Carotenoids of Centennial Variety Sweet Potato, *Ipomea batatas* L.

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The carotenoids of Centennial variety sweet potato, *Ipomea batatas* L., were analyzed. The major carotenes found were, in per cent, β-carotene 86.35, phytoene 2.55, phytofluene 1.95, and ζ-carotene 1.77. α- and γ-Carotenes and derivatives of α-carotene were also present.

Centennial variety sweet potato is the most commonly grown sweet potato in the Southeast, but no study of its carotenoids has been reported. A study of the various carotenoids and their relative amounts are reported here.

METHODS AND MATERIALS

Centennial sweet potatoes harvested October 18, 1967, were cured at 29° C. and high humidity for 10 days and then stored at 13° C. After 60 days' storage, 2 kg. of raw, peeled sweet potatoes were extracted by the method of Purcell (1962). Samples were also taken for moisture determination.

The hexane solution of the nonsaponifiable extract containing the carotenoids was concentrated to about 150 ml. and held overnight at −10° C. β-Carotene crystals formed and were removed by filtration. This greatly reduced the amount of β-carotene in solution and facilitated subsequent partitioning and chromatography. The filtrate was partitioned in a 40-transfer countercurrent apparatus using 40 ml. of hexane and 40 ml. of 95% MeOH for each transfer. Three distinct fractions were obtained, I (nonhydroxycarotenes), II (monohydroxycarotenoids), and III (polyhydroxycarotenoids). The various fractions were chromatographed on magnesium oxide as described by Purcell (1962). The β-carotene crystals were also chromatographed on magnesium oxide. Several faint and poorly separated bands formed above the main β-carotene band. Spectral examination suggested the presence of γ-carotene and carotene epoxides which were removed from solution by the β-carotene crystals. These bands were combined with fraction I before fraction I was chromatographed on magnesium oxide. Chromatographic bands which were not clearly separated on magnesium oxide or had absorption spectra indicating a mixture of pigments were rechromatographed on 80- to 200-mesh alumina deactivated with 10% H_2O. The alumina columns were developed with hexane and increasing amounts of ether to obtain desired movement. Fractions which moved too slowly with 10% ether in hexane were developed with 89% hexane–10% ether–1% dry ethanol.

Partition coefficients for the various fractions were determined, according to Petracek and Zechmeister (1956a), using hexane–95% methanol for fractions I and II and hexane–90% methanol for fraction III. Carotene hydrocarbons and their epoxides had partition coefficients greater than 5.0, while monohydroxycarotenoids and their epoxides had partition coefficients from 0.5 to 2.0. Partition coefficients of the polyhydroxycarotenoids ranged from 0.03 to 3.0. The effect of HCl in methanol on the partition coefficients was used to determine the presence of allylic hydroxyl groups (Petracek and Zechmeister, 1956b) and on spectra to determine the presence of 5–6 epoxides. Tests for epoxides in all samples were performed by adding concentrated HCl to ether solutions of the pigments (Karrer and Jucker, 1962). A blue or green color was interpreted as a positive test.

Spectra were obtained with a Cary Model 15 recording spectrophotometer. The spectra of the carotenes of fraction I were determined in hexane and the spectra of those in fractions II and III were determined in benzene before and after treatment with acid. The various fractions were identified on the basis of chromatographic behavior, partition coefficients, presence of epoxides, acid-induced changes in spectra, and partition coefficients, and comparison of absorption spectra with those reported by Curl and Bailey (1957). The amounts of pigments were estimated using the absorption coefficients at maximum absorption previously used (Purcell, 1962).

RESULTS AND DISCUSSION

The total carotene content of the sample based on absorption of the nonsaponifiable extract was 0.13 mg. per gram of fresh or 0.45 mg. per gram of dry matter. This is very close to the 0.46 mg. per gram of dry matter reported by Purcell (1962) for Goldrush variety. The fractions isolated from the Centennial variety are shown in Tables I and II in order of elution from magnesium oxide columns. Comparison of these data with those of Purcell (1962) show that the epoxide components of the Centennial variety are more diverse than those of Goldrush. The most significant difference is the presence of α-carotene and α-carotene derivatives.

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Table I. Carotenes and Epoxide Derivatives Isolated from Centennial Variety Sweet Potato[a]

Fraction	Spectral Maxima: Before acid treatment	Spectral Maxima: After acid treatment	Epoxy	% of Total Carotenoid
Phytoene	286	286	[b]	2.55
Phytofluene	363,348,330	362,348,330	...	1.95
α-Carotene	471,443,419	469,442,419	...	0.90
β-Carotene	478,450,(425)[c]	477,450,(425)	...	86.35
ζ-Carotene	425,400,380	425,400,380	...	1.77
Noncarotene	No maxima	...	...	
Unknown	(470),448,422,400	470,424,400	*	0.01
Luteochrome	445,420,400	No maxima	**	0.21
α-Carotene 5′,6′-epoxide	448,422,398	426,400,380	**	1.05
Mutatochrome	452,426,(405)	453,426,404	*	0.84
Unknown	(440),425,(403)	(450),425,(402)	*	0.02
Unknown	448,425,(405)	448,425,407	**	0.22
γ-Carotene	490,458,434	488,457,432	...	0.77
cis-γ-Carotene	450,428I2[d]484,455	450,430	...	0.13
Unknown	433,408	465,435	*	0.01
Unknown	472,443,422	470,442	*	0.02
Aurochrome	425,400,378,360	425,400,378,360	*	0.05
β-Carotene 5,6,5′,6′-diepoxide	475,448,427	424,404,382	*	0.05
Unknown	425,400,380	445,420,400	*	0.58
Unknown	465,440	(425),396,(370)	*	0.07
Unknown	448,424,400	(448),426,402,380	*	0.01

[a] Spectra in hexane. [b] No visible reaction, *definite reaction, **strong reaction. [c] Parentheses indicate definite shoulder. [d] Isomerized with iodine.

Table II. Mono- and Polyhydroxycarotenoids Isolated from Centennial Variety Sweet Potato[a]

Fraction	Spectral Maxima: Before acid treatment	Spectral Maxima: After acid treatment	Epoxy	% of Total Carotenoid
Hydrocarbon mixture	487,459,(435)[b]	487,459,(435)	...[c]	0.01
Unknown	409	No maxima	...	0.01
Unknown	438	425	...	0.05
Unknown	478,450,430	434,417,387	...	0.09
Cryptoxanthin 5,6,5′,6′-diepoxide	480,457,430	(457),434,408,385	*	0.06
Hydroxy-α-carotene 5′,8′-epoxide	460,435,(415)	460,435,(415)	**	0.01
Unknown	(490),454,430,(408)	No maxima	...	0.01
Unknown	458,432,408	(457),432,407	**	0.04
Cryptoxanthin 5,6,5′,8′-diepoxide	459,430,408	433,408,386	**	0.25
Cryptoxanthin 5,8-epoxide	465,437,(413)	460,433,410	**	1.10
Unknown	462,435,410	No maxima	...	0.02
Unknown	458,432,408	No maxima	...	0.01
Unknown	478,454,430,414	434,407,384	*	0.02
Unknown	480,456,432	460,435,407	*	0.01
Hydroxy-ζ-carotene	435,410,387	433,408,386	...	0.06
Hydrocarbon mixture	(480),460,432	(485),459,434	...	0.01
Monohydroxy mixture	(450),(425),405	(450),432,405	...	0.01
Lutein 5,6-epoxide	483,455,430	460,435,410	*	0.17
cis-Violaxanthin	479,452,428	(455),433,408,385	**	0.09
Violaxanthin	481,450,426	(455),432,407,385	*	0.06
Unknown	(475),434,400,385	No maxima	*	0.01

[a] Spectra in benzene. [b] Parentheses indicate definite shoulder. [c] No visible reaction, *definite reaction, **strong reaction.

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