STORING SUGARBEET ROOTS UNDER COLD WATER[1/]

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Toward the end of the processing campaign, beet roots in storage piles generally deteriorate in several ways. Freezing and thawing may render a great many tons of beets so soft that they are lost in the sluice water or in washing, or are discarded in the piling lot. The deteriorated beets may involve the additional labor of removal, by hand, on the picking table. More subtle losses occur in excessively high respiration of beets in hot spots, particularly in the early part of the season. Sprouting in the piles is common. Severe wilting of beets on the edges of the pile is common. A combination of all of these factors tends to bring a lowered percentage extraction of sugar and fewer pounds of bagged sugar per ton of beets.

If it were possible to store beet roots under water at near-freezing temperatures without gross deterioration of the roots, many of these problems might be avoided. Rapid cooling of the beets would be possible if abundant cold water were available in the late fall. Freezing and thawing might be completely avoided in the period of severe cold at the end of the processing season.

This paper reports an experiment relating to the length of time beet roots may be stored under water, together with sugar analyses on beets stored under water and those stored under almost ideal conditions in the air.

Material and Methods:

About one-half ton of each of three varieties of beets grown at East Lansing, Michigan were supplied by Dr. George Hogaboam and F. W. Snyder of the United States Department of Agriculture. Two walk-in refrigerators, located outdoors, and convenient to the plant science greenhouses, were likewise made available by them. Four 50-gallon oil drums were filled with water and placed in each refrigerator. In one refrigerator,--hereafter called "gradually cooled",--the beets were placed in water at about 60°F., and were gradually cooled to about 35°, over a period of four or five days. In the other refrigerator,--hereafter called the "cool" refrigerator,--the water was at about 37°F., when the beets were added, and, although warmed somewhat by the beets, cooled to about 35° within 24 hours.

Within each refrigerator, air was bubbled through two of the barrels for one minute each day, at the rate of about 6 liters per minute. This produced vigorous stirring and aeration. Roots of variety 1 were in barrels by themselves, while those of varieties 2 and 3 were in a barrel together, but were marked by easy identification with an indelible pencil.

1/ Journal Article No. 3169, Mich. Agr. Exp. Sta.

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There was some difficulty in maintaining a constant temperature. On two occasions after the 5-week sampling date (December 4), malfunction of the refrigerator controls permitted the water temperature to rise to 40° in the cool refrigerator.

Check samples were stored in the same rooms in heavy canvas bags, in an attempt to provide ideal storage conditions. In each case, weighed tare samples for each variety and treatment were stored dry in heavy canvas bags, or under water in mesh bags to permit measurement of weight changes in the samples, so that suitable corrections could be made when sugar percentages were subsequently run.

At intervals, samples of ten beets from each variety and treatment were taken and analyses for sugar and purity percentage were made in the sugar laboratory of the Michigan Sugar Company with the assistance and supervision of M. G. Frakes, Research Director.

On December 18, after 7 weeks of submergence, the roots in water in the gradually cooled refrigerator were discarded. In the cool refrigerator the residue of submerged beets from the 4 barrels were combined and were continued in storage under water in one barrel. Two new lots of beet roots were obtained in addition. One lot consisted of variety 1 stored in bags in the cool refrigerator from October 31 to December 18. The other lot consisted of beets that had been stored in a factory pile until December 18. About half of each lot was stored under non-aerated water, and half in heavy canvas bags. As before, losses or gains in the sample weight were determined and sugar analyses were made after 4 and 6 weeks of storage.

(Table 1 is on following page)

TABLE 1

Average sugar percentages, corrected for changes in sample weight in storage, for all varieties stored in the ways and for the periods shown, at temperatures approximating 35°F. (See text)

Storage method	Storage experiment started Oct. 31		
	Percent Sugar		
	5 wks. storage-Dec. 4	7 wks.-Dec. 18	13 wks. Jan. (28
Cool throughout			
in canvas bags (air)	15.62	15.60	15.66
in water, aerated	15.31	14.58	
in water, non-aerated	15.44	13.92	11.06
Gradually cooled			
in canvas bags (air)	15.57	16.20	
in water, aerated	13.22	12.05	
in water, non-aerated	13.24	11.68	

	Storage experiment started Dec. 18	
	4 wks.-Jan. 14	6 wks.-Jan. 28
Cool throughout		
Beets from bags		
Stored in air in bags	14.99	15.55
Stored in water	15.85	15.07
Beets from pile		
Stored in air in bags	15.85	15.75
Stored in water	16.60	15.37

Results:

In the refrigerator where beets were stored in water that was gradually cooled, fermentation was obvious in the water before the end of the cooling period. Observation of beets that were removed showed that damage to the exterior layer of the beets had occurred. When on two occasions just after the 5 weeks sampling date (Dec. 4) the water rose to 40° in the "cool" refrigerator, the odor indicated deterioration, and considerable foam formed on top of the water. Repairs to the refrigerator and new controls avoided difficulty of this sort during the rest of the experiment. But the condition of the beets in storage indicated that irreparable damage had been done by storage in water for about two days at approximately 40°. When beets were stored in continuously cold water, varying from 32-37°, no deterioration could be seen up to 5 or 6 weeks. When a beet was planted in the warm greenhouse after six weeks storage under water (Jan.28) it rotted within a week or two. The water in the barrels was sampled after 5 weeks and tested for dry matter, by evaporation to dryness. Total dry matter averaged 0.14% in the stirred, but unfiltered water. Sugar tests indicated about 0.05% sugar in the water.

At intervals, sugar analyses were made on the samples and in each case, the sugar percentages were corrected for the change in weight of the samples. In general, the samples stored in the heavy canvas bags, at about 35°F., decreased about 4% in weight while those stored in water increased as much as 7% by December 4. In the beets stored in the gradually cooled water, the uptake of water was less and, when beets deteriorated in longer storage, the sample weight decreased to about the original weight of the beets. Sound beets stored in cold water were very conspicuously firmer than those stored in the heavy canvas bags. The extreme turgidity of these beets due to excess water was noticeable even in the rasped samples weighed out for sugar analysis.

Table 1 shows the sugar percentages after various periods of storage. Values for the 3 varieties are averaged, since all behaved the same. In the experiment started on October 31, there appears to have been a slight drop in the sugar percentage in the beets stored in cool water for 5 weeks as compared with those stored in the bags at 35°. Storage for the first few days in gradually cooled water led to clearly lower sugar percentages. Storage for 7 weeks led to further losses in sugar amounting to perhaps 1%. This relatively rapid drop was probably connected with the obvious deterioration that occurred when the water was twice warmed to 40°. Aeration of the water appeared to be without effect.

The experiment was repeated on a smaller scale, using beets stored until December 18 in canvas bags, and beets stored in the factory piles. During the 4 weeks period after December 18, no loss in sugar was found as a result of storage in water, in either lot, in comparison with the beets stored in a bag. The larger sugar percentage found in the roots stored in water is attributed to sampling difficulties. In the previous experiment, the results from 3 samples were averaged, while in this case but one sample was available. From 4 to 6 weeks there appears to have been some loss of sugar in all lots, but it is doubtful if the changes can be considered significantly different for storage treatments. Small errors in correction of sugar percentages due to loss or gain in sample weights could account for these changes that approximate 0.5%.

Purity values are not included, although they were taken. Only in cases where there was obvious deterioration of the beets could consistent differences be seen.

SUMMARY AND DISCUSSION:

Sugar losses in beets stored under near-freezing water are compared with those in beets stored under almost ideal conditions, i.e., at high humidity at 35° F. At the end of 4, 5 or 6 weeks of such storage it is difficult to state positively that there was any difference in sugar content, although there was a trend toward greater loss in the storage in water. This period of storage, that is, 6 weeks after "freeze-up",--in Michigan and many other regions might be sufficient to carry beets the last 6 weeks of

the processing campaign without deterioration from freezing and thawing. It is difficult to appraise how much value this might have in commercial practice.

In any case, the idea requires further investigation. Present trials indicate that bacterial deterioration may be considerably retarded by slight treatment of the water with sulphur dioxide, etc. Trials now in progress indicate that storage in dilute brine and at controlled pH may be a definite improvement over storage in water.

A rough estimate of the volume involved is of some interest. A layer of beets one foot deep on one acre would approximate 1000 tons. To store enough beets to operate a factory for 6 weeks, slicing 4000 tons a day, would require a pond of approximately 8 acres, 20 feet deep.