

CONSTITUENTS OF CRUDE CAROTENE OF CARROTS

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(Received for publication, December 1, 1944)

Carrots have been known for some time to be a rich source of carotene, Wackenroder (1931); Bills and McDonald (1932); and Barnes (1936). Kuhn and Lederer (1941) found that besides beta-carotene, the carotene of carrots consisted of 10 to 20 per cent alpha-carotene. Strain (1939) showed also that carrots contained alpha carotene. Recent work by Kemmerer and Fraps (1943, 1944) showed that the carotene extracts of plants are complex in nature and may consist of beta-carotene, of impurity A, of neo-beta-carotenes B and U, and sometimes of alpha-carotene. The neo-beta-carotenes are stereoisomers of beta-carotene and can be formed from and converted to beta-carotene. Neo-beta-carotene B and alpha-carotene have one-half the vitamin A activity of beta-carotene while impurity A does not appear to possess vitamin A activity. Kemmerer and Fraps (1943) report that neo-beta-carotene U does not possess vitamin A activity, while Deuel, Johnston, Sumner, Polgar, and Zechmeister (1944) report that it has 38 per cent of the vitamin A activity of beta-carotene.

Recently it was observed in this laboratory that the proportion of alpha-carotene was lower in some samples of dehydrated carrots received from the National Research Council than in dehydrated carrots prepared in Texas. Because of this observation and because of the recent findings on the complexity of natural carotene, it seemed desirable to determine the constituents of the crude carotene of a number of different samples of carrots.

EXPERIMENTAL PROCEDURE

Fresh carrots were collected from local markets. Dehydrated carrots grown in California, that were received from the National Research Council and from the University of California, and dehydrated carrots, grown and manufactured in Texas, were used. All the carrots were analyzed for the crude carotene constituents by methods already published by Kemmerer and Fraps (1943).

DISCUSSION OF RESULTS

The crude carotene content and the percentages of constituents of the crude carotene for the carrots are given (Table 1); this table also includes the percentages of beta-carotene equivalents—Kemmerer, Fraps, and Meinke (1945)—which are the percentage of beta-carotene plus one-half the alpha-carotene plus one-half the neo-beta-carotene B. This beta-carotene equivalent is a measure of the vitamin A-active carotenes. Carrots with a high percentage of alpha-carotene will have a lower beta-carotene equivalent than carrots having a low percentage of alpha-carotene. The percentages of constituents were calculated on the total amount of the

TABLE 1

Constituents of Crude Carotene of Carrots

Source and variety	Crude carotene <i>p. p. m.</i>	Impurity A	Percentage of constituents				Beta-carotene equivalent
			Neo-beta-carotene U	Beta-carotene	Neo-beta-carotene B	Alpha-carotene	
Fresh carrots (dry basis) from College Station							
Imperator—early stage of growth.....	386	5.8	0.0	60.1	0.0	34.1	77.2
Imperator—late stage of growth.....	528	7.7	0.0	55.1	0.0	37.2	73.7
Purchased on market.....	36 ¹	6.5	0.0	64.7	0.0	28.8	79.1
Purchased on market.....	698	2.7	3.5	73.3	0.0	20.5	83.6
Purchased on market.....	101 ¹	6.2	0.0	53.1	2.1	38.6	73.5
Purchased on market.....	1036	6.2	0.0	52.1	5.6	36.1	73.0
Purchased on market.....	1120	3.3	1.3	58.8	4.0	32.6	77.1
Mean.....	754	5.5	0.7	59.6	1.7	32.5	76.7
Dehydrated carrots from National Research Council, grown in California							
Not known.....	750	7.1	2.5	62.7	4.0	23.7	76.6
Imperator.....	942	7.7	0.0	62.9	7.9	21.5	77.6
Chantenay.....	855	3.7	0.0	70.5	6.3	19.5	83.4
Not known.....	716	4.6	3.2	67.3	5.2	19.7	79.8
Mean.....	816	5.8	1.4	65.8	5.9	21.1	79.4
Carrots grown and dehydrated in Texas							
Danvers Half Long.....	238	14.7	0.0	44.9	5.2	35.2	65.1
Amsterdam Forcing.....	247	13.7	0.0	49.6	0.0	36.7	68.0
Amsterdam Forcing.....	312	14.3	0.0	52.7	1.3	31.7	69.2
Chantenay No. 3.....	255	19.2	0.0	40.5	1.2	39.1	60.7
Red Core Chantenay.....	363	10.8	3.7	50.3	4.0	31.2	67.9
Imperator.....	348	11.4	0.0	51.3	0.0	37.3	70.0
Imperator.....	424	13.3	8.6	42.1	0.0	36.0	60.1
Morses Bunching.....	320	16.0	0.0	45.0	0.0	39.0	64.5
Morses Bunching.....	910	6.1	0.0	55.0	4.4	34.5	74.5
Monteg.....	344	14.0	3.0	46.4	3.4	33.2	64.7
Long Orange.....	733	9.8	4.3	49.9	3.6	32.4	67.9
Nantes.....	659	7.8	4.0	49.3	3.4	35.5	68.8
Nantes.....	730	4.4	0.0	60.6	0.0	35.0	78.1
Luxemburg Half Long.....	629	5.7	0.0	63.3	2.3	28.7	78.8
Touchon.....	920	7.7	0.0	59.5	0.0	32.8	75.9
Louisiana Danvers.....	930	5.2	0.0	60.2	3.2	31.4	77.5
Supreme Half Long.....	720	4.2	0.0	59.5	5.3	31.0	77.7
Mean.....	535	10.4	1.4	51.8	2.2	34.1	70.0
Dehydrated carrots from University of California, 1941							
Morses Bunching.....	208	10.0	0.0	47.8	0.0	42.2	68.9
Danvers Half Long.....	165	12.6	2.8	45.5	5.5	33.6	65.9
Red Core Chantenay.....	171	18.4	2.3	49.7	2.7	26.9	64.5
Imperator.....	185	15.4	2.2	47.3	2.3	32.8	64.9
Nantes.....	207	8.0	1.7	57.2	3.1	30.0	73.7
Mean.....	187	12.9	1.8	49.5	2.7	33.1	67.4

¹ Carotene determination made on wet basis.

several pigments recovered after adsorption on a calcium hydroxide column as was done by Kemmerer and Fraps (1943) in previous work. In only a few cases was the total below 90 per cent of the crude carotene.

On the dry basis, the crude carotene content of the fresh carrots ranged from 386 to 1,120 p.p.m. with a mean of 754 p.p.m.; the dehydrated carrots from the National Research Council ranged from 750 to 942 p.p.m. with a mean of 816 p.p.m.; the dehydrated carrots grown and dehydrated in Texas ranged from 238 to 930 p.p.m. with a mean of 535 p.p.m.; and the dehydrated carrots from the University of California ranged from 165 to 208 p.p.m. with a mean of 187 p.p.m. The low carotene content of the latter may be due to the long period of storage (1941 to 1944). Impurity A appears to be slightly higher in the Texas dehydrated carrots and those from the University of California than in those received from the National Research Council. Neo-beta-carotenes B and U were present in low amounts in the four groups of carrots. The greatest difference was in the percentages of alpha carotene. In the dehydrated carrots from the National Research Council it ranged from 19.5 to 23.7 per cent with a mean of 21.1 per cent; in the fresh carrots the range was 20.5 to 38.6 per cent with a mean of 32.5 per cent; in the Texas dehydrated carrots the range was 28.7 to 39.1 per cent with a mean of 34.1 per cent; and in the dehydrated carrots from the University of California the range was 26.9 to 42.2 per cent with a mean of 33.1 per cent. These differences are not due to variety since the Emperor and Chantenay carrots from the National Research Council contained considerably lower percentages of alpha-carotene than did the same varieties of carrots from Texas. Differences in soil and climate are the most likely factors.

SUMMARY

Fresh carrots grown in Texas contained 386 to 1,120 p.p.m. crude carotene on the dry basis with a mean of 754 p.p.m. Dehydrated carrots from the National Research Council contained 750 to 942 p.p.m. with a mean of 816; dehydrated carrots from the University of California contained 165 to 208 p.p.m. with a mean of 187; and dehydrated carrots grown and dehydrated in Texas contained 238 to 930 p.p.m. with a mean of 535 p.p.m. The percentage of alpha-carotene in the dehydrated carrots received from the National Research Council ranged from 19.5 to 23.7 with a mean of 21.1; the percentage in dehydrated carrots from the University of California ranged from 26.9 to 42.2 with a mean of 33.1; the percentage in fresh carrots grown in Texas ranged from 20.5 to 38.6 with mean of 32.5; and the percentage in carrots grown and dehydrated in Texas ranged from 28.7 to 39.1 with a mean of 34.1.

ACKNOWLEDGMENT

The writers are indebted for the samples of dehydrated carrots to P. L. Pavcek, National Research Council; G. W. Adriance, Horticulture Department, Texas Agricultural and Mechanical College, College Station, Texas; D. J. Pentzer, U. S. Fruit and Vegetable Products Laboratory, Weslaco, Texas; and G. Mackinney, University of California, Berkeley, California.

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