Seasonal variations of mineral content in range grasses consumed by sheep

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Introduction

Matching of livestock nutritional requirements with the optimum season for nutritional quality from the range grasses is an important element of livestock production systems. For example, grasses cure well, particularly in semiarid and arid climates, and stand as an excellent source of energy during their dormant season (Van Soest, 1994). *Rhynchelytrum repens* and *Cenchrus ciliaris* are cultivated species that were introduced to Mexico with good adaptation. Moreover, *Cenchrus ciliaris* because its wide distribution to these semiarid regions it has been considered as a naturalized grass. In addition, it has been mentioned as a south Texas and northeastern Mexico wonder grass (Hanselka, 1988); however, seasonality of rainfall and temperature are major influences on nutritional quality (Ramirez *et al*., 2003a). Minerals are required to meet the animal needs for optimum development and health and influence animal productivity as they are essential nutrients and affect animal performance (McDowell, 2003). Range grasses may be important sources of inorganic nutrients for ruminants; however, in some circumstances, they are deficient in one or more essential minerals. The aim of this study was to determine and compare seasonally the Ca, P, Na, Mg, K, Cu, Mn, Fe and Zn content in the forage of two cultivated and thirteen native grasses growing in northeastern Mexico.

Materials and Methods

The study was carried out at the "Sauces Ranch" of about 900 ha located in General Terán County of the state of Nuevo León, México. It is located at 25º24´26´´ west longitude and 99º46´33´´ north lat itude, with an altitude of 272 m. The climate is typically subtropical and semi-arid with a warm summer. Mean monthly air temperature ranges from 14.7ºC in January to 22.3ºC in August, although daily high temperatures of 45ºC are common during the summer. Peak rainfall months are May, June and September. Annual rainfall during the year of study was about 360 mm distributed as follows; 25 mm in winter, 32 mm in spring, 238 mm in summer and 65 mm in autumn. The main type of vegetation is known as the Tamaulipan Thornscrub or Subtropical Thornscrub Woodlands (SPP–INEGI, 1986).

Grasses such as *Bouteloua curtipendula* (Gould & Kapadia), *Bouteloua trífida* (Thurber), *Brachiaria fasciculata* (Sw.), *Digitaria insularis* (L.), *Chloris ciliata* (Swartz.), *Leptochloa filiformis* (Lam.) Beauv, *Panicum hallii* (Vasey.), *Panicum obtusum* (H.B.K.), Parodi., *Paspalum unispicatum* (L.), *Setaria macrostachya* (H.B.K.), *Setaria grisebachii* (Fourn.), *Tridens eragrostoides* (Vasey & Scribn.) Nash, *Tridens muticus* (Torr.) Wash. And the cultivated *Cenchrus ciliaris* (L.) and *Rhynchelytrum repens* (Willd.) Hubb, were collected for nutritional studies because they represent and important source of forage for grazing ruminants in northeastern Mexico (Ramírez *et al*., 1999). In this study, *C. ciliaris* has been considered as reference grass of good nutritional quality. Collection of grasses was made during the four seasons beginning in autumn of 2001 (October 20), followed by winter of 2002 (January 21), spring of 2002 (April 28) and summer of 2002 (July 23). As encountered in four sites, randomly located in all ranch, grasses were hand harvested Samples were stored in paper bags in the field and transported to laboratory. The sites of collection were grazed by livestock. Partial dry matter was determined subjecting samples to oven at 55° C during 72 h, then were ground in a Wiley mill (1 mm) and stored in plastic containers for further analyses.

In each season, by quadruplicate, samples were analyzed for DM and ash content (AOAC, 19). Mineral content was estimated by incinerating the samples in a muffle at 550° C, during 5 hours. Ashes were digested in a solution containing HCl y HNO_3, using the wet digestion technique (Diaz-Romeau and Hunter, 1978). Concentrations of Ca, Mg, K, Na, Fe, Mn, Zn and Cu were estimated using an atomic absorption spectrophotometer. The P content was estimated in a colorimeter (AOAC, 1997).

Data were statistically analyzed using an experimental design of two ways of classification (being grasses and seasons the study factors), with interaction between seasons and grasses. The interaction seasons x grasses was significant (P<0.05), thus analyses of variance were carried out among seasons and among grasses within seasons (Steel and Torrie, 1980).

Results.

Table 1

Seasonal and annual means of Ashes, Ca, P and Mg in cultivated grasses *Cenchrus ciliaris*, and *Rhynchelytrum repens* and thirteen native grasses growing in northeastern Mexico

Grasses	Ashes							Ca						
	Dictamen							Seasons						
	w	sp	su	f	M	SEM	Sig	w	sp	su	f	M	SEM	Sig
B. curtipendula	11	11	9	8	10	0.1	***	4	4	5	3	4	0.3	***
B. trifida	10	7	7	8	8	0.1	***	3	5	7	5	5	0.2	***
B. fasciculata	14	15	12	17	15	0.1	***	7	8	6	7	7	0.1	***
C. ciliaris	8	8	9	9	8	0.3	*	6	4	5	7	6	0.1	***
C. ciliata	11	10	9	10	10	0.05	***	9	7	6	7	7	0.2	***
D. insularis	10	9	8	11	10	0.1	***	3	4	4	4	4	0.2	***
L. filiformis	14	13	12	12	13	0.3	*	5	5	4	6	5	0.5	***
P. hallii	10	9	9	11	10	0.05	***	6	7	6	5	6	0.3	***
P. obtusum	14	15	11	13	13	0.4	*	9	9	5	7	7	0.3	***
P. unispicatum	14	14	11	15	14	0.05	***	7	5	8	6	7	0.3	***
R. repens	10	9	7	6	8	0.06	***	6	8	4	6	6	0.2	***
S. grisebachii	16	11	12	15	14	0.4	**	4	4	4	5	5	0.2	***
S. macrostachya	13	10	15	14	13	0.03	***	3	4	5	3	4	0.3	***
T. eragrostoides	8	8	8	9	8	0.06	***	4	4	5	5	4	0.3	***
T. muticus	7	6	6	7	7	0.03	***	5	5	5	5	5	0.1	***
Seasonal means	11	10	10	11	11			6	5	5	5	5		
SEM	0.2	0.2	0.1	0.2				0.1	0.7	0.1	0.1			
Significant level	***	***	***	***				***	***	***	***			
Requirement*								3.6 g kg-1						

Table 1 Continued.-

Grasses	P							Mg						
B. curtipendula	0.8	1.3	0.6	0.9	0.9	0.1	**	0.7	0.9	0.7	0.7	0.8	0.1	*
B. trifida	0.7	1.0	0.8	0.4	0.7	0.02	***	0.6	0.9	1.0	0.8	0.8	0.02	***
B. fasciculata	0.9	1.2	1.5	1.4	1.3	0.02	*	2.2	1.1	3.1	3.7	2.5	0.03	***
C. ciliaris	1.1	1.2	1.5	1.1	1.2	0.1	*	1.1	1.8	1.2	1.9	1.5	0.30	NS
C. ciliata	1.1	1.2	1.5	1.4	1.3	0.03	***	1.9	1.8	1.8	1.9	1.8	0.1	NS
D. insularis	1.0	1.4	1.0	1.1	1.1	0.04	**	0.7	2.1	1.1	1.1	1.2	0.04	***
L. filiformis	1.2	1.0	1.8	1.8	1.5	0.03	***	1.6	0.8	1.6	2.1	1.5	0.1	***
P. hallii	1.1	0.6	1.2	1.3	1.1	0.1	***	1.3	0.7	2.8	3.2	2.0	0.1	***
P. obtusum	1.4	1.1	1.4	1.7	1.4	0.1	*	2.1	1.5	1.6	1.6	1.7	0.1	***
P. unispicatum	0.9	1.6	1.7	1.3	1.4	0.02	**	1.5	2.5	3.4	2.0	2.6	0.04	***
R. repens	0.8	0.6	0.9	0.8	0.8	0.02	*	2.0	2.0	3.0	2.0	2.3	0.1	***
S. grisebachii	0.9	1.1	1.3	1.7	1.3	0.1	***	2.0	1.1	2.0	2.5	2.0	0.1	***
S. macrostachya	1.5	1.1	1.5	1.7	1.5	0.1	***	1.3	1.2	2.0	1.3	1.6	0.1	***
T. eragrostoides	1.1	1.3	1.0	1.1	1.1	0.05	*	1.3	1.2	1.2	1.3	1.3	0.04	NS
T. muticus	0.5	1.3	0.6	0.4	0.7	0.01	***	0.7	2.2	1.3	1.0	1.3	0.02	***
Seasonal means	1.0	1.1	1.2	1.2	1.1			1.4	1.5	1.9	1.8	1.7		
SEM	0.02	0.01	0.01	0.02				0.02	0.03	0.03	0.1			
Significant level	***	***	***	***				***	***	***	***			
Requirement*				2.5 g kg-1							1.0 g kg-1			

Table 2

Seasonal and annual means of K, Na, Cu, and Fe in cultivated grasses *Cenchrus ciliaris*, and *Rhynchelytrum repens* and thirteen native grasses growing in northeastern Mexico

Grasses	K							Na						
	Seasons							Seasons						
	w	sp	su	f	M	SEM	Sig	w	sp	su	f	M	SEM	Sig
B. curtipendula	3	7	6	4	5	0.8	***	0.1	0.1	0.2	0.2	0.2	0.1	**
B. trifida	2	4	4	2	3	0.1	***	0.2	0.1	0.2	0.2	0.2	0.04	*
B. fasciculata	6	2	33	18	15	0.4	***	0.1	0.2	0.4	0.2	0.2	0.1	***
C. ciliaris	16	29	16	24	21	0.3	***	0.6	1.0	0.7	1.4	0.9	0.1	***
C. ciliata	10	7	21	15	13	0.7	***	0.4	0.2	0.5	0.4	0.4	0.1	***
D. insularis	7	16	19	9	13	0.3	***	0.2	0.2	0.2	0.2	0.2	0.1	NS
L. filiformis	4	1	10	9	6	0.5	***	0.1	0.1	0.3	0.3	0.2	0.1	***
P. hallii	5	2	19	13	10	0.6	***	0.1	0.3	0.3	0.2	0.2	0.1	NS
P. obtusum	13	11	27	17	17	0.7	***	0.3	0.1	0.2	0.3	0.2	0.1	NS
P. unispicatum	7	21	16	13	14	0.3	***	0.2	0.4	0.2	0.2	0.2	0.2	NS
R. repens	7	7	12	8	9	0.7	***	0.1	0.3	0.1	0.2	0.2	0.1	NS
S. grisebachii	8	7	33	19	17	0.8	***	0.1	0.2	0.2	0.1	0.2	0.1	NS
S. macrostachya	19	11	60	29	25	2.8	***	0.3	0.2	1.1	0.4	0.5	0.04	***
T. eragrostoides	14	19	11	13	14	1.3	***	0.2	0.1	0.2	0.3	0.2	0.03	***
T. muticus	2	6	7	4	5	0.3	***	0.2	0.1	0.1	0.2	0.2	0.03	***
Seasonal means	8	10	18	13	12			0.2	0.2	0.3	0.3	0.3		
SEM	0.4	0.4	0.3	0.4				0.01	0.02	0.02	0.01			
Significant level	***	***	***	***				***	***	***	***			
Requirement*				5.0 g kg-1						1.0 g kg-1				

Table 2 Continued.-

Grasses	Cu							Fe						
B. curtipendula	2	2	1	2	2	0.3	NS	56	66	92	84	74	6.0	***
B. trifida	3	2	2	2	2	0.2	**	79	78	189	75	105	20.1	***
B. fasciculata	3	4	8	2	4	0.2	***	100	128	153	175	139	5.8	***
C. ciliaris	5	10	8	9	8	0.2	***	114	164	120	176	144	8.1	***
C. ciliata	3	3	6	4	4	0.2	***	119	108	100	105	108	10.4	***
D. insularis	2	6	3	2	3	0.3	***	58	108	143	191	125	12.5	***
L. filiformis	6	5	2	3	4	0.4	***	118	120	126	124	122	18.4	***
P. hallii	3	2	6	3	3	0.2	***	188	126	188	180	170	5.7	***
P. obtusum	6	5	3	4	5	0.3	***	188	176	188	181	183	8.5	***
P. unispicatum	4	6	4	4	4	0.2	***	116	135	152	186	147	6.0	***
R. repens	3	4	6	4	4	0.2	***	53	77	135	97	91	5.5	***
S. grisebachii	2	3	7	3	4	0.2	***	104	90	147	122	116	7.8	***
S. macrostachya	2	3	8	3	4	0.5	***	91	75	105	99	105	11.4	***
T. eragrostoides	4	5	3	3	4	0.4	***	146	108	173	110	135	13.9	***
T. muticus	2	2	2	2	2	0.1	NS	117	86	137	113	115	4.6	***
Seasonal means	3	4	5	3	4			110	116	150	138	129		
SEM	0.1	0.1	0.1	0.1				4.7	6	6	6			
Significant level	***	***	***	***				***	***	***	***			
Requirement*				9 mg kg-1							40 mg kg-1			

Table 3

Seasonal and annual means of Mn and Zn in cultivated grasses *Cenchrus ciliaris*, and *Rhynchelytrum repens* and thirteen native grasses growing in northeastern Mexico

Grasses	Mn							Zn						
	Seasons							Seasons						
	w	sp	su	f	M	SE M	Sig	w	sp	su	f	M	SE M	Si g
B. curtipendula	46	49	49	47	45	1.2	***	31	45	64	50	48	4.5	***
B. trifida	38	30	38	36	36	0.8	***	15	25	29	27	24	3.8	***
B. fasciculata	54	31	78	89	63	2.0	***	46	46	64	55	52	3.1	***
C. ciliaris	27	44	33	39	36	1.4	***	41	52	43	71	52	1.5	***
C. ciliata	70	67	80	76	88	2.8	***	31	51	46	45	43	1.3	***
D. insularis	28	27	23	33	27	1.4	***	61	47	74	60	69	2.8	***
L. filiformis	25	24	29	22	25	1.9	***	49	43	62	61	53	3.8	***
P. hallii	46	38	45	45	43	1.0	***	29	39	58	29	37	2.3	***
P. obtusum	34	32	34	38	35	0.8	***	32	44	58	52	46	3.4	***
P. unispicatum	25	46	48	42	40	0.7	***	66	53	82	76	69	2.1	***
R. repens	30	24	29	27	28	1.5	***	50	51	39	43	46	2.7	***
S. grisebachii	31	29	35	30	31	1.2	***	55	57	69	59	60	5.4	***
S. macrostachya	31	36	40	33	35	1.5	***	59	59	57	43	55	5.6	N S
T. eragrostoides	38	31	44	40	38	2.1	***	50	64	66	53	58	4.4	***
T. muticus	22	29	30	28	27	0.6	***	29	38	31	37	34	1.4	***
Seasonal means	36	35	42	42	40			43	47	56	51	49		
SEM	0.8	1.7	0.8	0.8				1.3	0.8	0.4	1.0			
Significant level	***	***	***	***				***	***	***	***			
Requirement*				30 mg kg-1							26 mg kg-1			

Implications

It is concluded that in general, all minerals, in all grasses, varied among seasons and among grasses within seasons. Growing beef cattle grazing on these grasses could not require supplementary Mg, K, Fe, Mn and Zn but they must require P, Na and Cu supplementation throughout the year, whereas, Ca would be complementary when seasonal rainfall is sparse.

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