Mold in Maple Syrup

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Mold is a serious concern in maple syrup production. Any attempt to sell maple syrup contaminated with mold is prohibited in the U.S. Fortunately, mold growth can be prevented through proper production and packaging practices.

What is it?

Molds are fungi that can grow on a wide variety of foods and beverages, including maple syrup. They exist in and on food products as spores until conditions are favorable for growth. One study identified twenty-three genera of fungi in maple syrup samples including the mold genera *Eurotium, Penicillium, Aspergillus, Wallemia,* and *Cladosporium* (Frasz and Miller, 2015). In another report, *Penicillium* and *Aspergillus* were reported as the predominate fungal genera in maple syrups (Whalen and Morselli, 1984).

Some molds can cause product discoloration or off-flavors, while others can impact human health by causing allergic reactions or by releasing mycotoxins, which can cause a variety of serious adverse health effects. While no recalls or reports of illness have been reported for mold in maple syrup, some of the genera of mold found in maple syrup are known to produce mycotoxins (Bhunia, 2018). With the ever-evolving nature of microorganisms, it is essential that mold growth be controlled to protect the quality and safety of maple syrup.

Why does it develop?

Mold spores exist in both properly and improperly packaged maple syrups (Fiore, 2020). However, the spores will not germinate and grow until they are exposed to oxygen and sufficient moisture.

A combination of factors contribute to mold growth. In general, mold spores can germinate and grow when:

- Water is available for microbial growth, which correlates with syrup density being below 66 °Brix
- Food grade containers are unclean or improperly sealed
- Syrup is hot-packed below 180 °F

Maple syrup must contain a minimum of 66 % soluble solids (66 °Brix) according to the Food and Drug Administration (FDA; Maple sirup, 1993). At 66 °Brix, the water available for microorganisms, referred to as water activity, is low enough (≤ 0.85; Frasz and Miller, 2015) to inhibit growth of all pathogenic bacteria (Sperber and Doyle, 2009). However, yeasts and molds can still grow at this water activity (Beuchat, 1983) unless the syrup is properly packaged and pasteurized.

If the syrup density is below 66 °Brix, syrup will ferment or mold irrespective of pasteurization. Ensuring a minimum density of 66 °Brix will both prevent mold growth in unopened syrup and meet the requirements of the law.

Current Good Manufacturing Practices require that all foods be packaged in clean, sanitary containers (Part 117, 2015). Unclean containers can introduce biological, chemical, or physical hazards deeming the syrup unsafe for consumers. Mold spores are a biological hazard known to survive on packaging materials (Siroli e t al., 2017). Cleaning and sanitizing containers can reduce the abundance of molds (Dagnas and Membré, 2013) and subsequently slow the growth of mold in opened syrup. Clean containers with a water rinse or detergent to ensure any foreign objects, such as glass, plastic, dust, or insects are removed. If using a detergent, rinse the containers with water to prevent a detergent residue. Sanitize with a disinfectant to eliminate or reduce biological hazards that may produce mycotoxins or deteriorate syrup quality. Allow containers to air dry fully before hot-filling with maple syrup.

Hot-filling or hot-packing maple syrup is a required practice in the maple syrup industry. This is a process in which syrup is heated to a minimum of 180 °F to kill all pathogenic and spoilage microorganisms. The syrup is then packaged in food grade containers capable of withstanding high temperatures, such as stainless steel, glass, and high-density polyethylene (HDPE), or other food grade containers that can withstand fill temperatures above 180 °F.

Immediately after filling, syrup containers should be capped and inverted to pasteurize the container. Pasteurization is the process of killing all pathogenic and spoilage microorganisms; it does not kill spores or eliminate toxins. To kill germinated fungi and spoilage bacteria, invert containers for several minutes (Sperber and Doyle 2009).

How can mold be prevented?

- Check that the syrup contains between 66 to 68.9 °Brix at room temperature.
- Use cleaned and sanitized food grade, hot-fill containers with an airtight, hermetically sealed lid that prevents air exchange and leaks.
- If reheating syrup, heat it to a minimum of 180 °F (ideally 185 to 200 °F) before bottling.
- Cap and invert filled syrup bottles while syrup is at or above 180 °F. Invert containers for several minutes.
- Inform consumers to refrigerate syrup after opening.

How can moldy syrup be handled?

Moldy syrup must be discarded. Attempting to fix syrup by removing the mold, boiling, and repackaging is considered adulteration (21 U.S.C 342). According to section 402(a)(4) of the Food, Drug, and Cosmetic Act a food is adulterated:

> (3) if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food; or (4) if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health. (21 U.S.C 342)

Section 402 (b) states that a food is also considered adulterated if, "damage or inferiority has been concealed in any manner" (21 U.S.C. 342).

Attempting to sell or introduce adulterated syrup into interstate commerce is prohibited, according to section 301(a) of the Food, Drug, and Cosmetic Act (21 U.S.C. 331). Furthermore, customers should not be advised to skim mold off the top and re-boil contaminated syrup, but rather, to throw it away, and to refrigerate new syrup after opening (Hopkins et al., 2014).

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