



An Investigation on Serum Mineral Levels of Healthy Norduz and Hair Goats Raised in Semi-Intensive Conditions[#]

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ARTICLE INFO	ABSTRACT
<p>[#]This study was presented as poster at the Balkan Agriculture Congress, 8th-11th September 2014, Edirne, Turkey</p> <p><i>Research Article</i></p> <p>Received : 21/04/2020 Accepted : 15/07/2020</p> <p>Keywords: Atomic absorption Hair goat Norduz goat Serum minerals Blood analysis</p>	<p>The aim of this study was to determine the some serum minerals and their interactions between in 2, 3 and 4 years-old healthy Norduz (n=45) and Hair (n=31) goats raised in semi-intensive conditions. Mineral levels were determined with Atomic absorption spectroscopy (AAS) in ppm level. Results were calculated as Fe 1.578±0.088 and 1.379±0.095 mmol/L, Cu 1.300±0.067 and 1.303±0.080 mg/L, Zn 0.972±0.029 and 0.937±0.029 mg/L, K 4.574±0.091 and 2.102±0.074 mmol/L, Mg 2.089±0.057 and 4.670±0.098 mmol/L, Mn 2.163±0.152 and 2.215±0.198 mg/L, Pb 0.078±0.005 and 0.087±0.006 mg/L for Norduz and Hair goats, respectively. While the differences in the mineral levels of hair goats were not significant, significant differences has been found between the age groups in terms of K, F and Pb in Norduz goats. In addition, while there was no statistically significant difference between 3-year-old goats, statistically significant differences hs been found for Fe and 2-year-old goats K and Mg in 4-year-old goats. Moreover, with respect to correlation coefficients, positive correlations were obtained both between K-Mg at Norduz goats and between Fe-Cu, Fe-K, Fe-Mg, K-Mg at Hair goats in all years-old groups.</p>

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Yarı Entansif Koşullarda Yetiştirilen Sağlıklı Norduz ve Kıl Keçilerinin Serum Mineral Düzeyleri Üzerine Bir Araştırma

MAKALE BİLGİSİ	ÖZ
<p><i>Araştırma Makalesi</i></p> <p>Geliş : 21/04/2020 Kabul : 15/07/2020</p> <p>Anahtar Kelimeler: Atomik absorpsiyon Kıl keçisi Norduz keçisi Serum mineralleri Kan analizi</p>	<p>Bu çalışmanın amacı, yarı-entansif koşullarda yetiştirilen 2, 3 ve 4 yaşlı, sağlıklı Norduz ve Kıl keçilerinin serum mineral düzeylerinin ve bunlar arasındaki etkileşimin belirlenmesidir. Mineral seviyeleri, ppm seviyesinde Atomik absorpsiyon spektroskopisi (AAS) ile belirlenmiştir. Sonuçlar Norduz ve Kıl keçileri için sırasıyla Fe 1,578±0,088 ve 1,379±0,095 mmol/L, Cu 1,300±0,067 ve 1,303±0,080 mg/L, Zn 0,972±0,029 ve 0,937±0,029 mg/L, K 4,574±0,091 ve 2,102±0,074 mmol/L, Mg 2,089±0,057 ve 4,670±0,098 mmol/L, Mn 2,163±0,152 ve 2,215±0,198 mg/L, Pb 0,078±0,005 ve 0,087±0,006 mg/L olarak hesaplandı. Kıl keçilerinin mineral düzeylerindeki farklılıklar anlamlı bulunmazken, Norduz keçilerinde K, F ve Pb bakımından yaş grupları arasında anlamlı farklılıklar bulunmuştur. Ayrıca, 3 yaşlı keçiler arasında istatistiksel olarak anlamlı bir fark bulunmazken, 2 yaşlı keçilerde Fe ve 4 yaşlı keçilerde K ve Mg için istatistiksel anlamlılıklar bulunmuştur. Ayrıca korelasyon katsayıları bakımından, Norduz keçilerinde K-Mg ve tüm yaş gruplarındaki Kıl keçilerinde Fe-Cu, Fe-K, Fe-Mg, K-Mg arasında pozitif korelasyonlar elde edilmiştir.</p>

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Introduction

Quite a number of minerals that necessary for breeding of sheep and goat are responsible from healthy work and the orderly functioning of organisms. Minerals with more than 100 ppm (parts per million) in living organism are classified as macromineral, while minerals less than 100 ppm are named as micromineral. Total macro mineral (Ca, Cl, K, Mg, Na, P, S etc.) content of body is always much more than micro minerals (trace minerals; As, Br, Co, Cr, Cu, Fe, Fl, I, Li, Mn, Mo, Ni, Pb, Se, Si, Sn, V, Zn etc.). Also effects of mineral levels on an animal performance is a matter that has been sensitively addressed in terms of animal health. Because, mineral intakes in animals are very important for health (Soetan et al., 2010). When mineral levels in the body stores decrease, function of immunity and enzyme; maximum growth and fertility; normal growth and fertility are gradually decrease (Anonymous, 2020a). If mineral deficiency are more, clinical symptoms begin to appear. For instance, it is known that the lack of Mg at the advanced level causes grass tetany (lactation tetany) disease in sheeps and goats. If the is no deficiency in Mg intake in the animal, an absorption disorder should be considered, when this clinical situation emerges. Absorption problems of Mg often arise when there are excess Ca and K in the diet (Swaminathan, 2003). Also, the mineral interaction of this situation in animal was presented in Figure 1.

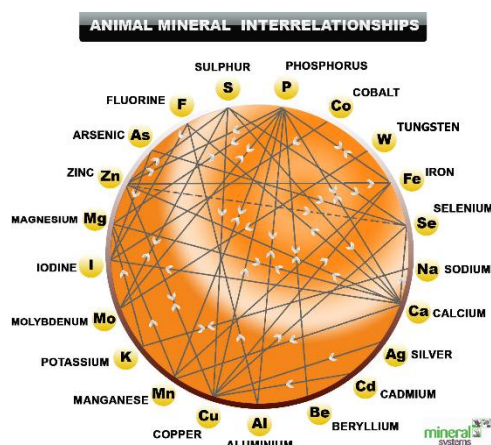


Figure 1. Animal mineral interactions (Anonymous, 2020b)

Attention is drawn first to lack of nutrition or malnutrition (not enough feeding) related to basic restrictions in animal husbandry. This situation is particularly the case for ruminants when the content of the main feed source is influenced by seasonal fluctuations (Ogunleke et al., 2014). The mineral content of pastures, especially for small ruminants, varies considerably depending on the season. Therefore, mineral deficiency are seen in sheeps and goats (Kawas et al., 2010; Xin et al., 2011). Wool and hair loss and fleece-eating disease are an important health problems in small ruminants. Especially fleece-eating disease is an important cause of economic loss for farms. Also, progressive K and S deficiency, which is not noticed in time, causes various symptoms related to wool and hair. In other hand, if S and Mo are very low concentrations in living organism, also being low concentrations of some of the other minerals (Ca, P, Fe, Mn, Zn, Cu, Co, Se) comes to mind (Patkowska-Sokola et al., 2009).

Mineral contents of the diet may be deficient. In this situation, mineral supplements are gave to ensure the best performance possible in which case. However, mineral supplements should never be higher than the level in the diet. The other hand, the range between the amount of safe reinforcement and toxic levels for most trace minerals is rather low. For this reason, effective setting of mineral levels requires expertise.

Material and Method

Study Design and Sampling

Clinically healthy Norduz (n=45) and Hair (n=31) goats raised in Small Ruminant Breeding Unit of Research and Application Farm of Van Yuzuncu Yil University were used as study material. This farm lies on 38° 575' N and 43° 287' E coordinates, Van, Turkey. Goats raised in this farm were pastured at open range fields twice a day. First grazing time was from early times in the morning to the Sun's transit time (the hour when the Sun's rays are come upright on the earth). Second grazing time also started in the afternoon and continued until sunset.

On the other hand, this district was poor in terms of the quality and the quantity of pasture in general. Nevertheless, no dietary changes and / or experimental applications had been made with regard to the goats used in the study.

Serum samples were obtained from 2, 3 and 4 years-old non pregnant but lactating goats. Samples were taken from the goats via Vena Jugularis using 5 ml syringes. Blood samples taken were transferred into anticoagulant tubes. All samples were centrifuged at 1500×g for 10 minutes in room temperature (20 to 22°C / 68 to 72°F) in Animal Science Department's Laboratuar. The serum final version of the samples were stored at -20°C until analysis.

Biochemical Analyses

Dilution of serums (1:50) with deionized water were performed as described in the "standard conditions" (Anonymous, 2020c). In addition, the dilution ratio is maintained at an appropriate absorbance range for concentrations. Levels of Fe, Cu, Zn, K, Mg, Mn and Pb were determined with AAS (Brend: Thermo Scientific, Model: ICE-3000 series) located in Van Yuzuncu Yil University, Central Laboratory. Determined of concentrations of the minerals were made after calibrating the device by using standard concentration values (Fernandez and Kahn, 1971). As the effective wavelength were used 248.3, 324.8, 213.9, 766.5, 285.2, 279.5, 283.3 nm for Fe, Cu, Zn, K, Mg, Mn and Pb, respectively. Results were measured as ppm. Because different units were used in references, calculated results were presented as mg/L for Fe, Cu, Zn, Mn, Pb and mmol/L for K and Mg.

Minerals Ranking

Minerals ranking of Norduz and Hair goats was made according to ppm levels (Patkowska-Sokola et al., 2009).

Mineral Rates Calculation

1 ppm=1 mg/L, 1 mEq/L= 1 mmol/L Equations (Anonymous, 2020d)

$$\text{mg} \times \text{Valance} / \text{Atomic or molecular weight} = \text{mEq}$$

1 mg/L=0.0411 mmol/L for Mg (SI unit, Mg; Atomic weight is 24, Valence is 2), 1 mg/L= 0.0256 mmol/L for K (SI unit, K; Atomic weight is 39, Valence is 1)

Statistical Analyses

In the present study, all statistical analyses were done using SPSS ver 17.0 (SPSS Inc, Chicago, IL, USA) (SPSS, 2008). Significant differences in the probability of mineral analysis ($P < 0.05$) were compared using Duncan's Multiple Range Test. Then, the relationships between minerals were analyzed to suggest to revealing with Pearson Correlation Coefficient ($P \leq 0.05$) (Steel and Torrie, 1980). The statistical significance levels of the study were expressed as follows: ^{NS} $P > 0.05$, * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$

Results

In this study, minimum-maximum (min-max) and mean concentration \pm standard error ($\bar{x} \pm S_x$) of serum mineral values belonging to 2, 3 and 4 years-old Norduz and Hair goats were presented in the Table 1. In this study, mineral levels of Norduz goats were calculated as Fe 1.578 \pm 0.088 mg/L, Cu 1.300 \pm 0.067 mg/L, Zn 0.972 \pm 0.029 mg/L, K 4.574 \pm 0.091 mmol/L, Mg 2.089 \pm 0.057 mmol/L, Mn 2.163 \pm 0.152 mg/L and Pb 0.078 \pm 0.005 mg/L, while mineral levels of Hair goats were found as Fe 1.379 \pm 0.095 mg/L, Cu 1.303 \pm 0.080 mg/L, Zn 0.937 \pm 0.029 mg/L, K 4.670 \pm 0.098 mmol/L, Mg 2.102 \pm 0.074 mmol/L, Mn 2.215 \pm 0.198 mg/L and Pb 0.087 \pm 0.006 mg/L.

Table 1. Blood mineral levels of Norduz and Hair goats

Mineral	Norduz				Hair				General	
	Age			Total	Age			Total		
	2	3	4		2	3	4			
Fe mg/L	N	17	14	14	45	12	8	11	31	76
	Min	0.922	0.404	0.523	0.404	0.886	0.636	0.789	0.636	0.404
	Max	2.577	2.287	2.114	2.577	2.263	2.542	2.301	2.542	2.577
	\bar{X}	1.939	1.441	1.277	1.578	1.513	1.122	1.420	1.379	1.293
	Sx	$\pm 0.118^a$	$\pm 0.520^b$	$\pm 0.157^b$	± 0.088	± 0.140	± 0.226	± 0.140	± 0.095	± 0.066
	P		**				NS			
Cu mg/L	N	17	14	14	45	12	8	11	31	76
	Min	0.755	0.112	0.607	0.112	0.640	0.647	0.785	0.640	0.607
	Max	2.135	1.865	2.277	2.277	1.985	1.570	2.840	2.840	2.840
	\bar{X}	1.439	1.172	1.248	1.300	1.220	1.140	1.508	1.303	1.133
	Sx	± 0.083	± 0.143	± 0.127	± 0.067	± 0.107	± 0.098	± 0.167	± 0.080	± 0.051
	P		NS				NS			
Zn mg/L	N	17	14	14	45	12	8	11	31	76
	Min	0.701	0.673	0.755	0.673	0.634	0.720	0.625	0.625	0.625
	Max	1.410	1.336	1.294	1.410	1.197	1.166	1.141	1.197	1.410
	\bar{X}	0.928	0.978	1.021	0.972	0.883	0.959	0.976	0.937	0.957
	Sx	± 0.044	± 0.060	± 0.127	± 0.029	± 0.051	± 0.052	± 0.045	± 0.029	± 0.021
	P		NS				NS			
K mmol/L	N	17	13	12	42	12	8	11	31	73
	Min	3.796	4.038	3.085	3.085	4.060	3.714	3.870	3.714	3.085
	Max	5.684	5.787	4.746	5.787	5.608	5.660	5.615	5.660	5.684
	\bar{X}	4.892	4.607	4.063	4.574	4.775	4.363	4.767	4.670	4.615
	Sx	$\pm 0.109^a$	$\pm 0.133^a$	$\pm 0.164^b$	± 0.091	± 0.148	± 0.217	± 0.151	± 0.098	± 0.067
	P		***				NS			
Mg mmol/L	N	17	13	10	40	11	8	11	30	70
	Min	1.337	1.626	1.482	1.337	1.620	1.304	1.432	1.304	1.304
	Max	2.833	2.509	2.309	2.933	2.844	2.802	3.155	3.155	3.155
	\bar{X}	2.200	2.106	1.866	2.089	2.076	1.951	2.238	2.102	2.094
	Sx	± 0.094	± 0.084	± 0.092	± 0.057	± 0.117	± 0.138	± 0.126	± 0.074	± 0.045
	P		NS				NS			
Mn mg/L	N	16	14	14	44	10	8	11	29	73
	Min	0.756	1.104	0.744	0.744	0.660	1.168	1.008	0.660	0.660
	Max	3.936	4.692	4.243	4.692	4.066	4.057	4.296	4.296	4.692
	\bar{X}	1.863	2.379	2.290	2.163	2.072	2.398	2.195	2.215	2.132
	Sx	± 0.228	± 0.280	± 0.282	± 0.152	± 0.386	± 0.305	± 0.349	± 0.198	± 0.120
	P		NS				NS			
Pb mg/L	N	17	14	14	45	12	8	11	31	76
	Min	0.011	0.012	0.020	0.011	0.011	0.012	0.011	0.011	0.011
	Max	0.179	0.123	0.122	0.179	0.127	0.138	0.127	0.141	0.141
	\bar{X}	0.097	0.074	0.060	0.078	0.081	0.096	0.081	0.087	0.082
	Sx	$\pm 0.008^a$	$\pm 0.011^{ab}$	$\pm 0.010^b$	± 0.005	± 0.008	± 0.013	± 0.008	± 0.006	± 0.004
	P		*				NS			

^{NS} $P > 0.05$, * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$, Duncan's Multiple Range Test was performed at $P < 0.05$. Means with the same letter are not significantly different.

Table 2. Mineral levels of Norduz and Hair goats in the same age groups

Mineral	Age									
	2			3			4			
	Norduz	Hair	Total	Norduz	Hair	Total	Norduz	Hair	Total	
Fe mg/L	N	17	12	29	14	8	22	14	11	25
	\bar{X}	1.939	1.513	1.762	1.441	1.122	1.325	1.277	1.420	1.340
	Sx	±0.118	±0.140	±0.097	±0.520	±0.226	±0.122	±0.157	±0.140	±0.106
	P	*			NS			NS		
Cu mg/L	N	17	12	29	14	8	22	14	11	25
	\bar{X}	1.439	1.220	1.352	1.172	1.140	1.160	1.248	1.508	1.368
	Sx	±0.083	±0.107	±0.068	±0.143	±0.098	±0.094	±0.127	±0.167	±0.104
	P	NS			NS			NS		
Zn mg/L	N	17	12	29	14	8	22	14	11	25
	\bar{X}	0.928	0.883	0.910	0.978	0.959	0.970	1.021	0.976	1.000
	Sx	±0.044	±0.051	±0.033	±0.060	±0.052	±0.041	±0.127	±0.045	±0.034
	P	NS			NS			NS		
K mmol/L	N	17	12	29	13	8	21	12	11	23
	\bar{X}	4.892	4.775	4.845	4.607	4.363	4.514	4.063	4.767	4.415
	Sx	±0.109	±0.148	±0.088	±0.133	±0.217	±0.117	±0.164	±0.151	±0.131
	P	NS			NS			**		
Mg mmol/L	N	17	11	28	13	8	21	10	11	21
	\bar{X}	2.200	2.076	2.153	2.106	1.951	2.043	1.866	2.238	2.070
	Sx	±0.094	±0.117	±0.073	±0.084	±0.138	±0.075	±0.092	±0.126	±0.089
	P	NS			NS			*		
Mn mg/L	N	16	10	26	14	8	22	14	11	25
	\bar{X}	1.863	2.072	1.943	2.379	2.398	2.387	2.290	2.195	2.248
	Sx	±0.228	±0.386	±0.201	±0.280	±0.305	±0.204	±0.282	±0.349	±0.216
	P	NS			NS			NS		
Pb mg/L	N	17	12	29	14	8	22	14	11	25
	\bar{X}	0.097	0.081	0.091	0.074	0.096	0.083	0.060	0.081	0.073
	Sx	±0.008	±0.008	±0.006	±0.011	±0.013	±0.008	±0.010	±0.008	±0.008
	P	NS			NS			NS		

NS P>0.05, * P≤0.05, ** P≤0.01, *** P≤0.001

Table 3. Correlation levels between minerals in Norduz goats

M	Age	N	Cu	N	Zn	N	K	N	Mg	N	Mn	N	Pb
Fe	2	17	0.3827	17	0.1279	17	0.5372*	17	0.5952*	16	0.2122	17	-0.1335
	3	14	0.4812	14	0.2489	13	0.5317	13	0.3963	14	0.2154	14	0.2072
	4	14	0.7937**	14	0.5410*	12	0.6865*	10	0.6172	14	-0.2289	14	0.4060
	T	45	0.6002***	45	0.1776	42	0.6695***	40	0.5829***	44	-0.0447	45	0.3207*
Cu	2			17	0.2473	17	0.5927**	17	0.4678*	16	0.1085	17	-0.6422**
	3		1.0000	14	-0.2856	13	-0.0633	13	-0.0724	14	-0.1466	14	0.4302
	4			14	0.4023	12	0.5963*	10	0.7222*	14	-0.4068	14	0.5473*
	T			45	0.0331	42	0.3442*	40	0.3027	44	-0.2189	45	0.2153
Zn	2					17	0.4162	17	0.3828	16	0.2106	17	-0.5879*
	3					13	0.1659	13	0.0853	14	0.8289**	14	-0.0006
	4				1.0000	12	0.0953	10	0.4149	14	0.0617	14	-0.1036
	T					42	0.0376	40	0.1692	44	0.4335**	45	-0.2884
K	2							17	0.8380***	16	0.2832	17	-0.5045*
	3						1.0000	13	0.6802**	13	-0.1467	13	0.0657
	4							10	0.8507**	12	-0.1776	12	0.5638
	T							40	0.8140***	41	-0.0351	42	0.2086
Mg	2									16	0.2850	17	-0.4413
	3								1.0000	13	-0.1025	13	0.2993
	4									10	-0.0775	10	0.3937
	T									39	0.0484	40	0.0504
Mn	2											16	0.1452
	3											14	-0.1576
	4										1.0000	14	-0.3230
	T											44	-0.1790

NS P>0.05, * P≤0.05, ** P≤0.01, *** P≤0.001, M: Mineral, T: Total

According to the Table 1, no statistical significance ($P>0.05$) between age groups of Hair goats, while statistical significances were for K ($P\leq 0.001$), Fe ($P\leq 0.01$) and Pb ($P\leq 0.05$) in Norduz goats. Also, total values of each race and overall values of all goats were given in the same table. Additionally, Duncan analysis were performed for 3 different age groups, after than analysis results were sorted as a, b from big to small. In here, only Fe, K and Pb results of Norduz goats were according to Duncan results.

Mineral levels of goats in the same age groups were presented in the Table 2. According to the table, only Fe levels in 2 years old goats had a significant difference ($P\leq 0.05$) between Norduz and Hair goats. There was no statistical significance ($P>0.05$) in terms of mineral levels for goat races aged 3 years old. However, statistical differences of K ($P\leq 0.01$) and Mg ($P\leq 0.05$) levels of 4 years old goats were significant.

Correlation tables of Norduz and Hair goats blood minerals were also presented in the Table 3 and Table 4, respectively. According to correlation coefficients between mineral levels, the highest positive correlations were acquired between Fe-Cu ($P\leq 0.001$), Fe-K ($P\leq 0.001$), Fe-Mg ($P\leq 0.001$) and K-Mg ($P\leq 0.001$) in Norduz goats. Besides, correlations between Zn-Mn ($P\leq 0.01$), Fe-Pb ($P\leq 0.05$) and Cu-K ($P\leq 0.05$) were also positive and significant. Also, there was any negative and significant correlation in Norduz goats (Table 3).

In the Table 4, highest positive correlations were calculated between Fe-K ($P\leq 0.001$), Fe-Mg ($P\leq 0.001$), K-Mg ($P\leq 0.001$) and Cu-Mg ($P\leq 0.001$) in Hair goats. The other hand, correlations between Zn-K ($P\leq 0.01$), Fe-Cu ($P\leq 0.05$), Fe-Zn ($P\leq 0.05$), Cu-Zn ($P\leq 0.05$), Cu-K ($P\leq 0.05$) and Zn-Mg ($P\leq 0.05$) were also positive and significant. Regarding the negative correlations, correlation coefficient between only Cu-Pb was found significant ($P\leq 0.05$).

Table 4. Correlation levels between minerals in Hair goats

M	Age	N	Cu	N	Zn	N	K	N	Mg	N	Mn	N	Pb
Fe	2	12	0.1928	12	0.3867	12	0.9221***	11	0.8394**	10	0.1664	12	-0.2121
	3	8	0.7339*	8	0.4749	8	0.8815**	8	0.9223**	8	-0.3652	8	-0.1573
	4	11	0.6798*	11	0.5961	11	0.7178*	11	0.7353**	11	-0.0245	11	-0.4868
	T	31	0.4503*	31	0.3895*	31	0.8577***	30	0.7821***	29	-0.1033	31	-0.3272
Cu	2			12	0.4715	12	0.4146	11	0.5117	10	0.1706	12	-0.0991
	3		1.0000	8	-0.0984	8	0.7039	8	0.8257**	8	-0.2149	8	-0.1481
	4			11	0.4823	11	0.3486	11	0.6967*	11	-0.0919	11	-0.5553
	T			31	0.3740*	31	0.4069*	30	0.6808***	29	-0.3620	31	-0.3461*
Zn	2					12	0.6022*	11	0.5504	10	0.1971	12	0.2744
	3				1.0000	8	0.2165	8	0.2294	8	-0.3987	8	-0.0735
	4					11	0.8085**	11	0.7748**	11	0.5308*	11	-0.1657
	T					31	0.4880**	30	0.5300*	29	0.1439	31	0.0296
K	2							11	0.9160***	10	0.1801	12	-0.1016
	3						1.0000	8	0.9781***	8	-0.4190	8	0.0370
	4							11	0.8741**	11	0.2697	11	-0.1408
	T							30	0.8773***	29	0.0032	31	-0.1197
Mg	2									10	0.1302	11	-0.0074
	3								1.0000	8	-0.4011	8	0.0757
	4									11	0.2447	11	-0.3050
	T									29	0.0021	30	-0.1364
Mn	2											10	-0.3742
	3										1.0000	8	0.2470
	4											11	0.1820
	T											30	0.0476

^{NS} $P>0.05$, * $P\leq 0.05$, ** $P\leq 0.01$, *** $P\leq 0.001$, M: Mineral, T: Total

Table 5. Mineral ranking of Norduz and Hair goats

Breed	Age	Rank												
Norduz	2	K	>	Mg	>	Fe	>	Mn	>	Cu	>	Zn	>	Pb
	3	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
	4	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
	Total	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
Hair	2	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
	3	K	>	Mg	>	Mn	>	Cu	>	Fe	>	Zn	>	Pb
	4	K	>	Mg	>	Mn	>	Cu	>	Fe	>	Zn	>	Pb
	Total	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
General	2	K	>	Mg	>	Mn	>	Fe	>	Cu	>	Zn	>	Pb
	3	K	>	Mg	>	Mn	>	Cu	>	Fe	>	Zn	>	Pb
	4	K	>	Mg	>	Mn	>	Cu	>	Fe	>	Zn	>	Pb
	Total	K	>	Mg	>	Mn	>	Cu	>	Fe	>	Zn	>	Pb

In the Table 5, mineral levels of Norduz and Hair goats were ranked from major to minor (Patkowska-Sokola et al., 2009). According to this, while K (1st), Mg (2nd), Zn (6th) and Pb (7th) were in the same column for all animals, there were changes in the Mn, Cu and Fe ranking (3rd, 4th and 5th).

Also, proportional values of the minerals interacting with each others were presented in the Table 6. While

proportional values were given, ppm levels were presented as mg/L and mmol/L.

Data collected from Anonymous (2020c) were compiled taking into account the synergistic and antagonistic effects of Figure 1 and, were presented in the Table 7. Here, the correlation results of minerals are expressed differently. Firstly, according to which other minerals with synergistic and antagonistic effects of the minerals analysed were ranked.

Table 6. Mineral rates of Norduz and Hair goats

Breed	A	Cu/Zn mg/L/mg/L	Fe/Cu mg/L/mg/L	Fe/Mn mg/L/mg/L	Fe/Zn mg/L/mg/L	Mg/K mmol/L/mmol/L	Mg/Mn mmol/L/mg/L	Pb/Cu mg/L/mg/L	Pb/Fe mg/L/mg/L
Norduz	2	1.551	1.347	1.041	2.089	0.450	28.733	0.067	0.050
	3	1.198	1.230	0.606	1.473	0.457	21.539	0.063	0.051
	4	1.222	1.023	0.558	1.251	0.459	19,826	0.048	0.047
	T	1.337	1.214	0.730	1.623	0.457	23.498	0.060	0.049
Hair	2	1.382	1.240	0.730	1.713	0.435	24.378	0.066	0.054
	3	1.189	0.984	0.468	1.170	0.447	19.796	0.084	0.086
	4	1.545	0.942	0.647	1.455	0.469	24.808	0.054	0.057
	T	1.391	1.058	0.623	1.472	0.450	23.090	0.067	0.063
General		1.184	1.141	0.606	1.351	0.454	23.897	0.072	0.063

A: Age, T: Total

Table 7. Major nutritional relationship of minerals (Anonymous 2016a)

Analysed minerals	Synergists		Antagonists	
	Analysed	Non-analysed	Analysed	Non-analysed
Fe	Cu*, K, Mn*	Cr, Na, P, Se	Cu*, Mn*, Pb, Zn	Al, Ca, Cd, Co, Cr, Hg, P, Sn, V
Cu	Fe*	Ca, Co, Na, Se	Fe*, K, Pb, Zn	Ag, Cd, Hg, Mo, P, S, Se
Zn	K, Mg, Mn*	Cr, P	Cu, Fe, Mn*, Pb	Ca, Cd, Co, Cr, Hg, Ni, P, Se, Sn
K	Fe, Mg, Mn, Zn	Co, Na, P	Cu	Ca, Co, Li, Na
Mg	K*, Mn*, Zn	Ca, Cr, P	Fe, K*, Mn*, Pb	Ca, Cd, Co, Na, P
Mn	Fe*, K, Mg*, Zn	P	Cu, Fe*, Mg*, Pb	Ca, Cd, Cr, Co, P, V
Toxic Pb	-	-	Cu, Fe, Mg, Mn, Zn	Ca, S, Se

*Having both the synergist and the antagonist effects on the other analysed minerals

Discussion and Conclusion

In a study carried out by Sowande et al. (2008), K and Mg levels were reported as 5.79±0.08 mmol/L and 0.72±0.03 mmol/L in Wad goats by respectively. Rumosa Gwaze et al. (2012) reported that Mg concentration in Nguni does were 1.03±0.022 mmol/L and 0.96±0.031 mmol/L in dry and wet seasons, respectively. In the same study, no statistical significance was reported between young and mature goats. Moreover, in a study carried out by Yatoo et al. (2013), Fe, Cu, Zn and Mg were determined as 1.548±0.173 mg/L, 0.548±0.094 mg/L, 0.864±0.211 mg/L and 2.11±0.24 mmol/L, respectively. In another study carried out by Bagnicka et al. (2014), Fe, K and Mg were presented as 21.54 µmol/l, 3.59 mmol/L, 0.79 mmol/L at the end of lactation period (180th day), respectively. Furthermore, Fathy Nawito et al. (2015) demonstrated Fe, Cu and Zn levels as 4.91±0.09 ppm, 0.49±0.05 ppm, 4.65±0.24 ppm in non-pregnant goats reared in South Sinai, Egypt, respectively. In a study on experimental doses of Mn in kids, the average of blood Mg level of 140th day was 3.14±0.19 mg/kg in the control group (Pitropovska et al., 2014). In another study where high dose of Pb investigated, Pb levels of blood in Red Sokoto goats grazed freely on open pastures in Zaria changed between 0.26 mg/L and 1.56 mg/L while the mean value of 0.89±0.43 mg/L. Because the Red Sokoto goats

were grazed freely in Zaria, the blood Pb level has been reported to exceed the permissible limit so not safe for human consumption (Ugumanim et al., 2015). Elevated blood Pb levels in goats grown around primary pollution sites caused by Pb-Zn pollutants was investigated in an other study (Swarup et al., 2006). In that study's result, mean blood Pb levels was 0.015±0.015 µg/ml in control group, while 0.373±0.093 µg/ml was in goats around drinking water that were thought to be contaminated with metal wastes.

In the presented study, the K levels was lower than Sowande et al. (2008)'s result. Further, Fe, Cu, Zn levels were approximately 3, 0.3, 2 times more from Fathy Nawito et al. (2015)'s results, respectively. But then, an overlapping results was obtained in terms of 3 minerals reported by Bagnicka et al. (2014). The value of Mn in the Pitropovska et al. (2014)'s report was higher than that of the 2 years-old young animals in this study. Additionally, the Pb value of this study presented was higher than the value reported by Swarup et al. (2006). However, Pb values were within acceptable physiological limits.

In the study, statistical significant were found between 2 years old Norduz and Hair goats for Fe (P≤0.01). There was also statistical significant between 4 years old goats for K (P≤0.001) and Pb (P≤0.05). When the results

examined, it was understood that the levels of these 3 minerals of 2 years old goats were higher than 3 and 4 years old. Regarding this situation, it can be considered normal for goats with higher mineral levels within the physiological limits to be younger.

In the study's result, as for correlation coefficients between mineral levels, the best positive correlations ($P \leq 0.001$) were obtained between Fe-Cu, Fe-K, Fe-Mg and K-Mg in Norduz goats. Moreover, correlations between Cu-K ($P \leq 0.05$), Fe-Pb ($P \leq 0.05$) and Zn-Mn ($P \leq 0.01$) were positive and significant. Also, there was no significant negative correlation between mineral levels in Norduz goats. Moreover, while the best positive correlations ($P \leq 0.001$) were obtained between Fe-K, Fe-Mg, Cu-Mg and K-Mg, low level statistical significance ($P \leq 0.05$) were between Fe-Cu, Fe-Zn, Cu-Zn, Cu-K and Zn-Mg in Hair goats. But, a negative statistical significance ($P \leq 0.05$) was between Cu-Pb.

According to the mineral ranking statements from major to minor, K, Mg and Mn were taken in top 3. Pb from a toxic trace element was the last rank as expected. While Zn was in the 2nd last place, Cu and Fe were sometimes replaced with each other in 4th and 5th ranks. Significant differences in the age groups of races were not determined in order.

Some of the mineral ratios were actually mentioned earlier in connection with Table 3 and Table 4. While Cu, Zn, Fe, K and Mn are nutritional minerals, Pb is a toxic mineral (Anonymous, 2020c). As can be seen from Figure 1 and Table 7, many minerals have both synergist and antagonist potency on the same other minerals. Similar cases were between Fe-Cu, Fe-Mn, Mg-K and Mg-Mn. This situation means that the balances of these minerals are more complicated. If the Table 3 and the Table 4 were considered, correlation coefficient of Mg-K were significant as $P < 0.001$ in Norduz and Hair goats. Hence, the presence of substantial balance between Mg-K has been demonstrated by correlation coefficient analysis performed in this study. A similar situation is also true for Fe-Cu. Mc Dowell (1985) reported that the lower value of Mg in both seasons was related to high K concentration. At the same time, he declared that high dietary K was interfered with Mg absorption in ruminant animals.

As a result the fact that difference of some other studies results and this study may be due to nutrition program, quality of pastures and differences of genetic. But goats, like any other small ruminants, should consume feed containing essential minerals for support body functions (maintenance, activity, growth, pregnancy, lactation). Additionally, because considering that small ruminants were more active from large ruminants, minerals are very important for regulatory systems on the performance of ruminants life. Mineral levels of the goats in this presented study were also within the reference ranges. Therefore, it was not necessary to use mineral supplements at the end of the study.

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