in As (*Anke*, 1985; *Anke et al.*, 1986b).

**Tabela 4. Efekti nedostatka As u ishrani koza (Anke i sar., 1987c).**  
**Table 4. Effects of As deficiency in goats (Anke i sar., 1987c)**

<b>Koncepcija, % / Conception rate, %</b>		
Prvi servis / 1 <sup>st</sup> servis	75	57 **
Ukupni / overall	89	71 **
Jalova (ne koncipira) / open (not conceiving)	11	29 **
Servis/koncepcija / Services/conception	1,3	1,9 **
Pobačaj,% / Abortion rate %	0,8	15 ** <sup>(1)</sup>
Veličina legla / Litter size	1,4	1,4 NS
Broj odgajenih jaradi po kozi do 91 dana / Kids/kidded doe at 91 days	0,73	0,48 **
Odnos polova Ž : M / Sex ratio F:M	1: 1,6	1: 1,7 NS
<b>Mleko / Milk</b>		
Prinos mleka, kg/dan / Yield, kg/day	1.01	0.81 **
Mlečna mast, % / Fat %	3.46	3.97 *
Protein, % / Protein, %	2.77	3.10 *
<b>Mortalitet / Mortality</b>		
Odrasle koze,% / Adult goats, %	24	48 **
Jarad, % / Kids, %	5.8	32 *

<sup>(1)</sup> Odrasle koze / Adult goats;

## Conclusion

High production and milk yield in goats require also more macro- and microelements, and increase needs. Their adequate balancing in feed meals for goats is more difficult due to the specific nutrition of goats, i.e. due to the use of feeds with insufficiently studied nutritive value. Cd and As deficit in nutrition of offspring and adult goats can have an unfavorable effect on growth, but can also decrease yield, and may cause health problems. Therefore, adequate goat nutrition requires maximum balancing of all nutrients in feed meals, which is achieved by using various feeds and mineral premixes.

## Uticaj zastupljenosti kadmijuma i arsena u obroku na proizvodne i reproduktivne osobine koza

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### Rezime

Mikroelementi su životinjama potrebni u malim količinama i učestvuju u skoro svim fiziološkim i biohemijskim procesima. Počev od strukture kostiju pa do održavanja strukture proteina i lipida, mikroelementi igraju važnu ulogu. Obezbeđenje životinja sa mikroelementima obavlja se putem hrane, posebnim dodavanjem (putem predmeša) ili putem vode. U intenzivnoj proizvodnji njihovo dodavanje je obavezno, jer se samo tako mogu obezbediti u dovoljnim količinama za optimalno zdravstveno stanje i proizvodne rezultate. Osim esencijalnih minerala, koji se redovno koriste u ishrani koza, postoji još 10 elemenata prisutnih u tragovima (mg/kg ili ppm) koji su takođe, neophodni za organizam koza, a to su: Fe, J, Cu, Zn, Mn, Co, Mo, Se, Cr, F. Pored navedenih, u tkivima koza identifikovani su još i: Al, B, Ge, Cd, As, Pb, Hg, Ru, i Nb, za koje još nije utvrđeno u kojoj su meri neophodni u organizmu koza. Njihov nedostatak u ishrani koza u velikoj meri može doprineti nižoj proizvodnji i lošem zdravstvenom stanju.

**Ključne reči:** koza, minerali, proizvodne osobine

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