MONTHLY VARIATION IN CAROTENE CONTENT OF TWO IMPORTANT RANGE GRASSES, SPOROBOLUS FLEXUOSUS AND BOUTELOUA ERIOPODA [1]

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INTRODUCTION

Much of the semiarid mesa land lying in the south-central part of New Mexico along the Rio Grande has an average annual precipitation of from 8½ to 10 inches. Approximately half of this precipitation usually occurs in July, August, and September, the primary growing season during which most of the range grass is produced. Two of the most important range grasses of this area are black grama and mesa dropseed grass. These two grasses were selected in 1936 for a study of their nutritive properties at different stages of maturity.

Black grama (*Bouteloua eriopoda* (Torr.) Torr.), one of the very palatable grasses for livestock, grows on the mesas, hills, and dry open ground of large areas of range land in Texas, New Mexico, Arizona, and southern Utah. The upright stems of this grass remain green for a distance of 4 to 6 inches from their bases throughout the winter. Mesa dropseed grass (*Sporobolus flexuosus* (Thurb.) Rydb.) is found on the mesas of western Texas, New Mexico, Arizona, southern Utah, and southern California. It grows to a height of 20 to 30 inches and is very palatable throughout the growing season.

MATERIALS AND METHODS

The two grasses, black grama and mesa dropseed, were collected on the 15th of each month from an enclosure on a ranch of the New Mexico College of Agriculture and Mechanic Arts, located approximately 22 miles north of Las Cruces. The rainfall data were obtained from a rain gage on the experimental plot. The first sample was collected February 15, 1937, and similar collections will be made monthly until the completion of the project, which was planned to cover a period of 5 years. The bunches of grass in the plot were staked out in series of 12. The first series was harvested only on January 15 of each year and represents grass in an ungrazed pasture. The sixth series was harvested June 15 and contained some mature grass that had grown since June of the year before, along with new grass of the current season. The October series contained only the current year's growth at its approximate maturity. The black grama was cut 2½ inches and the mesa dropseed 3 inches above the surface of the ground. The samples were placed in canvas bags, weighed, taken to the laboratory, and subjected to analysis within an hour or an hour and a quarter after cutting. Occasionally, when it was not possible to begin the analysis

[1] Received for publication September 6, 1938.

[2] Acknowledgment is due R. W. Caldwell, of the California Agricultural Experiment Station at Davis, Calif., for valuable assistance in connection with certain phases of the project and for criticizing the manuscript.

immediately, the samples were placed in a mechanical refrigerator at a temperature of −3.0 to +1.0° C. and analyzed the following morning.

All the samples were finely pulverized in a Wiley mill except those containing fresh green growth with a moisture content of 50 percent or over, which were ground in a mortar with fine sea sand. All the samples, regardless of the method of grinding, were analyzed without drying as soon as they could be transported to the laboratory and prepared.

The plants were analyzed for carotene by the method of Guilbert,[3] with modifications suggested by R. W. Caldwell. Seven months after the beginning of this project, Munsey [4] published the results of his referee work on carotene methods. From reports and comparisons by other workers it is believed that the method used in the present work gives results that very closely approximate those obtained with the Fraps-Guilbert method used in the referee work. A 92-percent methyl alcohol wash solution was used instead of the 90-percent solution specified by the Guilbert method. Briefly, the procedure consists in subjecting the pulverized sample to saponification in aldehyde-free alcoholic potassium hydroxide and extraction with peroxide-free ethyl ether. The ether solution, after washing free from chlorophyllins, flavones, and alkali, is distilled under reduced pressure, the residue taken up in petroleum ether (boiling point, 35°–60° C.), and the xanthophyll removed by washing with 92-percent methanol. The carotene in petroleum ether solution, after making up to convenient volume, is determined colorimetrically, a dye solution prepared from orange G and naphthol yellow crystals being used for comparison. The dye solution was standardized against a sample of β-carotene [5] having a melting point of 184° C. Duplicate determinations were made upon the two range grasses and very close checks were obtained. The error averaged less than 4 percent.

ANALYTICAL RESULTS

The results of the analyses, presented in table 1 and figure 1, show that in 1937 the carotene value for black grama increased above the February and March levels to a high level in June, and then fell somewhat during July and August. This July and August period was rather dry and the grass made little growth, which may account for its low carotene content. The September value, which is the highest of the year, can be attributed to the fresh green growth that followed heavy early September rains. This growth continued at least until the middle of October, when the carotene value was approximately 15 percent less. The carotene values declined during the early winter months to a level of approximately 15 mg. per kilogram during February and March 1938. The black grama grass during February and March 1938 contained approximately three times the carotene content present during the same months of 1937. The winter of 1937–38, so far as minimum temperatures are concerned, was very mild. According to the records of the United States Weather Bureau station at State College, N. Mex., the average minimum monthly temperature for October 1936 and the three following months was

[3] GUILBERT, H. R. DETERMINATION OF CAROTENE AS A MEANS OF ESTIMATING THE VITAMIN A VALUE OF FORAGE. Indus. and Engin. Chem., Analyt. Ed. 6: 452–454. 1934.

[4] MUNSEY, V. E. REPORT ON CAROTENE. Jour. Assoc. Off. Agr. Chem. 20: 457–458. 1937.

[5] This sample was supplied through the courtesy of Dr. H. H. Strain, of the Carnegie Institution of Washington.

42.6°, 32.2°, 27.9°, and 21.4° F., respectively; the minimum monthly temperatures from October 1, 1937, to April 1, 1938, averaged 2.13° F. warmer than for the same period of 1936 and 1937. It is believed that this difference in temperature permitted a larger fraction than usual of the upright stems to remain green during the winter and thus furnished plant material with a higher carotene content.

Guilbert and his coworkers [6] found the minimum carotene requirement for cattle, sheep, and hogs to be 25 to 30 micrograms daily per kilogram of body weight. On this basis, the black grama grass contained, at its lowest level during February and March 1937, over three times the minimum amount of carotene needed for 900-pound range cattle during normal consumption of the dry grass. The carotene content of this grass seems to be influenced by stage of maturity, temperature, precipitation, and many other factors, but there nevertheless appears to be an abundance of carotene, even through the winter months, to satisfy the vitamin A requirement of range cattle.

TABLE 1.—*Monthly carotene content of black grama and mesa dropseed grasses and related meteorological data*

[Milligrams of carotene per kilogram of feed, dry basis]

Date	Carotene [1] content of—		Average minimum monthly temperature	Total precipitation	Date	Carotene [1] content of—		Average minimum monthly temperature	Total precipitation
	Black grama	Mesa dropseed				Black grama	Mesa dropseed		
1937	*Milligrams*	*Milligrams*	*° F.*	*Inches*	*1937*	*Milligrams*	*Milligrams*	*° F.*	*Inches*
Feb. 15	5.4	0	28.9	0.65	Nov. 15	80.0	0	30.5	--------
Mar. 15	5.8	0	33.4	.44	Dec. 15	26.6	0	29.0	0.48
Apr. 15	20.7	24.3	40.1	--------	*1938*				
May 15	32.7	37.5	50.1	.87					
June 15	82.8	81.7	57.9	.67					
July 15 [3]	52.5	93.7	65.1	.36	Jan. 15	24.1	0	27.0	.55
Aug. 15	38.2	84.7	65.5	1.04	Feb. 15	15.7	0	31.4	.39
Sept. 15 [3]	125.7	138.6	59.7	3.21	Mar. 15	13.4	0	35.1	.06
Oct. 15 [3]	105.9	68.4	46.2	.89	Apr. 15	[2] 26.5	0	40.5	.03

[1] Carotene results are averages of duplicate determinations.
[2] Average for April includes only 1 determination on black grama.
[3] Samples were ground in a mortar with sea sand.

The mesa dropseed grass during the growing season contained as much carotene, and in most cases a good deal more, than the black grama grass. However, the mesa dropseed grass dies with the coming of frost and freezing weather and the carotene is soon destroyed. In 1937 all the carotene was destroyed as early as November 15. This early loss of carotene suggests a somewhat limited winter usefulness of this grass except as a dry winter forage.

The seasonal characteristics of the two range grasses are clearly shown in figure 1. Although the amount of carotene in the black grama grass was slightly smaller than that in the dropseed grass during the growing season, the black grama was slower in maturing and maintained high carotene values for 30 days longer. The black grama always contained some carotene, even during the winter, when the amount was small, but no carotene was found in the dropseed from

[6] GUILBERT, H. R. See footnote 3.
——— MILLER, R. F., and HUGHES, E. H. THE MINIMUM VITAMIN A AND CAROTENE REQUIREMENTS OF CATTLE, SHEEP, AND SWINE. Jour. Nutrition 13: 543-564. 1937.

November 15 to April 15. The high carotene period of both grasses occurred during the early part of the growing season, which was influenced to a large extent by the exact time of the summer rains.

Other workers also have found a rapid change in carotene content of grass with change in season. Atkeson, Peterson, and Aldous,[7] of the Kansas Agricultural Experiment Station, reported that typical pasture plants showed relatively high carotene values in early summer, marked decreases during the hot summer months, and high carotene

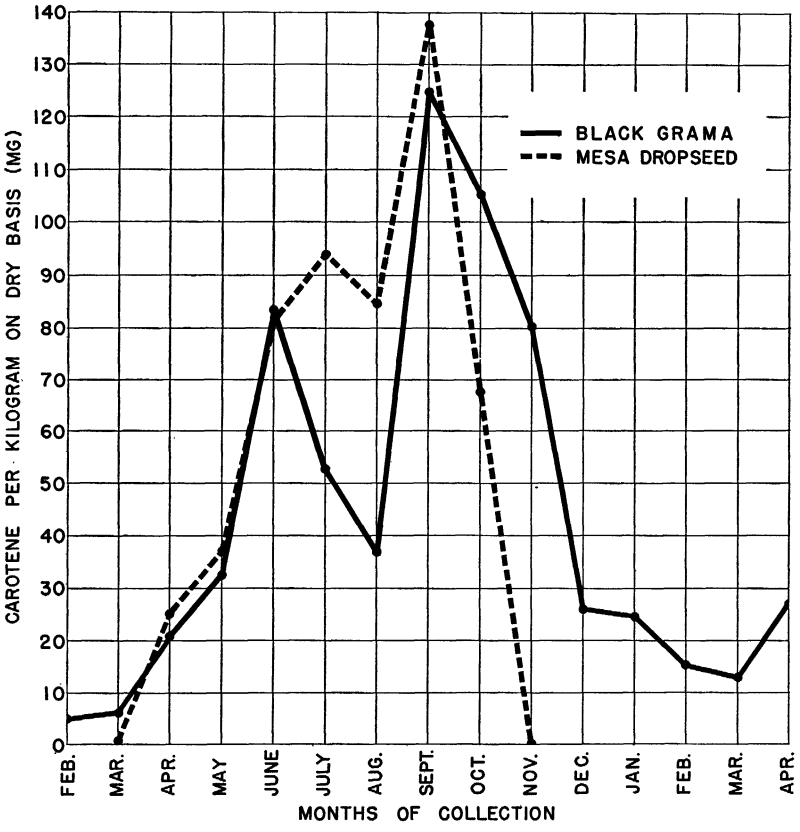

FIGURE 1.—Carotene content of two range grasses when samples were collected the 15th of each month.

values after the fall rains. Some of the native pasture grasses, such as big bluestem and buffalo grass, were very low in carotene content by November. Smith and Stanley,[8] of the Arizona Agricultural Experiment Station, working on the vitamin A potency of blue grama grass by the rat-growth method, found the early cut grass twice as potent as the mature grass and 100 times as potent as the November samples.

[7] ATKESON, F. W., PETERSON, W. J., and ALDOUS, A. E. THE OBSERVATIONS ON THE CAROTENE CONTENT OF SOME TYPICAL PASTURE PLANTS. Jour. Dairy Sci. 20: 557–562, illus. 1937.

[8] SMITH, MARGARET CAMMACK, and STANLEY, E. B. THE VITAMIN A VALUE OF BLUE GRAMA RANGE GRASS AT DIFFERENT STAGES OF GROWTH. Jour. Agr. Research 56: 69–71. 1938.

SUMMARY

The monthly carotene content of two important southern New Mexico range grasses, black grama and mesa dropseed, has been presented. Both grasses are moderately high in carotene during the growing season. The mesa dropseed loses all of its carotene soon after the fall freezes end the growing season. The black grama grass, whose upright stems remain green for a distance of from 4 to 6 inches of their base throughout the winter, contain an amount of carotene that seems to be ample to satisfy the vitamin A requirements of range cattle.