Respiration and Spoilage Studies Employing a Modification of Method Developed by Stout and Fort

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The advantage in minimizing the losses accruing between harvest and the processing of sugar beets is apparent. Already, much has been learned and put into practice regarding the handling and storage of beets to reduce sugar loss. In contrast, however, very little direct effort has been made to evaluate and improve the anatomical and physiological properties of the beet root which affect storage quality and which are unquestionably governed by genetic complexes not yet unified by selection except that coincident with the improvement of other characters.

A prerequisite for embarking on a breeding program for the improvement of a desired quality is the establishment of a test which will itself measure or correlate closely with the specific character or characters under study. The work of Stout and Fort provides a method which permits measurements of storage losses of individual samples held under comparable environmental conditions. This paper reports some modifications in technique and the results obtained in preliminary evaluations on storage quality of different lines of beets.

Methods and Materials

The storage quality of several varieties of sugar beets was investigated in the fall of 1949, using measurements of oxygen consumption as a criterion. The method of Stout and Fort[2] was used except for the water-oxygen displacement method used by them in feeding and measuring oxygen into the barrels. Oxygen measurements in the course of this study was read directly from a wet test gas meter. A balloon instead of a glass carboy was used for holding the 24-hour supply of oxygen for each barrel (see Figure 1). The distribution line was used for oxygen instead of water. A water trap was inserted, however, in the connection of the balloon with the barrel so that air from the barrel would not get into the balloon.

A normally open solenoid valve was used in the distribution line ahead of the meter and controlled by a mercury switch which in turn was operated by a bellows. The bellows was not used as an intake or to influence the pressure in the line, but merely to reflect the pressure in the line and to open and close the mercury switch. The mercury switch was adjusted to close when the oxygen pressure in the line equaled eight-tenths of an inch of water and to open again at six-tenths. The balloons were filled individu-

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[2] Stout, Myron. Studies on the respiration and spoilage of sugar beets. Proc. Amer. Soc. Sug. Beet Tech., 1950.

ally to the same relative pressure each morning by merely opening the inlet to the balloon and closing the outlet. The difference in meter reading at start and end of fill represented the volume of oxygen, at the existing temperature and pressure, which was drawn into the barrel during the previous 24-hour period. By calculation one can convert to absolute values taking into account atmospheric pressure changes during the period, but for a comparative ranking of the storage qualities of two or more varieties run simultaneously this is not necessary. For publication, calculations were made to absolute values from the average of readings obtained during each period of one week.

The beets for study were taken from the border rows of a single variety test. The beets used in the first test were dug, topped (by cutting off the usual portion of the crown), and washed November 1, then stored outside in burlap bags until placed in sealed drums on November 5. Beets used in the second test were dug November 2, trimmed as mother beets, washed, and placed in crates in the root storage cellar until space was available to run respiration rates. The crowns were cut off before the beets were weighed and placed in the sealed drums. The size of samples for the first test was 110 pounds and for the second test 100 pounds, all weights being accurately made. The average weight per beet exceeded two pounds.

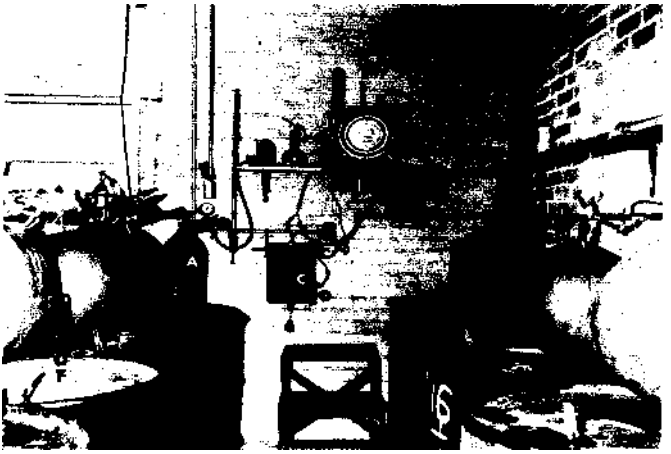

Figure 1. A—Oxygen tank and pressure-reducing valve. B—Solenoid valve. C—Bellows. D—Mercury switch. E—Gas meter. F—Water trap.

Results and Discussion

The results of the first test begun November 5, 1949, are given. in Table 1. Nine varieties and two replications were used in the first test.

Table 1.—Oxygen used by different sugar beet varieties stored six weeks at 70° F., and calculated minimum sucrose loss (mean of two samples).

Variety	O_2 at Vo used per 100 pounds beets per day (cubic feet)	O_2 used per kg. beets per hour (mg.)	Min. sucrose loss per ton per day (calc.) (pounds)
C455	.3187	11.85	.51
GW201	.3291	12.23	.52
B389	.3320	12.34	.53
GW85	.3357	12.49	.53
GW59	.3420	12.71	.54
B359	.3586	13.33	.57
C304	.3590	13.34	.57
A102	.3795	14.11	.60
A100	.4235	15.74	.67
LSD 5% pt.	.0224	....	.
LSD 1% pt.	.0299	....	

From the appearance of the daily oxygen measurements obtained early in the test it was doubted that the differences in oxygen consumption between varieties would be significant with only two replications. An analysis of variance using the variates, varieties, and replications substantiated this doubt. For the second test it was decided to run more replications and fewer varieties. Subsequently, an analysis of variance was made using the variates, replicates, weeks, and varieties, which reduced the error appreciably. Thus, this method of analysis was used for obtaining errors and calculating LSD (least significant difference) for results given in both tables. The results for the second test are given in Table 2.

Table 2.—Cubic feet of oxygen (at Vo) consumed per day by 100 pounds of beets of three varieties stored at 70° F. during the six weeks from December 21 to February 1.

Week	C455	Variety B389	GW201	Weekly Mean
1st	.3912	.4015	.4387	.4105
2nd	.3342	.3297	.3552	.3397
3rd	.3235	.3147	.3398	.3260
4th	.3358	.3217	.3443	.3339
5th	.3695	.3305	.3870	.3623
6th	.3713	.3492	.3932	.3712
Variety Mean	.3542	.3412	.3764	..
Varieties LSD—5% pt. = .0219, 1% pt. = .0290				
Weeks LSD—5% pt. = .0155, 1% pt. = .0205				

The first test (Table 1) showed highly significant differences between varieties but no significant differences between the varieties C455, GW201, and B389. Taking these three varieties and studying their rate of respiration in a second test with six replications gave results (Table 2) which show GW201 as poorer in storage quality in comparison with the other two varieties, using oxygen consumption as the criterion. That differences *in* storage

quality between varieties do exist appears to the writers to be a valid conclusion. However, the relative ranking of varieties with regard to storage, or keeping, quality might well change as further refinements in techniques are made.

Summary

A study of respiration and spoilage rates of different sugar beet varieties, lines, and individuals was initiated in the fall of 1949. By measuring oxygen consumed at daily intervals over an extended period, combined with a rating *on* the observed soundness of the beets at the end of the period, an estimation in the differential storage quality between genetically different materials was made. Also, techniques for measuring respiration rates and evaluation of storage qualities which might be sufficiently accurate and more applicable to a breeding program were under investigation.