

MAPLE SAP DELIVERED TO A CENTRAL EVAPORATOR PLANT—A PROGRESS REPORT

by J. C. Kissinger*, Lloyd Sipple** and C. O. Willits*

*Eastern Utilization Research and
Development Division
Agricultural Research Service
United States Department of
Agriculture
600 East Mermaid Lane
Philadelphia, Pennsylvania, 19118

**J. L. Sipple and Son,
Bainbridge, New York

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There is essentially no information available in the literature on the microbial population of maple sap at the time it is delivered to the evaporator house. With the increased interest shown in central evaporator plants and the expansion in numbers of these facilities throughout the maple area, it is of extreme importance that this be known. Since it is well recognized that the quality of maple sirup is dependent upon the extent of fermentation which the sap has undergone and that the magnitude of microbial contamination in the sap at the time of delivery has a pronounced effect on the length of time the sap can be safely stored, the following study was undertaken.

This consisted of a preliminary survey of the effects of various methods of sap collection on the microbial population of sap at the time it is delivered to the central evaporator plant and observation of microbial growth in sap during storage and the effects of such growth on the quality of the sirup produced.

EXPERIMENTAL

The maple sap used in these studies was that delivered to a central evaporator plant by the different patrons and represented sap produced under conditions normal to commercial sap production. These included seven suppliers who collected sap in open buckets with covers; two suppliers who collected sap by means of the closed plastic sap by means of the closed plastic tubing systems; and nine suppliers who used a combination of both systems. In all cases, the sap was transferred to hauling tanks in which it was delivered to the plant.

SAP SAMPLES

Producers delivery tanks:—Samples of sap were obtained from these tanks immediately upon arrival at the plant and information was obtained relative to the approximate age of the sap.

Evaporator feed tank:—A sample was taken from this tank every 24 hours during the survey period.

The samples were taken aseptically in sterile bottles for microbiological studies. Bacteria colony counts were made on all samples using Tryptone-glucose Extract agar (Difco). (Mention of commercial products does not imply their endorsement by the U. S. Department of Agriculture over similar products not mentioned.) Yeast counts were made on the evaporator feed tank samples using Sabouraud Dextrose Agar (Difco). All plates for yeast and bacteria counts were incubated at evaporator house room temperature (85°-87°F) for 48 hours prior to counting with a Quebec Colony Counter.

All samples were examined for degrees Brix (% sugar) using a Lafayette hand refractometer and the pH of each sap sample was measured using Accutint indicator paper. Sap temperature was recorded at the time of sample.

RESULTS AND DISCUSSION

The study was made late in the sap flow season so that it occurred during a period when there was a pronounced rise in daytime temperatures. This permitted the correlation of increased sap temperatures to microbial growth and to the resulting sirup quality. During the period of this study there were sap flows on each of three successive days. The volumes of sap delivered by different suppliers, during this period, exceeded the daily production capacity of the plant so that some of the sap had to be held in storage for as long as 72 hours before it could be processed. During the three days of sap flow, the patrons collected and delivered sap once in each 24 hour period. The average age of the sap

from the time it left the tree until delivery at the plant was 18 hours. Average temperatures of the sap in the patrons' tanks at time of delivery each of three days were 38° 46° and 51°F, respectively. The Brix of the sap averaged 2.5° and the pH 6.4. The bacterial populations of sap obtained by the different collection methods are shown in Figure 1. Unfortunately, there was no delivery of sap collected by the tubing system during the sampling period on the first day. However, a comparison of bacteria counts made on sap collected from closed plastic tubing systems on the second and third days indicated that it would have been extremely low. Since the tubing is essentially emptied each day, there was little carry-over of contamination from day to day. The increase in bacteria count in tubing-gathered sap for the second and the third day, even though small could be accounted for in part by the increase in sap temperature and more particularly from contamination from sap left in hauling tanks from the preceding day.

The highest bacteria counts were those in sap collected with buckets. On the first day, the bacteria count in this material averaged 26×10^3 colonies per ml. On the second day, as the average sap temperature rose from 38°F to 46°F, the bacteria count multiplied 6 fold to 160×10^3 colonies per ml. and on the third day, when average sap temperature rose 5°F to 51°F, the bacteria count increased 12 fold to 320×10^3 per ml. Temperature increase is not the complete explanation for this large increase in bacterial population. It is well known that during a period when sap flows on successive days, it is a common practice among producers not to empty all buckets and other equipment com-

pletely or to sanitize the equipment each day. Hence, a very small amount of the sap collected on the third day was in the buckets, gathering pails or hauling tank 48 to 72 hours. This long "incubation" of bacteria in even a small amount of sap acted as inoculum and accounted for a good part of the very high bacterial populations of the sap delivered on the second and third days.

The sap collected by a combination of the two methods (buckets and tubing) had bacteria counts almost as high as those for sap collected only in buckets. These results are reasonable, since this sap was exposed to the same conditions of contamination and long storage as was the sap collected in buckets, except for the dilution by the much less contaminated sap collected in the closed tubing systems.

The sample of sap drawn from the evaporator feed tank on the first day represented sap stored for a maximum of three hours and was a composite of the sap delivered to the plant by the different patrons. The sample drawn from the feed tank on the second day represented sap which had an average storage time of 24 hours. The sample taken on the third day represented sap, some of which had been in stand-by storage over 48 hours. Stand-by storage was required because deliveries of sap had begun to exceed the plant's production capacity late on the first day of operation.

The feed tank samples were analyzed for both bacterial and yeast populations. The pH and degrees Brix values remained the same as when delivered namely 6.4 and 2.5°.

The effect of storage on bacterial and yeast populations of sap and the effect of these factors on sirup quality are shown in Figure 2. As would be expected, the bacteria colony count of the first day (3 hours storage after the sap was delivered to the plant) was low and in the same range as the counts on the delivered sap and the yeast count was even lower (1). The sample

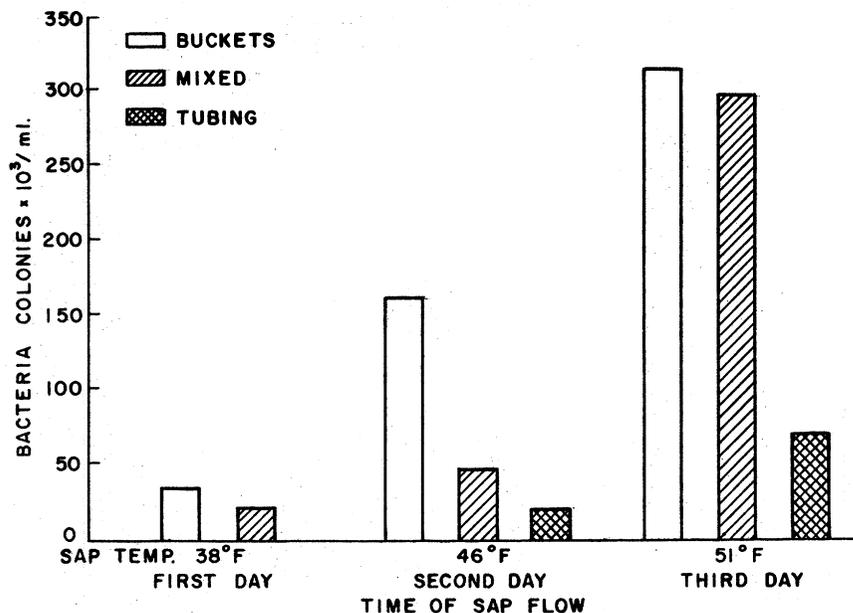


Fig. 1. Comparison of contamination level and temperature of maple sap with sap collection method.

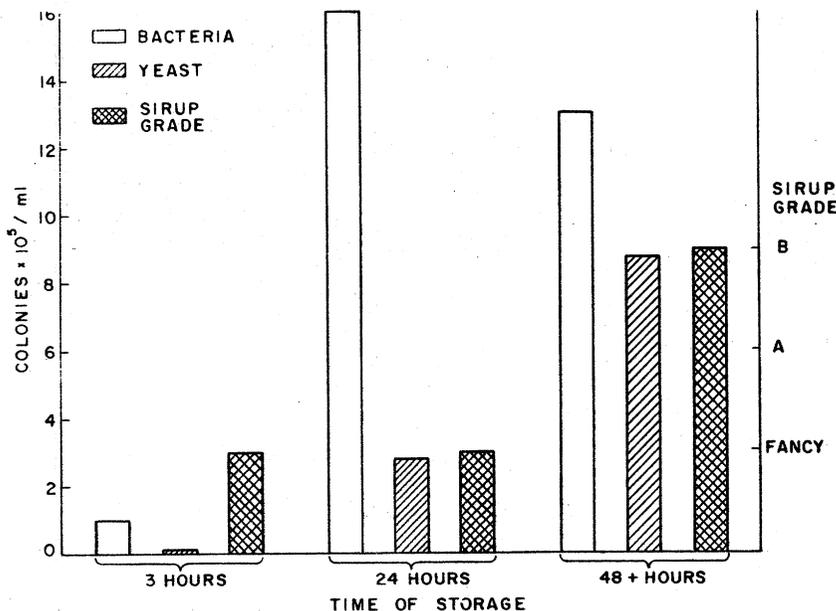


Fig. 2. The effect of microbial population and storage age of raw sap on maple sirup quality.

taken 24 hours later showed a pronounced 14-fold increase in bacteria count with an even greater (28-fold) increase in yeast count. The sample taken on the third day showed a slight decrease in bacteria count, but the yeast count increased 3-fold over that of the previous day and 87-fold over that of the first day.

The sirup made from the sap stored in the evaporator feed tank for only 3 hours (first day) was very light in color and of fancy grade. Fancy grade sirup continued to be made on through the second day from sap stored 24 hours even though the bacteria count increased 14 fold. The sirup made on the third day from sap stored in excess of 48 hours showed a pronounced increase in its color which lowered the grade level to U. S. grade B (New York number 2). Since the bacteria colony count had been slightly diminished from that of the second day, it is doubtful therefore if this darkening was caused by bacterial activity. However, the very

large increase in yeast population, between the second and third day, no doubt could be the cause of increased darkening of the sirup. This is comparable with recent laboratory observations (2) which showed that the normal sap bacteria do not attack sucrose, the natural sap sugar, to yield invert sugar which is essential to color formation, whereas it is a well established fact that yeasts do.

This preliminary study strongly indicates that yeasts and not bacteria are involved in the production of dark colored sirup; further the populations of all micro-organisms, including yeast, increase logarithmically with incubation (storage) time.

This study shows that sap, when delivered to the evaporator, cannot be stored for more than 24 hours without danger of producing a dark, low grade sirup, unless the sap is sterilized prior to storage. Therefore, both the evaporator plant

manager and the sap producers should (a) observe all sanitary precautions to prevent microbial growth in the sap (3), (b) hold the sap in storage buckets and tanks for the shortest possible time, preferably not more than 18-24 hours and (c) sanitize all equipment at frequent intervals when the air temperatures are 60°F and above.

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