Maple Marshmallow Spread

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Overview

The Cornell Maple Program works with industry collaborators and university partners to facilitate the development of new maple products. This product is a shelf-stable maple marshmallow spread, sweetened solely with maple syrup and maple sugar. It was developed using amber maple syrup and maple sugar for one formulation and dark syrup and sugar in a second formulation.

Maple marshmallow spread is designed to compete as a gourmet version of popular marshmallow spreads. It has a variety of suggested uses such as a hot beverage topping, sandwich spread, baking ingredient, and enjoyed by the spoonful as a treat. This product is formulated with physical properties and additives to ensure a quality, stable, and safe product. Commercial production requires an approved, food safe process and a certified facility.

Currently, the market of maple syrup is growing rapidly, with a compound annual growth rate (CAGR) of 5.9 % anticipated from 2023 to 2031 (Straits Research, 2022). Maple syrup is recognized as a sustainable, natural sugar with a distinctive flavor profile. Unlike highly processed sweeteners, maple syrup contains compounds with potential health benefits including minerals, amino acids, vitamins such as riboflavin and niacin, and antioxidants including gallic acid, quercetin, and kaempferol (Mohammed et al., 2022). Popular commercial brands of marshmallow spread contain corn syrup and cane sugar as sweeteners, which positions maple marshmallow spread to compete well in this sector. Production cost and price analyses indicate strong potential for profitability.

The Science of Maple Marshmallow Spread

Maple Syrup and Sugars

Maple syrup consists of 66 to 68.9 % sugars, according to the Food and Drug Administration (FDA) and United States Department of Agriculture (USDA) regulations. The majority of sugar in maple syrup is sucrose, a disaccharide composed of one glucose and one fructose. Sucrose can be hydrolyzed into glucose and fructose when it is subject to the enzymatic activity of invertase. The 1:1 composition of glucose and fructose is called invert sugar. Invert sugar can impede the crystallization of sucrose, decrease the water activity (measurement of free water in the product), and reduce viscosity (Childs &

Wightman, 2022). Due to these beneficial properties of invert sugar, the maple marshmallow spread was developed to have all sugars converted to invert sugar to achieve a better shelf-stability and spreadability.

Egg White

Egg white, also known as albumen, contains 10 to 15 % protein and 85 to 90 % water (Brady, 2013). When egg whites are whipped, air is incorporated into the viscous liquid and a foam structure forms. The albumen proteins temporarily stabilize the air bubbles in the egg white foam; these proteins uncoil when whipped and the hydrophilic ends are attracted to water while the hydrophobic ends are attracted to air pockets. Within a few minutes, the proteins recoil, liquid drains out between the air pockets, and the foam collapses. In order to create a shelf-stable foam structure, the stabilizers, cream of tartar and xanthan gum are added.

Egg whites whipped to "soft peak"

Stabilizers

Cream of tartar, the potassium salt of tartaric acid, is often used to stabilize egg whites and prevent sugar crystallization in confections, both of which are necessary when producing marshmallow spread. It also lowers the pH, which prevents the egg white proteins from recoiling, and thus maintains a stabilized foam for longer (Brady, 2013).

Xanthan gum is a food hydrocolloid, a type of nondigestible polysaccharide, commonly used as a stabilizer and thickener. It can help to stabilize the foam structure, provide a thicker mouthfeel, and reduce water activity. These characteristics improve the sensory properties and food safety of marshmallow spread. Another benefit of using xanthan gum is that it has a special shear-thinning property, which allows consumers to more easily spread the product on bread or other foods.

Necessary Equipment and Supplies

- Stand mixer with whisk attachment
- Rubber spatula
- Saucepan
- Kitchen scale
- High moisture barrier packaging
- Thermometer
- Measuring spoons
- Piping bags and tips

Recipe

Ingredients

250 g Inverted maple syrup[1]

150 g Maple sugar

120 g Water

95 g Pasteurized liquid egg white

2.9 g (½ teaspoon) Cream of tartar

1.0 g (¼ teaspoon) Xanthan gum

0.49 g Potassium sorbate (0.1% of the total recipe)

0.1 g (3 drops) Invertase (0.02% of the total recipe)

[1]To fully invert maple syrup, add 1 tsp of invertase per gallon of syrup. For rapid conversion, hold maple syrup with invertase at 120 – 150 °F for 24 hours. Where time is not a factor, stir the solution thoroughly and store at room temperature for 3 – 5 days.

Directions

1. In a medium saucepan, add inverted maple syrup, granulated maple sugar, and water. Stir over low heat until sugars dissolve.

2. Heat the sugar mixture to 240 °F on medium-low heat. Immediately remove from heat and allow to cool to ≤180 °F.

3. While the sugar mixture is cooling, add pasteurized liquid egg whites and cream of tartar into the bowl of a stand mixer with a whisk attachment. Whip the mixture on medium-high speed until reaching a soft peak (approximately 5 minutes).

4. Add xanthan gum to the egg white mixture and mix for one minute.

5. Once the sugar mixture has cooled to ≤180 °F, turn the stand mixer on low. Slowly add the syrup to the whipped egg white mixture by pouring it down the side of the mixing bowl.

5. Increase the stand mixer speed to high and continue to whip for 10 minutes.

6. To prevent crystallization and mold during storage, add invertase and potassium sorbate to the finished spread in the stand mixer and whip until combined.

7. Transfer the spread into food grade, high moisture barrier containers. Store the finished product in the freezer, refrigerator, or at 50 to 70 °F and out of direct sunlight to maintain quality. Refer to the "Packaging" section for storage options.

Recipe yield is approximately 490 g (17 oz).

Regulations

Regulation Requirements

Commercial production of maple marshmallow spread requires a scheduled process from a process authority and production in a licensed kitchen inspected by a state department. For New York, this is the New York State Department of Agriculture and Markets. This product has a water activity >0.75; to prevent or eliminate food safety hazards, water activity will serve as a "critical control point" or step in the manufacturing process that must be monitored and recorded. For more information, please see the Basics of Maple Marshmallows bulletin and the Getting Started: Value-Added Products bulletin.

Food Additives

A food additive is any substance that becomes a component of or otherwise affects the characteristics of any food. Food additives must be "generally recognized as safe" (GRAS) or approved for use by the FDA; these include preservatives, stabilizers, anti-caking agents, among others. Three food additives are recommended for this product to maintain quality and stability (cream of tartar and xanthan gum) and to prevent mold growth (potassium sorbate). Please refer to "The Science of Maple Marshmallow Spread" section for information on the functionality of the stabilizer food additives.

Cream of tartar (Potassium acid tartrate) stabilizes egg whites and prevents sugar crystallization. In addition to marshmallow spreads, this food additive is commonly used as a stabilizer in bakery products (USDA-ARS, 2023). The FDA has labeled cream of tartar as a GRAS food substance. There are no limitations on the amount added to food products (Potassium acid tartrate, 2023).

Xanthan gum is used as a stabilizer and thickener. It is common in marshmallow spreads, bakery products, sauces, and dairy products (USDA-ARS, 2023). This additive can be used in marshmallow spreads if a "food grade" label is on the xanthan gum packaging. To safely use the additive, follow guidelines provided on the manufactures label (Xanthan gum, 2023).

Potassium sorbate is a common food preservative used to prevent mold growth. Mold growth can occur when the water activity is at or above 0.65. Although, most molds grow in products with a water activity of >0.80 (Roos et al. 2018). The water activity of the marshmallow spread is >0.75, thus control of mold growth should be considered. Potassium sorbate is considered a GRAS food substance with no limitations on the amount added to food products (Potassium Sorbate, 2023).

Packaging

Marshmallow spread requires packaging that is suitable for preventing moisture migration and microbial contamination. Plastic jars are the current industry standard for

marshmallow spread products. Among all types of plastic, high density polyethylene (HDPE) and polypropylene (PP) have the best barrier property against moisture (Qorpak, 2022). Other marshmallow spread products use an opaque polyethylene terephthalate (PET) which can prevent moisture migration and protect color changes and quality loss. During consumer evaluations, maple marshmallow spread received good acceptance scores on appearance (see "Consumer Evaluations" section below), so a clear container or opaque container can be used. It is worth noting that the color of maple spread may darken during storage. However, this was not evaluated.

Maple marshmallow spread in transparent packaging

Market Projections

The market size of maple syrup was USD 1.57 billion in 2022, and it is predicted to reach USD 2.63 billion in 2031 (Straits Research, 2022). Maple marshmallow spread can be an excellent addition to the range of maple-related products.

The demand for premium confections has risen significantly, and the popularity of flavored marshmallows has grown due to consumers' increasing interest in diverse and innovative flavors (Fortune Business Insights, 2021; Introspective Market Research, 2023). As such, maple marshmallow spread has the potential to capture a portion of this growing market segment. The unique flavor profile of maple syrup, combined with the novelty of the marshmallow spread format may attract consumers seeking new, unique products. By targeting niche markets, it is possible to gain a competitive advantage.

Unlike commercially available marshmallow spreads which use corn syrup and other highly-processed sugars, maple marshmallow spread includes sugars processed through boiling maple tree sap. Additionally, the beneficial nutrients and antioxidants in maple

(Eggleston et al., 2022; Phillips et al., 2009) are maintained in the syrups. As of 2022, roughly 47% of consumers occasionally purchase confections that they consider "healthier" or "better-for-you" (National Confectioners Association, 2022). Meanwhile, around 90% of consumers care about environmental commitments and social responsibility practices (National Confectioners Association, 2022). Given these benefits, maple marshmallow spread is expected to have promising growth potential in the market.

At the time of this publication, gourmet marshmallow spreads are uncommon in the marketplace. The few products sold are packaged in 5.9 oz (168 g), 7 oz (198 g), or 8 oz (227 g) containers and sold for $1.28 to $2.19 per ounce. Based on the ingredients only (Table 1), maple marshmallow spread has a per ounce production cost of $0.31. The cost can decrease with bulk purchasing and sourcing for competitive pricing.

Table 1. Estimated costs of ingredients per 17 oz (490 g) batch.

Ingredient	Cost per 490 g batch
Maple Syrup *(Cornell)*[1]	$4.63
Invertase *(LorAnn Oils)*	$0.02
Liquid Egg Whites *(Bob Evans)*	$0.56
Xanthan Gum *(Bob's Red Mill)*	$0.07
Cream of Tartar *(McCormick)*	$0.07
Potassium Sorbate *(Modernist Pantry)*	$0.03
Total cost per 490 g batch:	$5.38

[1]Includes syrup used to make granulated sugar and inverted syrup, using a wholesale price of $50 per gallon. Does not include the cost of converting syrup to sugar.

Consumer Evaluations

To understand consumer insights, a sensory test was conducted with 72 participants at the Cornell Sensory Evaluation Center in Ithaca, NY. Consumers were given samples of two formulations and a sample of a commercial vanilla marshmallow spread. On a 9-point scale, with 1 as "dislike extremely" and 9 as "like extremely", the average overall liking score was 6.54 for amber maple spread (Figure 1a), and 6.51 for dark maple spread (Figure 1b); both received higher scores as compared to the commercial marshmallow spread (6.46). As a reference, the average overall liking score in the Cornell Sensory Evaluation Center database is 5.94. An alternative perception of this data is that amber and dark marshmallow spreads were each liked moderately or more by 59% of panelists (Figure 1a and b). Overall, the formulations received good acceptance rate from the panelists.

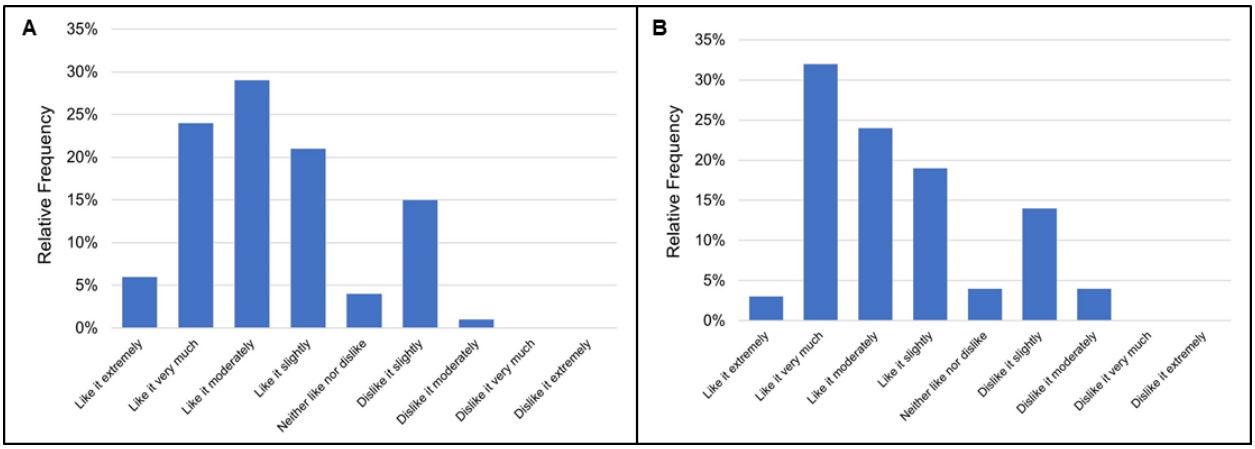

Figure 1. Overall liking rates of a) amber maple spread and b) dark maple spread on 9-point scale (n = 72).

Panelists were asked to provide insight on specific characteristic of the marshmallow spread. The commercial marshmallow spread was rated as being too sweet, sticky, and thick. The maple marshmallow spread could be improved by lowering the sweetness and foaminess in both formulations, and increasing the stickiness for the amber syrup formulation. Following the feedback from panelists, the recipe was adjusted to include a heating temperature (240 °F) and an addition of invertase to increase stickiness of the final product. The recipes presented above reflect these changes. Additional improvements to the maple spread could be using a blend of dark and amber syrups to achieve a desired flavor intensity.

Maple marshmallow spread being whipped in stand mixer

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Citations

Brady, J. W. (2013). Proteins. In. J. W. Brady (Ed.), Introductory Food Chemistry (pp. 277-374). Comstock Publishing Associates.

Childs, S., & Wightman, A. (2022). Maple Syrup: The Raw Product for Making Maple Confections. In A. Clyne (Ed.), *New York State Maple Confections Notebook* (6th ed., pp. 1–10). Cornell Maple Program.

Eggleston, G., Triplett, A., Bett-Garber, K., Boue, S., & Bechtel, P. (2022). Macronutrient and mineral contents in sweet sorghum syrups compared to other commercial syrup sweeteners. Journal of Agriculture and Food Research, 7, 100276.

Fortune Business Insights. (2021). North America Marshmallow Market. https://www.fortunebusinessinsights.com/north-america-marshmallow-market-105434, accessed on 05/02/2023

Introspective Market Research. (2023). Marshmallows Market. https://www.digitaljournal.com/pr/news/marshmallows-market-global-industry-analysis-size-share-growth-trends-and-forecast-2022-2029-report-by-introspective-market-research, accessed on 05/02/2023

Mohammed, F., Sibley, P., Guillaume, D., & Abdulwali, N. (2022). Chemical composition and mineralogical residence of maple syrup: A comprehensive review. Food Chemistry, 374, 131817.

National Confectioners Association. 2022, 13 March. Sweet Insights: State of Treating 2022. https://candyusa.com/sweet-insights-state-of-treating-2022/

Phillips, K. M., Carlsen, M. H., & Blomhoff, R. (2009). Total antioxidant content of alternatives to refined sugar. Journal of the American Dietetic Association, 109(1), 64-71.

Potassium acid tartrate, 21 C.F.R. § 184.1077, 2023.

Potassium sorbate, 21 C.F.R. § 182.3640, 2023.

Qorpak. (2022). Plastic Barrier Properties. https://www.qorpak.com/pages/plasticbarrierproperties, accessed on 04/25/2023.

Roos, Y.H., Finley, J.W., & J.M. deMan. (2018). Water. In J.M. de Man, J.W. Finely, W.J. Hurst, and C.Y. Lee (Eds.), Principles of Food Chemistry. (pp. 1-38). Springer International Publishing. https://doi.org/10.1007/978-3-319-63607-8

Straits Research. (2022). Maple Syrup Market. https://straitsresearch.com/report/maple-syrup-market, accessed on 04/25/2023.

United States Department of Agriculture, Agricultural Research Service (USDA-ARS). FoodData Central, 2022. fdc.nal.usda.gov

Xanthan gum, 21 C.F.R. § 172.695, 2023.

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