Maple Sirup. XX.

Conversion of "Buddy" Maple Sap into Normal Maple Sirup

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SUMMARY

Maple sirup produced from "buddy" sap has a disagreeable odor and flavor and does not meet specifications of the U. S. Department of Agriculture for maple sirup. Inoculation of buddy sap with *Pseudomonas geniculata*, strain 4, and incubation for 1 day at 23°C or 3 days at 3°C results in a sirup with typical maple flavor and no "buddy" off-flavors. Sirup made from the sap fermented with *Pseudomonas geniculata*, strain 4, is dark amber in color.

"BUDDY" MAPLE SIRUP has a characteristic unpleasant flavor that makes it unpalatable and unfit for table sirup by Federal and State specifications (Willits, 1958). The buddy sirup is made from buddy maple sap, but is not the result of improper processing. The undesirable qualities, however, are developed during the boiling and concentrating procedures since buddy sap has no particularly identifiable odor or flavor in itself.

The cause of buddy sap is not known, although several theories have been offered by maple producers. Since buddy sap usually occurs toward the end of the maple sap season, it has been suggested that (a) there is a change in the composition of the sap related to physiological changes taking place in the tree as it comes out of dormancy, a condition usually accompanied by noticeable swelling of the leaf buds, hence the term buddy sap; or (b) the change is in some way caused by the heavy growth of bacteria (Edson, 1910) that occurs when practices are not sanitary. The latter theory has been disproved. Holgate (1948) stated that buddy sap occurred even when the sap had been collected aseptically and was free of bacterial growth. There are no chemical or physical tests for buddy sap, and it cannot be detected until the sap is boiled and partially concentrated. The characteristic odor becomes noticeable in the vapor of the boiling sap.

A sugar bush may contain some maple trees that are "early leafers," i.e., they come out of dormancy before the other trees. "Early leafers" may occur because of natural variation in tree physiology, or they may be the result of different growth conditions within the bush. The "buddiness" of the sap from these trees is usually not suspected, and the sap may be pooled with large quantities of normal sap. The intensity of the characteristic buddy flavor is so great that the sap from one "buddy" tree can render worthless all the sirup from an entire bush. At other times, mild weather in mid-maple season may cause sufficient changes in all the trees to produce only buddy sap, resulting in serious economic losses.

The fixed costs of maple sirup production are covered by the early sap runs of the season. Profits from this crop are usually made from the mid- and late-season sap runs. Therefore, any treatment salvaging the buddy sap would increase the net returns of maple sirup production.

This paper describes a method of treating buddy sap to obtain a sirup that possesses the characteristic maple flavor and is free of buddy odor and flavor.

MATERIALS AND METHODS

Material. Maple sap was obtained aseptically as previously described (Naghski and Willits, 1955). The buddy condition of the sap was determined by boiling a small volume and observing the odor—and flavor when necessary. Fresh sap was used in most of the studies, but several experiments were carried out with sap collected aseptically during previous maple seasons and held frozen at −18°C in sterile one-gallon metal cans. When the frozen sap was to be used the sap was thawed at room temperature for about 18 hr. Before the cans were opened, 95% ethyl alcohol was poured on the tops and spouts and ignited, thus reducing contamination during transfer of the sap to sterile carboys.

Culture. The organism used in these studies is *Pseudomonas geniculata*, strain 4, previously described (Naghski and Willits, 1955) by this Laboratory as having strong maple-flavor-inducing properties when grown in maple sap. The organism was grown in a Brunswick fermenter, with aeration, on a medium composed of: $MgSO_4$, 0.1%; NaCl, 0.1%; KCl, 0.05%; KH_2PO_4, 0.1%; Na_2HPO_4, 0.2%; yeast extract, 0.5%; glucose, 1%. After 24 or 48 hours of growth at 22°C the cells were collected in the centrifuge and resuspended in a small quantity of sterile water.

Procedure. Eight gallons of sap were transferred to each of two 12-gallon carboys. The sap in each carboy was inoculated with a volume of the suspension of *Pseudomonas geniculata* sufficient to give an initial count of 2 or 3×10^6 organisms/ml of sap. One carboy was incubated at room temperature (about 23°C) and the other at about 3°C.

Immediately after the sap was seeded, and after 24 and 72 hours of growth at room temperature, two gallons of sap were removed and converted into maple sirup by standard procedures previously described (Naghski *et al.*, 1957). Samples from the carboy stored at 3°C were removed immediately after seeding, and after 3, 6, and 9 days of incubation, and the sample saps were immediately converted into sirup. The sirups were evaluated by an experienced taste panel.

Color of the sirups was estimated by using color standards for maple sirup established by the U. S. Department of Agriculture. The invert sugar was determined as described (Naghski *et al.*, 1955).

RESULTS AND DISCUSSION

Sirup made from buddy sap prior to fermentation with *Pseudomonas* may have varying degrees of buddiness, ranging from a mild off-flavor to a strong,

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characteristic odor that does not have to be confirmed by tasting. However, after 24 hours of incubating the sap with the organisms at room temperature, the buddy flavor can no longer be detected in the sirup made from such a sap and maple flavor is present in varying degrees. Since, normally, the temperature at which maple sap is collected is about 1–5°C, the second carboy was incubated at about 3°C to determine whether the bacterial action on the sap at this temperature would also prevent the buddy flavor from occurring in the sirup. After three days of growth, the sap was made to a sirup in which the buddy flavor was missing and maple flavor was distinguishable. These results are shown in Table 1.

The longer incubation at the lower temperature leads to greater risks of contaminating the sap, and sirups have been made that were "stringy," undoubtedly from the action of contaminating bacteria capable of producing polymerized sugars and gums.

The color of the maple sirups became darker as fermentation progressed. The unfermented saps yielded sirups lighter than light amber (U. S. fancy grade), but after 24 hours' exposure to bacterial action at room temperature, or six days at 3°C, the color of the sirups was darker than dark amber (commercial grade).

Although the dark color produced by the growth of the *Pseudomonas* reduces the economic value of the maple sirup, this process does allow the recovery, and conversion into commercial maple sirup, of buddy sap that would normally be rejected on the market (a total loss of both sap and processing costs). It is possible, therefore, to continue collecting sap after the time when buddy conditions would usually cause a shut-down of operations, thus increasing the crop from a stand of maple trees.

The mode of action of the bacteria in converting the components of buddy sap so the buddy flavor and odor are not produced is not known. However, since it has been shown that maple sap increases in nitrogen content as the season progresses, it is possible that the metabolism of this nitrogen removes the source of the undesirable components and allows the normal maple flavor to develop.

Although only *Pseudomonas geniculata,* strain 4, was used in this study, there is no reason to doubt that practically all bacteria capable of growth on maple sap with the resultant production of good maple-flavored sirup will be able to convert the buddy sap into maple sirup. However, strains of bacteria that impart off flavors and colors to maple sirup as a result of growth in normal maple sap will probably not improve the flavor of sirup by growth in the buddy sap.

Table 1. Evaluation of "buddy" maple sirups incubated with *Pseudomonas geniculata,* strain 4.

Sample	Incubation		Percent invert	Color of sirup[a]	Flavor of sirup
	Days	°C			
1	0	3	<2	<1	Buddy
2	3	3	>2 <4	2	Not buddy; some maple
3	6	3	>3 <5	>3	Maple
4	9	3	>4 <6	>3	Maple
5	0	23	<2	<1	Buddy
6	1	23	>2 <4	>3	Not buddy; some maple
7	3	23	>5 <6	>3	Maple

[a] U. S. Department of Agriculture color standards for maple sirup: 1 = light amber; 2 = medium amber; 3 = dark amber.

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