Dry Matter Digestibility of Fourwing Saltbush (*Atriplex canescens*) Mixed with Blue Grama (*Bouteloua gracilis*)

R. Chris Marquart
Robert J. Kinucan*
Delmer I. Davis
Sul Ross State University, Box C-110, Alpine, TX 79832

ABSTRACT

Fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.] is a widespread shrub in arid regions of the western United States, is highly palatable, and possesses high dry matter digestibility (DMD). This study compared the DMD of fourwing saltbush at four phenological stages of development when mixed in different proportions (100, 75, 50, 25 and 0%) with blue grama [*Bouteloua gracilis* (H.B.K.) Lag. *ex* Steud.]. Fourwing saltbush had higher DMD when alone than when mixed in any proportion with blue grama ($P \leq 0.05$). Dry matter digestibility was also higher in fourwing saltbush at earlier stages of phenological development ($P \leq 0.05$). Adding fourwing saltbush in any proportion to blue grama enhanced DMD. Further, it had positive or negative associative effects on DMD depending on mixture proportion and stage of development. These associative effects may be attributed largely to crude protein levels of the forage mixture.

KEY WORDS: Associative effect, Trans-Pecos

Fourwing saltbush, a native, facultative-evergreen shrub widely distributed in western North America, provides forage for livestock and wildlife (Peterson et al., 1987; Plummer et al., 1966). It furnishes relatively large amounts of essential nutrients, including protein, phosphorus, calcium, and carotene, even during winter months (Shoop et al., 1985), and has a crude protein content as high as 24.2% (Welch, 1978).

Fourwing saltbush is a major constituent of cattle diets when it is abundant (Shoop et al., 1985). It commonly occurs in association with numerous semiarid species, and is consumed with them. Cattle on the central shortgrass plains eat appreciable amounts of saltbush when it is available, especially during winter (Shoop et al., 1985). In the Chihuahuan Desert it grows with other forage species, including blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), sideoats grama (*Bouteloua curtipendula*), honey mesquite (*Prosopis glandulosa*), and catclaw acacia (*Acacia greggii*).

To optimize forage use, grazing managers should understand associative effects of fourwing saltbush on digestible nutrients when consumed with other forages. The digestibility of dry matter content of fourwing saltbush may vary with phenological stage of development, and proportion of different species in the diet.

Accepted 1 July 1992. *Corresponding author.

The objectives of the study were to: 1) determine how DMD of fourwing saltbush varied through the growing season; 2) determine if combining fourwing saltbush with blue grama enhanced DMD of the forage mixture; and 3) determine what proportion of fourwing saltbush gave the greatest digestibility enhancement to the forage mixture.

METHODS AND MATERIALS

Plant materials used in this study were collected throughout the Trans-Pecos and grown in a common plot in Alpine, Texas. New twigs and leaves of fourwing saltbush were collected in 1988 at four different stages of phenological development: before seed development (8 June); at first sign of seed development (21 August); at full seed maturity (5 October); and once seeds dried on the plant (4 November). Blue grama samples (leaves and stems) were collected on 4 November, after plants had cured. A single collection date was used for blue grama to provide a comparison standard for the varying effects of saltbush phenology.

Six plants were sampled at each date, air dried and ground in a Wiley Mill to pass through a 0.02-inch mesh screen. Samples were then dried in a convection oven at 104 °F for 7 hrs and partitioned into the following mixtures for each of the four phenological sample periods:

Fourwing saltbush	100%	75%	50%	25%	0%
Blue grama	0%	25%	50%	75%	100%

Dry matter digestibility was determined using the *in vitro* digestibility technique described by Ellis (unpublished, Texas A&M University Forage Digestibility Lab). Rumen inoculum was collected from a single fistulated steer (Hereford-Angus crossbred) grazing on pastures containing the forage species analyzed in this study. Fermentations were conducted in 3 oz. polypropylene tubes containing about 0.018 oz. of test forage, 1.2 fluid oz. of medium and 0.3 fluid oz. of rumen fluid inoculum. Duplicate subsamples, together with duplicates of a standard oat hay forage (with digestibility estimates established from *in vivo* methods) were analyzed. Each subsample pair was averaged and treated as a single observation. Only pairs with less than $\pm$ 3% difference from the pair mean were used. Undigested neutral detergent fiber was taken to represent truly indigestible dry matter of the sample, and true digestibility was calculated by deduction. The Kjeldahl method was used to determine crude protein (CP) for the six samples of fourwing saltbush and blue grama (AOAC, 1984), and percent CP for the forage mixtures calculated from proportionally weighted means.

One-way analysis of variance and Duncan's new multiple range test were used to compare results among species proportion treatments and among sample dates ($P \leq 0.05$). Least squares linear regression was used to assess relationships between DMD and proportion of fourwing saltbush in the forage samples ($P \leq 0.05$). All analyses were performed using SPSS/PC+ (SPSS, 1988).

RESULTS AND DISCUSSION

Dry matter digestibility of fourwing saltbush alone was significantly higher than when mixed with blue grama (Table 1). In each case, a greater proportion of

fourwing saltbush resulted in enhanced DMD. This relationship was also true for crude protein (Table 2). Digestibility within a forage mixture was significantly higher at earlier phenological stages of development (Table 1). The same trend was apparent for CP (Table 2). Dry matter digestibility decreased with greater proportions of blue grama in the forage mix (Figure 1). Conversely, the greater the proportion of fourwing saltbush, the more digestible the forage mixture became. This was further illustrated in the linear regressions for sample mixture DMD for each fourwing saltbush phenological stage (Figure 2). All regressions were significant, with $r^2 \geq 0.60$.

Table 1. Mean dry matter digestibility (%) of fourwing saltbush at different phenological stages when mixed in varying proportions with blue grama.

% Fourwing saltbush	Collection dates (1988)			
	8 Jun	21 Aug	5 Oct	4 Nov
100	71.24 a,A[1]	67.92 a,AB	61.21 a,BC	60.22 a,C
75	62.98 b,A	55.50 b,B	57.73 a,B	57.85 a,B
50	60.17 b,A	52.17 c,B	43.92 b,C	47.83 b,BC
25	48.00 c,A	48.87 c,A	42.86 b,A	47.09 b,A
0	38.11 d,A	38.11 d,A	38.11 b,A	38.11 c,A

[1]Means followed by the same lower case letter within a column, and means followed by the same upper case letter within a row are not significantly different at $P \leq 0.05$.

Table 2. Crude protein (%) of fourwing saltbush and blue grama forage mixtures.

% Fourwing saltbush	Collection dates (1988)			
	8 Jun	21 Aug	5 Oct	4 Nov
100	17.48	17.14	13.38	11.77
75	14.93	14.67	12.08	10.64
50	13.39	12.33	10.49	9.53
25	9.84	9.75	8.89	8.41
0	7.30	7.30	7.30	7.30

Pure fourwing samples were higher in DMD than any other combination. Although fourwing saltbush may constitute the bulk of the diet when it is young and lush, or when the selection differential is so narrow that dietary choices are limited, it is not selected in the diet at all times (Shoop et al., 1985). Other species, which

apparently offered the animals more balanced nourishment, were often selected.

The *in vitro* estimated digestibility of fourwing saltbush-blue grama mixtures was different than that calculated from weighted estimates of pure sample digestibilities. For example, the estimate obtained from actual digestion was different for 50% mixtures when compared to the weighted averages obtained from digestibility of pure samples (Figure 3). This clearly demonstrated that associative effects were present when the two forages were mixed and subjected to fermentation. Early in the summer, DMD was about 5% greater than expected when 50% of the forage mixture was composed of fourwing saltbush. This suggested that the associative effects improved digestibility when fourwing saltbush harvested at that time was mixed with grass in the diet.

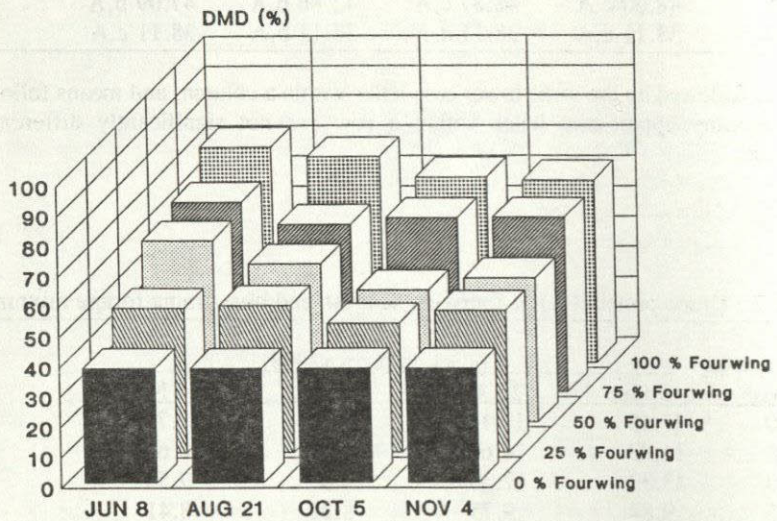

Figure 1. Dry matter digestibility (%) for different forage mixtures of blue grama and fourwing saltbush collected at four stages of phenological development.

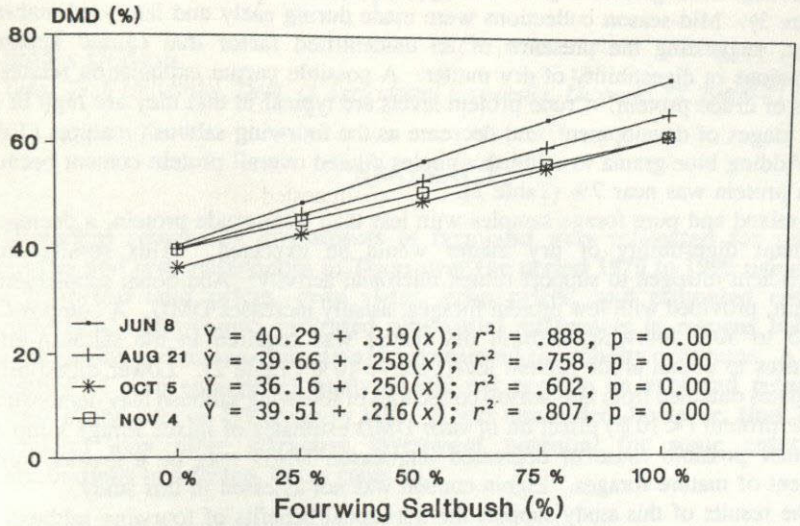

Figure 2. Linear regressions of dry matter digestibility at four phenological stages for five combinations of fourwing saltbush and blue grama.

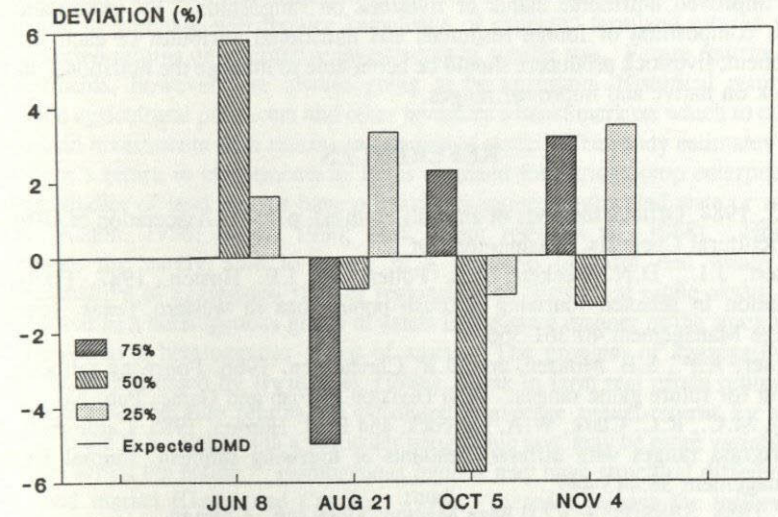

Figure 3. Deviation of actual dry matter digestibility (DMD) from expected DMD for three forage mixture proportions (25, 50 and 75% fourwing saltbush) at four sample periods. Actual DMD is the mean of analyzed replicated forage samples. Expected DMD was calculated from a weighted mean of relative proportions of DMD using estimates of DMD from 100% fourwing saltbush and 100% blue grama. The deviation was derived by subtracting expected DMD from actual DMD.

Conversely, when fourwing saltbush obtained from mid-season collections was mixed with blue grama, digestibilities were as much as 6% less than expected (Figure 3). Mid-season collections were made during early and late seed maturity phases, suggesting the presence of an unidentified factor that caused apparent depressions in digestibility of dry matter. A possible partial explanation relates to levels of crude protein. Crude protein levels are typical in that they are high in the early stages of development, and decrease as the fourwing saltbush matures (Table 2). Adding blue grama to saltbush samples diluted overall protein content because grass protein was near 7% (Table 2).

In mixed and pure forage samples with less than 10% crude protein, a decreased ruminant digestibility of dry matter would be expected. This results from insufficient nitrogen to support rumen microbial activity. Additional supplemental protein, provided with low protein forages, usually increases DMD. A composition of 25 to 50% fourwing saltbush dry matter was required in the saltbush-grass mixtures to obtain crude protein levels above 10% (Table 2). Lower digestibility estimates obtained from late-season collections of fourwing saltbush may demonstrate a low protein ($<10\%$) effect on *in vitro* DMD estimates of mixed forage samples. Another possible cause of depressed late-season DMD may be a greater lignin content of mature forages. Lignin content was not assessed in this study.

The results of this study support the nutritional benefits of fourwing saltbush in ruminant diets. Digestibility declined through the growing season, but was always greater than that of blue grama. The DMD of blue grama was enhanced by the addition of fourwing saltbush, and mixtures with the highest proportion of fourwing saltbush had the highest digestibilities. Undoubtedly fourwing saltbush contributes to an improved nutritional status of livestock on rangelands. By understanding species composition of forage resources and nutritional attributes of each forage component, livestock producers should be better able to manage the nutritional status of stock on native and improved ranges.

REFERENCES

AOAC. 1984. Official methods of analysis. 14th ed. p.1141. Association of Official Agricultural Chemists, Washington, DC.

Peterson, J.L., D.N. Ueckert, R.L. Potter, and J.E. Huston. 1987. Ecotypic variation in selected fourwing saltbush populations in western Texas. Journal Range Management 40:361-366.

Plummer, A.P., S.B. Monsen, and D.R. Christensen. 1966. Fourwing saltbush: a shrub for future game ranges. Utah Division of Fish and Game, Pub. No. 66-4.

Shoop, M.C., R.C. Clark, W.A. Laycock, and R.M. Hansen. 1985. Cattle diets on shortgrass ranges with different amounts of fourwing saltbush. Journal Range Management 38:443-449.

SPSS. 1988. SPSS/PC+ V2.0 Base Manual. SPSS Inc., Chicago.

Welch, B.L. 1978. Relationships of soil salinity, ash, and crude protein in Atriplex canescens. Journal Range Management 32:132-33.