Comparative chemical composition of armed saltbush and fourwing saltbush

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Abstract

Armed saltbush [*Atriplex acanthocarpa* (Torr.) Wats.] and fourwing saltbush [*A. canescens* (Pursh) Nutt.] are browsed by livestock and white-tailed deer (*Odocoileus virginianus* Raf.). The objective of this study was to compare the chemical composition of these 2 shrubs growing together in south Texas. Leaves and stems from the outer 5 cm of current year's growth of each species were randomly collected from each of 5 stands in November 1985 and February, May, and August 1986. Samples were analyzed for crude protein (CP), calcium, potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), and in vitro organic matter digestibility (IVOMD). Height and standing crop were also determined. Crude protein of armed saltbush leaves ranged from 32% in February to 19% in August. Fourwing saltbush leaf CP ranged from 24% in February to 12% in August. Armed saltbush leaves and stems generally had greater P concentrations than fourwing saltbush. Calcium, K, and Mg concentrations and leaf IVOMD of the 2 species were similar. Fourwing saltbush had lower Na concentrations and greater leaf standing crop than armed saltbush. Laboratory-determined values suggest that both species may provide nutritious browse for cattle and deer on saline rangeland.

Key Words: ***Atriplex acanthocarpa, Atriplex canescens,* browse, crude protein, in vitro digestibility**

Saltbushes (*Atriplex* sp.) are found in semiarid environments in the western United States, the Middle East, Australia, Africa, and Siberia (Davis 1981), and many species are valued as forage for domestic and wild herbivores. Two saltbushes native to North America are armed saltbush [*A. acanthocarpa* (Torr.) Wats.] and fourwing saltbush [*A. canescens* (Pursh) Nutt.].

Armed saltbush grows on saline soils from south Texas west to Arizona (Vines 1960, Jones 1982). The half-shrub is palatable to cattle (*Bos.* sp.) and white-tailed deer (*Odocoileus virginianus* Raf.) (Vines 1960, J.H. Everitt, USDA-ARS, Weslaco, Texas, pers. commun.) and has potential for use in revegetation of saline rangeland (T. Gonzalez, SCS, Laredo, Texas, pers. commun.). Fourwing saltbush occurs from Canada south to Mexico and west to southern California (Vines 1960). The shrub is considered valuable browse for cattle, sheep, and deer (Stubbendieck et al. 1982) and is widely used in revegetation.

The chemical composition of fourwing and numerous other saltbushes is well documented (Beadle et al. 1957, Pieper et al. 1959, Chatterton et al. 1971, Cordova and Wallace 1975, Khalil et al. 1986, Petersen et al. 1987). However, the chemical composition of armed saltbush has not been documented. The objective of this study was to compare the chemical composition of armed saltbush with that of fourwing saltbush.

Materials and Methods

The study was conducted on the Hinnant-Fulbright Ranch in northeastern Zapata County, Texas. Study sites were on a rolling hardland range site. Soils are Maverick clay (fine, montmorillonitic, hyperthermic Ustollic Camborthid). Electrical conductivity of these soils exceeds 4 dS m^{-1} in the surface 25 cm and 12 dS m^{-1} in the 25 to 50 cm depth (Fanning et al. 1965). Topography is gently rolling with less than 3% slope. Hot summers and short, mild winters characterize the climate. Mean annual precipitation is about 38 cm, with peaks in May and September (Fulbright 1985). Associated woody vegetation includes honey mesquite (*Prosopis glandulosa* Torr.), creosotebush (*Larrea divaricata* Cav.), blackbrush (*Acacia rigidula* Benth.), guajillo (*Acacia berlandieri* Benth.), guayacan [*Porliera angustifolia* (Engelm.) Gray], leatherstem (*Jatropha dioica* Sesse ex Cerv.), allthorn (*Koeberlinia spinosa* Zucc.), vine ephedra (*Ephedra antisyphlitica* Berl. ex C.A. Meyer), allthorn goatbush [*Castela texana* (T. & G.) Rose], trecul yucca (*Yucca treculeana* Carriere), lotebush [*Condalia obtusifolia* (Hook.) Weberb.], and knifeleaf condalia (*Condalia spathulata* Gray). Associated herbaceous vegetation includes berlandier nettlespurge (*Jatropha cathartica* Teran & Berl.), Texas varilla (*Varillis texana* Gray), threeawns (*Aristida* sp.), and multiflowered false-rhodesgrass [*Chloris pluriflora* (Fourn.) Clayton].

Five stands supporting both saltbush species were sampled. Each stand was a replication (block) in statistical analyses since samples were collected, dried, and chemically analyzed separately for each stand. Samples of the outer 5 cm of current year's growth from at least 4 randomly selected individuals of each species were collected within each stand in November 1985, and February, May, and August 1986. Samples were dried at 40° C to a constant weight, separated into stems and leaves, and ground in a Wiley mill to pass a 1-mm screen. Dry and organic matter contents were determined following AOAC (1980) procedures. Crude protein (CP) (% N × 6.25) was determined by the micro-Kjeldahl procedure (AOAC 1980) and is reported on an organic-matter basis. Mineral analyses were done by the Soil Testing Laboratory, Texas Agricultural Extension Service, Texas A&M University, College Station. Atomic absorption spectrophotometry was used to determine calcium (Ca) and magnesium (Mg) concentrations. Sodium (Na) and potassium (K) levels were determined with flame photometry, and phosphorus (P) content was determined colorimetrically (Parkinson and Allen 1975). All assays were done in duplicate and values are reported on a dry matter basis.

In vitro organic matter digestibility (IVOMD) was determined by the procedure of Tilley and Terry (1963). Rumen inocula were obtained from a Jersey cow fed a high quality roughage diet. Forages with known in vivo digestibilities were included in each digestion batch to standardize results.

Height and standing crop of armed and fourwing saltbush were determined in August 1986. Height of 20 randomly selected, mature plants of each species was measured in each of 4 stands. Plants were then cut at ground level and dried at 55° C to a constant weight, separated into leaves and non-leaf material (stems, branches, trunks) and weighed. Density of armed and fourwing saltbush was estimated in April, 1988 by counting the number of individuals rooted in 6 randomly placed 2.44 by 15.25-m plots in each of 4 stands.

Bimonthly rainfall data from the Hinnant-Fulbright Ranch for 1985 and 1986 were obtained from C.W. Hanselka, Texas A&M University, Corpus Christi, Texas.

Chemical composition and digestibility data were analyzed by

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Table 1. Temporal trends in mean percent crude protein (CP), calcium (Ca), phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), and in vitro organic matter digestibility (IVOMD) of armed and fourwing saltbush leaves and stems, Zapata County, Texas, 1985–1986.

	Sampling date and species							
	November 1985		February 1986		May 1968		August 1986	
Variable and plant part	Armed	Fourwing	Armed	Fourwing	Armed	Fourwing	Armed	Fourwing
CP								
Leaves	20.1a[1]	18.9a	32.4a	23.7b	24.6a	18.5b	18.8a	11.6b
Stems	9.1b	8.4b	20.1b	14.7c	14.3c	10.1d	10.9b	4.6c
Ca								
Leaves	1.8a	1.6a	1.3a	1.8a	1.3ab	1.5a	1.4a	1.3ab
Stems	1.0b	0.7c	1.3a	1.2a	1.4ab	1.1b	1.3ab	1.0b
K								
Leaves	1.6ab	2.3a	2.7a	2.8a	2.6a	2.7a	2.3ab	2.5a
Stems	1.3b	1.4b	2.1a	2.2a	2.6a	2.4a	2.1ab	1.9b
Mg								
Leaves	1.3a	1.0ab	0.9ab	1.1a	0.8a	0.8a	0.8a	0.7a
Stems	0.7b	0.3c	0.6b	0.5b	0.4b	0.4b	0.4b	0.3b
Na								
Leaves	7.7a	2.7b	9.4a	2.6c	9.8a	2.2c	10.5a	2.7c
Stems	3.3b	1.1c	4.4b	1.4d	5.4b	1.3c	5.4b	1.1d
P								
Leaves	0.23a	0.19a	0.29a	0.23ab	0.29a	0.21b	0.23a	0.18b
Stems	0.17a	0.09b	0.28a	0.16b	0.24ab	0.10c	0.20ab	0.07c
IVOMD								
Leaves	68.0a	66.2a	62.6ab	71.0a	66.6a	62.5a	58.2b	61.7a
Stems	34.2b	32.0b	59.1b	45.4c	47.7b	36.9c	41.5c	31.3d

[1]Means for a variable within a sampling date followed by the same letter are not significantly different at the 0.05 level according to Tukey's test. Leaves were compared to stems within a sampling date.

analysis of variance using a randomized complete-block experimental design with stands as blocks and sampling dates as a split in time. The sampling date × species and plant part interaction was significant ($P<0.05$) for all variables except P and K, thus a separate analysis of variance was done for each sampling date to compare species and plant part means. Tukey's test was used to separate means, where appropriate (Snedecor and Cochran 1967). Height and standing crop data were analyzed using *t*-tests. Inferences based on the results of this study are restricted to the study area.

Results and Discussion

Rainfall during August 1985 to August 1986 was 29.2 cm (Fig. 1). Rainfall was above average in June–July 1985 and 1986, but was below average during the remainder of the study.

Crude protein concentration of armed saltbush leaves and stems exceeded that of fourwing saltbush on all sampling dates except November 1985 (Table 1). Crude protein of armed saltbush leaves ranged from 32% in February to 19% in August while that of fourwing saltbush leaves ranged from 24% in February to 12% in August. Crude protein values for fourwing saltbush were similar to those reported for 4 fourwing ecotypes from west Texas (Petersen et al. 1987).

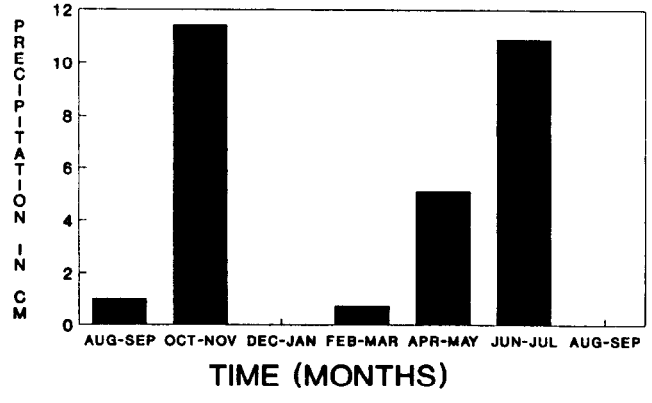

Fig. 1. *Bimonthly precipitation (cm) from August, 1985 through September, 1986 on the Hinnant-Fulbright Ranch, Zapata County, Texas.*

Calcium, K, and Mg levels were similar in armed and fourwing saltbush leaves and stems on all sampling dates except November (Table 1). In November, levels of Ca and Mg were higher in armed than in fourwing saltbush stems.

Sodium levels in armed saltbush leaves ranged from 7.7 to 10.5%, compared to 2.2 to 2.7% for fourwing saltbush leaves (Table 1). Armed saltbush stems were also higher in Na than fourwing saltbush stems on all sampling dates. Other researchers have reported lower Na concentrations in fourwing saltbush in comparison to other *Atriplex* species (Wallace et al. 1973, Smit and Jacobs 1978, Khalil et al. 1986).

Levels of Na in fourwing saltbush were higher than the 0.21% in leaves reported by Khalil et al. (1986), whereas K levels were much lower than the 6.06% they reported. Differences between our results and those of Khalil et al. (1986) possibly resulted because distinct biotypes of fourwing saltbush exist with regard to Na and K accumulation (Richardson 1982). Certain biotypes tend to exclude Na and absorb large amounts of K, while others accumulate Na and absorb less K. Also, differences in soil Na content probably caused results to differ between studies.

Phosphorus levels were similar in armed and fourwing saltbush leaves in November and February and were higher in armed than in fourwing leaves in May and August (Table 1). Armed saltbush

Table 2. Mean height (cm), standing crop/plant (g) of leaves and woody material, and total standing crop/plant (g) of armed and fourwing saltbush in August 1986, Zapata County, Texas.

	Saltbush species	
Characteristic	Armed	Fourwing
Height	65	95**
Leaf standing crop/plant	40	114*
Woody material standing crop/plant	146	920**
Total standing crop/plant	186	1,034**

*,**Significant difference between species at the 0.05 or 0.01 level, respectively.

leaves had P levels ranging from 0.23 to 0.29%, compared to 0.18 to 0.23% for fourwing saltbush leaves. Armed saltbush stems had higher P concentrations than fourwing saltbush stems on all sampling dates.

The IVOMD of fourwing saltbush leaves exceeded that of armed saltbush in August, but digestibility of leaves of the 2 species was similar on other sampling dates (Table 1). Armed saltbush stems were more digestible than fourwing saltbush stems on all sampling dates except November, when digestibility was similar. Lower digestibility of fourwing stems was expected because they are woodier than stems of armed saltbush.

Fourwing saltbush plants were 46% taller than armed saltbush (Table 2). Although leaf standing crop of fourwing saltbush was almost triple that of armed saltbush, the leaf:stem ratio was higher for armed saltbush than for fourwing (1:3.7 and 1:8.1, respectively). Total standing crop/plant of fourwing was 5.6 times higher than armed saltbush. Estimated mean density of armed saltbush was 1,648 ± 921 plants ha^{-1} ($\bar{x}$ ± SE, n = 4) compared to 2,836 ± 1,194 plants ha^{-1} for fourwing saltbush.

These data suggest that fourwing and armed saltbush on saline rangeland may provide nutritious browse for cattle and deer. Research on animal performance while consuming these plants is needed to fully understand their importance to herbivores on saline rangeland in southern Texas. Results of laboratory analyses may be misleading because many shrubs contain secondary plant metabolites that may interfere with protein digestibility (Robbins et al. 1987). Further research is needed to determine if armed saltbush and fourwing saltbush contain secondary plant metabolites.

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