

# Chemical Analysis of Mountain Sheep Forage in the Virgin Mountains, Arizona



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**Abstract.** Eighteen forage species used by mountain sheep (Ovis canadensis) were collected monthly in 1981 and analyzed for dry matter, protein, acid detergent fiber, neutral detergent fiber, lignin, ether extract, ash, calcium, phosphorus, carotene, and combustible energy. Baseline data on plant nutrition are presented in tabular form as a reference source for wildlife biologists, range managers, and scientists in related fields.

## Introduction

Mountain sheep diets have been studied in Texas (Hailey 1968), New Mexico (Howard and DeLorenzo 1975), Arizona (Halloran and Crandell 1953, Seegmiller and Ohmart 1982), California (Dunaway 1970, Ginnett and Douglas 1982), Nevada (Barrett 1964, Deming 1964, Yoakum 1966, Brown et al. 1976, Brown et al. 1977) and Mexico (Dominguez 1976). Brown et al. (1976) and Seegmiller and Ohmart (1982) evaluated diets of sheep by age classes, but other studies have been more general.

Restrictions to forage quality and quantity are known to limit deer populations in central Arizona (Hanson and McCulloch 1955, Swank 1958) and have been suggested as limiting factors for desert bighorn lambs (Seegmiller and Ohmart 1982, DeForge and Scott 1982). In several areas, lamb mortality has been directly attributed to nutritional deficiencies (Hansen 1960, Monson 1960). Seegmiller and Ohmart (1982) suggested that lamb survival may be maximized by habitat manipulation of sheep ranges for high quality forage with high concentrations of energy and other nutrients. Current literature describes mountain sheep diets, but the nutritional quality of important forages is unknown.

Our study was conducted to determine nutritional parameters of selected mountain sheep forages in the Virgin Mountains, Arizona, and to provide data useful to land managers for improvement of mountain sheep habitats. These data are representative of mountain sheep forage but are applicable to other ungulates.

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## Study Area

The study area was a 283.3 ha enclosure located 5 km southeast of Littlefield in the Virgin Mountains of northwest Arizona. The topography of the enclosure varies from sandy wash bottoms and rolling bajadas to rugged mountains and precipitous cliffs. Elevations range from 854 m to 1,516 m. Vegetation of the area is desert scrub with components of the Mohave Desert predominating (Turner 1982). The enclosure is described in detail by Morgart and Krausman (1981).

## Materials and Methods

In 1981, 18 forage species (Table 1) were collected and analyzed monthly for chemical content. Selection of plant species for analysis was based on their occurrence in mountain sheep diets in the Virgin Mountains (Morgart and Krausman, unpubl. data). With the exception of desert peachbrush (*Prunus fasciculata*), all species were seasonally important. Plant material collected mimicked plant parts selected by mountain sheep. Plant collections were made at midmonth, over a 1- to 2-day period, within or immediately adjacent to the enclosure. At least 100 g (fresh weight) of plant material were harvested from a minimum of 25 individuals (10 for succulents) of each species. Furthermore, efforts were made to collect plants over a range of the habitat available and from different slopes and aspects.

Immediately after collection, plant material was weighed in a pretared brown paper bag. Samples were maintained for approximately 48 hours at ambient temperatures until received at the Animal Sciences Laboratory, University of Arizona. Plant material was frozen and stored at -20 C until analysis.

Dry matter was determined by heating samples to a constant weight in a convection oven at 35 C. This process was accomplished in 48 hours for browse, grasses and forbs, while succulents took up to 5 days. Dried material was then ground to a 2-mm particle size with a Wiley laboratory mill for further analytical procedures. The percentage of ether extract (lipid) was determined by the procedure described by the Association of Official Agricultural Chemists (1980). Fiber, lignin and cellulose determinations were according to Goering and Van Soest (1970). Nitrogen was determined using a macro Kjeldahl  $H_2SO_4$  digestion procedure. Calcium and phosphorus were determined with an atomic absorption spectrophotometer. In addition, nitrogen, calcium and phosphorus determinations were verified using a micro Kjeldahl  $H_2SO_4$  digestion and an autoanalyzer. Total energy was calculated with bomb calorimetry. Carotene was quantified by the colorimetric method of the Association of Official Agricultural Chemists (1980).

Single sample determinations of the various nutritional parameters were made. Following completion of all laboratory analyses, anomalous data points were re-analyzed for verification of accuracy. In some cases, monthly samples on either side of a data point in question were also re-analyzed.

## Results

Results of chemical analyses are presented in Table 1. Our purpose was to present nutritional values of key forage plants as an easily accessed reference.

## Discussion

Nutritional values of forage change as plants mature. Plant phenology serves as a useful index to forage quality because younger plants typically have higher nutritive value than older plants (Pearson et al. 1982, Morgart and Krausman, unpubl. data). Phenological events in the Mohave Desert are triggered by heavy rains (Beatley 1974). Typically, most precipitation in northwest Arizona falls between late autumn and spring (Sellers and Hill 1974, National Climatic Center 1973-1981), and the timing and duration of these events dictate the relative success of the spring growing season (Beatley 1974).

Precipitation at the enclosure was 21.8 cm in 1981. This compares to a 15-year average of 17.8 cm at Beaver Dam, Arizona (Sellers and Hill 1974, National Climatic Center 1973-1981). With the exception of October 1980, rainfall from September 1980 to February 1981 was below normal. Although heavier than normal rains fell in March 1981, spring growth was less than would be expected in a "normal" year (Morgart and Krausman, unpubl. data). Most vegetation was mature by May and dormant by June and July, coincident with rising temperatures and declining precipitation. Higher than normal precipitation in August and September triggered good fall regrowth. New growth continued in most of the forage species sampled throughout December.

Mountain sheep diets in the Virgin Mountains, Arizona, were investigated by Morgart and Krausman (unpubl. data). They observed that plant species analyzed for chemical content (Table 1) contributed >50% of the forage consumed monthly in 1981 (Fig. 1). Grasses were an important dietary component in all months but April and May. They comprised >20% of the diet from July to September with peak use (54%) occurring in September. Most of the use was on big galleta (Hilaria rigida) during this period.

Forbs were prevalent in the diet in spring and summer, with peak use occurring in March (46%). Globe mallow (Sphaeralcea sp.) was the dominant forb consumed in most months. Alfileria (Erodium cicutarium) was used most heavily in March and April.

Browse species comprised >13% of the diet in all months. Peak use occurred in May (53%) when range ratany (Krameria parvifolia) and white ratany (K. grayi) were 37% of the diet. Flat-top buckwheat brush (Eriogonum fasciculatum) was the most common browse eaten in the late winter and early spring. Winterfat (Eurotia lanata) was a common dietary component in late summer and fall. Barrel cactus (Ferocactus acanthodes) was fed upon all year, but was most commonly eaten in winter and early spring.

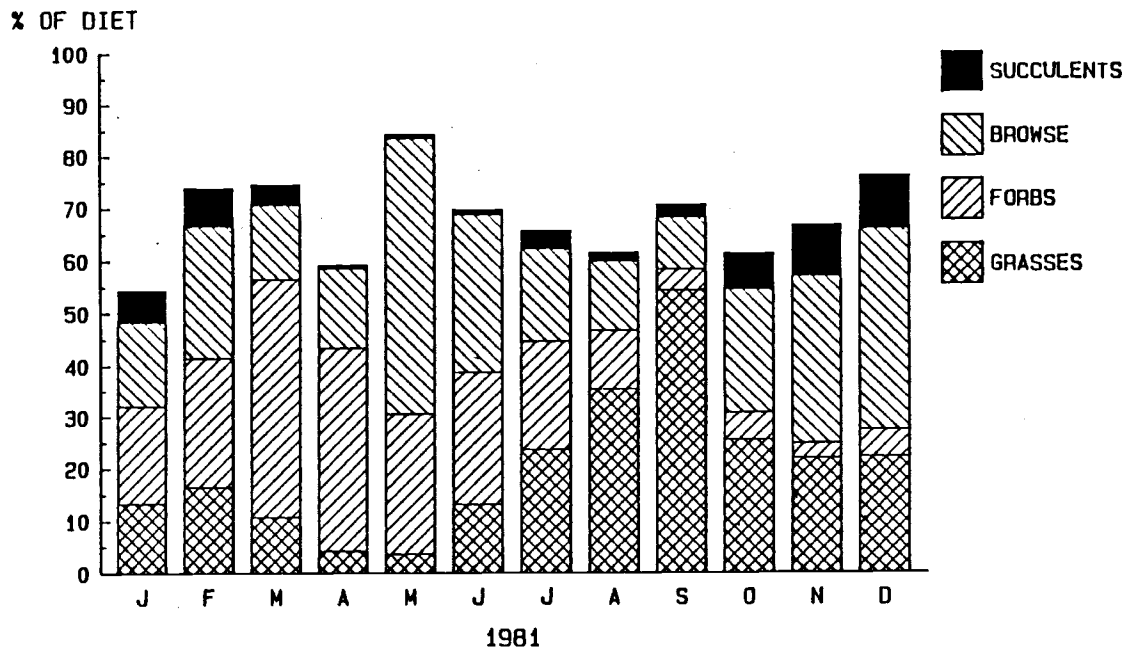


Figure 1. Percent occurrence of grasses, forbs, browse, and succulents in chemically analyzed mountain sheep forage collected in the Virgin Mountains, Arizona, 1981.

### Management Applications

A knowledge of nutritional values of key forage species has practical application in ungulate management and research. Forage quality can be used as one criterion for assessing habitat suitability for wildlife. Potential nutritional deficiencies can be identified on ranges supporting marginal populations of wildlife and on areas under consideration for wildlife introductions. Monitoring seasonal nutritional levels of key forage species can help livestock managers determine optimal times for grazing a range or when to supplement the diet. Finally, an awareness of forage values can assist land managers in manipulating the range to achieve the most productive plant species mix for a specific species.



Table 1. Laboratory analysis of selected forages found in mountain sheep diets in the Virgin Mountains, Arizona, 1981.

Month	Dry matter*	Protein	Fiber		Lignin	Ether extract	Ash	Calcium	Phosphorus	Carotene	Combustible energy
			ADF	NDF							
%											
											mg/kg
<b>GRASSES</b>											
<u>Bromus rubens</u> (Red brome)											
Jan	94.91	20.29	23.54	54.84	2.86	3.31	11.88	0.89	.374	59.0	4.10
Feb	40.21	19.57	26.75	65.56	2.86	3.11	10.12	0.63	.250	16.0	4.23
March	30.41	16.03	31.41	59.93	3.21	2.29	9.47	0.63	.293	32.0	5.53
April	48.84	5.21	38.98	69.14	3.25	1.59	6.41	0.22	.165	6.0	5.30
May	93.06	5.12	39.71	74.27	4.59	0.99	5.95	0.29	.136	0.2	4.89
June	95.56	4.60	45.65	75.22	5.72	0.31	7.27	0.17	.128	0.7	3.94
July	92.93	1.84	46.95	71.59	5.46	0.50	5.26	0.14	<.100	0.0	4.10
August	92.85	3.00	46.23	72.32	5.90	0.50	5.33	0.26	<.100	1.5	4.06
Sept	91.20	1.56	53.19	73.66	5.54	1.12	4.23	0.11	.103	0.0	4.07
Oct	93.75	6.99	49.87	68.49	5.22	2.23	4.61	0.26	.100	0.3	4.09
Nov	92.76	1.34	42.53	72.25	10.66	0.23	4.61	0.65	.100	0.0	3.99
Dec	91.62	2.91	48.96	73.96	5.80	0.24	5.34	0.28	.100	0.0	4.01
<u>Hilaria rigida</u> (Big galleta)											
Jan	95.72	3.14	50.39	75.58	8.97	1.07	7.33	0.37	.100	0.5	4.70
Feb	89.77	4.48	46.10	79.63	6.81	1.11	5.78	0.26	<.100	0.3	5.45
March	93.48	6.98	45.17	78.23	7.95	0.88	6.45	0.25	.124	5.0	5.74
April	64.30	8.00	44.25	77.36	5.91	1.44	7.62	0.32	.170	10.0	4.90
May	57.37	6.35	42.67	75.66	8.75	2.33	6.12	0.32	.118	13.0	5.17
June	78.75	4.41	49.21	75.99	7.99	1.71	6.95	0.31	.126	76.0	4.18
July	78.82	6.03	43.28	77.21	8.03	2.93	6.96	0.44	.124	7.0	3.85
August	52.46	8.20	38.82	75.01	7.07	1.33	6.68	0.43	.101	51.0	4.19
Sept	62.80	11.42	34.36	74.12	7.17	0.90	7.51	0.10	.267	26.0	4.16
Oct	93.22	2.88	51.17	78.41	9.36	1.21	5.89	0.15	.100	2.8	4.05
Nov	81.75	8.40	38.54	71.86	7.89	1.90	5.87	0.18	.155	7.9	4.18
Dec	90.49	5.74	42.83	75.68	9.26	1.54	6.36	0.24	.101	7.0	4.23
<u>Muhlenbergia porteri</u> (Bush muhly)											
Jan	95.13	5.47	51.07	75.84	7.62	1.84	4.29	0.42	.112	3.0	4.42
Feb	92.47	5.34	51.03	77.02	10.01	1.56	3.60	0.24	.102	1.0	4.15
March	92.46	8.88	49.63	77.28	8.49	1.54	4.41	0.325	.129	9.0	6.52
April	47.92	8.50	42.67	75.63	5.20	1.22	5.09	0.34	.174	8.0	4.71
May	82.35	7.23	48.93	43.31	8.96	1.21	3.54	0.28	.124	11.0	5.31
June	88.28	4.27	52.35	77.82	9.17	1.75	3.37	0.22	.132	15.0	4.30
July	59.55	2.75	50.05	78.00	9.46	2.46	3.17	0.22	.134	8.0	4.20
August	61.59	6.40	42.66	74.89	10.31	1.66	3.69	0.34	.136	50.0	4.30
Sept	69.30	9.56	48.39	54.20	7.67	2.42	5.01	0.57	.243	21.0	4.48
Oct	91.59	3.38	52.60	78.44	11.31	2.11	3.17	0.27	.100	2.6	4.35
Nov	86.13	5.79	52.15	78.22	9.74	1.58	2.94	0.46	.100	3.0	4.39
Dec	92.73	6.12	51.87	78.26	10.26	2.21	3.70	0.43	.100	15.0	4.34
<u>Poa fendleriana</u> (Mutton bluegrass)											
Jan	95.84	11.98	31.95	56.96	5.75	4.14	7.44	0.50	.181	39.0	4.27
Feb	91.88	10.67	33.25	65.27	4.51	4.34	7.42	0.42	.177	36.0	4.19
March	50.71	13.06	33.46	65.49	4.40	3.26	7.39	0.32	.263	16.0	5.15
April	32.82	7.09	41.03	73.14	6.52	2.21	8.04	0.17	.318	14.0	5.70
May	67.89	5.89	42.10	71.38	6.60	2.60	7.13	0.31	.177	27.0	5.30
June	94.10	3.63	51.74	75.23	8.74	2.60	6.17	0.15	.112	8.0	5.49
July	76.75	10.37	37.43	62.21	5.56	6.07	6.80	0.35	.161	55.0	4.30
August	51.26	11.60	47.40	59.42	7.22	6.20	7.40	0.33	.160	114.0	4.42
Sept	70.40	13.00	37.24	63.87	6.25	8.30	7.19	0.41	.217	69.0	4.46
Oct	91.93	2.70	47.88	73.54	9.72	2.45	4.75	0.20	.100	14.0	4.12
Nov	84.00	13.84	36.42	62.07	7.24	8.66	6.22	0.33	.250	48.0	4.44
Dec	48.52	13.87	33.65	64.76	5.56	5.26	6.41	0.49	.137	118.0	4.36

Month	Dry matter*	Protein	Fiber		Lignin	Ether extract	Ash	Calcium	Phosphorus	Carotene	Combustible energy
			ADF	NDF							
											%
											mg/kg
<u>Stipa coronata</u> (Crested needlegrass)											
Jan	96.17	8.91	37.70	71.57	8.47	3.76	6.98	0.45	.122	25.0	4.39
Feb	91.84	9.25	37.94	74.17	6.58	3.04	6.61	0.38	.112	10.0	5.40
March	95.72	14.10	37.44	74.87	6.71	2.39	6.57	0.325	.119	14.0	6.06
April	70.70	10.59	38.12	74.77	4.74	2.93	8.77	0.325	.146	19.0	5.49
May	70.91	8.67	37.88	74.15	5.15	2.25	7.11	0.24	.138	24.0	5.31
June	86.47	7.33	41.16	73.58	6.74	3.52	7.55	0.38	.160	46.0	4.24
July	91.82	5.80	40.21	70.36	6.95	4.68	8.44	0.42	.117	21.0	4.50
August	63.11	7.00	39.53	69.34	8.66	4.70	7.38	0.38	.130	60.0	4.33
Sept	67.30	8.99	41.99	71.16	8.23	4.81	8.94	0.55	.194	14.7	4.40
Oct	91.92	6.49	41.75	73.30	8.61	4.66	5.97	0.22	.139	36.0	4.40
Nov	87.41	9.62	42.99	71.80	7.63	3.64	5.82	0.41	.166	8.4	4.46
Dec	91.60	8.87	39.22	75.34	5.98	3.85	6.03	0.41	.129	14.0	4.49
<u>Stipa speciosa</u> (Desert needlegrass)											
Jan	95.96	7.55	43.57	70.61	8.57	4.45	5.41	0.25	<.100	24.0	5.49
Feb	88.39	7.72	39.77	73.73	8.70	3.31	5.06	0.23	<.100	20.0	5.27
March	93.12	7.68	41.11	69.32	7.59	3.29	5.87	0.23	.100	18.0	5.45
April	75.70	7.14	41.81	70.05	4.99	2.22	6.74	0.35	.113	10.0	5.57
May	69.99	5.46	40.61	70.25	6.14	2.50	5.78	0.26	<.100	15.0	5.57
June	7.81	5.49	44.35	72.20	8.81	3.75	5.73	0.19	.125	46.0	4.29
July	94.08	4.86	40.54	69.25	7.49	3.47	5.31	0.14	<.100	19.0	4.35
August	74.97	5.70	37.99	68.64	6.77	4.50	5.04	0.23	<.100	40.0	4.42
Sept	81.20	6.56	43.50	70.54	6.22	5.46	5.70	0.21	.157	7.0	4.45
Oct	92.90	5.37	45.67	70.68	9.84	3.63	4.45	0.18	.102	21.0	4.36
Nov	90.77	8.43	41.04	71.52	8.56	4.35	3.80	0.27	.100	8.7	4.54
Dec	90.52	12.16	37.46	67.56	7.02	3.20	5.82	0.25	.127	40.0	4.36
FORBS											
<u>Artemisia ludoviciana</u> (Sagebrush)											
Jan	94.43	8.16	41.16	47.40	8.09	4.79	5.99	1.33	.166	16.0	4.35
Feb	38.02	19.01	33.53	39.53	5.71	3.69	9.14	0.95	.254	21.0	4.13
March	27.51	18.59	30.67	44.95	6.45	2.88	8.25	1.06	.305	9.0	4.12
April	30.12	13.13	42.06	58.31	10.55	2.91	7.16	0.63	.254	5.0	5.77
May	46.66	7.55	43.33	53.28	8.53	4.73	4.71	0.62	.155	15.0	5.35
June	75.60	7.35	43.73	50.27	9.11	5.22	4.60	0.81	.121	20.0	5.15
July	58.88	6.73	39.67	67.69	8.25	3.85	4.99	1.16	.088	8.0	4.50
August	51.80	10.00	41.11	51.60	10.37	6.30	5.75	0.75	.165	33.0	4.45
Sept	64.70	9.87	37.18	50.35	7.87	8.60	4.97	0.94	.269	21.0	4.65
Oct	93.41	8.13	40.85	56.38	10.43	7.38	4.75	1.49	.131	21.5	4.57
Nov	81.32	6.65	46.96	52.88	9.94	7.27	4.59	0.81	.176	3.5	4.57
Dec	45.86	12.38	51.00	51.08	7.17	4.86	6.94	1.01	.134	13.0	4.30
<u>Erodium cicutarium</u> (Alfileria)											
Jan	43.49	21.74	17.58	20.13	3.53	1.42	16.48	3.85	.250	12.0	6.36
Feb	27.69	20.49	20.16	25.95	3.68	1.15	15.94	3.00	.204	3.0	3.81
March	41.37	14.96	25.77	26.25	5.11	1.30	19.65	2.06	.222	9.0	4.38
April	28.80	9.13	35.74	34.90	5.64	0.97	20.48	3.43	.190	6.0	4.25
May	92.70	4.64	34.63	34.34	6.08	0.69	16.11	3.88	<.100	0.4	3.90
June	92.53	7.48	38.23	40.79	7.51	0.87	21.21	4.14	<.100	0.6	2.96
July	**	**	**	**	**	**	**	**	**	**	**
August	**	**	**	**	**	**	**	**	**	**	**
Sept	**	**	**	**	**	**	**	**	**	**	**
Oct	**	**	**	**	**	**	**	**	**	**	**
Nov	28.14	23.93	28.13	29.74	4.32	0.16	27.28	**	.319	3.2	2.71
Dec	22.87	12.28	20.42	22.07	3.12	0.83	19.46	**	.247	3.0	3.46

Month	Dry matter*	Protein	Fiber		Lignin	Ether extract	Ash	Calcium	Phosphorus	Carotene	Combustible energy
			ADF	NDF							
%											
										mg/kg	Mcal/kg
<u>Sphaeralcea</u> spp. (Globe mallow)											
Jan	95.36	19.81	27.48	39.00	5.17	2.44	11.40	2.86	.201	14.0	4.08
Feb	78.79	22.07	21.22	35.92	4.57	2.42	10.82	2.35	.273	4.0	4.14
March	39.91	23.35	22.65	37.35	4.48	1.24	11.78	1.69	.362	2.0	5.30
April	31.78	16.87	37.79	42.93	8.32	1.07	9.56	1.67	.358	11.0	4.07
May	57.86	12.14	30.24	48.20	7.21	2.54	9.12	1.80	.239	18.0	5.11
June	74.09	6.94	36.68	50.70	9.18	1.51	8.37	2.17	.198	20.0	3.89
July	92.74	5.92	43.87	62.15	9.15	1.65	6.77	1.44	.116	9.0	3.90
August	90.59	5.50	47.29	65.95	12.03	1.27	7.24	1.51	<.100	17.0	4.02
Sept	54.60	18.64	27.48	44.06	7.27	2.21	10.67	1.38	.333	6.0	3.93
Oct	92.40	8.05	42.81	57.42	10.09	1.21	6.86	1.45	.100	26.6	3.90
Nov	43.87	12.05	37.49	50.71	8.48	1.11	8.39	1.47	.233	3.2	4.14
Dec	70.16	17.62	32.90	44.29	10.17	1.53	9.76	1.88	.196	15.0	4.12
<u>BROWSE</u>											
<u>Ambrosia dumosa</u> (White bursage)											
Jan	93.54	6.96	46.64	53.01	12.36	2.19	8.95	1.70	<.100	0.5	5.67
Feb	89.98	8.47	43.75	48.74	12.07	2.16	8.48	1.36	.103	0.9	4.32
March	62.85	13.70	36.46	46.91	8.13	2.00	9.99	1.97	.162	4.0	5.42
April	33.67	17.80	35.47	42.83	9.42	3.11	10.33	1.65	.238	6.0	5.57
May	75.09	10.01	31.61	51.27	8.47	3.43	9.89	1.81	.108	2.0	5.37
June	93.72	6.15	44.99	49.80	10.29	1.94	8.43	2.20	<.100	0.7	3.97
July	83.70	5.97	45.10	57.55	10.66	1.38	7.81	1.75	<.100	0.2	3.90
August	87.89	5.20	48.44	64.75	11.67	1.20	5.63	1.97	<.100	3.8	3.99
Sept	84.80	7.58	49.28	66.58	9.60	1.74	6.80	1.54	.142	0.4	4.10
Oct	92.25	5.83	47.24	66.77	9.69	1.26	6.40	1.17	.100	0.9	4.15
Nov	74.67	9.61	48.70	58.71	10.17	1.72	7.97	1.05	.100	0.6	4.24
Dec	88.00	7.73	53.96	60.77	10.63	1.70	7.91	1.03	.104	3.0	4.17
<u>Ephedra nevadensis</u> (Mormon tea)											
Jan	73.44	9.98	42.75	48.31	9.39	2.59	4.48	1.93	<.100	5.0	4.41
Feb	90.44	10.31	43.94	47.95	7.82	2.59	4.61	1.49	.106	1.0	4.37
March	84.10	9.73	41.22	48.13	7.71	1.82	5.44	1.53	<.100	1.5	5.81
April	63.85	10.36	39.81	46.33	5.55	2.71	6.04	1.94	.107	0.4	4.80
May	92.07	8.64	34.09	45.37	6.55	2.91	5.62	2.06	<.100	2.0	5.31
June	93.39	9.86	41.21	50.31	8.22	2.23	5.00	1.83	<.100	2.0	4.10
July	63.92	9.28	43.33	48.74	10.12	1.97	5.00	1.44	<.100	0.6	4.20
August	72.09	8.90	40.28	45.93	7.02	2.15	6.68	2.41	<.100	0.4	4.18
Sept	72.0	7.65	39.31	45.56	7.58	2.86	7.15	2.18	.133	0.7	4.04
Oct	88.80	11.17	39.94	46.15	9.32	3.26	5.44	1.61	.100	0.3	4.27
Nov	68.03	10.84	43.45	47.10	8.71	1.70	5.21	2.07	.100	0.3	4.34
Dec	78.86	8.94	42.29	44.06	9.18	2.65	6.96	2.59	.100	0.5	4.18
<u>Ephedra viridis</u> (Mormon tea)											
Jan	91.88	7.41	41.82	50.57	8.41	1.83	4.65	1.97	.110	6.0	4.44
Feb	90.50	6.01	46.27	52.51	9.02	1.85	4.40	1.57	<.100	4.0	5.35
March	78.28	7.70	41.68	48.45	7.46	2.31	5.47	1.71	<.100	2.0	4.90
April	64.52	8.88	40.66	48.54	5.75	1.42	6.45	2.55	.159	1.6	5.73
May	94.54	7.43	39.50	45.30	8.01	1.57	6.16	2.31	.106	6.0	5.32
June	95.48	7.55	40.57	47.85	7.21	0.94	4.98	2.04	<.100	3.0	4.20
July	63.77	7.51	41.05	46.81	9.85	1.32	5.67	1.82	<.100	3.8	4.10
August	71.80	7.60	37.39	48.44	8.41	1.15	7.07	2.38	<.100	0.7	4.02
Sept	70.00	6.32	41.67	47.29	7.44	2.33	6.61	2.20	.127	2.0	4.18
Oct	85.71	6.81	45.71	46.79	8.70	1.47	6.13	2.35	.100	0.9	4.12
Nov	67.70	9.74	44.32	45.01	9.34	3.31	4.50	2.16	.100	0.4	4.25
Dec	75.96	9.81	40.48	51.23	7.25	1.49	7.32	2.89	.101	0.5	4.25



Month	Dry matter*	Protein	Fiber		Lignin	Ether extract	Ash	Calcium	Phosphorus	Carotene	Combustible energy	
			ADF	NDF								
											mg/kg	Mcal/kg
<u>Eriogonum fasciculatum</u> (Flat top buckwheat brush)												
Jan	94.90	6.22	36.48	41.31	10.57	1.71	5.50	1.94	.103	13.0	4.18	
Feb	88.88	7.01	36.06	39.05	9.51	1.58	5.59	1.65	<.100	10.0	4.18	
March	90.46	12.06	33.55	35.97	9.39	1.19	5.83	1.80	.107	14.0	5.87	
April	46.66	7.71	32.94	39.82	7.25	1.02	5.46	1.27	.129	15.0	5.60	
May	66.73	5.99	31.79	78.27	8.65	1.70	4.72	1.24	.105	14.0	5.08	
June	83.41	5.01	37.79	44.42	9.87	1.39	5.16	1.76	<.100	6.0	4.17	
July	83.62	5.55	35.50	45.98	9.82	1.87	4.72	1.50	<.100	6.0	4.10	
August	87.24	5.10	41.28	50.19	9.77	1.76	6.62	1.63	.154	14.0	4.09	
Sept	75.80	6.31	39.37	46.49	10.37	1.80	5.27	1.84	.134	4.0	4.19	
Oct	93.11	4.50	44.07	43.96	12.58	1.51	5.92	1.26	.100	18.0	4.15	
Nov	74.74	7.51	34.55	41.66	10.67	1.57	4.31	1.84	.100	6.4	4.22	
Dec	90.77	6.03	51.69	51.85	10.41	1.55	4.77	1.45	.100	15.0	4.21	
<u>Eurotia lanata</u> (Winterfat)												
Jan	94.47	7.87	44.24	63.95	8.16	2.66	6.92	1.50	<.100	7.0	4.28	
Feb	93.96	7.49	45.96	65.88	8.98	2.38	6.58	1.17	<.100	4.0	5.56	
March	88.32	11.62	40.72	61.35	8.09	2.25	7.32	1.52	.133	8.0	4.15	
April	45.59	12.45	37.81	58.94	5.15	1.55	8.61	1.22	.137	20.0	4.91	
May	92.31	7.95	40.25	67.28	5.96	2.07	6.12	1.32	<.100	25.0	5.29	
June	88.64	7.85	41.76	67.57	8.13	2.15	5.92	1.32	<.100	12.0	5.12	
July	98.23	9.45	36.54	48.78	7.38	5.91	5.20	0.81	.156	19.0	4.40	
August	66.39	7.80	43.46	83.40	8.48	1.73	5.05	1.17	<.100	19.0	4.63	
Sept	63.30	9.30	43.24	64.67	8.81	2.51	6.33	1.30	.147	7.0	4.33	
Oct	90.08	10.81	39.53	62.06	6.54	2.41	6.78	1.20	.113	16.0	4.24	
Nov	72.04	10.21	52.49	63.06	12.04	3.05	5.19	1.29	.123	3.6	4.36	
Dec	89.12	11.18	44.08	63.19	9.05	3.09	7.36	1.39	.120	18.0	4.15	
<u>Krameria grayi</u> (White ratany)												
Jan	90.98	6.55	41.94	58.28	11.70	1.02	3.61	0.87	.108	7.0	4.32	
Feb	94.20	6.29	44.17	58.46	11.89	1.30	3.69	0.61	.104	4.0	4.94	
March	93.28	6.63	39.37	57.51	6.79	0.97	3.65	0.74	.113	18.0	4.35	
April	60.91	10.65	38.36	53.56	8.07	0.83	5.13	1.13	.190	17.0	6.79	
May	93.92	9.05	29.07	47.03	7.29	1.81	5.07	0.87	.163	24.0	5.80	
June	94.94	8.50	36.73	49.13	9.35	1.19	5.06	0.64	.138	18.0	4.29	
July	79.02	8.57	40.73	51.27	11.38	0.31	4.55	0.63	.117	6.0	4.15	
August	86.51	7.45	41.15	55.04	9.06	0.25	4.79	0.91	<.100	5.0	4.29	
Sept	90.10	6.37	42.43	63.12	9.02	1.08	4.86	0.78	.150	5.3	4.41	
Oct	94.68	8.42	39.04	53.85	9.31	1.23	5.15	0.70	.140	12.0	4.33	
Nov	86.90	7.00	49.61	53.87	11.13	1.85	4.04	0.35	.100	2.9	4.29	
Dec	91.40	6.50	47.27	58.14	11.25	1.67	4.28	0.30	.107	4.0	4.34	
<u>Krameria parvifolia</u> (Range ratany)												
Jan	90.35	4.65	49.40	63.66	13.12	0.85	2.45	0.71	<.100	4.0	4.52	
Feb	83.97	5.03	47.83	61.23	12.82	1.38	3.44	0.78	.106	1.0	4.91	
March	93.21	7.07	45.03	63.53	9.76	1.17	3.05	0.66	.104	1.5	5.72	
April	63.86	8.84	40.08	52.65	5.85	1.49	4.38	1.12	.142	23.0	6.40	
May	92.92	9.36	31.86	48.78	8.58	1.41	3.93	0.78	.117	20.0	5.40	
June	93.88	6.91	33.17	48.73	7.94	1.09	4.26	0.65	.150	8.0	4.60	
July	85.08	6.48	40.41	53.44	11.05	1.15	3.84	0.68	<.100	4.0	4.30	
August	89.10	4.90	46.51	60.52	8.95	1.62	4.52	0.90	<.100	2.5	4.23	
Sept	91.00	3.82	46.94	61.44	9.99	1.23	3.21	0.58	.135	2.0	4.30	
Oct	93.43	4.89	46.53	60.07	11.96	1.21	3.22	0.65	.105	5.5	4.36	
Nov	88.53	5.76	50.17	66.92	14.14	0.71	3.23	0.31	.100	3.0	4.49	
Dec	90.95	4.46	49.50	68.54	11.82	0.70	2.87	0.36	.100	0.3	4.12	

Month	Dry matter*	Protein	Fiber		Lignin	Ether extract	Ash	Calcium	Phosphorus	Carotene	Combustible energy		
			ADF	NDF									
											%	mg/kg	Mcal/kg
<u>Prunus fasciculata</u> (Desert peachbrush)													
Jan	93.58	5.49	54.50	66.33	13.97	3.28	3.46	0.75	<.100	5.0	4.54		
Feb	88.42	6.02	51.48	64.20	12.08	3.18	3.38	0.96	.113	3.0	5.51		
March	88.89	6.90	48.14	58.87	9.29	2.20	3.67	0.86	.103	6.0	6.34		
April	47.67	10.88	36.77	43.62	6.88	2.05	5.17	0.83	.150	9.0	5.34		
May	65.69	7.02	39.67	52.75	11.08	2.81	4.33	1.00	.104	15.0	6.02		
June	79.71	7.86	47.73	58.81	11.72	2.19	4.21	1.02	<.100	5.0	5.77		
July	80.95	5.59	42.30	50.23	10.25	3.22	4.84	1.20	<.100	8.0	4.60		
August	82.39	4.50	49.42	56.31	11.85	3.16	4.35	1.20	<.100	4.5	4.53		
Sept	72.00	6.06	50.01	57.02	9.98	3.10	4.10	0.93	.158	3.7	4.48		
Oct	86.58	4.75	46.38	58.06	10.61	2.96	3.37	0.72	.111	4.0	4.32		
Nov	80.74	6.86	48.43	63.39	10.61	5.73	2.74	0.45	.121	2.9	4.64		
Dec	86.21	6.00	53.47	63.12	11.30	3.24	3.38	0.66	.100	8.0	4.53		
<u>SUCCULENTS</u>													
<u>Ferocactus acanthodes</u> (Barrel cactus)													
Jan	15.91	5.01	27.90	36.33	1.97	2.02	17.13	4.94	<.100	2.0	4.00		
Feb	12.48	5.44	32.21	37.93	3.10	2.70	17.39	3.04	.112	0.5	3.94		
March	10.99	4.29	28.51	34.92	3.35	1.26	20.89	4.69	<.100	0.5	3.42		
April	12.69	3.93	30.37	39.36	1.99	0.71	19.05	0.33	<.100	0.1	3.84		
May	11.25	5.10	29.96	41.14	3.48	0.51	16.08	4.25	<.100	4.0	3.45		
June	14.86	4.22	29.93	39.60	3.88	0.97	15.70	6.25	<.100	1.0	2.70		
July	11.27	5.20	31.04	44.56	3.40	2.32	15.05	3.24	<.100	2.0	2.88		
August	12.04	3.20	31.25	37.46	4.62	0.48	20.71	5.25	<.100	3.8	2.52		
Sept	10.50	5.59	30.24	41.91	2.45	1.34	21.55	2.44	.146	2.0	2.62		
Oct	11.35	3.63	32.05	40.21	8.98	0.70	12.84	1.50	.102	2.3	2.90		
Nov	12.54	4.40	27.75	31.68	4.18	1.03	20.07	5.94	.100	0.9	2.52		
Dec	11.14	5.38	31.35	43.86	3.98	0.67	22.07	2.76	.100	0.0	2.70		

\* All values except dry matter reported on a moisture free basis.  
\*\*Plant not available for sampling.

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