

NOTE
**MINERAL STATUS OF RANGE PLANTS FOR
GRAZING RUMINANTS IN SEMI-ARID AREAS
OF ISFAHAN PROVINCE**

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ABSTRACT

The mineral status of dominant and palatable range plants (Graminae, Leguminosae, Apiaceae and Chenopodiaceae) in semi-arid areas of Isfahan province was investigated. Samples were taken from two main areas of the province including Semirom and Fereydan. An analysis of the whole plants revealed that the content of phosphorus for all species except for *Vicia variabilis*, during vegetative and reproductive growth stages, was lower than the critical value required for ruminants ($P < 0.01$). The magnesium content in whole plants for both growth stages, was lower than the critical value for ruminants ($P < 0.01$) except for *Eurotia ceratoides*. The sodium content in *Ferulago angolata*, Russian brome (*Bromus tomentellus*) ($P < 0.001$), pubescent wheat grass (*Agropyron trichophorum*), feather grass (*Stipa barbata*) and *Vicia variabilis* was lower than the critical value ($P < 0.01$). A deficiency of copper, zinc and calcium was observed in some of the species. Data obtained from whole plant samples suggest that semi-arid ranges of

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Isfahan province require mineral supplementation for grazing ruminants, especially for phosphorus, magnesium, copper and sodium.

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بررسی عناصر معدنی گیاهان مرتعی مورد مصرف نشخوار کنندگان در مراتع نیمه استپی استان اصفهان

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به ترتیب دانشجوی سابق کارشناسی ارشد دانشگاه تربیت مدرس (عضو هیات علمی مرکز تحقیقات منابع طبیعی و امور دام استان اصفهان)، دانشیار گروه علوم دامی، استادیار دانشکده منابع طبیعی دانشگاه صنعتی اصفهان و اعضای هیات علمی مرکز تحقیقات منابع طبیعی و امور دام استان اصفهان، اصفهان، ایران.

چکیده

به منظور بررسی وضعیت عناصر معدنی گیاهان غالب و خوش خوراک مراتع نیمه استپی استان اصفهان از دو منطقه سمیرم و فریدن نمونه برداری شد. گونه های مورد مطالعه از تیره های گندمیان، بقولات، چتریان و اسفنا جیان بودند. با استفاده از روش های آزمایشگاهی، یازده عنصر معدنی در این نمونه ها اندازه گیری شد. میزان فسفر کلیه گونه های مورد مطالعه به جز گونه *Vicia variabilis* در دو مرحله رویشی و زایشی، پایین تر از حداقل میزان تعیین شده برای نشخوار کنندگان بود ($P < 0/01$). غلظت منیزیم تمام گونه ها به جز گونه *Eurotia ceratoides* در هر دو مرحله رشد از سطح بحرانی برای نشخوار کنندگان پایین تر بود ($P < 0/01$). میزان سدیم گونه های *Bromus tomentellus*، *Ferulago angolata*، ($P < 0/001$).

پایین تر از ($P < 0.01$) *Vicia variabilis* و *Stipa barbata*، (*Agropyron trichophorum*) سطح بحرانی بود. همچنین کمبود مس، روی و کلسیم در برخی از گونه ها مشاهده شد. اطلاعات حاصله از تجزیه کلیه نمونه ها نشان داد که مراتع نیمه استپی استان اصفهان (فریدن و سمیرم) برای دام های چرا کننده احتیاج به مکمل مواد معدنی بخصوص فسفر، منیزیم، مس و سدیم دارد.

INTRODUCTION

The principal factors limiting the performance of grazing animals are low protein content of grasses, low-energy intake due to high fiber content and mineral deficiencies or imbalances (11). At least 26 mineral elements are required by at least one or more animal species (5). These elements are generally required in small amounts. They have a great deal of importance in body tissue growth as well as the responsibility of several physiological functions. A deficiency of one or more of the essential minerals in animals can lead not only to a decrease in productivity but also to metabolic diseases in cases of severe deficiencies (11). In addition, wasting disease, low fertility, pica, bone abnormalities and other clinical signs of mineral deficiency are frequently observed in Venezuelan cattle (16). Furthermore, based on whole plant samples from creeping bluestem (*Schizachyrium stoloniferum* Nash.) in Florida ranges, the amounts of potassium, magnesium, phosphorus, zinc, calcium and the Ca : P ratio were inadequate when compared to the National Research Council's requirements for dry, pregnant cows (7, 8). Also, Rauzi (15) reported that the nutritional value of fringed sagewort (*Artemisia frigida*) with regard to the phosphorus and crude protein content was inadequate for livestock after late July.

In general, mineral especially phosphorus deficiencies and mineral imbalances are reported from almost all tropical regions of the world (2, 11, 13). This study was designed to measure the calcium, phosphorus, magnesium, potassium, sodium, sulfur, iron, manganese, zinc, copper and

cobalt contents of some plant species in the semi-arid rangelands of Isfahan province. Such information is not available at present.

MATERIALS AND METHODS

In the spring and summer of 1993, dominant and palatable range plant samples were collected from the areas of Semirom and Fereydan (Table 1). These areas account for approximately 80% of the good rangelands in Isfahan province. Semirom and Fereydan are located in the south and southwest of Isfahan province, respectively. These regions are semi-arid with mild summer and cold winter.

Table 1. Plant species studied.

Species	Family	Study areas		Sampling time
		Fereydan	Semirom	
<i>Agropyron trichophorum</i>	Graminae	X	-	May-July
<i>Bromus tomentellus</i>	Graminae	X	X	June-Aug.
<i>Stipa barbata</i>	Graminae	-	X	July
<i>Astragalus cyclophyllus</i>	Leguminosae	-	X	June-Aug.
<i>Onobrychis melanotricha</i>	Leguminosae	-	X	June-Aug.
<i>Vicia variabilis</i>	Leguminosae	X	-	June
<i>Cachrys ferulasea</i>	Apiaceae	X	-	June-July
<i>Eryngium bilardiari</i>	Apiaceae	X	-	June-July
<i>Ferula ovina</i>	Apiaceae	X	-	June-July
<i>Ferulago angolata</i>	Apiaceae	X	-	June-July
<i>Eurotia ceratoides</i>	Chenopodiaceae	-	X	June-Sep.

Plant materials were sampled from each species in ungrazed areas during two growth stages of range plants including vegetative and reproductive growth stages (May-September). The grasses were cut at 2 cm above ground level. Sampling was intended to simulate grazing or browsing by sheep (6). The unwashed samples were air-dried and ground with stainless steel blades (20 mesh screen). Samples were ashed at 500°C for 6 hr. The ash was dissolved in a 1:1 HCl solution and used for determination of calcium, magnesium, sodium, potassium, iron, manganese, zinc, copper and cobalt (1). Concentrations of calcium, magnesium, iron, manganese, zinc, copper and cobalt were determined by atomic absorption spectrometry

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(1, 3, 9), sodium and potassium by flame spectrophotometry (4), phosphorus by spectrophotometry (1) and sulfur by gravimetric method (4). The results are presented on a dry matter basis. The statistical analysis was performed using STATGRAPHIC (10) and statistical indices such as means and standard error, were obtained. The mineral status of each range plants was assessed by comparing the concentration of each mineral with established critical levels (5, 11, 12, 14).

RESULTS AND DISCUSSION

Mineral analysis of the forage consumed by the grazing animal is basic to mineral status diagnosis. If mineral concentrations are below minimum requirements or above tolerance levels, there is an immediate suggestion of a nutritional problem (11).

Concentrations of macronutrients in range plants are presented in Table 2. The highest phosphorus content was found in *Vicia variabilis* (0.270 %), whereas the lowest phosphorus content was found in *Stipa barbata* (0.084 %). Phosphorus content in whole plants during vegetative and reproductive growth stages except for *Vicia variabilis* (vegetative growth stage) was lower ($P < 0.05$) than the critical value of 0.25 percent (11, 14) for ruminants (Table 2). McDowell (11) stated that in most livestock grazing areas within tropical countries, soils and plants are low in phosphorus. For the greater part of the year, mature forages contain less than 0.15% phosphorus. The data presented in Table 2 indicate that the maximum content of magnesium was observed in *Eurotia ceratoides* (0.110 and 0.143 % for vegetative and reproductive growth stages, respectively) and the lowest in *Agropyron trichophorum* (0.016% for both stages of growth) and *Stipa barbata* (0.016 % for reproductive stages). Content of magnesium in whole plants for both growth stages except for *Eurotia ceratoides* was lower than ($P < 0.01$) the critical value of 0.1 % for ruminants (Table 2). The highest and lowest contents of calcium were observed during the reproductive stage of *Cachrys ferulacea* (1.206 %) and *Agropyron trichophorum* (both growth stages), *trichophorum* (0.192 %). The calcium

Table 2. Range plant mineral concentrations in two growth stages for comparing to critical levels[†].

Species	Stage ¹	Region ²	Mean (ppm)										
			Ca	P	Mg (%)	K	Na	S	Fe	Mn	Zn	Cu	
<i>Agropyron trichophorum</i>	V	Fereydan	0.206*	0.105***	0.016***	1.190	0.041	0.450	353.5	34.46	209.42	1.26	5.01*
	R	Fereydan	0.192**	0.158**	0.016***	1.420	0.022**	0.430	299.89	54.04	221.71	1.94	5.21*
<i>Bromus tomentellus</i>	V	Fereydan	0.336	0.180***	0.030**	1.742	0.028**	0.443	1017.05	57.14	24.32	3.21	7.65
	R	Fereydan	0.290	0.131***	0.026***	1.363	0.028***	0.467	599.22	61.47	289.22	1.58	6.08
<i>Bromus tomentellus</i>	V	Semirom	0.337	0.141***	0.023***	1.943	0.040	0.313	619.61	64.63	256	1.05	6.84
	R	Semirom	0.314	0.057***	0.029**	0.791	0.032*	0.412	1102.5	85.06	384	2.10	2.28*
<i>Stipa barbata</i>	R	Semirom	0.258	0.084***	0.016***	0.850	0.030**	0.364	778.28	32.65	21.32**	1.04	6.94*
	V	Semirom	1.336	0.156*	0.060***	2.053	0.056	0.523	166.56	64.27	50.70	3.05	7.71
<i>Onobrychis melanotricha</i>	R	Semirom	0.992	0.081***	0.058**	1.790	0.054**	0.431	484.98	69.62	141.17	2.26	7.16
	R	Semirom	0.592	0.143***	0.046**	1.369	0.073	0.496	352.11	55.95	113.52	2.13	8.41
<i>Vicia variabilis</i>	V	Fereydan	0.723	0.270	0.046**	1.827	0.037**	0.540	306.10	43.64	16.64***	2.14	15.31

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Table 2. Continued.

Species	stage ¹	Region	Ca		P		Mg (%)		K	Na	S	Fe	Mn	Zn (ppm)		Co	Cu
			Mean	Mean	Mean	Mean	Mean	Mean									
<i>Cachrys</i>	V	Fereydan	1.050	0.183**	0.046**	2.018	0.810	0.688	218.75	41.35	21.16	3.31	8.62				
<i>Ferula</i>	R	Fereydan	1.206	0.099***	0.054**	1.508	0.707	0.751	185.37	44.72	32.37	3.31	6.68				
<i>Eryngium</i>	V	Fereydan	0.876	0.218*	0.081	2.462	0.035	0.586	231.04	45.07	108.68	2.58	11.14				
<i>bitardari</i>	R	Fereydan	1.054	0.200*	0.093	2.000	0.056	0.523	193.67	71.22	315.45	2.68	10.71				
<i>Ferula</i>	V	Fereydan	0.885	0.192**	0.039**	2.713	0.051	0.592	389.55	26.41	113.31	1.96	8.67				
<i>ovina</i>	R	Fereydan	1.311	0.088***	0.035***	1.534	0.056	0.960	308.62	33.18	185.78	2.75	6.8*				
<i>Ferulago</i>	V	Fereydan	0.510	0.182***	0.030***	2.853	0.027***	0.563	121.67	27.07	31.17	1.94	5.17**				
<i>angolata</i>	V	Semirom	0.591	0.147**	0.110	2.310	0.071	0.662	761.03	82.58	360.31	2.48	8.17				
<i>Eurotia</i>	R	Semirom	0.455	0.123***	0.143	1.610	0.171	0.485	519.11	52.56	322.40	3.16	5.87*				
<i>ceratoides</i>	Critical L.		0.3	0.25	0.10	0.8	0.06	0.20	50	20	30	0.1	8				

† Significant differences between mineral contents and critical levels. * Significant at the 0.05 probability level,

** Significant at the 0.01 probability level, ***Significant at the 0.001 probability level.

¶ Growth stages including vegetative (V) and reproductive (R).

§ Critical levels based on ruminant needs (11, 14).

content, except in *Agropyron* was higher than the critical value for ruminants. *Cachrys ferulacea* in vegetative growth stage had the highest content of sodium (0.810 %) while, the lowest sodium content was observed in *Ferulago angolata* (0.027 %). The content of sodium in *Agropyron trichophorum*, *Bromus tomentellus*, *Stipa barbata* (reproductive stage) and *Ferulago angolata* and *Vicia variabilis* (vegetative stage) was below ($P < 0.01$), the critical level of 0.06 % (11).

The maximum content of zinc was observed in vegetative stage of *Eurotia ceratoides* ($360.31 \text{ mg kg}^{-1}$) and the lowest (16.64 mg kg^{-1}) in vegetative stage of *Vicia variabilis*. *Vicia variabilis* and *Stipa barbata* ($P < 0.01$) did not meet dietary zinc requirements (30 mg kg^{-1}) of ruminants (Table 2). The content of copper in *Agropyron trichophorum*, *Stipa barbata*, *Eurotia ceratoides* and *Ferula ovina* in reproductive stage ($P < 0.05$) and *Ferulago angolata* in vegetative stage ($P < 0.01$) was lower than the critical level of 8 mg kg^{-1} for ruminants (14). Other micro-minerals probably exist in higher concentrations than the critical levels suggested by the NRC (14). Therefore, selective grazing by ruminants could not lead to higher phosphorus and magnesium concentrations in diets than occurred in samples, because phosphorus and magnesium contents in whole plants were lower than their critical value both in vegetative and reproductive growth stages.

A deficiency of magnesium was also found in both areas (0.04% for Fereydan and 0.55% for Semirom).

Results of this study indicate that grazing flocks on Semirom and Fereydan rangelands require mineral supplementation of phosphorus, magnesium, copper and sodium.

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