Progress in Buddy Maple Sap Fermentation

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The cause of "buddy" flavor in maple sirup is not known; but since the flavor appears at the end of the sap season when maple trees come out of dormancy, this characteristic flavor has been associated with the physiological changes that occur in the trees as the buds begin to swell. "Buddy" flavor cannot be detected in sap from budding trees, but it becomes noticeable in the steam and sap concentrate during the manufacture of sirup. The occurrence of this "buddy" substance imparts a very disagreeable flavor to the sirup that makes it unpalatable and unsalable. Thus, 'buddy" flavor marks the end of the sap collection season for the maple producer and presents

1. "Buddy" sirup is unfit for sale as table sirup according to Federal and State specifications. (1)
2. Late runs of good quality sap can be lost by the sap producer who removes his sap collecting equipment in anticipation of the appearance of "buddiness."
3. Sap from only a few early leafing trees will, when mixed with a large pool of normal sap, cause its spoilage since a minute quantity of "buddy" substance added to sap is sufficient to produce a "buddy" flavor in the resulting sirup.
4. The producer or central plant operator who produces "buddy" sirup suffers a substantial economic loss.

Early warm weather during the 1955 maple season brought to the attention of sirup producers the economic losses which can result from the harvest of quantities of "buddy" sap. Sirup producers became aware of the need for a method to remove the "buddy" flavor from sap and sirup, thus salvaging materials which would otherwise be lost to them. Since 1955 the problem of salvaging "buddy" sap and sirup has been investigated at the Eastern Regional Research Laboratory of the U..S. Department of Agriculture at Philadelphia; and as a result of this work a means has been found whereby "buddy" flavor can be removed from maple sap and sirup to produce a salable product.

Investigations conducted at the Philadelphia laboratory confirmed unpublished data of the Ohio State University that normal sap contains little, if any, free amino acids, and that as the maple tree undergoes physiological changes attendant to its coming out of dormancy, these free amino acids begin to build up in the sap. It was therefore suspected by the workers at the Philadelphia laboratory that these free amino acids are implicated in the formation of "buddy" flavor. This being the case, it was reasoned that if free amino acids could be removed from sap before true maple flavor was formed in the sap evaporation (boiling) process, then the resulting sirup would be free of "buddy flavor. The simplest method by which these amino acids could be removed without altering other properties of the sap was by fermentation.

The salvaging of a "buddy" maple sap or sirup by fermentati was successfully accomplished by the Maple Investigations group of the Philadelphia laboratory. In 1956, Naghski, Reed, and Willits (2) observed that fermentation of maple sap has a marked effect on the flavor and color of the sirup. Further investigations reported by Willets, Frank and Bell (3) showed that the flavor and color of maple sirup can be enhanced by fermenting the sap with microorganisms, **Pseudomonas geniculata.** This led to the investigation of the effect of controlled fermentation with this organism on "buddy" sap and sirup. In 1961, Wasserman and Willits (4) reported the successful conversion of "buddy" maple sap into a marketable maple sirup by fermenting the sap with **Pseudomonas geniculata.** The sirup made from the fermented sap was dark amber in color and had a typical maple flavor without any "buddy" off-flavor. This fermentation was carried out on a laboratory scale, and the application of this process on a large scale remained to be done.

In 1963, a pilot scale fermentation of commercially produced "buddy" sirup was made using the equipment of a central sap evaporator plant which had received a large shipment of "buddy" sap. The "buddy" sirup was diluted, inoculated with a pure culture of **Ps. geniculata** and fermented. The fermented, diluted sirup was then evaporated to sirup in commercial equipment. The sirup produced was free of "buddy" flavor and was dark in color. Unfortunately, a contaminant was introduced which resulted in the production of a ropy sirup.

This experiment was repeated at the end of the 1965 maple sap season using the storage and evaporating facilities of a central sap evaporation plant. This experiment varied

om the previous fermentation in that sap in which "buddiness" had been detected was used rather than diluted "buddy" sirup. The "buddy" flavored sap was detected by evaporating two gallons from a suspected shipment of sap to sirup density in a candy kitchen steam kettle and tasting the product. A 3000 gallon tank mounted beside the evaporator house was used as the sap fermentor. To eliminate the danger of fermentation by adventitious microorganisms, sanitary precautions were taken at all stages of the experiment. The tank was washed and then sanitized with a 10% hypochlorite solution which was completely drained before the tank was filled with 2500 gallons of the "buddy" sap. The microbial population of the "buddy" sap was reduced to a very low count during the filling operation by pumping it through two Aquafine* ultraviolet water purification units at a rate of 8 gallons per minute. Each unit was fitted with two 30-watt germicidal lamps around which the sap flowed in a ½ inch layer. The exposure of the sap microorganisms to the actinic rays from the ultraviolet lamp resulted in the reduction of the population of these organisms to a very low level (essentially sterile). The sap was then inoculated with 6 gallons of a 48-hour sap culture of **Pseudomonas geniculata,** strain no. 4, containing 7 x 10 (5) cells per ml. The inoculum was added to the sap as it was being pumped into the tank. During the incubation period of 48 hours at 50°-60° F. (avg. daily temp.), 2-gallon samples were taken at 8 hour intervals and evaporated to sirup density in a candy kitchen steam kettle. These were taste tested for "buddy" flavor. After 48 hours incubation, the "buddy" flavor was no longer detectable in the sirup obtained from the two gallon sap samples. The 2500 gallons of fermented sap were then converted to a standard density sirup using commercial maple sap evaporators. This sirup was medium amber in color, had no detectable "buddy" flavor, and was of acceptable commercial grade.

If sirup has been made inadvertently from "buddy" sap, the salvaging of the maple sirup by the removal of the "buddy" flavor not only recovers processing costs but adds a little to exporator plant income. By the same token, conversion of "buddy" sap already harvested to a salable product converts loss to profit for the sap producer. However, it would be to the advantage of the sap producer to avoid the reprocessing of sirup by detecting "buddiness" as it first appears in the sirup and then fermenting the unprocessed sap before it has been evaporated to sirup. Since "buddiness" in sap results from physiological changes in the trees, it may occur at any time during the sap season. The production of "buddy" sap early in the sap season is not typical, but it can and does occur. Therefore, the producer should be on the alert for its presence. A quick test for the detection of "buddy" flavor in maple sirup has been developed. (5) When the "buddy" flavor is detected, the producer will have to be prepared to ferment the sap or sirup. Tanks used for fermentation must be thoroughly cleaned and sanitized. The unprocessed sap must be pasteurized or sterilized using ultraviolet light or heat (boiling); and in the case of sirup fermentation, the water used for dilution must be free of microbial contamination. If this is done, the fermentation can be carried out successfully.

The remaining problem is to develop methods for the commercial productions of the **Pseudomonas geniculata,** so that the organism can be readily available to the maple sirup producer on a day-to-day basis in such form that he will be able to recover "buddy" stored sap and sirup. The urgency of the solution to this problem is magnified by the gain in numbers of central sap evaporator plants, because these plants must obtain their sap from a large number of sap producers, some of whom may have woods conditions favorable to "buddy" sap production.

*Mention of company or trade name does not imply endorsement by the Department over others not named.

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