Some Effects of Virus Yellows on Sugar Beet Processing Quality

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Received for publication April 13, 1959

In recent years the disease, virus yellows, has become of increasing importance to the U. S. sugar beet industry, especially in some far western sections. Considerable evidence has been accumulated, both in Europe and the United States, that infection by the yellows virus can markedly reduce yield, sucrose content, and purity of beets. Bennett, Price, and McFarlane (1) have recently reported that factors such as fertilization level, beet variety, strain of virus, and maturity of beets at the time of infection are important in determining the extent of damage to the crop. Very little is known, on the other hand, of the effects of virus yellows infection on the processing quality of beets. The work reported here was undertaken to provide some answers to the question of processing quality effects such as sedimentation and filtration rates, lime salts, color, purity, and nitrogen levels.

In the fall of 1957 we obtained from J. S. McFarlane some beets which were grown at Salinas, California, as part of the yellows resistance breeding program of the U. S. Department of Agriculture. The variety was 5554H1, which is an F_1 hybrid between two inbred lines. The beets were planted December 16, 1956, and inoculated with virus yellows on April 15, 1957. A control planting of the same variety was sprayed regularly to control the aphid vector. Spraying greatly delayed infection of these beets, but by harvest time (August 20) almost all of the beets showed symptoms of yellows. Table I shows data supplied by Dr. McFarlane on the field effects of the virus infection. Considering the high yield of 34 tons per acre, it appears that virus effects in the control beets were slight and that the two batches of beets give a fair comparison between healthy and infected beets. The differences in yield are highly significant.

The beets were processed in the small-scale processing laboratory at Albany, California, (2) after 45 days' storage at 1° C. The Olsen diffuser was operated at 70° C., draft 135, and a retention time of 45 minutes, with cossettes having an average

[1] Western Regional Research Laboratory, Albany, California, a laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

length of 14 to 18 meters per 100 g. The diffusion juice was limed and carbonated immediately in the model Dorr carbonator (3) at 80° C., using 2% lime on beets, 23 minutes retention time, and a recycle ratio of 7 to 1. Final first carbonation alkalinity was .078 and .111% CaO for the control and .089 and .110% CaO for the infected beets. The two lower

Table 1.—Effect of Virus Yellows on Beet Growth.

	Control	Inoculated	Loss %
Yield, tons/acre	34.09	21.58	36.8
Gross sugar, tons/acre	5.48	3.21	41.4
Sucrose, % on beet	16.08	14.90	7.3

Table 2.—Effect of Virus Yellows on Diffusion.

	Control	Inoculated
Beets:		
Polarization, %	18.01	16.73
Apparent purity, %	87.2	86.2
Total N, %	0.17	0.19
Pulp:		
Total N, %	0.09	0.09
Apparent purity, %	81.3	71.2
Diffusion juice:		
Apparent purity, %	93.2	92.3

Table 3.—Effect of Virus Yellows on Carbonation.

	Control	Inoculated	
1st carb.:			
Sedimentation rate	17	14	lbs./ft.² hr.
Filtration rate	107	32	
2nd carb.:			
Total N	435	560	mg./liter, 10% RDS
Color	.12	.15	O.D., 10% RDS[1]
Lime salts	.012	.014	g. CaO/100 Brix
Purity	95.4%	95.2%	pol/RDS × 100

[1] Adjusted to pH 7, optical density at 420 less optical density at 720 mμ, in Spectronic 20 spectrophotometer.

alkalinities corresponded to pH 10.15, measured at 80° C. The processing characteristics of the two samples are shown in Tables 2 and 3. Table 2 compares the two samples for the diffusion step.

Beet polarization at time of processing was higher than at harvest time, indicating that both batches dehydrated approximately 10% during storage, but the ratio of sugar contents between control and inoculated beets is the same as at harvest time. There was no spoilage apparent in the beets when they were taken out of storage. Pulp and beet purities were calculated from the equation

$$P = \frac{S}{R} \times \frac{100\text{-}R}{100\text{-}T} \times 100$$

where P = purity, %
S = beet polarization, %
R = press juice refractometric dry solids (RDS), %
T = beet dry solids, %

This purity is not comparable to the diffusion juice purity but it is a measure of the difference between the control and infected beets. The infected beets show the same non-sugar elimination during diffusion as the control, as evidenced by pulp and diffusion juice purity, even though extraction was more complete for the control beets. The infected beets show a higher total nitrogen content, and, furthermore, this increase is carried through to the diffusion juice, since the same amount of nitrogen is retained in the pulp in each case.

Equilibrium was considered to be established when conditions on the carbonation station had been constant for one hour, which is approximately 3 retention times. At this time 95% of the material in the system has been replaced. The sedimentation and filtration rates were then measured, and a sample of first carbonation juice filtrate was subjected to batch second carbonation. This was accomplished by heating the filtrate to a boil in a steam-jacketed pot, gassing for 3 minutes with CO_2 followed by boiling for 5 minutes to remove excess CO_2. The juice was filtered immediately and analyzed for sucrose, RDS, total nitrogen, color, and lime salts. Results are shown in Table 3. All data in the table are averaged from runs at pH 10.15 and at alkalinity 0.11% CaO for each sample of beets.

The most noticeable effects of yellows damage are in filtration rate, total N, and sedimentation rate. The color difference is significant but is difficult to interpret, since no information

is available on how much of the thin juice color is retained by the white sugar. The lime salts and purity differences between healthy and infected beets are not statistically significant.

In this test yellows-affected beets gave only slightly poorer thin juice, but filtration was markedly lower, as compared with the control beets. Infected beets produced more soluble nitrogen than the controls. Although changes in processing quality as a result of yellows infection were rather minor, they were all toward poorer-quality juices.

Acknowledgment

The authors are indebted to Richard Knowles, Taysir Jaouni, and Robert Patterson for assistance in the processing laboratory and to Marion Long, Henry Wright, and Earl Potter for nitrogen, solids, and reducing sugars analyses.

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