THE STORAGE OF MAPLE SYRUP

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ABSTRACT

IT IS often necessary to hold maple sirup in storage thru the summer for fall and early winter sale. Maple sirup may be held in storage without appreciable change if kept under suitable conditions.

Storage temperatures should be low to minimize darkening.

Containers should be filled hot and full in order to exclude oxygen, which will discolor sirup, and in order to prevent mold growth, which will cause off-flavors and inversion of sugar.

Maple sirup may be reheated for canning without appreciable change in character.
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INTRODUCTION

The market for maple sirup is quite seasonal as the demand is very light during the summer months.\(^1\) It is often necessary, therefore, for the producer who sells directly to the consumer to hold part of his sirup in storage thru the summer for fall sale, instead of selling it at wholesale prices. It is important that this stored sirup should not deteriorate in quality if this operation is to prove profitable. Prevention of the darkening of color is especially important.

The experiments described in this bulletin were designed to determine the factors causing darkening of maple sirup during storage so that recommendations might be made for optimum storage conditions which would prevent deterioration of quality.

SIRUP USED FOR THE EXPERIMENT

The sirup employed in the storage experiments was made from first run sap on March 11, 1945. The sap was evaporated in a 2½ × 8 foot, wood-burning Grimm evaporator, with galvanized iron pans. The finished sirup was filtered thru a felt strainer while hot, placed in clean gallon jugs with screw caps, and the jugs then inverted until cool. This maple sirup graded in color as New York No. 1 and had a very fine maple flavor.

It was stored in the sugar house until April 15, 1945, when it was removed, heated to boiling, refiltered thru a felt strainer, and poured into glass test tubes. These tubes were sealed, either with rubber stoppers or with a melted mixture of vaseline and paraffin.

STORAGE CONDITIONS

Several tubes of sirup were stored under each condition so that a fresh tube could be opened each month for study thus eliminating the necessity of resealing with change of headspace and the danger of contamination with mold. As a control for all other conditions, tubes containing 30 milliliters of sirup were sealed with the vaseline-paraffin mixture and stored in the dark at room temperature (70° to

75° F). To determine the effect of light, a similar set of tubes was exposed to diffuse daylight at the same temperature.

The influence of temperature was found by storing one set of tubes in a cold room at 34°F and another set in an incubator at 100°F.

To determine the effect of headspace, three sets of tubes sealed with rubber stoppers and containing 30, 25, and 20 milliliters of sirup, respectively, were placed with the room temperature control samples. These samples had head spaces of 6, 22, and 38 per cent, respectively. The sirup in another set of tubes was inoculated with mold from a jar of moldy sirup. These tubes were sealed with rubber stoppers and likewise stored with the controls.

Each month during the experiment (7 months) a tube of sirup was taken from each set and the contents analyzed for color, pH, and invert sugar content. The original sirup at the beginning of storage had a pH of 6.6, an invert sugar content of 0.34 per cent (wet basis), and a total sugar concentration of 66.5 per cent (hand refractometer).

METHODS OF ANALYSIS

The pH of the sirup was determined directly with a Beckmann glass electrode pH meter. At no time during the storage period was the pH of any sample found to vary significantly from that of the original sirup.

For making color measurements, 5 milliliters of sirup were diluted to 50 milliliters with distilled water, and the solution filtered thru a dry paper. The color of maple sirup was measured in a Coleman Universal spectrophotometer, and the values recorded as log $I_0/I$ at 400 m$\mu$.\(^2\)

The invert sugar was determined by the method of Munson and Walker, using a sirup solution clarified with neutral lead acetate.\(^3\) The cuprous oxide was determined by the volumetric permanganate method.

FACTORS AFFECTING STORED MAPLE SIRUP

EFFECT OF STORAGE TEMPERATURE ON COLOR

In Fig. 1 the changes in color of maple sirup during storage at different temperatures are shown graphically. The sirup stored in the

\(^2\)Io represents the amount of light passing thru water; $I$ the amount passing thru the maple sirup sample. The ratio of $I_0/I$ is known as the light absorption of the colored sample and the log $I_0/I$ is a measure which is directly proportional to the color intensity. 400m$\mu$ (millimicrons) is a convenient choice of light wavelength for sensitive measure of the brown color of maple sirup.

\(^3\)Methods of analysis of the A. O. A. C. Ed. 5. 1930. (Pages 379–381.)
cold room at 34°F showed no appreciable darkening during a period of 7 months. That stored at room temperature darkened gradually until, at the end of 7 months, the color was about 1.2 times that of the original sirup. In the case of the sirup stored in the incubator at 100°F, the darkening was much more rapid and, at the end of 7 months, it was about 1.6 times as dark as the original sirup. This would be a serious deterioration in quality. It is evident from these results that maple sirup should be stored at as low a temperature as is practical.

**EFFECT OF HEADSPACE ON COLOR**

In Fig. 2 the effects of different percentages of headspace on the color of stored maple sirup are shown graphically. It may be seen that as the percentage of headspace increases the darkening of the sirup becomes more serious. It is apparent that when maple sirup is to be stored the container should be well filled to minimize the color increase due to oxygen in the headspace.

**Fig. 1.—Effect of Storage Temperature on the Color of Maple Sirup.**
Samples were stored in sealed tubes in the dark at the temperatures indicated.

**Fig. 2.—Effect of Headspace on the Color of Stored Maple Sirup.**
Samples were stored in sealed tubes, with the headspace indicated, at room temperature in the dark.

**EFFECT OF LIGHT AND MOLD ON COLOR**

On the graph in Fig. 3 are shown the color changes of maple sirup stored in diffused daylight, and that upon which mold is growing, as compared with the control samples stored in the dark at the same temperature. It is evident that neither light nor mold causes any pronounced darkening of color of stored maple sirup.
EFFECT OF STORAGE CONDITIONS ON INVERT SUGAR CONTENT

Fig. 4 shows graphically the changes in invert sugar content of maple sirup stored under various conditions. It may be seen that temperature and headspace are negligible factors in the inversion of the sucrose in maple sirup. Mold, however, causes very serious inver-

![Fig. 3.—Effect of Light and Mold on the Color of Stored Maple Sirup.](image)

**FIG. 3.**—Effect of Light and Mold on the Color of Stored Maple Sirup. Samples were stored in sealed tubes at room temperature.

![Fig. 4.—Effect of Storage Conditions on the Invert Sugar Content of Maple Sirup.](image)

**FIG. 4.**—Effect of Storage Conditions on the Invert Sugar Content of Maple Sirup. Samples were stored in sealed tubes at room temperature.

sion which might be objectionable if the sirup were to be used for making candy or cake frostings, since invert sugar interferes with crystallization. In addition, the mold causes an objectionable off-flavor in the sirup.

EFFECT OF REHEATING ON COLOR

If maple sirup is canned while hot, it is less likely to mold or ferment as the hot sirup sterilizes the container, and on cooling the can is vacuum sealed. Mixing several runs of sirup and reheating before canning makes a more uniform product in both color and density.

An experiment was devised to study the effect of reheating on the color of maple sirup. Maple sirup was boiled in a glass flask which was equipped with a reflux condenser to prevent and change in sugar concentration during the experiment. At definite time intervals, samples were withdrawn which, after cooling, were analyzed for color and for invert sugar.
Fig. 5 shows graphically the relation between the time of boiling and the color of maple sirup. Altho maple sirup may be heated to the boiling temperature without serious darkening, extended periods of boiling cause excessive discoloration. At the end of 7 hours the color was four times as great as that of the original sirup.

Fig. 6 shows the effect of continued boiling on the invert sugar content of maple sirup. It is evident that, altho sirup may be boiled for a short time without producing serious amounts of invert sugar, the rate of inversion increases with the time of boiling. It was also noticed that at the end of 7 hours boiling the delicate maple flavor was almost completely obscured by a strong caramel flavor.

The foregoing experiment shows clearly that maple sirup may be reheated for packaging without serious deterioration of quality. It should, however, be heated rapidly and removed promptly for canning as soon as the desired temperature is attained.

**SUMMARY**

Maple sirup may be successfully held in storage if it is carefully packed and kept under suitable conditions.

The temperature of storage should be as low as is practical to mini-
mize the darkening of the sirup. A cool, dry cellar would be very suit-
able. Dampness should be avoided to prevent the rusting of tin con-
tainers. Attic or loft storage cannot be recommended as such loca-
tions are usually very hot during the summer.

Containers for stored sirup should be well filled to prevent discolor-
atation of the sirup by the oxygen in the headspace.

Sirup should be canned hot and the container tightly sealed at
once to prevent the growth of mold which causes serious inversion
of the sucrose in maple sirup.

Maple sirup may be reheated for canning without serious deteriora-
tion of quality if the heating is done rapidly. Prolonged boiling causes
pronounced darkening, some sucrose inversion, and change of flavor.