Buddy Maple Syrup in Value-Added Products

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Overview of Buddy Maple Syrup and its Potential Uses

Sap harvested from maple trees late in the sugaring season or spring of each year is known to develop off-flavors during syrup production. These changes can appear as a subtle mocha flavor, described by maple producers as resembling a Tootsie Roll, and develop into more prominent metallic and sulfur flavors. This range of late season flavors is referred to as "buddy" and is considered an off-flavor defect according to the United States Standards for Grades of Maple Syrup. This means that buddy syrup may not be bottled and sold as "Grade A" maple syrup and can only be sold in bulk as a "Processing Grade" food ingredient (USDA, 2015). However, buddy maple syrup can still be used to produce a range of maple products that either mask buddy flavors or undergo processing methods that reduce or remove buddy flavor defects. This article reviews the composition of buddy maple syrup and contains overviews of production procedures for a selection of value-added products, including beer, wine for distillation, root beer, and mustard.

Production of mustard (A), beer (B), and wine (C) with buddy maple syrup.

Chemical Composition of Buddy Maple Syrup

Buddy maple syrup off-flavors develop at the end of the sap flow season as maple trees break from dormancy. During this period, multiple compositional changes occur, as reported in a composition analysis of Québec Grade A and buddy maple syrups (Decabooter et al., 2023) and of New York maple syrup samples. In comparison with Grade A samples, buddy maple syrups contained lower total phenolics (antioxidants) and sucrose, and higher levels of glucose and fructose (invert sugars) and minerals (Table 1; Decabooter et al., 2023).

Table 1. Composition of Grade A and buddy maple syrup samples from New York state and Québec.

Analysis	New York Grade A Dark[1]		Québec Grade A Dark[2]		New York Buddy[1]		Québec Buddy-1[2]		Québec Buddy-2[2]	
	Average	SD[3]	Average	SD	Average	SD	Average	SD	Average	SD
°Brix	67.0	0.0	66.3	0.0	67.4	1.0	65.5	0.0	65.2	0.0
Total Phenolics (µg/g)[4]	<200	0.0	230.89	1.3	<200	0.0	133.13	3.8	149.38	11.5
Sugars (mg/g)[5]										
Sucrose	ND[6]	ND	678.9	5.2	ND	ND	522.1	3.7	382.3	4.2
Glucose	ND	ND	8.9	1.0	ND	ND	23.0	1.3	57.4	2.2
Fructose	ND	ND	4.9	0.1	ND	ND	20.1	1.5	31.2	1.7
Minerals (µg/g)[7]										
Calcium	1120.0	0.0	1144.9	235.9	1573.3	293.0	1271.6	32.2	1215.9	57.1
Iron	2.5	0.0	10.6	4.0	2.5	0.0	4.7	0.7	9.5	1.5
Potassium	2640.0	0.0	522.3	153.0	2960.0	121.2	420.3	77.7	456.3	148.2
Magnesium	176.0	0.0	230.9	30.8	223.0	55.1	207.2	20.7	218.1	28.3
Manganese	9.3	0.0	12.1	5.8	30.8	24.3	12.8	3.5	13.5	4.8
Sodium	25.0	0.0	551.4	144.3	25.0	0.0	487.6	118.2	538.5	144.2
Phosphorus	8.3	0.0	363.5	607.1	13.4	2.3	12.7	0.7	343.7	5.2
Zinc	4.6	0.0	16.2	12.6	5.3	0.7	24.0	1.1	22.2	2.3

[1]Data collected at the Arnot Forest Sugarbush (Van Etten, NY); [2]Data from Decabooter et al., 2023; [3]SD = Standard Deviation from the Average; [4]Folin-Ciocalteu assay; [5]Liquid Chromatography; [6]ND = No Data; [7]Atomic emission assay ICP-OES.

Phenolic compounds are the primary antioxidants in maple syrup and are known for their bitter taste (Drewnowski and Gomez-Carneros, 2000) and health benefits (Ozcan et al., 2014). The total phenolics in syrup can differ based on tree physiology, soil type, geographic location, environmental stresses, weather conditions, and microbial contaminants (Lagacé et al., 2015).

Sucrose was the most abundant sugar in all maple syrup samples, with invert sugars accounting for 1.99% of total sugars in Grade A syrups and 7.6 to 18.8% of total sugars in buddy maple syrups (Table 1). The types of sugars in maple syrup can impact the quality of food products, particularly confections. The invert sugars, glucose and fructose, act as sugar crystal inhibitors and can lead to stickiness in some food products, particularly confections where sugar is a primary ingredient.

The most abundant minerals among the New York maple syrup samples were potassium, calcium, and magnesium, while calcium, sodium, and potassium were most abundant in

Québec samples (Table 1). In a larger study of Québec maple syrups, the most abundant minerals were potassium, calcium, and magnesium, respectively (PPAQ, 2018). While regional variations among minerals are known to occur, potassium and calcium are consistently prevalent minerals in maple syrups in the United States and Canada (Nimalaratne et al., 2020).

In New York samples, all minerals except iron and sodium were more abundant in buddy samples than in Grade A samples. In Québec samples, only calcium, magnesium and zinc concentrations were higher in buddy samples (Table 1). It is understood that mineral abundance increases as the sap harvesting season progresses (Nimalaratne et al., 2020). Higher mineral concentrations may contribute to the off-flavors detected in buddy syrup, although this has not been evaluated to date. For example, calcium was reported to have bitter, metallic, and astringent flavors (Lawless et al., 2003; Lim and Lawless, 2005), and magnesium presents astringent, metallic, and sour flavors (Lawless et al., 2003).

Investigations are currently underway to more fully understand the development and complexity of late season composition and flavors. At present, it is well established that there is an increase in concentration of select amino acids as maple trees break from dormancy; these amino acids undergo subsequent reactions to form volatile sulfur compounds (Camara et al., 2019; Zhang and Ho, 1991) that are volatile at room temperature and may be responsible for the buddy off-flavors (Camara et al., 2019; N'guyen et al., 2018).

Sensory Profile of Buddy Maple Syrup

In formal evaluations, buddy syrup samples were shown to have a variety of flavors, as the compounds associated with buddy flavor are thought to be more complex than the amino acids associated with buddy maple syrup. To understand this grade of maple syrup, the Cornell Maple Program partnered with the Cornell Sensory Evaluation Center (CSEC) to develop a buddy maple syrup flavor wheel (Stelick, 2021) with Grade A maple syrup flavor wheels as references (University of Vermont, n.d.; Government of Canada, 2021). The flavor wheel (Fig. 1) consists of terms to describe flavor and mouthfeel, with the center of the wheel containing broad flavor categories, and the outermost ring representing the specific flavor descriptors within each category. This standardized sensory vocabulary was designed to define the many potential flavors of buddy maple syrup and could be used to describe and differentiate the different buddy products. The gaps in the flavor wheel are intentional and can allow a direct comparison of buddy syrup terms with those in a previously established flavor wheel (Government of Canada, 2021).

Figure 1. Buddy maple syrup flavor and mouthfeel lexicon illustrating key flavor categories and descriptive terms.

Unlike Grade A maple syrup flavor that is dominated by sweet taste and maple, vanilla, woody, and smokey flavor notes (Fig. 2a), buddy maple syrups contain a mixture of flavor attributes from butter or mocha flavors to prominent metallic or sulfur flavors. The most frequent terms used to describe buddy syrup were bitter, sour, and sweet taste with metallic, butter, coffee, fruity, floral, and astringent notes, according to the CSEC (Fig. 2b). Flavor characteristics varied among individual syrups (Stelick, 2021), possibly due to the level of amino acids in the sap, sap storage and processing conditions, among other factors.

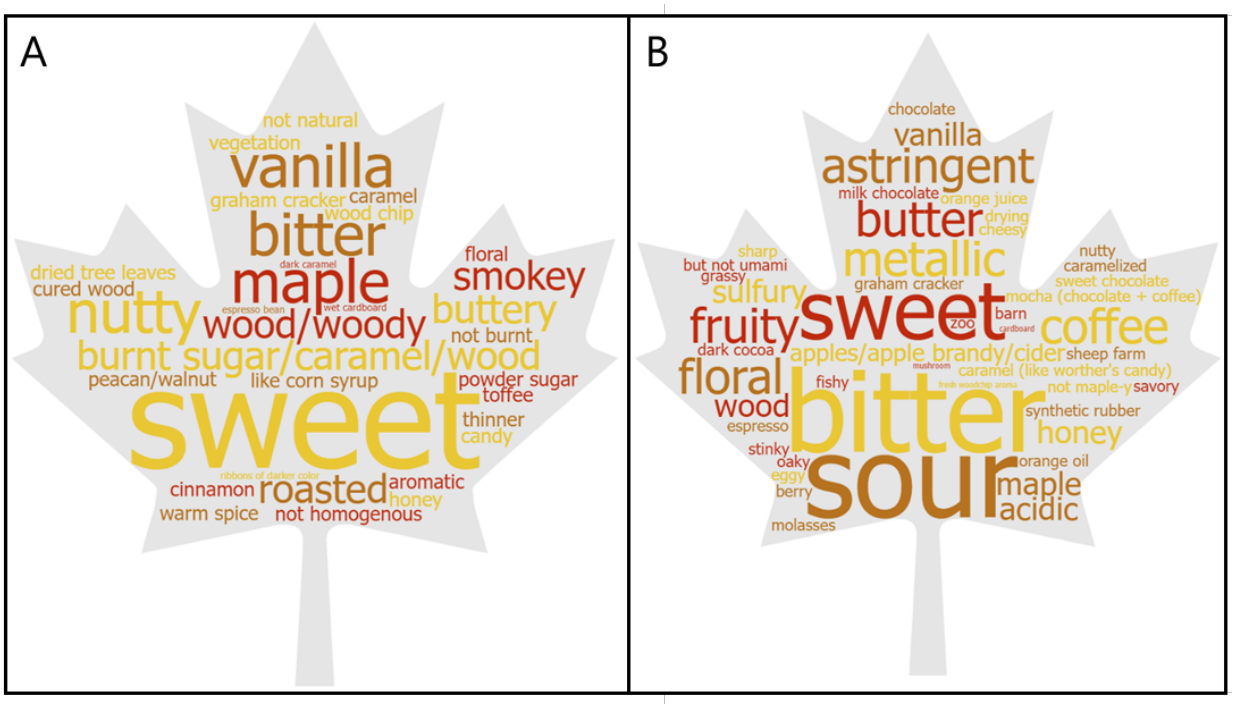

Figure 2. Differences between (a) Grade A and (b) Buddy maple syrup sample descriptors (Stelick, 2021). Size of text represents the frequency of the descriptor use.

Characterizing the flavors of buddy syrups can ensure that proper syrups are chosen for value-added products or processing grade sales. Additional research is underway at CSEC to determine consumer acceptance of buddy syrup with different flavor profiles.

Value-Added Products and Production Overviews

Buddy maple syrup flavors are complex and their interactions with other ingredients is not fully understood. Multiple preliminary trials were conducted to assess the practicality of producing value-added products with this syrup. Following pilot trials and in-house sensory evaluations, it was found that the buddy syrup flavor was not perceived in fully fermented products (beer and distilled spirits), was detected slightly in intensely flavored products (freshly dispensed root beer and mustard), and was notably perceived in infused syrups and delicately flavored confections.

Below are overviews of production methods for a selection of value-added products with slight to no buddy flavors perceived. It is expected that other fermented products, such as vinegar and kombucha (Clyne, 2019), and intensely flavored products, such as sauces and vinaigrettes, can be produced using this type of syrup. The characteristic flavors found in buddy maple syrups (Fig. 2b) can be used to identify potential product pairings. For example, the bitter flavors reported by Stelick (2021) can be softened with fats such as dairy products or nuts, while bitter and sour flavors pair well with some beers. Interestingly, the volatile sulfur compounds produced in buddy maple syrup are known

to contribute a postive background flavor in multiple beers (Landaud et al**.,** 2008; McGorrin, 2011). Meanwhile, other flavors can be difficult to mask, as was found in a pilot shelf-life study of bottled root beer. In this study, samples of root beer were produced with mild or intense buddy syrup and were compared against a control made with Grade A syrup. Throughout six months of storage, chocolate and sour flavor notes were perceived in samples prepared with a mild buddy maple syrup, but were deemed acceptable and difficult to distinguish from the control. In intense buddy maple syrup samples, sulfur, sour, bitter, and chocolate notes persisted, but their flavor intensity decreased over the six months of storage. As you can see, the use of buddy maple syrups in value-added products is complex, and more information is needed to fully understand its potential in the food and beverage industry.

The production overviews listed below are recipe examples and were not evaluted for food safety. Any value-added product that is to be produced commercially and sold must follow state and federal regulatory requirements. More information can be found in the Regulation Requirements section.

Production Overview for Brewing Beer with Buddy Maple Syrup

Robert Daniel, Cornell Maple Program

To produce a maple beer, you will need a 5-gallon or 18.9 L carboy, heat source, pot or kettle, temperature probe, and food grade containers such as glass bottles or a food grade drum. In this example, maple syrup is used in the primary and secondary fermentation stages. Information on brewing is available in "Brew Chem 101: The Basics of Homebrewing Chemistry" by Janson (1996). Additional resources can be found through the Cornell Craft Beverage Institute and Cornell Brewing Extension Lab at Cornell University.

1. Heat 5 gallons (18.9 L) of purified water in a stainless pot over high heat.
2. While the water is heating, dissolve 3.5 lb (1.6 kg) of dry malt extract and 2 lb (907 g) of buddy maple syrup (67 °Brix) into the water.
3. As the water nears boiling, adjust the heat to prevent boiling over.
4. Once a rolling boil starts, add 0.5 oz (14.18 g) of hop pellets and 5 lb (227 g) of maltodextrin. Set a timer for 60 minutes.
5. When ten minutes remain, add one Whirlfloc tablet and 0.5 teaspoon (2.2 g) of yeast nutrient.
6. After a total boil time of 60 minutes, turn off the heat, adjust the wort volume to 5.5 gallons (20.8 L), and chill the wort to 70 °F.

7. Transfer the wort to a sanitized fermentation vessel, add yeast, and secure the vessel with a fermentation lock. As an example, 4.22 fl. oz (125 mL) of Wyeast 1084 Irish Ale liquid yeast can be used for each 5-gallon (18.9 L) batch.
8. Begin and maintain the fermentation at 70 °F for 10 to 14 days. Fermentation is complete when the fermentation lock stops bubbling and a thick sediment forms at the bottom of the fermentation vessel.
9. Using a sanitized racking wand and tubing, siphon the beer into another sanitized container without disturbing the sediment.
10. Sanitize bottles, caps, and all other bottling equipment.
11. Estimate the volume of liquid to be bottled.
12. For each 5-gallon (18.9 L) batch, initiate the secondary fermentation by dissolving either 0.38 lb (170 g) of buddy maple syrup or 0.27 lb (124.5 g) of corn sugar into the siphoned beer.
13. Pour the siphoned and sweetened beer into the sanitized bottles and immediately cap. Store the bottled beer for approximately ten days at 70 °F for carbonation.

Production Overview for Producing a Distilling Wine with Buddy Maple Syrup

Christian J. Mercado Acevedo, MFS, Caldamentum

To produce a maple distilling wine, you will need an airlock, 5-gallon or 18.9 L carboy, triple scale hydrometer, heat source, temperature probe, and food grade containers such as a food grade drum or other intermediary vessel to hold wine before distillation. More information for this product is available in Mercado Acevedo (2022a and 2022b) and Faust and Hemler (2019). Additional resources can be found through the Enology Extension Program at Purdue University and the Cornell Craft Beverage Institute and Cornell Enology Extension Lab at Cornell University.

1. In a 5-gallon (18.9 L) carboy, combine buddy maple syrup and water to make a 5-gallon solution with 25 °Brix. For guidance on calculations, please see the "Fermentation Calculations" section in Mercado Acevedo (2022b). To ensure sufficient headspace, do not fill past the shoulder of the carboy.
2. Add 150 mg nitrogen per L yeast nutrient (e.g., 0.48 g/L Fermaid O™) to the mixture.
3. Prepare distiller's yeast (*S. cerevisiae*) according to package instructions and add yeast to the carboy.
4. Close the carboy with an airlock.
5. Maintain the mixture at 70 °F and check °Brix every 2 to 3 days.

6. After one third of the fermentation is complete (1-2 days following onset of visible yeast activity / airlock bubbling), add another 150 mg nitrogen per L yeast nutrient and stir.
7. Allow fermentation to continue for approximately 10-14 days or until it reaches terminal gravity. To calculate terminal gravity, see "Specific Gravity for Wine & Distilled Spirits" (Brady Instruments, n.d.).
8. The fermentation is complete and ready to be distilled. Refer to Mercado Acevedo (2022b) for distillation instructions.

Production Overview for Root Beer with Buddy Maple Syrup

Ailis Clyne and Robert Daniel, Cornell Maple Program

To produce a carbonated soda, you will need a carbon dioxide (CO_2) tank and regulator, a stainless steel Cornelius keg, a kegerator, and gas and liquid tubing lines. The method described below is intended for short-term storage and serving for immediate consumption. The soda should be made and carbonated less than 1 week before serving. The carbonation levels presented below are based on trial and error and will differ based on product composition, storage temperature, desired level of carbonation, and container headspace. More background information for carbonating beverages is available in Song (2020).

1. Clean, sanitize, and assemble a 5-gallon (18.9 L) Cornelius keg with a ball lock according to manufacturer's instructions.
2. Perform a leak check by pressurizing the keg and applying Starsan or other foaming, no-rinse sanitizer to all connection points.
3. Weigh a root beer extract following manufacturer's instructions. For Cook's Root Beer extract, this would be 142 g of extract.
4. Add extract and 2.99 kg of buddy maple syrup to a 5-gallon keg. Rinse the containers used to measure each ingredient with filtered water and add this rinse to the 5-gallon (18.9 L) keg.
5. Bring the volume of the solution to 5 gallons (18.9 L) by adding filtered water.
6. Agitate the solution in the sealed keg until homogenous.
7. Set the kegerator temperature to 34-38 °F and the CO_2 regulator to 40 pounds per square inch (PSI) and begin carbonating.
8. Monitor and maintain these temperature and PSI settings while allowing carbonation to proceed; carbonate for 60 hours (2.5 days), before shutting off the CO_2 valves.
9. Dispense the soda slowly into single servings for immediate consumption at 7-10 PSI.

10. Do not store the keg at 7-10 PSI for extended periods; when not dispensing, store the soda pressurized at 40 PSI.

Production Overview for Mustard with Buddy Maple Syrup

Christian J. Mercado Acevedo, MFS, Caldamentum

To produce four pints of mustard, you will need a heat source, pot or kettle, strainer or filter, blender, and canning equipment. Production guidelines for other canned condiments are available in "Make Your Own Home-Canned Condiments" by Garden-Robinson (2022). Information on food safe product development can be found through the eCornell Food Product Development Certificate Program at Cornell University. At the time of this publication, a tuition grant is available for this course through the Cornell Food Spark Program.

1. Heat 300 mL of purified water, 250 mL of buddy maple vinegar or white vinegar (5% acidity), 500 mL of a dry white wine, 50 mL buddy maple syrup, 1 diced medium yellow onion, 2 minced garlic gloves, 5 g salt, and 11 g garlic powder in a pot or kettle over high heat.
2. Bring mixture to a boil and simmer for 15 minutes.
3. Cool mixture so that the product temperature cools from 212 °F to 70 °F within 2 hours.
4. Add 200 g of yellow mustard seeds and 100 g of brown mustard seeds to the mixture.
5. Allow mustard seeds to flavor the mixture for 24 hours at room temperature (about 68 to 72 °F).
6. Blend mixture containing mustard seeds in a blender to desired consistency.
7. Sterilize canning jars and lids.
8. Heat mustard mixture to 195 °F and hold it at this temperature for a minimum of 6 minutes.
9. Immediately hot-fill into sterilized jars.
10. Secure lids and invert the jars for a minimum of 2 minutes to ensure the container is pasteurized and has an airtight seal.
11. Store at room temperature; refrigerate after opening.

Regulation Requirements

Commercial production of a buddy maple syrup food or beverage product may require a scheduled process from a Process Authority. At minimum the product should undergo a product review by a Process Authority. This will inform whether a scheduled process is required. Scheduled processes are required for most food or beverage products

manufactured for sale in which refrigeration or additional steps such as thermal treatment are necessary to ensure a safe, stable product.

The Cornell Food Venture Center offers scheduled process services. A scheduled process is a document specific to a particular food product that states the process for making the product and all parameters that must be controlled in order to make the product safe. The overviews presented in this document are for informational purposes only and are not scheduled processes; it is the responsibility of each maple producer or food facility to ensure compliance and adhere to regulatory requirements.

Commercial production of alcoholic beverages requires registration with the United States Alcohol and Tobacco Tax and Trade Bureau (TTB). Information on registration is available in Faust and Hemler (2019) and on the TTB website (ttb.gov).

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