Mid-winter protein, phosphorus, and digestibility of *Chrysothamnus nauseosus* subspecies

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Abstract

Little has been done to evaluate the mid-winter crude protein, phosphorus, and in vitro digestibility of subspecies and accessions of rubber rabbitbrush (*Chrysothamnus nauseosus* ssp.) For those few studies that have been conducted, subspecies and accessional variation was not addressed. This study tested the hypothesis that certain subspecies and accessions of rubber rabbitbrush grown in a common garden on homogeneous soil would exceed other subspecies and accessions in crude protein, phosphorus, and in vitro digestibility. Also, the level of these traits for the various subspecies and accessions of rubber rabbitbrush were compared to other species of winter forages.

Significant differences for all 3 traits occurred among subspecies and accessions. Some accessions of rubber rabbitbrush were ranked high in crude protein, phosphorus, and digestibility in comparison to other species of winter forages. Enough variation exists among subspecies and accessions that a selection program could result in the development of superior forms of rubber rabbitbrush to be used as a winter forage.

Key Words: rubber rabbitbrush, in vitro digestibility, crude protein, winter forage, phosphorus

Rubber rabbitbrush *(Chrysothamnus nauseosus)* has 22 subspecies that are generally divided into green-stemmed and white-stemmed groups. These groups are further subdivided by flower, leaf, and achene characteristics (Weber et al. 1985, Anderson 1986, McArthur and Meyer 1987). Little has been done to evaluate the mid-winter crude protein, phosphorus, and in vitro digestibility of rubber rabbitbrush subspecies and accessions. For those few studies that have been conducted, subspecies and accessional variation was not addressed (National Academy of Sciences 1958, Dietz et al. 1962, Sampson and Jespersen 1963, Ward 1971). The National Academy of Sciences (1958) reported that crude protein content of mature rubber rabbitbrush plants was 5.6% of dry matter and phosphorus 0.14% of dry matter. Dietz et al. (1962) reported that winter rubber rabbitbrush has a crude protein content of 9.7% of dry matter and phosphorus 0.19% of dry matter. Sampson and Jespersen (1963) reported crude protein content ranging from 9% in winter to 11.8% in the spring. Ward (1971) reported winter in vitro dry matter digestion (IVDMD) of rubber rabbitbrush to be 44.4%. These levels would rank rubber rabbitbrush above average as a winter forage (Welch 1989).

Kufeld et al. (1973) reported that rubber rabbitbrush receives moderate use by wintering mule deer. Hanks et al. (1975) reported some differential browsing at the subspecies level by unidentified animals. Sampson and Jesperson (1963) found that 48% of the rumens of wintering deer in California study contained rubber rabbitbrush.

In general, energy, protein, and phosphorus are in short supply in winter forages (Dietz 1965). Therefore, we designed this study to test the hypothesis that certain subspecies and accessions of rubber rabbitbrush, grown in a common garden on homogeneous soil, would exceed other subspecies and accessions in crude protein, phosphorus and in vitro digestibility. We compared in a general way the levels of crude protein, phosphorus, and in vitro digestibility of the various subspecies and accessions of rubber rabbitbrush to other species of winter forages.

Materials and Methods

Seeds from 7 subspecies of rubber rabbitbrush were collected from 19 native populations from the western United States. Table 1 lists subspecies, accessions, and locations where seeds were acquired. Seeds were cleaned and transplants produced and placed on a common garden located at the Snow Field Station, Ephraim, Utah. Soil within the planting site is classified as a Woodrow silty clay loam (Swenson et al. 1981). A soil survey showed the soil within the planting site to be homogeneous. Transplants were planted at random. Transplants were watered twice during the summer and the garden kept free of weeds through mechanical and hand methods. The garden was protected from livestock grazing. However, a few mule deer do use the area in the winter and can

Table 1. Acquisition sites for accessions and subspecies of rubber rabbitbrush (*Chrysothamnus nauseosus* spp.) used in this study. Sites are listed by location, county, and state. Accessional names are the same as location.

Subspecies	Location/ accession	County	State
mohavensis	Lancaster	Los Angeles	California
albicaulis	Walker	Mono	California
turbinatus	Lund	Iron	Utah
hololeucus	Nephi	Juab	Utah
	New Cuyama	Santa Barbara	California
consimilis	Chester	Sanpete	Utah
	Trout Creek	Humboldt	Nevada
	Knolls	Tooele	Utah
	Rock Candy Mountain	Sevier	Utah
	Black Rock Desert	Pershing	Nevada
graveolens	Paragonah	Iron	Utah
	Point of Rocks	Mohave	Arizona
	Leeds	Washington	Utah
	Salina	Sevier	Utah
viridulus	Victorville	San Bernardino	California
	Benton	Mono	California
	Barstow	San Bernardino	California
	Palmetto	Esmeralda	Nevada
	Lee Vining	Mono	California

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browse at will throughout the entire garden.

On January 29, 1988, stem samples (vegetative and inflorescence tissues) were collected from all taxa (Table 1). Three randomly selected plants represented each accession. Previous work conducted on big sagebrush *(Artemisia tridentata)* showed that greater variation occurred among subspecies and accessions than plants within accession (Welch and McArthur 1979). Thus we opted to place more subspecies and accessions in the study and use fewer plants to estimate accession and subspecies means and variance. Furthermore, these same workers found no significant effect due to winter. In the current study, we sampled the top 6 to 7 cm of the stems, which approximates the portion of the plant consumed by wintering mule deer. Individual samples were placed in separate plastic bags, sealed, and transported to the laboratory.

The analyses performed were IVDMD, crude protein, and phosphorus. We used the IVDMD method outlined by Pearson (1970). Inoculum was obtained from a slaughterhouse steer. Welch et al. (1983) and Striby et al. (1987) found that inocula sources did not have a significant effect on the IVDMD of range forages.

Results and Discussion

Significant effects ($P<0.05$) due to subspecies were detected (Table 2). Fisher's test showed that subspecies *consimilis* was significantly more digestible than the other subspecies with the exception of subspecies *mohavensis*. Some caution is needed in interpreting these results. Some of the subspecies are represented by just 1 accession (e.g., ssp. *mohavensis* or ssp. *albicaulis)* and others by 2 or as many as 5. What is clear is that significant variation does exist among subspecies, not only for digestibility but for crude protein and phosphorus.

Table 2. Mid-winter nutrient content of subspecies of rubber rabbitbrush *(Chrysothamnus nauseosus)*. Data are expressed as means and standard deviations and on a dry matter basis.

Subspecies	IVDMD %	Crude protein %	Phosphorus %
consimilis	49.7±6.1a	10.4±1.9bc	0.14±0.05a
mohavensis	49.0±3.1ab	10.5±0.8bc	0.15±0.03a
turbinatus	47.6±2.9b	9.2±1.0c	0.12±0.02b
viridulus	46.4±5.1b	11.1±1.9b	0.15±0.03a
hololeucus	43.6±9.1bc	12.0±2.8a	0.14±0.04a
graveolens	42.7±5.4bc	9.9±1.0c	0.15±0.05a
albicaulis	35.9±2.5c	9.2±1.1c	0.12±0.03b

Means sharing the same columnar letter are not significantly different at the 5% level.

Significant effects ($P<0.05$) due to accessions were also detected. Fisher's protected LSD tests showed that Trout Creek, Black Rock, Knolls, New Cuyama, and Lee Vining were more readily digested than 11 of the other accessions. Fisher's protected LSD tests also showed that certain accessions contained higher amounts of crude protein and phosphorus than other accessions.

Certain subspecies and accessions of rubber rabbitbrush rank the highest for winter levels of crude protein (Tables 2, 3, and 4). These are subspecies *hololeucus* (12.0%) and accessions New Cuyame (15.0%), Victorville (14.1%), and Black Rock Desert (13.0%). These approach crude protein levels reported as high as 16% of dry matter for some accessions of big sagebrush (Welch and McArthur 1979). Also, Welch and Monsen (1981) and Otsyina et al. (1982) reported that certain accessions of fourwing saltbush *(Atriplex canescens)* contained winter levels of crude protein at 14 to 15% of dry matter. The point is that rubber rabbitbrush accessions with the highest levels of crude protein match well with the highest accessions of big sagebrush and fourwing saltbush. It has been estimated that the crude protein need of wintering mule deer and domestic sheep is about 7.5 to 8.9% of dry matter (Welch 1989). All subspecies and accessions of rubber rabbitbrush meet this requirement (Tables 2 and 3).

Table 3. Mid-winter nutrient content of accessions of rubber rabbitbrush *(Chrysothamnus nauseosus)*. Data are expressed as means and standard deviations and on a dry matter basis.

Accession	IVDMD %	Crude protein %	Phosphorus %
Trout Creek	55.1±4.0a	9.6±1.1b	0.14±0.03cd
Black Rock Desert	54.1±2.0a	13.0±0.3a	0.19±0.03ab
Knolls	52.0±3.9ab	10.2±1.3b	0.14±0.05cd
New Cuyama	50.9±6.3abc	15.0±2.1a	0.18±0.02ab
Lee Vining	50.4±3.3abc	10.9±0.9b	0.18±0.01ab
Lancaster	49.0±3.1bc	10.5±0.8b	0.15±0.03bcd
Palmetto	48.7±1.3bc	9.1±1.3b	0.12±0.04cd
Benton	48.0±7.0bc	10.3±1.4b	0.13±0.03cd
Lund	47.6±2.9cd	9.2±1.0b	0.12±0.02cd
Point of Rocks	47.5±5.8cde	9.7±1.0b	0.15±0.03bcd
Rock Candy Mt.	45.0±3.6cde	10.0±2.7b	0.11±0.05d
Victorville	44.4±1.1de	14.1±0.5a	0.16±0.01bc
Chester	42.6±1.7de	9.2±0.6b	0.13±0.05cd
Leeds	42.3±4.4de	9.5±0.5b	0.22±0.04a
Yaragonah	41.6±6.1e	9.8±1.2b	0.11±0.02d
Barstow	40.1±1.6e	11.0±0.7b	0.13±0.01cd
Salina	39.5±3.6ef	10.7±1.3b	0.14±0.02cd
Nephi	36.3±3.6f	9.0±1.0b	0.11±0.01d
Walker	35.9±2.5f	9.2±1.1b	0.12±0.03cd

Means sharing the same columnar letter are not significantly different at the 5% level.

Certain accessions of rubber rabbitbrush rank the highest for winter levels of phosphorus (Tables 3, and 4): Leeds (0.22%) and Black Rock Desert (0.19%). The phosphorus need for wintering

Table 4. Winter nutritive value of selected range plants. Data are expressed as a percent of dry matter (after Welch 1989).

Plant name scientific	In vitro digestibility	Crude protein	Phosphorus
	%	%	%
	Shrubs		
Purshia tridentata	23.5	7.6	0.14
Artemisia tridentata	57.8	11.7	0.18
Artemisia nova	53.7	9.9	0.18
Ceratoides lanata	43.5	10.0	0.11
Cercocarpus ledifolius	49.1	10.1	———
Atriplex canescens	38.3	8.9	———
Quercus gambelii	26.6	5.3	———
Chrysothamnus viscidiflorus	36.0	5.9	0.15
Cercocarpus montanus	26.5	7.8	0.13
Chrysothamnus nauseosus	44.4	7.8	0.16
Juniperus osteosperma	44.1	6.6	0.18
	Forbs		
Balsamorhiza sagittata	———	3.6	0.06
Helianthella uniflora	———	2.8	0.17
Sanguisorba minor	———	6.6	———
	Grasses		
Agropyron spicatum	45.5	3.2	0.05
Agropyron smithii	50.2	3.8	0.07
Sitanion hystrix	42.0	4.3	0.07
Agropyron desertorum	43.7	3.5	0.07
Agropyron desertorum (fall regrowth)	50.6	15.0	0.39
Hilaria jamesii	48.2	4.6	0.08
Festuca idahoensis	46.1	3.8	0.08
Oryzopsis hymenoides	50.5	3.1	0.06
Phalaris arundinacea	———	7.8	0.14
Stipa comata	46.6	3.7	0.07
Poa secunda	———	4.2	———
Sporobolus cryptandrus	53.2	4.1	0.07
Bromus inermis	47.0	4.1	0.12

mule deer and domestic sheep is about 0.20 to 0.25% of dry matter (Welch 1989). Wintering animals are in negative phosphorus budget. However, the higher the winter phosphorus content of the forage, the smaller the phosphorus deficit.

The Black Rock Desert accession has superior overall nutritive value with 54.1% IVDMD, 13.0% crude protein, and 0.15% phosphorus. Black Rock was 1 of 3 accessions eaten by wintering mule deer in the garden. The other 2 accessions were New Cuyama and Benton. From a nutritional point of view, the study results support further research into the nutritional quality of rubber rabbitbrush. Such research should be directed toward determining the preference of wintering mule deer and domestic sheep for the various subspecies and accessions of rubber rabbitbrush. Nutritive value alone is useless to the animal if the plant is not eaten. We do know several areas in Utah where populations of rubber rabbitbrush receive heavy annual use by wintering mule deer. One area is the north side of Salt Creek canyon east of Nephi, Utah. The rubber rabbitbrush growing there is a white stemmed spp. *hololeucus*. Another area is the Wasatch Plateau of Central Utah where wintering elk and deer heavily browse mountain rubber rabbitbrush ssp. *salicifolius*. Enough variation seems to exist that a selection program could result in the development of superior forms of rubber rabbitbrush to be used as a winter forage. This report with its documentation of variation in nutritive quality in rubber rabbitbrush augments earlier documentation of variation in browsing animal preference (Hanks et al. 1975, McArthur et al. 1979), rubber and resin content (Hegerhorst et al. 1987), and seed germination (McArthur et al. 1987).

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