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SWEET POTATO NUTRIENTS

Carotene and Ascorbic Acid Content in Improved Sweet Potato Variants

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This investigation shows the levels of carotene and ascorbic acid in present day varieties in relation to those found in the roots of about 240 clones originated as seedlings in the breeding program at the Oklahoma Experiment Station. The results indicate that the full potential of improved vitamin content in the sweet potato is not found in the varieties of this product, now available to consumers. The carotene content might easily be raised from 50 mg. per gram (dry) to 80 mg. Similarly the ascorbic acid content might be increased from the present level of 100 to 150 mg. per 100 grams. Frequency histograms are used to express the carotene and ascorbic acid analyses of the large number of seedling clones.

The sweet potato is recognized as a good source of carbohydrates, but its value as a source of vitamins is not yet fully appreciated. In recent years the nutritional value of the sweet potato has been greatly improved; at first, by selecting favorable mutations in clones and later, by selecting desirable individuals in seedling populations. Increases in the contents of vitamins A and C have been readily obtained by these methods (*8*).

The carotene and ascorbic acid contents of roots of large numbers of seedling sweet potatoes have been determined as part of a breeding program in progress at the Oklahoma Agricultural Experiment Station. Improvement in nutritional value is considered just as essential in a new variety as increased yields and resistance to disease.

Increasing Carotene Content of Sweet Potatoes

Prior to the initiation of a sweet potato breeding program in the United States, somatic variants showing increased carotene contents were selected within the clones grown as commercial varieties. Some of these varieties originating as sports have been reported by Miller (*4*), Elmer (*1*), and White (*12*). Mutations involving the carotene content of sweet potato roots are of relatively frequent appearance and may be in either direction. Thus, low carotene variants, if not eliminated, result in the deterioration of the desirability of commercial stocks of a sweet potato variety. The principal pigment in sweet potato roots is β-carotene, the precursor of vitamin A, according to Ezell and Wilcox (*2*); the flesh color of the sweet potato root is a good indication of its carotene content.

The examination of clonal varieties originating as carotene mutations reveals that the deviations from the original variety are not uniform. Thus, the mutant strains of the Yellow Jersey variety designated as Rols and Orlis respectively, have about four and ten times the carotene content of the original variety. Carotene mutations at two levels are also found in variants out of Nancy Hall, while the Maryland Golden variety emerged from the Big Stem Jersey with an approximate 10-fold increase in carotene.

After the breeding of sweet potatoes began in the United States, it soon became apparent that some hybrid seedling individuals produced roots higher in carotene than either parent. Thus, by crossing (or by selfing) selected parent sweet potatoes, high carotene individuals were found in the seedling populations. Because of this, many of the new varieties made available by this breeding program—e.g., Goldrush and Allgold—are higher in carotene than the best of the original varieties or those selected as high carotene mutations.

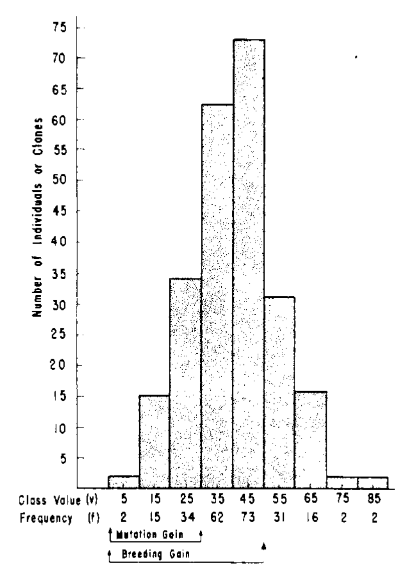

Figure 1. Distribution of 237 sweet potato clones in carotene classes

v. Mid-point indicates class value
f. number in each class, also indicated by column height. Clones were seedlings in the breeding program at the Oklahoma Agricultural Experiment Station. Carotene, milligrams per 100 grams of dry root tissue

[1] Deceased.

Carotene analyses of roots of approximately 240 clones, originating as seedlings in the breeding program at the Oklahoma Agricultural Experiment Station, have been obtained in the Biochemical laboratory. Representative samples of roots have been used and the carotene determined by the method of Moore and Ely (*5*). In this report the concentration of carotene is expressed as milligrams per 100 grams of dry root tissue.

These observations on carotene content have been classified and the results are presented in the frequency histogram in Figure 1.

The clones represented by these data were selected in the field for flesh color as well as for other characteristics. The mean of 40.1 mg. is much above that for an ordinary or unselected population of seedlings from the best parent plants.

As indicated by the data in Figure 1, the carotene content of sweet potatoes was increased to a level of about 25 to 30 mg. by selecting favorable mutations and in some recently introduced varieties (originated by breeding) the level is about 50 mg. Further improvement in carotene is possible through breeding, as indicated by the fact that the carotene in about $^{1}/_{5}$ of the clones for which analyses are available is above this 50-mg. level.

A high carotene sweet potato is desirable from the nutrition standpoint and it provides an attractive product for baking, canning, or freezing. A uniform distribution of the carotene throughout the root is desirable. Mottled or streaked roots, as found in some seedlings and varieties, is undesirable. The presence of the carotene in the flesh of the root just beneath the periderm adds to the attractiveness of the external or skin color.

Improving the Vitamin C Content of Sweet Potatoes

The roots of some sweet potato varieties are relatively high in ascorbic acid. Old varieties such as the Nancy Hall and several members of the Jersey group are in the high vitamin C class. Varieties of recent origin which are high in this vitamin are Heartogold, Queen Mary, Nemagold, and Allgold (*8*).

Some of the varieties and breeding lines used as parents in the breeding program in Oklahoma are of the high ascorbic acid types and many of the seedlings show this characteristic. Samples of adequate numbers of roots of over 240 seedling lines have been analyzed. The samples for analyses were taken from longitudinal halves of roots and assayed for reduced ascorbic acid according to the method of Morell (*6*) or a modification of the Heinze-Kanapaux procedure as described by Reder (*7*). The roots were analyzed at harvest time or shortly thereafter.

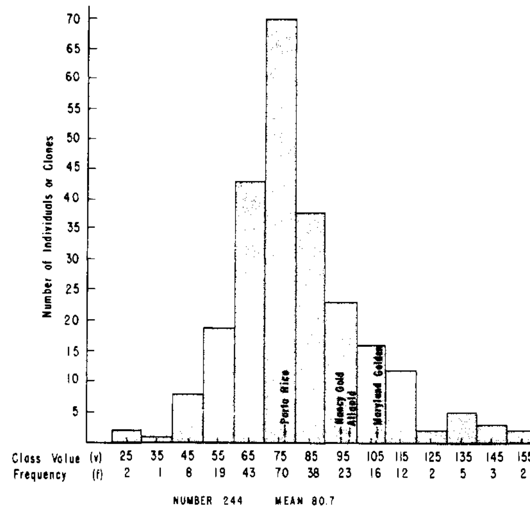

Figure 2. Distribution of 244 sweet potato clones in ascorbic acid classes

v. Class value
Number of clones in each class indicated by height of column and number at the base. Ascorbic acid, milligrams per 100 grams of dry root tissue

These lines were selected in the field on the basis of the carotene content of their roots, but obviously not for ascorbic acid. The distribution of these clones in classes according to the ascorbic acid contents of their roots as milligrams per 100 grams of dry tissue is given in Figure 2.

As indicated in Figure 2, the ascorbic acid in the Porto Rico variety corresponds to the modal class and is just below the mean of 80.7 mg. for the seedling individuals. The varieties Nancy Gold, Allgold, and Maryland Golden have higher ascorbic acid contents, exceeding the Porto Rico by 20 to 30 mg. About 10% of the breeding lines were above the level of these latter varieties in ascorbic acid, indicating that the maximum in vitamin C has not been realized in any of the varieties used commercially at the present time.

Discussion

The vitamin A content of the roots of sweet potatoes may be improved by selecting favorable mutations and by breeding. The latter method is a more positive approach to the problem of improved nutritional value in sweet potatoes and extends the probable limit for this improvement. Other desirable changes in the sweet potato—e.g., resistance to diseases—may be effected at the same time by this breeding procedure. It is expected that the varieties of the near future will show some improvement in carotene content over that for present day varieties.

At this time, it appears possible to raise the carotene level in this product from 50 to at least 85 mg. This conclusion is based on the performance of the parent lines represented in the present investigation. The use of available breeding lines with higher levels of carotene as parents might effect a further concentration of genes for carotene in this complex hexaploid and raise the potential for breeding for carotene content of the sweet potato. Furthermore, carotene probably does not have a direct function in the metabolic processes in the plant root, and therefore, it could be classed as an end product or storage compound. If this assumption is true, a very high concentration of carotene in the sweet potato may be obtained through breeding.

Szent-Gyorgyi (*9, 10*) first suggested that ascorbic acid might function in the respiratory metabolism of plants. Waygood (*11*) in 1950 obtained evidence to support this oxidation-reduction metabolic function. He reported that ascorbic acid functions as a carrier of molecular oxygen for the malic dehydrogenase–coenzyme I system just as for the other dehydrogenase systems. This metabolic function of ascorbic acid suggests that the potential for a further increase in this vitamin content through breeding is less than that of breeding for an increase in carotene.

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