ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. XXI, N2, 98 SECTIO EE 2003

Laboratory of Reproduction Biology, Chair of Animal Hygiene and Environment
Department of Animal Biology and Breeding, Agricultural University of Lublin

HANNA BIS-WENCEL

Effect of a Herbal-Mineral Mixture on Indicators of Goat Mineral Metabolism

Wpływ mieszanki mineralno-ziołowej na wskaźniki gospodarki mineralnej kóz

The biogeochemical region of ruminants habitation as well as their natural feeding conditions may bring about some disturbances in the mineral supply of animals. However, prophylaxis of such disorders should be preceded with preliminary examinations every time so that the mineral supply in the trophic system could be fully recognised.This assumption constituted the basis for the studies on the influence of mineral-herbal feeding of goats on the development of macro- and microelement values in goat serum and hairs as well as on the dynamics of changes.

MATERIAL AND METHODS

The studies were conducted for two years. In the selected region of south-eastern Poland (farm „Z") out of a herd of goats, a white improved breed, two treatment groups of animals were selected, whose habit, physical condition and age (3–4 years) were similar. Their body weight amounted to 40–45 kg, height in rump 62–67cm, milk efficiency 630–700kg. The group comprised 15 individuals each.

The soil samples were collected twice from the pastures and arable land at 0–15cm depth by means of a sampling stick at the height of the vegetative season (June, September). Determination of the total content of Ca, P, Mg, K, Fe, Cu, Zn, Mn and Co was made with spectral emission analysis method on high dispersion spectrograph Higler E-478 type using method of „one additive" and pouring elaborated by Gliński and Grajpel cit. (3).

The fodders were sampled regularly as they were introduced into feeding according to a sample representativeness rule. The content of mineral components like Ca, Mg, Na, K, Fe, Cu, Zn, Mn and Co in feedstuff was established by atomic absorption spectrophotometry method with flame spectrophotometer ASA-Unicam 939, while the phosphorus level with colorimetric analysis

acording to Fiske-Subbarow's method cit. (3). The mineral supply state of goats was assessed on the basis of dietary units applied after the Standards for Animal Feeding (10). The mean daily supply of each mineral element was calculated at the summer and winter feeding time. Recognition of mineral balance features of goats was carried out through the first experimental year, including all the basic periods in their feeding, i.e. the autumn-winter and spring-summer one. The goat groups K and D included into the experiment were fed identically. A difference was made by feed supplementation with a mineral-herbal mixture given to the animals from D group in the second experimental year. The mixture was prepared in the Laboratory of Reproduction Biology, AU in Lublin. The mixture was administered at the amount of 50g/animal per day and consisted of the following components: Dolomit – 55%, Phosphate (from Bonarka) – 10%, Fodder chalk – 3%, NaCl – 5%, flax – 5%, camomile – 4%, nettle – 8%, willow bark – 4%, horsetail, melilot, oak bark – 6%. Blood samples were collected from the goats five times at early hours, from the surface jugular vein according to the clotting method before the animals feeding. The quantitative analysis was made on these mineral elements: Ca, Mg, Na, K, Fe, Cu and Zn with atomic absorption spectrophotmetry ASA-Unicam 939, whereas the inorganic phosphorus content was determined by Fiske-Subbarov's method cit. (3). The goat hairs samples were taken twice. The material was sampled after Brochart's recommendations (4). The content of Ca, Mg, Na, Fe, Cu and Zn was fixed after ASA method, whereas the inorganic phosphorus content according to Fiske-Subbarov's method cit. (3).

The results were processed by means of statistical analysis. A two-directional variance analysis was performed as well as inter action significance estimated between the sampling dates and concentration values of each element with Fisher test. If a significant impact of a sampling date was recognized, a detailed comparison of the means was performed by Tukey test.

DISCUSSION

The content of mineral components in the soils of goat habitation region are presented in Table 1.The soils are highly calcium and zinc available, moderate as to Fe, Mn and Mo, poor in P, Mg and Cu (3,5). The analyzed soil samples demonstrated a very high level of Ca that limits P, Mg, Cu and Zn availability resulting from the natural antagonism between these elements. The reaction of the samples proved slightly acid. This factor is conducive to mineral element deficiency in plants. The low pH value causes lesser availability of numerous elements, induding copper. It is noteworthy that according to Kaniuczak (9) acid soils occur in about 60–80% of the total area of cultivated land. The feedstuff samples (Tab. 2) exhibited a low content of P, Mg, Cu, Zn and Mn. Availability of the studied fodder samples was mean regarding the other elements (2, 5). Standard deviation value in the mineral elements content in a particular feed manifests considerable differentiation of goat mineral supply at every feeding period. Strict determination of dietary units and their content in a fodder allowed to assess goat daily supply of a particular element (Tab. 3). It appears from the studies made that goat mean daily supply is conditioned by a season to a great extent, yet it was markedly higher in winter than in summer. The serum analysis of goats from K group makes it possible to state that the levels of organic phosphorus, magnesium and copper were contained within the lower limits or below the values regarded as regular (1, 3, 6, 8).

Table 1. Comparison of the results of reaction (1M KCL)) and mineral composition of grassland soil at farm Z

Soil type	*pH*	Statist. measure	Ca	P	Mg	K	Fe	Cu	Zn	Co	Mn	Mo
			g/kg d.m.				mg/kg d.m.					
Loessal	6.1	$\bar{x}$	17.3	2.8	1.8	3.1	9.9	4.4	196.0	1.0	226.0	3.5
		S D	2.2	0.4	0.2	0.1	1.5	0.3	26.0	0.2	30.0	0.2

Assuming the fact that goat serum reflects the state of their mineral supply it should be treated as an indicator of mineral supplementation direction. The results were close to the levels stated by Saba et al. (11) and Haenlein (8), that is within the range from 9.6 to 10.2 umol/dm^3. Even in the species of similar feeding conditions, like cattle, sheep and goats, there are significant differences in microelement metabolism, in particular Cu, Fe and Co. Although, a view prevails that copper and cobalt concentration values in serum do not testify to these elements deficiency, especially in young animals, some clinical symptoms of the shortage are observed. In the ruminant feeding practice great differences are recorded in copper and cobalt supply due to local differentiation in animal requirements. The differences are often past the adaptation capabilities especially of young animals and lead to deficiency diseases (3). It was proved that goat feeding supplemented by a mineral-herbal mixture yielded statistically significant differences between the means of K and D groups concerning macroelements in goat serum. They refered to Ca, inorganic P, Mg, Na and K. The differences for the microelements Fe, Cu and Zn were not significant statistically. Comparing the means at a particular sampling date absence of significant differences was stated only in relation to potassium concentration. A herbal ingredient in a mineral the mixture meant to improve mixture flavour influenced some technological aspects of its prevention from fractionation as well as increase of macro- and microelements availability (7). The data from literature confirm that zinc and magnesium exert a significant impact not only on organism cellular immunity but are of great weight in the humoral immunity processes while considering the immunity problems in animals (3, 6, 7, 12). Then again, a herbal supplement can inhibit the processes of element absorption as the compounds contained there being of quite differentiated structure are capable of lowering element availability, e.g. by forming chelate compounds, among others with copper (12). According to Anke and Risch (1) and Brochart (4) gradual and rather slow deposition of mineral elements in hairs reflects their actual levels present in animal organism.

Table 2. Content of macro- and microelements in fodders

Fodder type	Statist. measures	Ca	P	Mg	Na	K	Fe	Cu	Zn	Mn	Co
		g/kg s.m.					mg/kg s.m.				
Pasture forage	$\bar{x}$	8.5	3.0	1.0	1.3	16.4	120.0	3.6	37.8	35.4	0.6
	SD	3.8	2.0	0.6	0.2	4.0	18.0	1.2	10	5.0	0.1
Meadow hay	$\bar{x}$	7.3	2.9	1.3	1.8	18.2	120.8	3.2	32.0	40.2	0.5
	SD	2.8	1.8	0.6	0.2	3.0	17.0	1.0	11.0	5.0	0.2
Wheat bran	$\bar{x}$	9.8	7.0	4.6	5.4	17.7	132.4	9.7	80.2	39.0	0.5
	SD	1.7	0.9	1.6	1.2	3.9	11.0	1.4	18.0	4.8	0.1
Fodder straw	$\bar{x}$	2.2	0.6	0.4	1.6	15.0	115.0	0.4	20.7	21.5	0.1
	SD	0.5	0.1	0.1	0.4	3.0	8.6	0.1	4.1	1.4	0.02
Oat grain	$\bar{x}$	14.8	8.8	4.3	7.0	19.0	140.0	9.8	80.8	38.0	0.3
	SD	5.0	1.4	1.4	1.3	3.8	12.0	1.5	18.1	5.0	0.2
Barley grain	$\bar{x}$	13.8	8.8	4.6	8.1	18.9	142.1	10.8	81.1	37.0	0.2
	SD	4.3	1.5	1.5	1.4	3.6	9.9	1.3	18.0	4.1	0.1
Beet pulp dry	$\bar{x}$	13.2	1.0	0.9	4.4	10.4	144.5	0.9	35.6	27.4	0.09
	SD	0.5	0.05	0.02	0.3	0.03	1.2	0.2	0.5	0.5	0.01

Table 3. Mean daily mineral supply of goats

Mineral supply	Unit of measure	Kind of feeding	
		in summer	in winter
C a	g	16.3	21.2
P	g	7.3	9.9
Mg	g	3.4	6.0
Na	g	5.2	8.5
K	g	40.0	62.1
Fe	mg	285.0	405.0
Cu	mg	9.1	10.1
Zn	mg	117.3	108.0
Co	mg	0.9	1.1
Mn	mg	95.1	121.1

The content of mineral elements in goat hairs group K confirms in a great measure the results of serum examinations. The hairs were low in Cu as its level ranged from 5.3 to 5.8 mg/kg d.m., just like Zn, whose level reached 125.2-135.5 mg/kg d.m. In the hairs of the goats with dietary mineral ingredient there were recorded significant differences between the mean values of all the elements examined, except potassium, of K and D groups. The mean concentrations in the biological material at each sampling term did not show any statistically significant differences for potassium, iron or copper. From the data presented it follows that a mineral-herbal supplement has a positive influence on the growth and accumulation of elements like Ca, P, Mg and Na in goat organism, that is in serum and hairs. For the other elements the trends changed throughout the experimental period that impeded making an explicit assessment of the influence of the tested mixture on the element storage in the examined tissues. Admittedly, only combined determination of the mineral components in blood, hairs and milk provides a fuller picture of mineral supply. As to living animals some researchers also use the liver tissue obtained by a biopsy method or the bone tissue from the caudal vertebrae (3). Both treatments can be performed on the strict experimental material, hence they are impossible while examining productive animals. The changes between the successive samplings compared to the 1st term and between the experimental groups K and D allowed to state strong homeostasis in the mineral composition of both, serum and goat hairs. It was particularly evident in relation to Fe and Zn. That was most likely connected with a specific character of the from of goat feeding, as these animal feed great quantities of so-called unconventional feedstuff.

Table 4. Mean values and standard deviations of Ca, P, Mg, Na, K (mmol/l), Fe, Cu, Zn (μmol/l) in the serum of goats (n = 15)

Mineral element	Sampling dates																				Mean values for the groups		Mean values for the sampling dates				
	30 days before delivery				7 days before delivery				7-10 days past delivery				6 weeks past delivery				10 weeks past delivery										
	K		D		K		D		K		D		K		D		K		D								
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	X_K	X_D	X_{T1}	X_{T2}	X_{T3}	X_{T4}	X_{T5}
Ca	2.71	0.13	2.91	0.16	2.61	0.41	2.9	0.14	2.6	0.16	3.2	0.14	2.5	0.15	2.7	0.22	2.2	0.11	2.5	0.11	2.50^{a}	2.84^{b}	2.75^{c}	2.75^{c}	2.98^{d}	2.55^{b}	2.46^{a}
P	1.18	0.12	1.40	0.20	1.10	0.18	1.2	0.15	1.0	0.14	1.2	0.16	1.0	0.21	1.2	0.25	0.8	0.15	1.1	0.14	1.00^{a}	1.23^{b}	1.28^{b}	1.13^{a}	1.10^{a}	1.12^{a}	0.98^{a}
Mg	1.01^{ax}	0.13	1.1^{cy}	0.14	0.96^{ax}	0.07	1.32^{cy}	0.22	0.96^{ax}	0.11	1.1^{cy}	0.16	0.98^{ax}	0.17	1.1^{cy}	0.12	0.8^{ax}	0.14	1.17^{cy}	0.19	0.96^{a}	1.15^{b}	1.10^{a}	1.14^{a}	1.03^{a}	1.06^{a}	1.03^{a}
Na	137.9^{ax}	2.59	140.3^{cy}	4.81	139.1^{ax}	2.78	140.7^{cx}	2.32	138.2^{ax}	2.97	140.7^{cy}	3.83	139.5^{ax}	2.38	144.9^{by}	4.03	139.1^{ax}	2.28	142.6^{cy}	2.98	138.5^{a}	141.7^{b}	139.7^{a}	139.9^{a}	139.3^{a}	141.8^{a}	140.3^{a}
K	4.57	0.29	4.49	0.25	4.61	0.47	4.4	0.33	4.5	0.16	4.5	0.35	4.9	0.42	4.3	0.32	4.5	0.4	4.4	0.29	4.62^{b}	4.42^{a}	4.55^{a}	4.50^{a}	4.50^{a}	4.50^{a}	4.50^{a}
Fe	23.22	1.27	23.71	1.32	22.61	0.84	23.0	0.92	22.7	1.26	22.9	0.93	22.6	0.92	22.9	0.9	22.8	1.29	22.4	1.24	22.76^{a}	22.96^{a}	23.47^{a}	22.86^{a}	22.84^{a}	22.73^{a}	22.57^{a}
Cu	9.39	0.61	9.41	0.72	9.72	0.46	9.7	0.67	9.6	0.51	9.5	0.49	8.4	0.28	8.5	0.59	8.7	0.77	8.0	0.73	9.16^{a}	8.98^{a}	9.34^{b}	9.65^{b}	9.57^{b}	8.56^{a}	8.30^{a}
Zn	20.43	2.4	20.17	2.58	22.11	1.58	22.0	2.08	18.3	0.83	18.4	0.81	17.9	1.12	18.0	1.20	17.4	1.09	18.3	1.18	1922^{a}	1934^{a}	2026^{b}	226^{c}	1838^{a}	1798^{a}	1791^{a}

Table 5. Mineral elements levels in goat hairs (mg/kg s.m.) (n = 15)

Mineral element	Sampling dates								Mean values for the groups		Mean values for the sampling dates	
	7 days before delivery				10 weeks after lactation							
	K		D		K		D					
	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	X_K	X_D	X_{T1}	X_{T2}
Ca	1501.5	66.6	1593.8	57.8	1421.5	51.8	1568.7	91.6	1461.3^a	1580.3^b	1547.7^a	1494.0^b
P	216.1	22.2	277.8	45.4	191.7	8.6	238.5	17.6	203.9^a	258.1^b	247.0^a	215.0^b
Mg	229.7^b	19.9	291.1^c	25.9	195.3^a	9.7	299.4^c	40.8	212.5^a	295.4^b	260.4^a	247.5^b
Na	326.8	24.4	283.5	30.6	324.9	15.9	279.9	39.6	325.8^b	281.7^a	305.15^a	302.4^a
K	978.7	98.5	948.7	120.8	941.8	63.9	913.1	49.3	960.35^a	930.65^a	963.70^a	927.3^a
Fe	121.8	20.0	107.8	12.8	136.9	14.0	114.4	20.6	129.6^b	110.6^a	114.80^a	125.2^a
Cu	6.58^b	0.8	10.02^c	0.5	5.48^a	0.8	11.44^d	1.6	6.0^a	10.6^b	8.32^a	8.41^a
Zn	110.9^b	0.8	107.3^b	14.5	96.6^a	5.4	107.4^b	11.0	103.7^a	107.0^a	109.1^a	102.0^a

CONCLUSIONS

1. The studied soils were calcium and zinc available, while poor in phosphorus, magnesium and copper.

2. The analysis of fodder showed that the levels of phosphorus, magnesium and copper did not cover the mineral supply of goats sufficiently.

3. There were reported some changes in the mineral metabolism of goats manifested in a decrease of magnesium, phosphorus and copper content in serum and low levels of copper and zinc in hairs.

4. The studied mineral-herbal mixture exerted a positive influence on goat mineral metabolism.

5. In the serum of goats a statistically significant higher concentration of the macroelements was indicated like, calcium, phosphorus, magnesium, sodium and potassium in favour of the group administered a mineral-herbal mixture.

6. In hairs of the goat experimental group, statistically significant higher concentrations of all the elements, except potassium, were revealed.

REFERENCES

1. Anke M., Risch M.: Haaranalyse und Spurenelementstatus. VEB Gustav Fischer Verlag, 185, Jena 1989.
2. Arkuszewska E.: Przegląd niedoborów składników mineralnych (Ca, P, Mg, Na, Cu, Mn, Zn, Co) w niektórych paszach objętościowych stosowanych w żywieniu przeżuwaczy. Praca doktorska, SGGW, Warszawa 1995.
3. Bis-Wencel H.: Rozpoznawanie i zapobieganie niedoborom mineralnym u przeżuwaczy w regionie południowo-wschodniej Polski. Praca hab., wyd. AR Lublin 2001.
4. Brochart M.: Investigation of Nutritional Deficiencies and Inbalances by the Chemical Analysis of Hair. Vet. Sci. Comn., 2, 183, 1978.
5. Czuba R., Andruszczak E.: Zawartość mikroelementów w roślinach uprawnych w krajowej sieci gospodarstw kontrolnych. Zesz. Probl. Post. Nauk Rol., 242, 91, 1983.
6. Gooneratne R., Buckley W., Christensen D.: Review of Copper Deficiency and Metabolism in Ruminants. Can. J. Anim. Sci., 69, 819, 1989.
7. Grela E., Sembratowicz I., Czech A.: Immunostymulacyjne działanie ziół. Med. Wet. N, 54, 3, 152, 1998.
8. Haenlein C.: Mineral nutrition of goats. J. Dairy Sci. 63, 1729, 1980.
9. Kaniuczak J.: Zasobność w niektóre makro i mikroelementy gleb centralnej części obniżenia podkarpackiego na tle ich antropogenizacji. Praca dokt. AR Lublin, 1979.
10. Normy Żywienia Zwierząt Gospodarskich. Wyd. VIII, PWRiL, Warszawa 1988.
11. Saba L., Białkowski Z., Wójcik S.: Badania nad zaopatrzeniem mineralnym krów w wybranych obiektach regionu południowo-wschodniej Polski. Rocz. Nauk. Roln., B, 106, 25, 1990.
12. Underwood E., Suttle in.: The mineral nutrition of livestock. CABI, Publishing, Oxon 1999.

STRESZCZENIE

Doświadczenie przeprowadzono w fermie kóz rasy białej uszlachetnionej, w rejonie południowo-wschodniej Polski. Badania wykazały niedobory mineralne w układzie troficznym gleba-roślina-zwierzę. Deficyt dotyczył następujących pierwiastków: P, Mg, Cu i Zn. Wykazano korzystny wpływ zastosowanej mieszanki mineralno-ziołowej na metabolizm mineralny kóz. W surowicy zwierząt z grupy D, otrzymujących mieszankę, zaobserwowano statystycznie istotny wzrost poziomu Ca, P, Mg, Na i K. Zostało to potwierdzone podobnymi tendencjami w sierści badanych kóz. Po zastosowaniu dożywiania mineralnego stwierdzono statystycznie istotnie wyższe stężenia wszystkich pierwiastków, z wyjątkiem potasu.