Chemical Methods for Breeding Sugar Beets

H. W. DAHLBERG[1]

When we speak of chemical methods we, of course, include two important determinations—the determination of sugar and purity. Sugar is by far the most important single component in beets, and we believe it is of value to determine any other chemical compounds which have "a bearing on sugar content.

Our research department began using chemical methods for selection in 1931. At that time the determinations made were chiefly-total nitrogen, harmful nitrogen and ash content. Later electrical conductivity was substituted for ash determinations. Studies were made on the proportions of certain non-sugars which were eliminated in the factory process and the proportions which carried through into molasses. These studies gave us breeding lines which produced juices of somewhat higher purity than were obtainable from European seed varieties.

There are various ways of selecting for high sugar and high purity, and occasionally an unusual method of selection gives unexpected results. This is true of a selection we made in 1937, when we selected a small percentage of surviving beets from a Great Western commercial variety which had been planted in the fall in northern Colorado and subjected to very low temperatures during the winter. The main results of this selection were to give us a new variety, G.W. 201, which, compared with the parent variety, had the following characteristics:

Higher frost resistance
No loss in tonnage
An increase of 0.6 to 0.7 points in sugar content
A purity which averages slightly higher than other excellent Great Western varieties
Minimum sodium content—.023 to .035% Na—which is low for highly mineralized soils

In 1948 we began using a flame photometer in connection with selection of beets with minimum sodium content and during the past year and **a** half we have studied the sodium content of beets rather intensively. We find the same as some of the European investigators that there is a strong negative correlation between the sugar content of the root and the sodium content of the root. In a very large number of determinations on individual beets we found this negative correlation to be as high as —.830. As yet we do not know whether the sodium determination will be an important tool in selecting for higher sugar, but we have in progress an experiment which should give us valuable information on this point. At present we believe it is **a** very worth while determination, because a low sodium content not only normally indicates **a** high sugar content, but also tends to give a beet of higher purity.

[1] Director of Research, Great Western Sugar Co., Denver, Colo.

Van Ginneken found from a large number of analyses of many types of Holland beets that there were major differences in the sodium content of fodder beets and "half-sugar" beets, as compared with standard varieties of sugar beets. The former may contain two to three times as much sodium as do the improved varieties of sugar beets, and, of course, are very low in sugar content.

It seems quite probable that the white Silesian beet, the ancestor of most or all sugar beets, contained some blood lines going back to fodder beets or mangel-wurzels. It, therefore, seems logical to me that if we select beets of low sodium content we may eliminate more rapidly some of the undesirable genes originating in fodder beets. If this theory should be correct we may be able to reduce variations in sugar content by developing varieties of low sodium content.

In our research laboratory we have done a great deal of work on the pigments in sugar beet leaves, chlorophyll, xanthophylls and carotene, in the hope that thereby we might be able to select beets of high phofosynthetic efficiency. We have learned something about the relationships of the different pigments but have not been able to find large differences between varieties of varying sugar content. We believe that, at some time in the future when the chemistry of photosynthesis is more completely worked out, the analysis of leaf pigments may be of value. At present, the necessary determinations are too time-consuming, and we do not know enough about the action of the many pigments in the photosynthetic process.

At the present time we consider the following determinations to be the most useful in connection with breeding work:

Percent Sugar	**Percent Total Nitrogen**
Purity	**Percent CaO + MgO**
Percent Sodium	**Percent Ash**

The sodium content, percent on ash, should be low, and the sum of CaO + MgO, percent on ash, should be high for beets of high quality. Under our conditions of soil and climate, the figures are about as follows:

Percent on Ash

Na_2 0 — 6 to 7%
CaO + MgO — 18 to 23%

Chmical breeding methods will not come into their own until the selection material can be grown under uniform conditions of light, temperature and nutrition, such as can be obtained only when beets are grown in nutrient solutions. When beets are grown in soil the chemical constituents are too much influenced by variations in soil composition and fertility. We, therefore, during the next few years hope to grow a population of beets in nutrient solutions and make more chemical determinations for selection than we are now justified in doing.

Summary

Chemical breeding methods are considered to be of value for the purpose of securing juices of higher purity and also for the purpose of increasing sugar content. It is our belief that selection for minimum sodium content may be of some value in reducing variability of sugar content and eliminating low sugar individuals.