Evaluating Processing Methods to Produce Safe, Shelf Stable Maple Sap Beverages for Small Operations

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Abstract

In order for sugarmakers to take advantage of the newfound interest in maple sap beverages, processes must be developed that would allow small scale producers to process and package maple sap safely, efficiently, and economically. We investigated several methods that might be employed for seasonal markets during the harvest season of January-April. This study showed that maple sap might be only a marginally suitable alternative seasonal beverage, with a short shelf life for small producers. Due to the short shelf life, we would not recommend maple beverages be produced on a small scale until more research has been completed. Production of perishable maple beverages would most likely not be allowed in typical sugar operations due to federal, state or provincial regulations. Producers considering pursuing seasonal sap beverages should check their local regulations before investing time and funds producing beverage products.

Afin de profiter de l'intérêt nouveau pour la sève d'érable comme breuvage, des procédés doivent être élaborées pour permettre aux producteurs à petite échelle de traiter et d'emballer la sève d'érable de façon sécuritaire, efficace et économique. Nous avons étudié plusieurs méthodes qui pourraient être utilisées durant la saison de récolte du sirop d'érable, du mois de janvier au mois d'avril, visant un marché saisonnier de produits stables à température ambiante. Cette étude a démontré que la sève d'érable en tant que boisson saisonnière à courte durée de conservation à température ambiante ne pourrait être qu'une alternative acceptable marginale pour les producteurs à échelle réduite. En raison de la difficulté d'acidification de la sève et de risques relatifs aux niveaux du pH, nous ne recommanderions pas que de telles boissons de sève d'érable soient produites à petite échelle. La production de boissons de sève d'érable périssables par les opérations typiques de produits de l'érable ne serait fort probablement pas permise compte tenu de la réglementation fédérale, des états et des provinces. Les producteurs visant la production de sève d'érable saisonnière en tant que boisson devraient vérifier la réglementation locale qui s'applique avant d'investir temps et argent pour produire de tels breuvages.

Introduction

Consumers are attracted to beverages that are minimally processed and contain beneficial nutrients, similar to coconut water. However, little research has been conducted to evaluate if sap beverages are considered safe for consumers, while utilizing techniques available to small-scale operations.

Although maple syrup begins as sap, maple sap and syrup are two different types of products with distinct Brix and water activity properties. Maple sap has an extremely low Brix level (2% soluble solids), and during the boiling process, water is evaporated and sugars are concentrated in the finished syrup. Maple syrup typically has a final Brix between 66 and 68.9. Syrup is bottled hot and the heat and sugars help preserve the syrup as a shelf-stable and low risk food. Because sap contains a high moisture level and other nutrients, such as sugars, amino acids, and minerals, sap can promote rapid microbial growth and is not considered shelf-stable. The shelf life of sap is typically two days or less, depending on the storage temperature; therefore, sap by itself is considered quite perishable.

The FDA defines perishable products as potentially hazardous foods because of high pH and water activity levels that support the rapid growth of pathogenic bacteria, which can cause foodborne illness. Shelf stable foods can be safely stored at room temperature and are considered non-perishable foods.

Products can be made shelf stable typically by reducing the pH below 4.60 or reducing the water activity below 0.850. Other technologies can be utilized to produce shelf stable and commercially sterile foods, such as steam retorts or aseptic processing. Foods that cannot be made shelf stable by these processes can be pasteurized to lower the microbial load, and then stored at frozen or refrigerated temperatures to extend the shelf life.

The popular, functional maple beverages on the market are currently produced by either Ultra High Temperature pasteurization (UHT) combined with aseptic packaging techniques allowing a shelf life of 12-18 months or the use of High Pressure Processing (HPP) allowing a shelf life or 30-60 days to create a shelf stable product. Both of these technologies are prohibitively expensive for small producers considering creating a seasonal, local product for their customers.

This research project investigated whether small producers could create a quality refrigerated sap beverage product using pasteurization techniques with standard household utensils. We conducted a shelf life study with four treatments and an untreated sap control with two replications each. This was a preliminary study to establish baseline data on maple sap beverages to determine if producers might be able to offer maple sap beverages as a viable and safe additional product to consumers.

Objectives

1) To determine if pasteurization (heat treatments) and acidification of maple sap would extend the shelf life of sap which is extremely perishable even at refrigerated temperatures.

2) To help establish guidance for small maple producers interested in producing sap beverages on a small-scale.

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Materials and Methods

Twenty-five gallons of sap were collected at one sugarhouse in Somerset County, Maine and transported in cleaned and sanitized (100ppm bleach) food-grade plastic buckets to the University of Maine (UMaine) School of Food & Agriculture's Commercial Kitchen. Sap was processed using the following treatments in duplicate and a shelf-life study was conducted on these samples.

Sap Treatments & Codes

1) Control (Con); fresh sap, no treatment
2) Low pasteurization temp (LSP) 191° F (88° C) for 1 sec.
3) High pasteurization temp (HSP) 212° F (100° C) for 0.01 sec.
4) Acidified low pasteurization temperature (AcLo)
5) Acidified high pasteurization temperature (AcHi)

The control sap was poured directly into clean and sanitized pint glass canning jars and immediately refrigerated at 3-4°C (37.4 - 39.2°F). Pasteurization temperatures were selected from the Food and Drug Administration's Pasteurized Milk Ordinance (PMO): http://www.fda.gov/downloads/Food/GuidanceRegulation/UCM291757.pdf. The higher pasteurization temperatures were selected since they are more likely to reduce yeast and molds based on preliminary research findings. Sap was heated according to the selected temperature treatment and time in stainless steel kettles and then immediately poured into pint glass, canning jars. Acidified treatments were included in this study to determine if acidifying sap would extend the shelf life under refrigeration. The acidified treatment was determined through preliminary testing and lemon juice was selected as an acceptable acidifier for sap, as it did not negatively affect sap flavor. The sap was acidified to a pH of 4.20 with lemon juice and then heat treated according to the appropriate heating temperature and time, and then immediately bottled. All the heat-treated and acidified/heat treated sap samples were inverted for five minutes after capping to pasteurize the headspace. After cooling to room temperature, previously heated-treated samples were immediately stored at 3-4°C (37.4 - 39.2°F). Sap was tested initially and monitored for pH, Brix and also for initial aerobic plate counts (bacteria), yeast and molds using 3M™ Petrifilms™. Microbial testing occurred on days 0, 3, 7, 21, and 28.

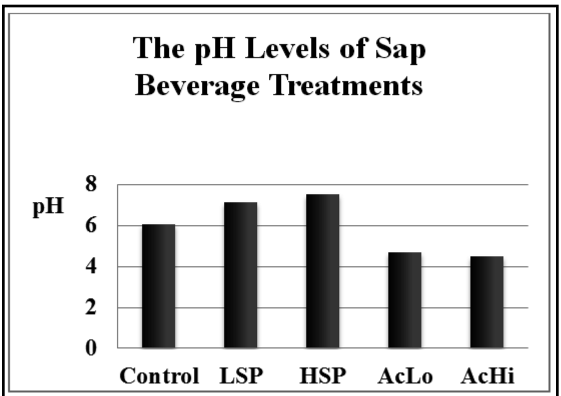

Figure 1: Averages are based on duplicate pH readings.

Results

When evaluating capped food products, pH is quite important, especially for acidified, shelf-stable food products. An acidified canned, shelf-stable food must have a pH level of 4.60 or lower in order to be considered shelf-stable to pre-

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vent the risk of Clostridium botulinum growth and botulinum toxin production. Figure 1 shows that the Control sap samples had a pH level that exceeded 4.60. When the sap was acidified to 4.20 with lemon juice, the sap appeared to have some buffering capacity, possibly due to the proteins and amino acids in the sap. The sap pH after acidification and heating exceeded a pH of 4.20, and in some instances above 4.60. If sap is packaged (capped) with pH levels above 4.60, and left at room temperature, this would present a botulism risk to consumers. Therefore, sap beverages would not be considered shelf-stable and would have to be stored under refrigeration at all times, unless properly processed using aseptic or HPP technologies. Therefore, labeling that the product must be kept refrigerated would be a critical factor to ensure the safety of the product and to avoid mishandling by the consumer.

As you can see from Table 1, the Control sap had a high bacterial load (approximately 1,000,000 viable bacterial cells per mL of sap) from these samples and continued to increase over time. All the heat treatments were effective in lowering microbial counts, but the Acidified High Pasteurization Temperature was the best treatment in reducing bacteria and appeared to reach a shelf life of at least 28 days under refrigeration. The

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Treatment	*Day 0*	*Day 3*	*Day 7*	*Day 21*	*Day 28*
Control	6.38	6.46	7.13	7.13	TNTC
LSP	2.85	2.84	3.59	4.04	5.48
HSP	1.33	1.36	1.29	2.0	4.07
AcLo	2.05	2.39	2.27	2.43	2.52
AcHi	ND	ND	ND	ND	<1.0

LSP = Low Pasteurization Temperature (191° F, 1 sec)
HSP = High Pasteurization Temperature (212° F, 0.01 sec)
AcLo = Acidified Low Pasteurization Temperature
AcHi = Acidified High Pasteurization Temperature
*(Acidified treatments were acidified with lemon juice concentrate prior to pasteurization)
After capping, heat treated containers were inverted for 5 min, cooled to room temp and stored at 3-4° C
ND = Not detectable (10 CFU/g)
TNTC = Too Numerous to Count
Averages n=4

Table 1: The Average Aerobic Bacterial Plate Counts (Log CFU/g) Over Time

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High Pasteurization Temperature treatment was also adequate, but the shelf life of this sample was approximately 21 days.

The graph in Figure 2 displays the trend of the bacterial counts over shelf life time. The Control (untreated sap) had high counts that kept increasing over time. However, the Acidified High Pasteurization Temperature samples remained quite low over time. The Acidified Low Pasteurization Temperature and Low Pasteurization Temperature treatments both had bacterial counts lower than the Control, but were still at high enough levels that they would not be considered safe for human consumption.

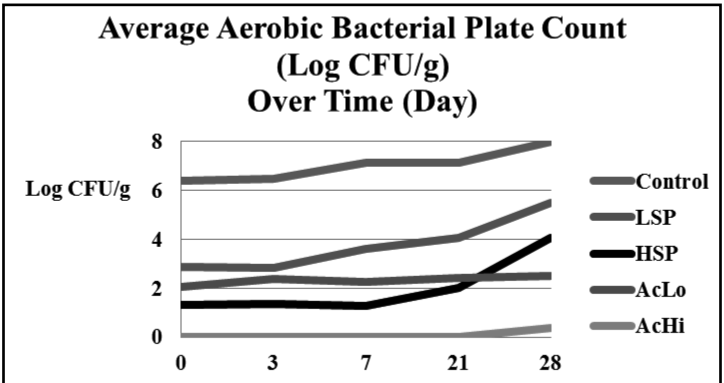

Figure 2: The Average Aerobic Bacterial Plate Count (Log CFU/g) Over Time. Averages are based on n=4

As expected, the Control sap samples contained yeast and molds. The yeast and mold counts were approximately 1,000

– 10,000 colonies/mL of sap (data not shown). All heat treatments appeared to be effective in destroying yeast and molds in the sap, as none were detected in all the heat-treated and also acidified/heat treated samples.

The day after processing, quality concerns arose as a cloudy precipitate formed at the bottom of all the sap samples, which tended to increase over storage time, especially in the untreated Control. These cloudy samples would most likely not be acceptable for consumers.

Discussion

Based on the microbial results, sap can carry a high microbial load of bacteria, yeast and molds and would require a pasteurization step in order to adequately reduce microbes of public health concern, such as bacterial pathogens. This preliminary research showed that heat, in combination with acidification, can lower microbial counts. A 28-day shelf life was obtained with acidifying the sap with lemon juice and heat-treating at a high temperature.

However, this preliminary research has raised more questions that should be further investigated before guidance can be provided to produce safe and acceptable maple sap beverages using only standard kitchen equipment. It is assumed that naturally occurring proteins and amino acids buffered the sap when the lemon juice was added, which caused the pH levels to increase after heating. Several other types of acidifiers could be investigated to determine if they are less affected by the buffering capacity of sap. However, sap has a subtle flavor and it would be important to select an acidifier that will not produce a chemical or acidic aftertaste in the sap. The white precipitate was most likely due to amino acids, proteins and possibly from the microbes within the sap, and the heat and/or acid treatments probably caused the proteins to precipitate out. A micron filter may help to prevent the precipitate, but the filter may exclude the beneficial sap nutrients, such as polyphenols and minerals, that are marketed in these maple sap beverages. However, Dr. Navindra Seeram et al. 2013, suggests that neither pasteurization nor sterilization appears to affect the constituents or health benefits of maple sap.

Worth noting, the University of Vermont Proctor Maple Research Center in 2014 conducted a sensory study on maple sap beverages and found sap beverage flavor ratings ranged from "objectionable" to "above neutral," but no samples achieved a "good rating" by their panelists. In addition, one beverage was cloudy or milky in appearance when poured into a glass and another sample had turned ropey. The sensory study evaluated a variety of different maple sap beverages, which included aseptic and HPP process products.

Conclusions

This study showed that maple sap can have a naturally high microbial load, high pH and water activity levels, placing it in the potentially hazardous food category because it is perishable. Sap may be a suitable alternative seasonal beverage, but has a short shelf life. Due to the difficulty with sap acidification, short shelf life, and white precipitate concerns, we would not recommend maple sap beverages be produced on a small scale at this time. Poor flavor and appearance of contamination have the potential to discourage consumers from purchasing sap beverage products.

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Until further work is done on the pasteurization processes for maple sap, we would recommend bottling sap with a co-packer using high pressure processing (HPP) or Ultra High Temperature pasteurization (UHT) combined with aseptic packaging techniques. It is not likely that production of perishable beverages would be allowed in typical sugar operations due to state or provincial regulations, and producers considering pursuing seasonal sap beverages should check with their regulatory agency for applicable requirements before investing time and funds prior to producing beverage products. Beverages are typically bottled in commercial facilities or a dedicated beverage facility where sanitation is extremely well controlled.

Further research will be conducted in 2016 to determine if higher temperatures, longer heat treatment times or another type of acidifier, will create a higher quality, safe and appealing value-added product option for the small producer.

Acknowledgments

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