THE CAROTENE CONTENT OF STORED NATIVE MEADOW HAY IN THE NORTHERN GREAT BASIN.

J. R. SCHUBERT, FARRIS HUBBERT, JR., W. A. SAWYER
W. F. BRANNON AND J. R. HAAG

DEPARTMENT OF AGRICULTURAL CHEMISTRY
OREGON STATE COLLEGE, CORVALLIS, OREGON
SQUAW BUTTE-HARNEY EXPERIMENT STATION, BURNS, OREGON

Recently there has been increasing interest in the vitamin A status of range cattle. This has resulted in part from concern as to the amounts of carotene supplied by available forage. Native hays used for winter feeding are a source whose potency can be readily measured. Holding such hays in reserve for periods up to several years may have an important influence on their carotene content. This study presents analyses which indicate the extent of carotene deterioration relative to the length of storage in the stack.

METHODS AND MATERIALS

The initial series of carotene analyses (Table I) were performed using a phasic extraction method (Peterson, 1941). When such a procedure is used with dehydrated and stored plant material, over-estimates are often encountered by inclusion of non-carotene pigments (Wall and Kelley, 1943). Consequently, all further values (Tables II and III) were obtained by the chromatographic technique of the latter authors as modified by Thompson and Bickoff (1951).

The results presented in Table I are a compilation of control analyses performed during the experiments described by Hubbert, et al. (1953). They are concerned with analyses of several crops of native mountain flood meadow hay consisting of 90 per cent sedges (Carex spp.) and rushes (Juncus spp.) and ten per cent grasses and forbs. These were sampled at intervals during a three year period.

The data in Table II involve analyses at one sampling time from available stacks of varying length of storage. These hays also were produced at the Squaw Butte Station.

The third group of values (Table III) represents a survey of native hays produced and stored on ranches throughout the area surrounding the station.

Technical Paper No. 987, Oregon Agricultural Experiment Station.

Composite samples were obtained from three elevations at five pace intervals around a given stack. The elevations were staggered to represent six levels.

RESULTS AND DISCUSSION

The influence of age of hay in a given stack on its carotene content is indicated to some extent within years by reference to individual values of the groups in Table I. The data were limited by exhaustion of stacks with heavy feeding. An anomaly is presented with increasing values in the first group, due probably to a combination of analytical and sampling variability. These values are representative of several crops sampled in different years which lessens the influence of harvesting variations from year to year.

The annual deterioration in carotene potency is shown by the values in the summary of Table I. The effect is moderated by the arbitrary inclusion of varied monthly intervals within yearly averages. Nevertheless, it appears that from the point of complete curing up to two years, an approximate 50 per cent reduction in crotene content occurs. Beyond this point the values appear relatively more stable. The question arises, however, as to the extent of non-carotene pigment contribution to possible over-evaluation due to the older method of analysis.

The range in analyses of from 35 to 52 ppm carotene for newly cured hay in the bunch (cocked) gives some idea as to the extent of influence of other variables in hay making practice within a single operation. Comparable analyses by the chromatographic method for two samples obtained in September, 1953 showed 41 and 36 ppm carotene.

The results in Table II from the Squaw Butte Station indicate that the initial years' decline in carotene content of stacked hays may be expected to exceed 50 per cent of the initial value. The summery figures show an average figure of 60 per cent. Of the remaining amounts, an average additional 75 per cent deterioration may be noted for the second year of storage. The principal uncontrolled variable in these values is the difference between years, such as would be imposed by climatic conditions influencing harvest stage of maturity or curing. Comparison of the 4.5 ppm average of hay stored for two years with the 17 ppm level value in the previous table shows the extent to which the phasic extraction method may over-estimate the potency of this plant material. The relative magnitude of this effect appears to increase with time.

Table I - Phasic Extraction Analyses of the Carotene Content of Several Stored Native Meadow Hays Sampled Over A Three Year Period.

Crop Year	Sampling Date	Approximate Age in Stack Yr.	Mo.	Carotene ppm
1949	*Aug. 1950	0	11	16
1949	Nov. 1950	1	2	18
1949	*Mar. 1951	1	6	26
1949	*Oct. 1951	2	1	21
1949	*Mar. 1952	2	6	13
1950	*Aug. 1950	From bunch		48
1950	Aug. 1950	From bunch		44
1950	Nov. 1950	0	2	49
1950	*Mar. 1951	0	6	42
1950	*Aug. 1951	0	11	25
1950	Mar. 1952	1	6	16
1950	Mar. 1951	0	6	40
1950	Oct. 1951	1	.1	30
1950	Apr. 1952	1	7	29
1951	Aug. 1951	From bunch		35
1951	*Aug. 1951	From bunch		52
1951	*Mar. 1952	0	6	42

Summary:

Age in Stack (Years)	No. of Samples	Carotene (ppm, avg.)
From bunch	4	45
Less than 1	6	36
1 - 2	5	24
2 - 3	2	17

* Samples indicated within each group are from the same stack. All others within each group are from the same meadow within a single section.

Table II - Chromatographic Analyses of the Carotene Content of Native Meadow Hays of Varying Age of Storage Available from a Single Section (Sampled November 1954)

Crop Year	Meadow No.	Stack No.	Carotene (ppm)
1954	3	C	45.5
1953	3	B	21.7
1953	3	A	12.4
1954	4	C	47.9
1953	4	B	15.6
1952	4	A	2.7
1954	5	B	28.8
1952	5	A	6.0
1954	6	E	48.5
1954	6	D	50.0
1953	6	C	19.1
1952	6	B	4.8

Summary: Age in Stack (Years)	No. of Samples	Carotene Avg. (ppm)
New Crop (1954)	5	44.1
1 (1953)	4	17.2
2 (1952)	3	4.5

Estimated hay composition: Sedge, 50%; Rush, 40%; Grass, 10%.

The analyses representative of haying practices in the Northern Great Basin area (Table III) essentially conform to the pattern found on the Station. The values by years are generally lower largely due to the half-year more advanced sampling date. The first year declines again approach 60 per cent of the initial values, although the subsequent annual rate of loss approximates 50 per cent. These findings appear to be relatively independent of the three types of forage concerned and are quite uniform between six widely dispersed ranches. Here again the variations between crop years are not accountable.

Table III - Chromatographic Analyses of the Carotene Content of Stored Native Meadow Hays from Various Sections in the Northern Great Basin
(Sampled March, 1955)

Crop Year	Principal Forage Type		Carotene (ppm)
1954	Nevada Bluegrass		40.6
1953	Nevada Bluegrass		11.6
1954	Nevada Bluegrass		37.7
1953	Nevada Bluegrass		11.2
1954	Nevada Bluegrass		31.4
1953	Nevada Bluegrass		20.8
1954	Nevada Bluegrass		32.2
1953	Nevada Bluegrass		12.8
1953	Nevada Bluegrass		16.5
1952	Nevada Bluegrass		8.8
Summary:	New Crop (1954)	Av. of 4	35.5
	One Year Old (1953)	Av. of 5	14.6
	Two Years Old (1952)	1 Sample	8.8
1954	Rush		42.0
1953	Rush		20.4
1953	Rush		15.2
1954	Rush		42.9
1953	Rush		14.8
1954	Rush		52.1
1953	Rush		19.9
1952	Rush		8.4
1954	Rush		26.8
1950	Rush		4.6
Summary:	New Crop (1954)	Av. of 4	41.0
	One Year Old (1953)	Av. of 4	17.6
	Two Years Old (1952)	1 Sample	8.4
	Four Years Old (1950)	1 Sample	4.6
1954	Sedge-Rush-Grass		36.7
1953	Sedge-Rush-Grass		12.0
1954	Sedge-Rush-Grass		37.6
1953	Sedge-Rush-Grass		13.0
1954	Sedge-Rush-Grass		34.1
1953	Sedge-Rush-Grass		15.7
1954	Sedge-Rush-Grass		34.2
1953	Sedge-Rush-Grass		13.9
1954	Sedge-Rush-Grass		34.2
1953	Sedge-Rush-Grass		12.9
1954	Sedge-Rush-Grass		38.8
1953	Sedge-Rush-Grass		11.2
Summary:	New Crop (1954)	Av. of 6	35.9
	One Year Old (1953)	Av. of 6	13.1

Bracketed samples within each ranch group are from the same section area.

It is interesting to consider the remarkably good quality of these native hays relative to their carotene content. The range of chromatographic analyses in the new crop summaries of 35 to 44 ppm is the same given by the National Research Council (Guilbert, et al., 1950) for best quality legume hays. Crude protein analyses of these same samples consistently ranged between 7 and 8 per cent, with minor deterioration with age in the stack.

By the same authority, the recommended nutrient allowance for wintering a 1000 pound mature pregnant cow is 3.3 mg carotene per pound of feed (7.3 ppm based on an intake of 18 pounds hay daily). Hence, it is apparent that hays stored up to two years can provide the optimum designated intake of carotene. The reduced available numbers of older samples indicate the effective utilization of stored hay.

SUMMARY

The carotene analyses of 61 samples of native mountain flood meadow hay are presented relative to their length of storage in the stack.

The carotene potency "half-life" was shown to be somewhat less than one year, with an annual deterioration approximating 60 per cent.

Phasic extraction analysis apparently over-estimates carotene content of these materials with the effect being aggravated by increasing length of storage.

The quality of these hays is excellent by the criterion of a carotene content range of from 35 to 44 ppm in the first year.

The average carotene content of the hays remains above the National Research Council recommended intake through the second year of storage in the stack.

LITERATURE CITED

Guilbert, H. R., Paul Gerlaugh and L. L. Madsen. 1950. Recommended nutrient allowances for beef cattle. 37 pp. Washington, D. C.: National Research Council.

Hubbert, Farris, Jr., Paul H. Weswig, J. R. Haag and W. A. Sawyer. 1953. Influence of age of meadow hay in beef cows' winter rations following summer grazing on sagebrush-bunchgrass range. Proc. W. Sec. Am. Soc. An. Prod. 4:XII, 1-9.

Peterson, Walter J. 1941. Recent developments in methods for determining carotene. Ind. Eng. Chem., Anal. Ed. 13:212.

Thompson, C. R. and E. M. Bickoff. 1951. A proposed modification of the A.O.A.C. method for carotene in alfalfa. J.A.O.A.C. 34:219.

Wall, Monroe E. and Edward G. Kelley. 1943. Determination of pure carotene in plant tissue. Ind. Eng. Chem., Anal. Ed. 15:18.