ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN–POLONIA
VOL. XVII, 46 SECTIO EE 1999

Pracownia Biologii Rozrodu Katedry Higieny Zwierząt i Środowiska Akademii Rolniczej w Lublinie

HANNA BIS – WENCEL

Indices of Mineral Metabolism in Goats from South – Eastern Poland

Wskaźniki gospodarki mineralnej u kóz w warunkach środowiskowych południowo-wschodniej Polski

Mineral metabolism disorders are among the most serious health problems in goat production. They result from the fact that bulk feed produced locally is used in goat feeding, so local mineral deficiency in the soil may cause low mineral content in green crop plants and, consequently, in animals.

The development of goat breeding in Poland, mainly in its south – eastern part, needs analysis and evaluation of mineral metabolism. Such data are very scarse in the Polish bibliography. H a e n l e i n (7) presented very rich world bibliography concerning mineral metabolism and mineral shortages in goats. Finding the main features of mineral metabolism in goats is crucial for working out prophylactic procedures and creating proper formulae for mineral feed mixtures.

The objective of the present work was to evaluate the mineral adequacy of goats based on mineral element concentrations of the soil, the feed and the animal.

MATERIAL AND METHODS

The features of mineral nutrition in goats were evaluated in the trophic system: soil – feed – animal.

The research was carried out over the period of one year on two Saanen goat farms, farm A having 150 animals and B – 55 animals. Milk yield averaged 1000 kg/year. Both farms were situated on loamy podzols with medium humus level and either acid or strongly acid reaction. Soil samples were collected during the peak of the vegetative season and the *pH* value as well as the levels of Ca, P, Mg, K, Fe, Cu, Mn, Mo and Zn were measured by means of emission spectrum analysis.

Feed samples were collected; their mineral contents were measured spectrophotometrically by atomic absorption; the level of P was analysed colorimetrically. Two experimental groups of 15 two- and three – year – old animals each were selected on both farms. Blood samples were collected three times during the gestation period in autumn and winter, i.e., during the first third of the gestation period (before 45th day), second (before 100th day) and third (before 150th day). Blood samples were collected again during the lactation period, at the beginning and the peak of the summer feeding, i.e., between 115th and 125th days, the 160th – 170th days and the 200th – 220th days of lactation.

Hair samples were collected according to the recommendations of B r o c h a r t (5) at 1st, 3rd, 4th and 6th blood sample collection. Mineral content in the hair was measured the same way as blood serum. The results were processed by mediums (M) and standard deviation (SD).

RESULTS AND DISCUSSION

On the basis of the analyses (Tab. 1) both of the soil types may be referred to as extremely low or deficient in Cu, P and Mg; Ca, K, Co, Mn, Mo and Zn content was medium; Fe was high. Acidity must be considered as an additional factor favoring mineral shortages in plants. This is apparent especially in the case of Cu.

Most feeds (Tabs. 2 and 3) were low in P, Mg, Cu, Zn and Mn; other minerals were relative to dietary requirements of larger ruminants. Mineral consumption standards in goats are not yet fully defined and the views diverge strongly. According to G a l l (6) daily mineral matter requirements of milk breed goats are as follows: Na – 2.0g, Mg – 2.0g, Cu – 10.0mg, Zn – 75mg, Mn – 50mg, Ca – 0.1mg per 1kg of dry matter. J a m r o z and N o w i c k i (8) in accordance to the ARC (3) norms gave the following values for goats as well as for sheep: Ca – 3.5mg, P – 3.0mg, Mg – 1.5-2.0g, Na – 1.5-2.0g, K – 5.0g, S – 1.5g, Cl – 1.0g, Mn – 50-60mg, Fe – 30-60mg, Cu – 5-10mg, Co – 0.08-0.1mg, Mo – 0.1mg. According to the values above, the examined feeds did not fulfil the mineral matter requirements of goats, especially regarding P, Mg and Cu, and to some extent, also Zn and Na.

Mineral content in blood serum (Tab. 4) for inorganic P, Mg and Cu was below or in the bottom part of the values considered to be proper by such authors as A n d r e w s et al. (1); H a e n l e i n (7), S h e r m a n and R o b i n s o n (11) and the Polish authors: S a b a and B i a ł k o w s k i (9, 10) and B i a ł k o w s k i et al. (4). Consequently, it may be stated that those values reflected the mineral content of the feeds as it is assumed that, in the case of goats, blood serum is a good reflection of the mineral content in the entire organism.

A n k e and R i s c h (2) analyzed the Zn, Mn and Cu levels and detected that the physiological Zn level of goat hair was 117mg/kg DM in comparison to 93 mg/kg DM, which is called „deficient".

Analogous values for Mn amounted to 2.1mg/kg DM in comparison to 1.1mg/kg DM. Cu normal level was 4.7mg/kg DM, in comparison to 3.0mg/kg DM. In

Table 1. (1M KCl) reaction and mineral composition of greenland soils on A and B (M, SD) farms

Farm	Soil type	n*	*pH*		Ca	P	Mg	K	Fe	Cu	Co	Mn	Mo	Zn
					g/kg of DM*					mg/kg of DM				
A	Podzol composed of sandy loam	20	6,1	M	12.3	2.5	2.1	2.9	8.8	6.4	1.4	320	4.5	286
				SD	2.1	0.4	0.3	0.1	1.2	0.3	0.1	30	0.3	42
B	Podzol composed of loose sand	20	6,2	M	14.1	2.4	1.6	3.8	9.2	6.5	1.6	276	3.2	252
				SD	2.2	0.7	0.4	0.2	1.5	0.5	0.1	58	0.2	56

n* – Number of collected samples, DM* – dry matter, M – medium, SD – standard deviation.

Table 2. Macroelement content in forage (mg/kg of DM*)

Forage type	Farm	Number of tests	Ca		P		Mg		Na		K	
			M	SD	M	SD	M	SD	M	SD	M	SD
Green forage from the pasture	A	15	8.3	3.9	3.0	2.0	1.1	0.6	1.4	0.2	15.7	4.0
	B	-	-	-	-	-	-	-	-	-	-	-
Green forage from red clover	A	-	-	-	-	-	-	-	-	-	-	-
	B	17	7.9	2.6	2.5	0.8	4.9	1.7	1.5	0.4	19.1	3.2
Meadow hay	A	20	7.2	2.8	3.2	1.8	1.5	0.6	1.5	0.2	17.0	3.9
	B	20	9.3	2.8	2.9	1.8	1.4	0.5	1.7	0.3	17.2	3.0
Wheat bran	A	5	9.2	1.8	7.8	0.9	4.9	1.6	6.4	1.6	18.7	4.1
	B	5	10.1	1.7	7.6	1.1	4.3	1.9	7.0	1.7	19.1	3.9
Wheat straw	A	8	2.8	0.5	0.7	0.2	0.5	0.1	1.9	0.4	15.8	3.4
	B	8	2.7	1.0	0.5	0.1	0.7	0.2	1.5	0.4	16.0	3.0
Pressed oat	A	5	11.3	4.5	9.9	1.7	5.0	1.6	8.3	1.5	20.0	4.0
	B	5	14.0	5.1	9.1	1.7	4.8	1.7	8.0	1.5	19.6	3.8
Poly-past mangel	A	-	-	-	-	-	-	-	-	-	-	-
	B	7	22.0	7.1	2.0	0.7	2.0	0.6	10.0	2.5	11.0	1.5

DM* – dry matter, M – medium, SD – standard deviation.

Table 3. Microelement content in forage (g/kg of DM*)

Forage type	Farm	Number of tests	Fe		Cu		Zn		Mn		Co	
			M	SD	M	SD	M	SD	M	SD	M	SD
Green forage from the pasture	A	15	124.0	18.0	3.8	1.2	37.1	10.1	35.2	5.1	0.5	0.1
	B	15	-	-	-	-	-	-	-	-	-	-
Green forage from red clover	A	15	-	-	-	-	-	-	-	-	-	-
	B	15	151.0	14.1	3.0	1.0	37.2	7.0	60.4	9.0	0.4	0.1
Meadow hay	A	15	125.1	17.1	3.5	1.2	38.0	11.0	37.2	5.1	0.6	0.2
	B	15	120.8	17.0	3.2	1.0	37.0	11.0	36.6	5.0	0.7	0.1
Wheat bran	A	15	135.2	12.0	10.1	1.5	81.0	18.1	40.0	5.0	0.3	0.1
	B	15	132.1	11.0	10.7	1.4	83.3	18.0	39.7	4.8	0.3	0.1
Wheat straw	A	15	105.0	8.5	0.5	0.1	21.2	4.7	20.2	1.5	0.1	0.02
	B	15	107.1	9.0	0.6	0.1	20.1		21.3	1.7	0.2	0.02
Pressed oat	A	15	140.2	12.0	10.1	1.7	81.4	18.1	39.0	5.1	0.4	0.2
	B	15	140.0	11.8	9.9	1.5	80.9	18.2	38.0	4.8	0.5	0.2
Poly-past mangel	A	-	-	-	-	-	-	-	-	-	-	-
	B	15	191.0	10.7	1.3	0.4	40.1	5.0	120.3	13.5	0.4	0.1

DM* – dry matter, M – medium, SD – standard deviation.

Table 4. Mineral content in blood serum of goats

Element	Farm	Test											
		I		II		III		IV		V		VI	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Ca	A	3.2	0.6	2.9	0.5	2.35	0.4	2.17	0.3	2.07	0.4	2.1	0.4
mmol/l	B	3.0	0.5	2.9	0.4	2.3	0.3	2.2	0.3	2.1	0.3	2.0	0.3
P	A	1.0	0.1	1.1	0.3	1.2	0.4	1.1	0.3	1.0	0.3	1.0	0.3
mmol/l	B	1.2	0.2	1.0	0.1	1.3	0.3	1.1	0.2	1.0	0.1	1.2	0.2
Mg	A	0.7	0.06	0.8	0.07	0.9	0.07	0.9	0.09	0.8	0.06	0.8	0.01
mmol/l	B	0.6	0.05	0.8	0.06	0.8	0.05	0.9	0.09	0.7	0.07	0.7	0.07
Na	A	135	3.4	142	8.3	142	8.9	138	10.3	135	1.7	134	8.2
mmol/l	B	138	4.0	140	8.1	139	5.7	140	9.4	137	2.4	139	4.7
K	A	5.4	0.6	6.0	0.5	6.0	0.3	6.1	0.4	6.3	0.5	6.0	0.4
mmol/l	B	6.0	0.5	5.9	0.5	5.8	0.4	6.0	0.5	6.1	0.5	5.9	0.5
Cu	A	10.7	0.5	11.4	0.8	10.4	0.8	9.1	0.7	8.9	0.4	8.6	0.4
µmol/l	B	10.8	0.4	11.3	0.7	10.5	0.7	10.0	0.7	9.0	0.4	9.0	0.3
Zn	A	15.5	2.1	15.8	2.0	16.4	3.6	16.0	2.3	14.2	3.2	14.0	2.7
µmol/l	B	15.1	2.0	16.0	2.0	16.0	3.1	15.8	2.1	15.2	3.0	14.8	2.8
Fe	A	24.8	2.1	23.3	2.8	25.4	2.2	24.4	2.3	24.3	1.8	22.5	2.1
µmol/l	B	24.5	2.0	23.7	2.5	24.9	2.1	24.0	2.1	25.0	2.0	24.3	2.1

Table 5. Mineral content in hair of goats

Element mg/kg of dry matter	Farm	I		II		III		IV	
		M	SD	M	SD	M	SD	M	SD
Ca	A	1260	158	1351	142	1230	110	1205	78
	B	1264	120	1370	145	1150	120	1180	100
P	A	346	11	318	28	320	16	311	19
	B	340	12	320	30	312	17	300	18
Mg	A	242	16	242	21	238	25	219	18
	B	250	15	241	20	230	24	210	21
Na	A	496	21	468	29	495	20	419	32
	B	482	23	470	24	480	20	475	31
Cu	A	5.8	1.2	5.9	1.3	5.6	1.0	5.0	1.4
	B	6.0	1.3	5.8	1.0	5.7	1.2	4.9	1.0
Zn	A	135	11	139	11	128	10	125	8
	B	137	10	131	11	125	10	119	9
Fe	A	122	13.0	108	9	110	14	120	10
	B	124	12.0	105	8	110	12	112	9
Mn	A	25.1	7.4	22.7	8.6	21.9	8.1	24.4	7.9
	B	25.3	7.0	23.1	8.2	20.7	7.4	23.1	6.8

relation to the values obtained by A n k e and his co-workers (2), Cu levels were the closest ones. In the bio-geo-climatic conditions of the south-eastern part of Poland the soil is rich in Ca. Because of the clinical symptoms of copper shortage observed periodically there may occur the phenomenon of metabolical antagonism between Ca and Cu. B r o c h a r t (5) assents usefulness of mineral hair analysis for mineral metabolism evaluation.

The results constitute a starting point to create a proper formula for mineral feed mixture to be used in additional mineral feeding of goats.

CONCLUSIONS

1. The soils of pastures at the farms A and B had an acid *pH* value and were deficient in P, Cu, Mg, containing medium and large amounts of other examined elements.

2. The research into blood indicators confirmed the assumptions about the possibility of lack of minerals among goats. Low levels of inorganic Pb, Mg and Cu confirm the assumption.

3. The mineral analysis of the fur confirmed the existence of low levels of P, Cu and Zn.

REFERENCES

1. A n d r e w s A.M., I n g r a m P.L., L o n g s t a f f e J.: Osteodystrophia Fibrosa in Young Goats. Vec. Rec., 112, 404-407, 1983.
2. A n k e M., R i s c h M.: Haaranalyse und SpureneLementstatus. VEB G. Fischer Verlag, Jena 1979.
3. A R C: The Nutrient Requirements of Ruminants Livestock. Commonwealth Agricultural Bureau, London 1980.
4. B i a ł k o w s k i Z., S a b a L., R ó ż a n i e c k a K.: Zmiany profilu metabolicznego kóz w zależności od warunków żywienia i utrzymania. Ann. Univ. Mariae Curie-Skłodowska, sectio EE, vol. 4, Lublin 1986.
5. B r o c h a r t M.: Investigation of Nutritional Deficiencies and Inbalances by the Chemical Analysis of Hair. Vet. Sci. Comm. 2, 183-186, 1978.
6. G a l l O.: Ziegenzucht. Enke Verlag, Stuttgart 1982.
7. H a e n l e i n G.F.W.: Mineral Nutrition of Goats. J. Dairy Sci., 63, 1729-1730, 1980.
8. J a m r o z D., N o w i c k i B.: Kozy, chów i hodowla. PWN, Warszawa 1990.
9. S a b a L. B i a ł k o w s k i Z.: Metabolizm mineralny u kóz w warunkach biogeochemicznych południowo-wschodniej Polski. Materiały VIII Kongresu PTNW, Warszawa 1987.
10. S a b a L., B i a ł k o w s k i Z.: Składniki mineralne w glebie, paszach i organiźmie kóz jako wskaźniki zaopatrzenia mineralnego. Med. Wet., 43, 297-299, 1987.

11. Sherman D.M., Robinson R.A.: Clinical Examination of Sheep and Goats. Symposium on Sheep and Medicine Large Animal Practice, 5, 3-6, 1983.

STRESZCZENIE

Niniejsza praca jest próbą określenia cech żywienia mineralnego u kóz. Badanie wskaźników metabolizmu mineralnego u kóz przeprowadzono w dwóch gospodarstwach w południowo-wschodniej Polsce. Analizowano poziomy Ca, P, Na, K, Fe, Zn oraz Cu; stwierdzono pewne niedobory i dysproporcje w gospodarce mineralnej kóz. Gleby użytków zielonych posiadały niskie P, Cu i Mg, natomiast zawartość pozostałych składników była średnia lub wysoka. Stwierdzono niebezpieczeństwo niedostatku P, Mg, Cu oraz do pewnego stopnia Na i Zn. Analizy osocza krwi potwierdziły braki minerałów u kóz, a poziomy nieorganicznego P, Mg i Cu okazały się niskie. Mineralne analizy sierści potwierdziły niskie poziomy P, Cu oraz Zn. Wyniki badań będą ważne zarówno dla opracowania odpowiedniej mieszanki mineralnej, jak i dla stosowania jej w żywieniu kóz.