THE RATE OF PENETRATION OF SWEETOSE AND SUCROSE INTO DIFFERENT SIZED PICKLES

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THE RATE OF PENETRATION OF SUGEETOSE AND SUCROSE INTO DIFFERENT SIZED PICKLES

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INTRODUCTION AND LITERATURE REVIEW

The process of sweetening pickles is an important step in pickle making. Generally, sucrose is used for this process; however, recent work by Fabian and Pivnick (1) have shown that Sweetose may be substituted up to from 15 to 50 percent for sucrose depending upon the kind of pickles being sweetened. The resulting product will have consumer acceptance equal to pickles sweetened entirely with sucrose.

The present experiments were done to find out if the use of Sweetose for sweetening whole pickles had any advantages over sucrose in the rate of penetration, the reduction of shrinkage, or increasing the weight of the final product.

Very little work has been done on the sweetening process. It is known that when the sugar is added to the pickles there is an initial period during which water is withdrawn. This initial period is followed by a recovery period during which the pickles regain most or all of the water lost. During both periods there is a constant penetration of the sugar into the pickles until an equilibrium is reached. The decrease in the Brix reading of the liquor is due to two causes; first, the dilution of the sweet liquor by the water withdrawn from the pickles, and second,

to the penetration of the solids into the pickles.

Switzer and Fabian (2) worked with dextrose and sucrose in sweetening pickles. Several phases of their work agree closely with the result found in this experiment. They found that the rate of penetration of dextrose into the pickles was faster than that of sucrose. The time required to reach equilibrium between the pickles and the liquor was the same regardless of the initial concentration of the sugar. However, the kind of sugar had an effect on the rate of penetration of the sugar into the pickles. It required from 3 to 5 hours longer for sucrose than dextrose to penetrate the pickles. Sucrose caused more shrinkage than dextrose but the difference became less as the concentration of the sugar increased. Dextrose when mixed with sucrose reduced shrinkage. There was little difference in shrinkage of pickles sweetened with 75 percent sucrose and 25 percent dextrose and those sweetened with all sucrose. It was also found that from 36-48 hours were required for the pickles to reach equilibrium but the recovery period may continue for several weeks in the 3,000 size pickles.

Sather and Wiegand (6) tested 100 percent sucrose and a 100 percent enzyme converted corn syrup on apricots, apples, blackberries, boysenberries, loganberries, peaches, pears, prunes, raspberries, rhubarb, sweet cherries, RSP cherries, and strawberries finding little difference

in the drained weight of these fruits in the two syrups.

In the case of acid Fabian and Wadsworth (4) found that approximately 40 hours were required for acid to equalize in the pickle and the brine.

Switzer, Richardson, and Fabian (5) found that it required 24 hours to establish equilibrium between the water and the pickles when the salt was coming out of the pickles. Fabian and Fulde (3) found the size of the cucumbers, the salt concentration, and the ratio of the brine to cucumbers were factors affecting the rate of salt penetration.

EXPERIMENTAL PROCEDURE

Four hundred five grams of freshened salt stock were placed in quart mason jars and covered with 460 grams of liquor. Melted paraffin was layered over the top of the pickles and liquor. This kept the pickles completely covered with the liquor, prevented evaporation and kept the pickles submerged. The jars were also capped to prevent any loss of liquor due to evaporation. The following readings were taken: (a) Brix of the liquor, (b) The volume of the liquor, and (c) The weight of the liquor. From these data the weight of the pickles, the percent gain or loss of weight of the pickles, and the percent solids in the pickles were calculated. In this manner the rate of penetration of the sugar and the distribution of the liquor could be followed.

The experiments were run in duplicate; the jars were set up as follows:

1 and 1A. 405 grams of 15,000 size pickles and 460 grams of 50 Brix sucrose liquor.

2 and 2A. 405 grams of 15,000 size pickles and 460 grams of 50 Brix Sweetose liquor.

3 and 3A. 405 grams of 15,000 size pickles and 460 grams of 50 Brix liquor containing 15 percent

Sweetose and 85 percent sucrose.

4 and 4A. 405 grams of 3,000 size pickles and 460 grams of 50 Brix sucrose liquor.

5 and 5A. 405 grams of 3,000 size pickles and 460 grams of 50 Brix Sweetose liquor.

6 and 6A. 405 grams of 3,000 size pickles and 460 grams of 50 Brix liquor containing 15 percent Sweetose and 85 percent sucrose.

All Brix readings were taken with an Abbe' refractometer and corrected for differences in temperature. The pickles used were obtained from the H. W. Madison Company in Mason, Michigan. These pickles were in a brine of 60° salometer (16 percent salt). They were carefully sorted to obtain size 15,000 and size 3,000 pickles which are representative of the small and large sizes used to make sweet pickles. The selected pickles were freshened in flowing water until the salt was completely removed as shown by grinding them in a Waring Blendor and titration with standard silver nitrate solution using dichlorofluorescein as the indicator. The pickles were presoured to 40 grains. The sugar solutions were made up in gallon jars and carefully adjusted to 50 Brix.

DISCUSSION

The 15,000 Size Pickles

An examination of the data for 15,000 size pickles shows that whether the sweetening agent was 100 percent sucrose, 100 percent Sweetose, or 15 percent Sweetose and 85 percent sucrose there was little difference in the percent gain of weight and the percent sugar in the pickles as shown by Tables I, II, III, and Figure 3. There was no significant difference in the rate of penetration as shown by the decrease in Brix, Tables I, II, III, and Figure 1. The final percent of solids in the pickles was slightly greater when all Sweetose and when 15 percent Sweetose and 85 percent sucrose was used than when 100 percent sucrose was used, but the difference was so slight that it was within the range of experimental error (Tables I, II, III, and Figure 3).

In 15,000 size pickles that were sweetened with Sweetose and those that were sweetened with 15 percent Sweetose and 85 percent sucrose there was more liquor outside the pickles at the end of the experiment than in those that were sweetened with sucrose as shown by Tables I, II, III, and Figure 2. This indicates that the 100 percent Sweetose and 15 percent Sweetose and 85 percent sucrose removed more

water. This greater pull on the tissues of the pickle may be the reason the pickles in the 100 percent Sweetose and 15 percent Sweetose substitution for sucrose did not regain as much of the water as the 100 percent sucrose pickles.

None of the 15,000 size pickles regained as much liquor as they contained at the beginning of the experiment even though there was a gain in weight of the pickles as shown by Tables I, II, III, and Figure 2.

The 3,000 Size Pickles

A comparison of the percent solids in the pickles sweetened in each of the three liquors viz., 100 percent sucrose, 100 percent Sweetose, and 15 percent Sweetose and 85 percent sucrose, does not show any one liquor superior in rate of penetration to the other two as shown by Tables IV, V, VI, and Figure 4. There was a slight difference in the percent solids but this was within experimental error (Tables IV, V, VI, and Figure 6). The percent gain in solids was greatest in the all sucrose sweetened pickles.

A comparison of the volume of liquor in the jars showed a very great difference in the amount of liquor removed from the pickles (Tables IV, V, VI, and Figure 5). For example, at the end of 3 hours there was considerably more liquor removed from the all Sweetose sweetened pickles

than from the all sucrose sweetened pickles and several more ml removed from the 15 percent Sweetose and 85 percent sucrose sweetened pickles than from the all sucrose sweetened pickles. This indicated that this size of pickles was more severely shrunken by the Sweetose, and 15 percent Sweetose and 85 percent sucrose liquor. This may be responsible for the difference in weight at the end of the experiment. It is possible that the 15 percent Sweetose substitution exerts a greater osmotic pressure than the all sucrose liquor but there are still enough Sweetose particles to penetrate as fast as the all sucrose. The 15 percent Sweetose substitution liquor thus may have a greater shrinking effect with subsequently less recovery than either the all sucrose or all Sweetose.

The all sucrose liquor caused significantly less loss of weight, as shown by the percent gain or loss of weight column, (Tables IV, V, VI), than either of the other two liquors. The sucrose sweetened pickles also showed a gain of weight sooner than the all Sweetose or 15 percent Sweetose substitution sweetened pickles.

Comparing the Size 15,000 Pickles to Size 3,000 Pickles

It must be pointed out that there is a much greater surface area in 405 grams of 15,000 size pickles than there is in 405 grams of 3,000 size pickles. This fact accounts for many of the differences in rate of penetration and withdrawal of water.

A comparison of the decrease in Brix of the two size pickles showed a much faster rate of penetration in the 15,000 size pickles (Tables I, II, III, IV, V, VI, and Figures 1 and 4). There was a much greater surface area in the small pickles than in the large ones. However, as the Brix neared the equilibrium point the 3,000 size pickles almost overtook the 15,000 size pickles and reached equilibrium only a short time after the 15,000 size pickles.

Much more water was removed from the 3,000 size pickles and much less taken back into these pickles (Tables I, II, III, IV, V, VI, and Figures 2 and 5). Part of the inability of the 3,000 size pickles to regain as much water as the 15,000 size pickles may be attributed to the more severe pressure put on the 3,000 size pickles and the lack of elasticity of the tissues in this size as compared to the 15,000 size pickles.

There is a significant difference in the weight of the two sizes of pickles at the end of the experiment (Tables I, II, III, IV, V, VI). It must be noted that the weight of the larger pickles was distributed over a much smaller number of pickles indicating much more severe shrinkage.

The 15,000 size pickles immediately began to gain weight when the liquor was poured over them while the 3,000 size pickles showed a loss of weight for several hours even though sugar was entering the pickles (Tables I, II, III, IV, V, VI).

The final percent sugar was a little greater in the 15,000 size pickles although this difference was within experimental error (Tables I, II, III, IV, V, VI, and Figures 3 and 6). However, this difference occurred in every case.

SUMMARY

Under the conditions of these experiments:

1. There was no difference in the final weight of 15,000 size pickles sweetened with 100 percent Sweetose, 15 percent Sweetose and 85 percent sucrose, and 100 percent sucrose.

2. There was no significant difference in the rate of penetration of the liquors in the 15,000 size pickles.

3. There was less water recovered in the size 15,000 pickles sweetened with 100 percent Sweetose, and 15 percent Sweetose and 85 percent sucrose than in the 100 percent sucrose sweetened pickles.

4. There was no significant difference in the rate of penetration of the three liquors in the 3,000 size pickles.

5. There was a greater gain in weight and greater percent solids in the 3,000 size pickles sweetened with sucrose than when they were sweetened with 100 percent Sweetose, and 15 percent Sweetose and 85 percent sucrose.

6. There was more liquor removed and less liquor regained when 100 percent Sweetose, and 15 percent Sweetose and 85 percent sucrose were used than when 100 percent sucrose was used in the 3,000 size pickles.

7. Solids penetrated much more rapidly at first in

the 15,000 size pickles than in the 3,000 size pickles but the 3,000 size pickles tended to catch up and reached equilibrium only a short time after the 15,000 size pickles.

8. There was a greater gain in weight in the 15,000 size pickles than there was in the 3,000 size pickles in every case.

9. There was more liquor removed from the 3,000 size pickles than there was from the 15,000 size pickles in every case. There was less water recovered by the 3,000 size pickles than by the 15,000 size pickles.

TABLE I

RATE OF DIFFUSION OF 50° BRIX SUCROSE LIQUOR INTO 15,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	353	0	0
3	36.6	378	+ 5	30.2
6	33	382	+ 8.7	39.6
9	31.7	376	+ 9.6	42.4
12	31	370	+ 9.7	44
24	30	368	+ 10.5	46.2
31	29.8	366	+ 11.4	46.6
51	29.8	361	+ 11.4	47.1
103	29.8	359	+ 11.4	47.1
173	39.5	356	+ 11.4	47.1
336	29.6	356	+ 11.4	47.1

TABLE II

RATE OF DIFFUSION OF 50° BRIX SWEETOSE LIQUOR INTO 15,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	35.7	0	0
3	36.6	38.6	+ 5.2	30.9
6	32.2	38.1	+ 7.7	40.4
9	30.7	37.8	+ 8.5	43.7
12	30	37.4	+ 9	45.3
24	29.4	37.4	+ 9.7	46.6
31	29.4	37.2	+ 10	47
51	28.7	36.9	+ 11.1	47.8
103	29.4	37.0	+ 11.3	47.6
173	29.4	36.8	+ 11.3	47.8
336	29.4	36.8	+ 11.4	47.8

TABLE III

RATE OF DIFFUSION OF 50° BRIX 15 PERCENT SWEETOSE, 85 PERCENT SUCROSE LIQUOR INTO 15,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	354	0	0
3	35.8	380	+ 5.4	32.1
6	32.8	376	+ 8	39.5
9	31	374	+ 9.1	43.4
12	30.2	370	+ 10.3	45.8
24	29.4	370	+ 10.5	47.4
31	29.4	370	+ 11.2	48.2
51	29.4	370	+ 11.6	48.0
103	29.4	366	+ 11.4	47.8
173	29.4	366	+ 11.4	47.8
336	29.4	366	+ 11.4	48.0

TABLE IV

RATE OF DIFFUSION OF 50° BRIX SUCROSE LIQUOR INTO 3,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	353	0	0
3	38.6	422	- 6.3	19
6	35.5	442	- 4.9	25.9
9	33.4	413	- 2.8	31.6
12	32.2	403	- 1.1	34.9
24	30.4	400	+ 2.9	40.8
31	29.8	394	+ 3.1	42.2
51	29.4	388	+ 7	45.9
103	29.5	384	+ 8.1	45.7
173	29.1	374	+ 9.4	47.1
336	29.1	372	+ 8.9	47.1

TABLE V

RATE OF DIFFUSION OF 50° BRIX SWEETOSE LIQUOR INTO 3,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	357	0	0
3	38.7	476	- 7.6	18.2
6	36	432	- 7.7	23.1
9	34.1	432	- 6.3	28
12	32.7	424	- 4.8	31.8
24	30	410	- 0.4	39.8
31	29.7	402	+ 1.8	42.7
51	29	394	+ 5.2	44.6
103	29.2	390	+ 7.3	45.2
173	29	380	+ 8.4	46.8
336	29	378	+ 8.4	46.8

TABLE VI

RATE OF DIFFUSION OF 50° BRIX 15 PERCENT SWEETOSE, 85 PERCENT SUCROSE LIQUOR INTO 3,000 SIZE PICKLES

Hours	Degree Brix	Ml of liquor drained from pickles	Percent change in weight of pickles	Percent of total sugar in pickles
0	50	354	0	0
3	39.2	475	- 7.6	16.3
6	35.9	480	- 8.2	23
9	33.5	429	- 6.4	28.9
12	31	426	- 5.1	34.6
24	30.4	414	- 3.7	38.2
31	29.4	408	- 2.1	40.2
51	29.2	398	+ 1.8	42.8
103	29	389	+ 4.3	44.8
173	29	384	+ 5.7	45.6
336	29	380	+ 6.2	46.1

Legends for Figures 1 to 6

Figure 1. Rate of penetration of Sweetose, sucrose and a combination of the two sugars into 15,000 size pickles.

Figure 2. Volume of sweet liquor outside the 15,000 size pickles when sweetened with Sweetose, sucrose and a combination of the two sugars.

Figure 3. Amount of the respective sugars absorbed from a 50 degree Brix solution by 15,000 size pickles.

Figure 4. Rate of penetration of Sweetose, sucrose and a combination of the two sugars into 3,000 size pickles.

Figure 5. Volume of sweet liquor outside the 3,000 size pickles when sweetened with Sweetose, sucrose and a combination of the two sugars.

Figure 6. Amount of the respective sugars absorbed from a 50 degree Brix solution by 3,000 size pickles.

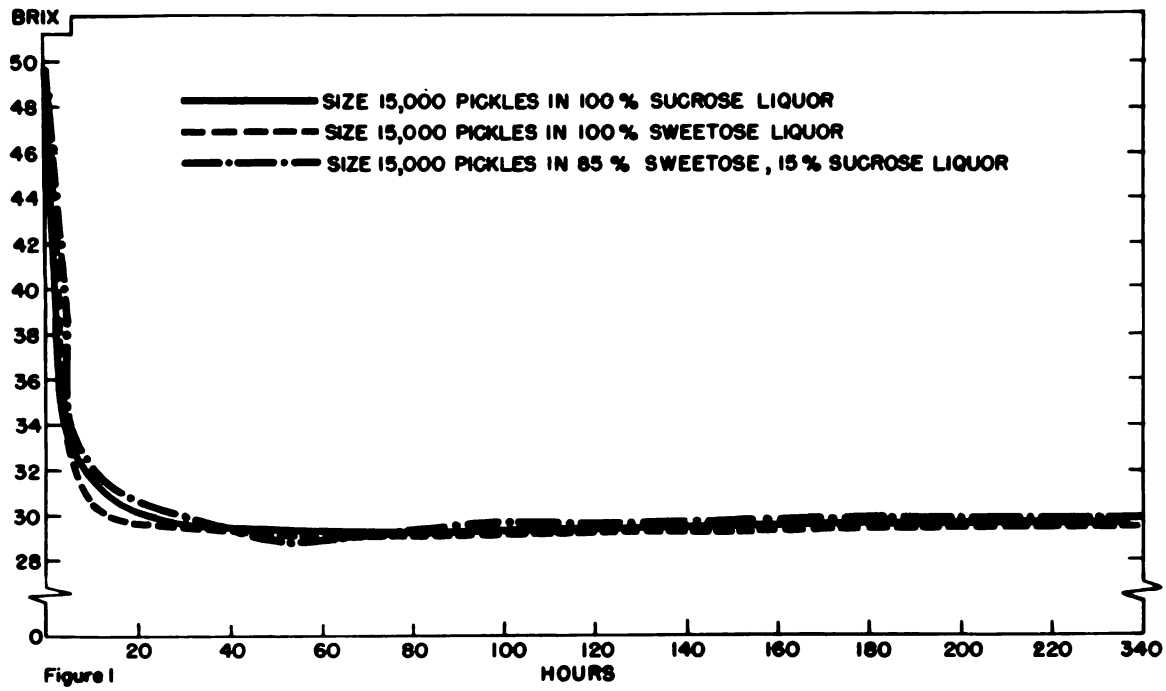

Figure 1

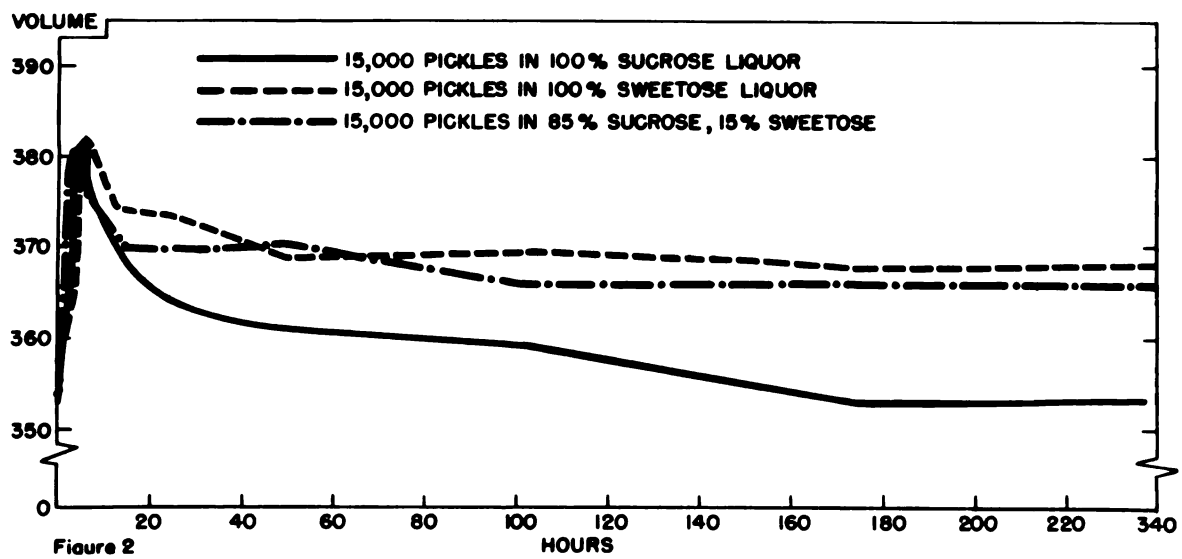

Figure 2

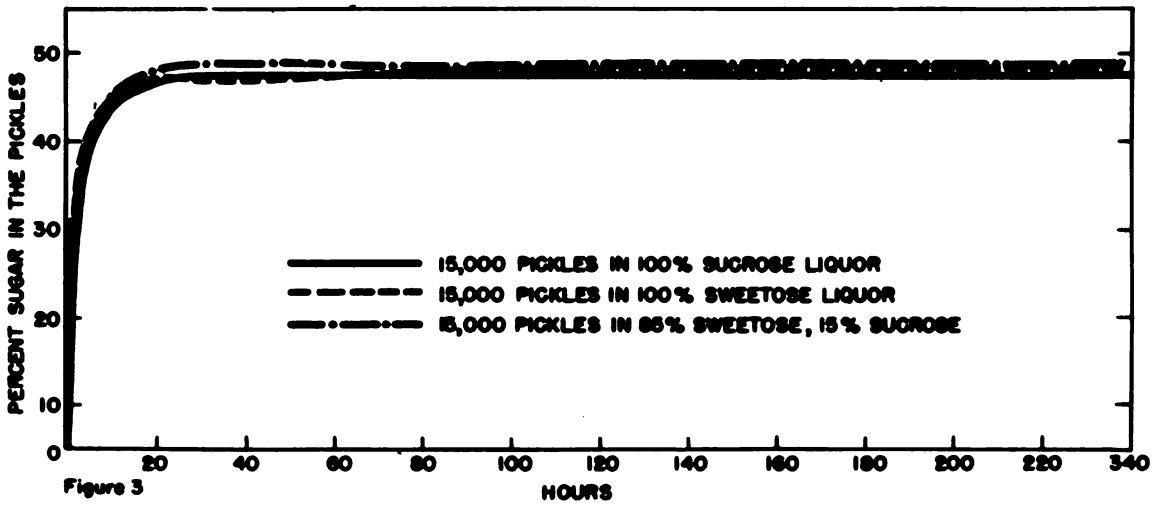

Figure 3

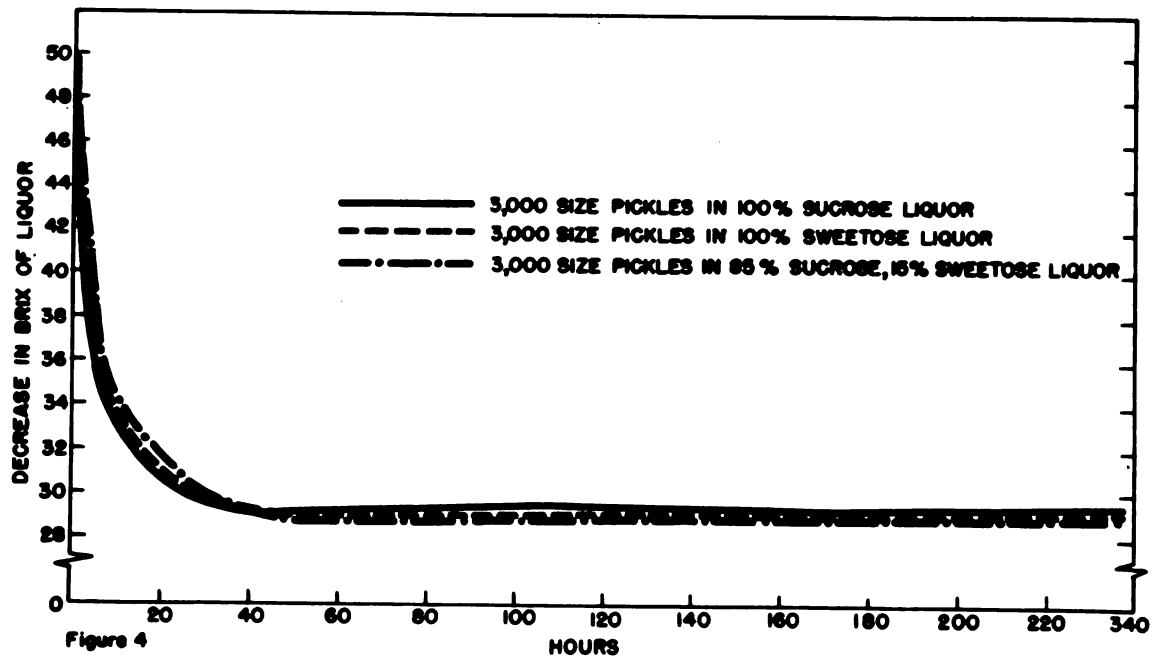

Figure 4

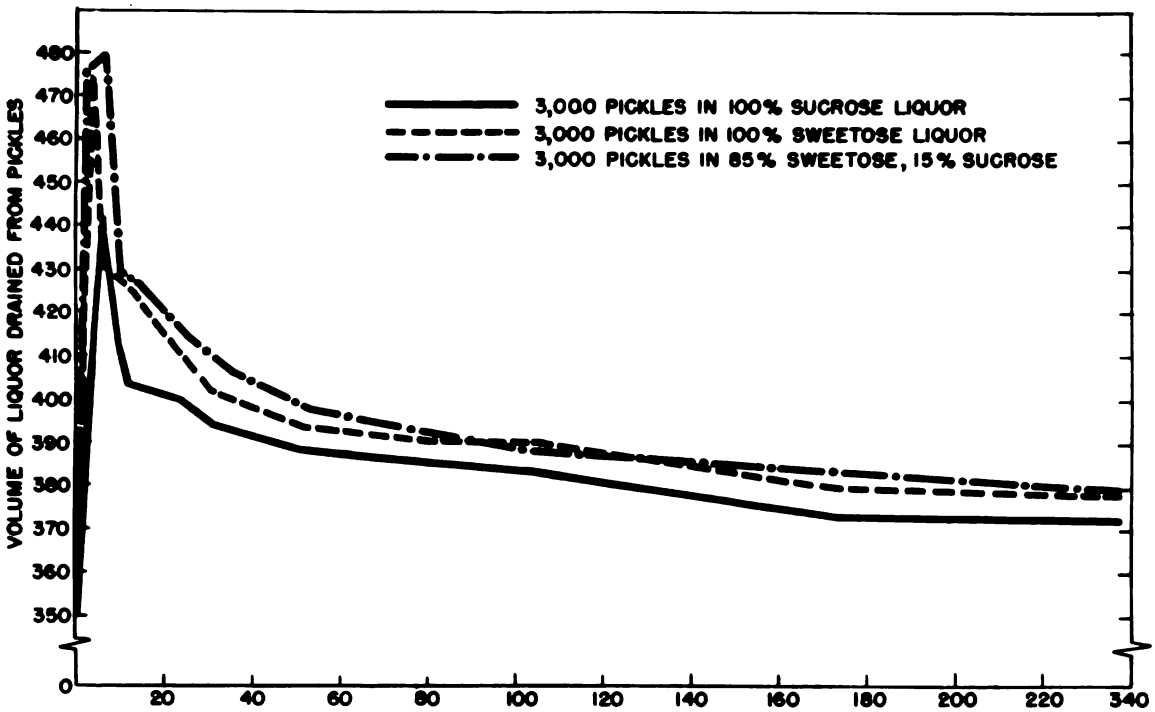

Figure 5

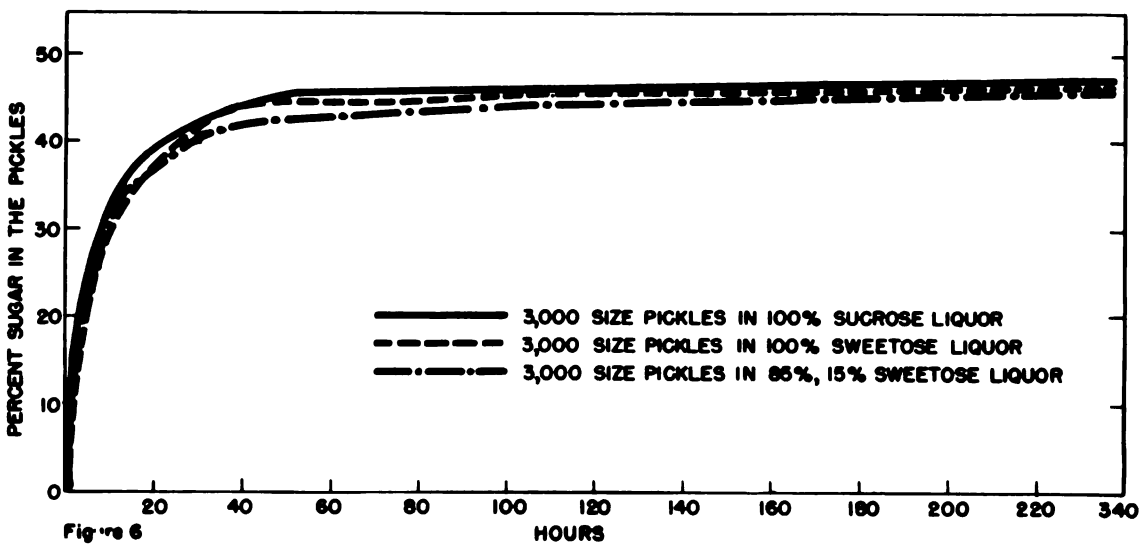

Figure 6

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