Research: Value-added

Producing Intense Flavored Maple Sugar Through Vacuum Boiling

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Maple sugar has many potential applications. One challenge to the expanded use of maple sugar in multi-ingredient confections is the mild flavor profile of sugar produced with the traditional recipe. Using an alternative vacuum-cooking method, intense flavored maple sugar can be produced from high-invert, dark syrup. Cooking under vacuum lowers the boiling point which allows syrup to be cooked to a very high density while preserving flavor and avoiding scorching. Trials conducted using this method produced sugar with a strong flavor that remained detectable and added maple character in a variety of foods and beverages.

Traditional maple sugar is produced by cooking maple syrup to 45° to 50° Fahrenheit over the boiling point of water, then stirring once the syrup cools to 200° F. Cooking to this high temperature creates a supersaturated solution wherein the syrup contains more dissolved sugar molecules than it can hold in a stable state. Stirring the syrup provides a nucleation-inducing shock that initiates a rapid crystallization process in which the sugar molecules bond to form stable crystals. For this traditional process to work, syrup must contain less than 2% invert sugars. The presence of glucose and fructose at levels higher than 2% may prevent crystallization and result in a failed batch. These low invert levels are typically limited to golden and amber syrups which yields sugar with mild flavor.

As an alternative, intense flavored maple sugar can be made from high invert dark syrup by carefully cooking it to 295° to 305° F, then cooling it to form an amorphous solid or hard candy. This solid can then be ground into a sugar and sifted into different size classes. Two drawbacks of this method are the possibility of scorching, and potentially creating flavors that are too intense for some applications due to the high finishing temperature.

Vacuum cooking is an approach that creates strong flavored sugar from dark syrup while avoiding these pitfalls. Vacuum cooking works because liquids boil at lower temperatures in a vacuum. Atmospheric pressure influences boiling point by acting like a heavy blanket on top of a liquid. In order to boil away water, each molecule needs enough heat energy to fight its way through the blanket. In a vacuum, the weight of the atmospheric blanket is reduced so water molecules need less energy to escape the syrup. Therefore, the boiling point of a liquid is lower in a vacuum.

To test this process, we constructed a system capable of boiling syrup under 24 inches Hg of vacuum. Under these conditions, the boiling point of water is 140° F (Figure 1). Without vacuum our target finishing temperature for amor-

Sugar: continued on page 28

Sugar: continued from page 27

phous sugar was 305° F which is 93° above the boiling point of water. With a target of 93° F above the boiling point of water under 24 inches of vacuum, the finishing temperature is adjusted to 233° F. This temperature is well below the scorch point and causes less caramelization.

To process syrup in this manner, a heat resistant vacuum vessel was needed. In our experiment we used a specialized steel chamber that resembled a heavy pot with a thick acrylic cover. The lid was fitted with a vacuum inlet, vacuum gauge, temperature gauge, and a valved release vent.

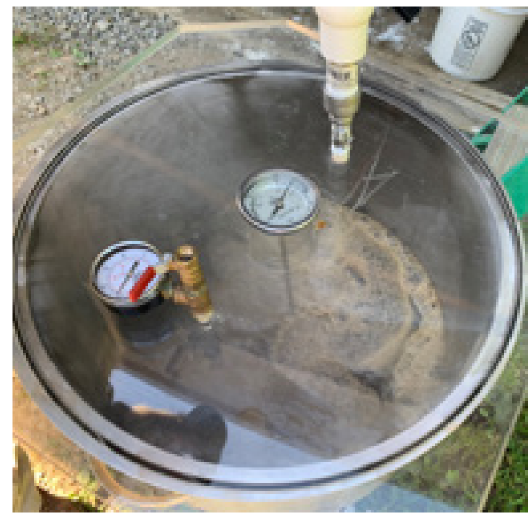
The next requirement was a vacuum system with a moisture trap capable of collecting and condensing steam to avoid damaging the vacuum pump. For our experiment, we connected a supply line to the releaser of a sap collection vacuum. This 60 cfm pump was capable of maintaining 24 inches of vacuum while the releaser fitted with two moisture traps protected the pump from condensed steam. The final requirement was a controllable heat source. We used a small propane burner designed for use with a finishing pan.

Vacuum (in Hg)	0	5	9	16	21	24	26	28	29
Boiling Point (°F)	212	205	194	176	158	140	122	104	80

Figure 1. Boiling point adjustments under vacuum

Once the equipment was assembled, cooking the syrup was straightforward. The temperature was continuously monitored to maintain a boil without allowing foam to overflow into the vacuum port.

A small amount of granulated defoamer was added once early in the boil by sprinkling it in the vacuum release valve, then gently opening the valve to draw the defoamer into the cooking vessel. The valve was opened very slowly to avoid splashing syrup on the lid.



Vacuum boiling vessel

Our total cook time for three gallons of 5% invert dark syrup was about two hours. After reaching the desired finishing temperature, the syrup was poured into shallow greased pans and allowed to cool for several hours. The cooled hard candy was then ground with a grain grinder and sifted through a sieve shaker with a mixture of sieve sizes.

The flavor of our experimental batch was a strong, classic maple flavor, much more intense than the flavor of maple sugar produced through the traditional crystallization method. Trial batches of recipes utilizing this sugar have shown a notable boost in maple flavor in the finished product. So far, sugars made from high invert syrups have been used in beer, chocolate, cotton candy and coffee sweetener. Other potential applications include general baking use and ice cream topping.

Importantly, the physical properties of this sugar are somewhat different. As a non-crystalline solid, the particles are more likely to attract water molecules. Therefore, storage in a sealed container with the air removed is needed to prevent caking and clumping. Finer particles will attract water and become sticky more quickly, while larger particles may stay clump free for months in a simple zip lock bag. Further research is needed to improve shelf stability.

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