

# Total Carbohydrate and Carotenoid Content of Sweet Potatoes as Affected by Cultivar and Area of Production<sup>1</sup>

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**Abstract.** Three cultivars of sweet potato (*Ipomoea batatas* Lam.) were grown at 7 production sites in Mississippi during 1959 and 1960, using plants from a common source. Forty U.S. No. 1 roots of each cultivar at each production site were sampled and carbohydrate and carotene content determined. Variation in carotene content was much greater among cultivars when compared to variation among production sites, however, there were highly significant differences within a cultivar among the various production locations. Carbohydrate content within a cultivar varied among production sites more than among those at any one production site. The feasibility of establishing a nutrient content range for fresh vegetable products is highly questionable.

Interest in the nutritional value of fresh fruits and vegetables has accelerated rapidly in the past year, stimulated in part by legislation governing the advertised nutritive content of foods and especially those materials referred to as GRAS (generally regarded as safe). The Food and Drug Administration (FDA), has promulgated regulations for controlling and enforcing, although without legal authority according to some (14), the claimed nutritive content of foods. Food lots deviating by 20% or more from advertised nutrient content will be subject to seizure and attempts are underway to establish minimal levels of those accepted nutrients (14).

Numerous reports (1-16) indicate that many of the plant products man uses for food vary widely in nutrient content. Carotene content and soluble solids (carbohydrates) of carrots are strongly influenced by cultivar, planting date, harvest date and growing season temp (2, 3, 10). Variations within a cultivar were as great as variation among cultivars. Variations in carotenoids of corn and sorghum (1) were even greater than those reported for carrots. Wang (16) reported that sucrose variation in sugar cane was highly significant and was affected by cultivar, production location, and year.

Stevenson (13) reported environmental responses exceeded cultivar differences in measuring the chipping quality of potatoes. Janes (10), working with 6 vegetables, found

variations in ascorbic acid and carotene content of as much as 100%, based on the area of production within the state of Florida.

Plant materials of such diverse types as carrots, cabbage, beans, potatoes, sugar cane and sweet potatoes have been shown to differ widely in their content of various nutrients depending on where they were grown. In most instances, environmental influences have exceeded cultivar influences on the specific nutrient under study (1-6, 8-16). Handling practices after harvest, especially storage conditions (4-6, 8, 12, 15), also influence the nutritive value of vegetable materials. The work reported herein was a study of the influence of cultivar and area of production in Mississippi on the carotene and carbohydrate content of 2 cultivars of sweet potato and a breeding line.

'Goldrush', 'Porto Rico' and M97-4 sweet potato, were grown at 7 locations in Mississippi during 1959 and 1960. The soil types at the various test sites were: (a) Crystal Springs - Providence silt loam, (b) Holly Springs - Grenada silt loam, (c) Laurel - Ruston fine sandy loam, (d) Pontotoc Ridge - Atwood silt loam and Pontotoc Flatwood - Lintonia silt loam, (e) Stoneville - Bosket very fine sand loam, and (f) Mississippi State - Marietta fine sandy loam.

Plants for the test were produced by bedding 3 bu of each cultivar in an electrically heated hotbed about March 15. They were pulled and transported to planting sites May 1-15. Each plot consisted of 4 rows 9.14 m long and 1.01 m wide and was replicated 4 times. All plots were fertilized with 9-5.2-10.0 (N-P-K) at the rate of 2700 kg per ha. Plants were set 0.3 m apart on bedded rows. Data were collected on the 2 center rows of each plot. Storage roots were harvested Oct. 1-15 each year and yield data recorded. Ten No. 1 grade roots of each cultivar were selected from each replicate at each production site and transported to Mississippi State, Mississippi. The day following harvest, the roots were washed in tap water, cut in half longitudinally, and macerated tissue was collected from half of each root by means of a power rasp. The material from the 10 roots was composited and a 20 g sample collected for analysis, placed in acetone, sealed and

refrigerated at 0°C until all samples were collected.

Carotene content was determined after the method of Thompson and Kon as described by Goodwin (7). The carotenes were extracted in acetone, transferred to petroleum ether and eluted on a magnesium oxide column with 2% acetone in hexane. The elutants were collected and the light transmission determined at 450 mμ using a B & L "Spectronic 20." Carotene content was determined by plotting against a standard curve.

An additional 10 g sample of macerated tissue from each plot was stored in 95% ethanol for carbohydrate analysis. The tissue in alcohol was boiled for 15 min and the insoluble material separated by filtration. Carbohydrate content was determined by the method described by Wilkins et al. (17).

Differences among cultivar in carotene content was obvious and the significant range was not calculated (Table 1). Differences in carotene content among locations varied as much as 62% for 'Goldrush' (91.53 vs. 148.69), 71% for 'Porto Rico' (31.13 vs. 53.51) and 93% for M97-4 (138.58 vs. 267.78). A portion of this variation was probably due to the different soil types. However, the soil at Crystal Springs, Holly Springs and the Pontotoc Ridge was quite similar in many respects. The soil at Laurel, Mississippi State and Stoneville was fairly comparable although that at Laurel was more sandy and of larger particle size. These soil type groupings tended to eliminate some of the variation, although an appreciable amount remained and was probably due to other environmental variables such as temperature and rainfall. 'Goldrush' appeared to be the more stable cultivar. Differences between years were small and easily accounted for by chance.

The effect of cultivar and area of production on carbohydrate content was also significant (Table 1). The lowest carbohydrate content came from Stoneville test plots. The plots at Holly Springs, Laurel, and Pontotoc produced roots with the highest carbohydrate content. There appeared to be a slight cultivar × location interaction, but it was not of significant magnitude. Grouping of the soil types indicated most, if not all, of the variation in carbohydrate content may have been due to other environmental variables.

These data seem to agree with findings for other vegetables (1, 2, 8-10, 12, 13, and 15) in that significant differences among cultivar and among production sites occurred. Differences among cultivars of sweet potatoes appear to be greater than with most other vegetable crops. Janes (10) in his work with cabbage, beans, tomatoes,

<sup>1</sup>Mississippi Agriculture and Forestry Experiment Station (MAFES) Journal Article No. 2783.

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Table 1. The effect of cultivar and production location on beta carotene and carbohydrates of sweet potatoes.

Cultivar	Location	Beta carotene content (µg/g)			Total carbohydrates (% fresh wt)		
		1959 <sup>2</sup>	1960	Mean	1959	1960	Mean
Goldrush	Crystal Springs	129.92 b	128.69 b	129.26	25.33 b	24.50 b	24.91
	Holly Springs	121.04 b	123.18 b	122.11	28.60 a	27.45 a	28.03
	Laurel	90.65 d	92.41 d	91.53	26.10 ab	25.70 ab	25.90
	Pontotoc						
	Ridge Soil	98.70 c	98.92 c	98.81	24.10 b	23.32 b	23.71
	Flatwoods	148.58 a	148.81 a	148.69	28.60 a	28.33 a	28.46
	Mississippi State	104.21 c	105.52 c	104.86	24.25 b	25.10 b	24.67
	Stoneville	91.65 d	91.66 d	91.65	19.43 c	18.19 c	18.81
	Average	112.11	112.73	112.42	25.20	24.65	24.92
Porto Rico	Crystal Springs	52.81 a	54.21 a	53.51	29.11 b	29.17 b	29.14
	Holly Springs	49.18 a	52.51 a	50.84	34.22 a	33.90 a	34.06
	Laurel	39.23 b	39.70 b	39.46	30.09 b	29.85 b	29.97
	Pontotoc						
	Ridge Soil	51.28 a	51.75 a	51.51	29.88 b	29.85 b	29.86
	Flatwoods	46.89 ab	47.27 ab	47.08	34.66 a	24.47 a	34.56
	Mississippi State	31.60 c	32.82 c	32.31	27.81 c	25.19 c	26.50
	Stoneville	31.13 c	31.13 c	31.13	21.73 c	21.76 c	21.74
	Average	43.16	44.20	43.68	29.64	29.17	29.40
M97-4	Crystal Springs	207.30 bc	213.28 bc	210.29	27.08 b	28.32 bc	27.70
	Holly Springs	266.98 a	268.58 a	267.68	28.19 b	29.60 ab	28.89
	Laurel	184.63 c	185.91 c	185.27	29.10 a	31.04 a	30.07
	Pontotoc						
	Ridge Soil	205.48 c	204.31 c	204.89	27.15 b	27.18	27.17
	Flatwoods	232.32 b	231.44 b	231.88	29.01 a	28.97 a	28.99
	Mississippi State	163.57 d	161.48 d	162.52	27.50 b	28.45 b	27.97
	Stoneville	138.62 e	138.54 e	138.58	21.58 c	21.61 c	21.60
	Average	199.84	200.51	200.17	27.09	27.88	27.48

<sup>2</sup>Mean separation in columns by Duncan's new multiple range test, 1% level.

collards, broccoli and carrots, reported differences of nearly 100% in content of various vitamins and minerals, depending on production location. The results reported in this study indicate that sweet potatoes vary as much as other crops. Both this study and the work of Janes (10) report differences of nearly 100% among production areas within a single state. Although environmental variations within a single state are quite wide, they are not as great as would be encountered if all the production areas within the continental U.S. were examined. Thus it appears entirely reasonable that variations in vitamin and mineral content (as well as other components) in excess of 100% deviation in an advertised nutrient or vitamin content may be expected. Assuming the cultivar mean should be established as the required or advertised level of a particular nutrient or vitamin, the suggested 20% deviation is not a practical limitation.

In this study, carbohydrate variation about the mean for a given cultivar exceeded 20% for all cultivars tested. The mean carbohydrate content for all cultivars tested was not a reliable measure even when the 20% deviation was used. If the over-all mean was used, variations exceeding 30% were evident. Carotene content deviation was much greater than total carbohydrate. Variation extremes about the cultivar mean was nearer 35% than the suggested 20% limit. Testing for deviation using an over-all experimental mean for carotene revealed deviations in excess of 100%.

The development of an average vitamin content for fresh vegetable

products and establishment of a 20% deviation limit appears to be neither practical nor feasible. In processed foods where additives may be controlled with a high degree of precision, it may be possible to control vitamins within the 20% limits. However, even under those conditions, the feasibility is highly questionable. The cultivar grown and the production environment would have to be much more rigidly controlled than at the present. Frequent chemical analyses would also be required. The cost of controlling the vitamin and mineral content of vegetable products would far exceed any benefit to be derived from such controls. These added costs would have to be absorbed by the consumer, thus resulting in increased food costs and no real benefits attained.

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