A Research Note

Fungi Associated with Pure Maple Syrup Packed at the Minimum Recommended Reheating Temperature

MARY LYNN WHALEN and MARIA FRANCA MORSELLI*

Maple Research Laboratory, Vermont Agricultural Experiment Station, Department of Botany, University of Vermont, Burlington, Vermont 05405

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ABSTRACT

In a study on container storage and syrup stability, when pure maple syrup was heated at the traditional minimum packing temperature of 82°C, 6.9% of syrups in all types of containers were surface-contaminated with a fungal mat; *Penicillium* and *Aspergillus* species predominated. Fungal growth was not found in syrups stored at 4°C for 12 months, only in syrups stored for the same length of time at 24 and 30°C. In a second container study, heating the maple syrup before packing at 93°C resulted in no detectable fungal growth. This higher-than-recommended reheating temperature successfully minimized the effect of cold ambient temperatures during syrup packing, so that the reheated syrup was hot enough to sterilize the container and the air space between syrup and cap.

Pure sugar maple syrup produced from maple sap consists predominantly of sugars (90 to 100% sucrose and 0 to 10% glucose), a detectable amount of nitrogen-containing compounds in the form of free amino acids, peptides and proteins, as well as some phenolic compounds and organic acids (8,9,16). Minerals and trace levels of vitamins also are present (3,4,8). These are all growth factors that are adequate for development and maintenance of many species of fungi and bacteria.

Since maple syrup should have a density of 66.9°Brix, at 15.5°C, set by Vermont regulation (15), the high osmotic pressure due to the concentration of sugars will inhibit bacterial growth (11). Jams and jellies rarely are contaminated with bacteria, but mold will grow on the jelly surface if the surface has been exposed to air (11) or when the container has not been sterilized. Fungi can contaminate syrup at any °Brix. However, it is generally believed by maple syrup producers that syrup contamination occurs only if it is packed at a density lower than 66.0°Brix. Mislivci (7) discussed the conditions for fungal growth. He stated that most food-invasmg species are mesophilic (8° to 35°C) and that most storage fungi are species of the genera *Aspergillus* and *Penicillium.* Another source of contamination can be heat-resistant spores (10). Murdock (10) stated that certain types of fungal spores can even survive 1 or 2 min at 93°C.

Traditionally maple syrup is packed at the "draw off" temperature of 99° to 103°C directly from the evaporator or the finishing pan; or, after storage, it is reheated to a minimum temperature of 82°C (6,16) and is packed immediately upon reaching that temperature. But syrup will cool somewhat upon dispensing. Once filled, the container is inverted or laid on its side to allow the syrup to sterilize the head space and closure. Bacterial or fungal contamination resulting from non-sterilization of the container may affect the syrup chemistry, hence the syrup color and/or flavor change (5) and possible toxicity due to mycotoxins may intervene (2).

This study identifies some organisms that were isolated from maple syrup packed at the minimum reheating temperature of 82°C.

MATERIALS AND METHODS

Syrup

In packing the maple syrup as part of a container storage and syrup stability study (14), we used one batch of US Grade A Light Amber syrup, previously graded as US Grade AA. The syrup was heated to 82°C in a vat in a commercial maple syrup packing plant. The pint-size containers were hot-packed with an automatic filling machine, capped immediately after filling with the aid of an electric screwcapping tool, and placed on their sides to pasteurize the closure and the headspace (14). The containers were then immediately stored in three temperature-controlled environments for 3, 6, 9, and 12-month intervals at 4, 24, and 30°C. As part of a second study (9), three grades of syrup (US Light, Medium and Dark Amber) were heated to 93°C before packing. Containers were filled and sealed exactly as in the first study, and stored for 3, 6, and 9-month intervals at 6 and 25°C.

Fungal and bacterial analysis

Any "fungal mat" found on the surface of the syrup was aseptically removed and divided into fourths. Each segment was initially plated on Rose Bengal Agar (BBL) and Sabouraud Maltose Agar (BBL) for fungi; and Trypticase Soy Agar (BBL) and Eosin Methylene Blue Agar (BBL) for bacteria. One ml of the source syrup was placed over the mat on each medium and allowed to be absorbed for 1 h. The upright plates then were incubated for 14 d at 27°C in the dark for fungi; and plates were inverted for 7 d at 27°C in the dark for bacteria. Following initial growth, fungal isolates were transferred to Czapek Dox Agar

Results and Discussion

When syrup was reheated at 82°C before packing, 6.9% of the containers used in the first study had a “fungal mat” clearly visible at the surface of the syrup. We recovered 25 isolates representing four fungal genera (Table 1). Fungi were found equally distributed in syrups stored at 24 and 30°C, and never when stored at 4°C. We did not find bacterial growth in any syrup.

Table 1. Fungi identified from contaminated syrup samples packed at the minimum recommended reheating temperature (82°C). Fungi are presented in decreasing order of occurrence.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of colonies recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillium notatum</td>
<td>6</td>
</tr>
<tr>
<td>Aspergillus niger</td>
<td>5</td>
</tr>
<tr>
<td>Aspergillus ochraceus</td>
<td>4</td>
</tr>
<tr>
<td>Penicillium chrysogenum</td>
<td>4</td>
</tr>
<tr>
<td>Candida sp.</td>
<td>2</td>
</tr>
<tr>
<td>Yeast</td>
<td>2</td>
</tr>
<tr>
<td>Aspergillus repens</td>
<td>1</td>
</tr>
<tr>
<td>Penicillium citrinum</td>
<td>1</td>
</tr>
</tbody>
</table>

Of the containers used in the second study, where syrup was reheated at 93°C before packing, no bacteria or “fungal mat” were found.

In conclusion, pure maple syrup should be packed hot at a temperature above 82°C, which is the current recommended reheating temperature, and syrup should be kept in cool storage (9) before sale, and refrigerated after purchase even if unopened. Our study indicates that reheating syrup to a temperature of 93°C will achieve the desired degree of sterility, assuming that syrup will cool during dispensing into containers. Direct packing at the “draw off” temperature of 99 to 103°C assures full sterility.

Also, we recommend further study on the possible damage to pure maple syrup by mycotoxin-producing fungi.

References