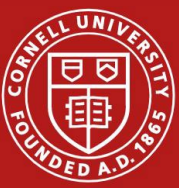




Maple Sports Drink

Catherine Belisle, Ph.D., 2022



Overview

The Cornell Maple Program developed two athlete-approved recipes for a Tart Cherry and a Tangerine Maple Sports Drink. These beverages are designed to hydrate and replenish carbohydrates and electrolytes lost during physical activity. Because of the health-benefits (antioxidants, vitamins, and minerals), Maple Sports Drinks can be marketed as a functional beverage, a lucrative market projected to increase 7.8% from 2021 to 2028 (Report Linker, 2022).



The Science of Sports Drinks

Electrolytes are minerals that are essential for the body to function (Felman & Tinsley, 2021). Sodium and potassium are the most common electrolytes in need of replenishment after physical activity. Sodium contributes to improved hydration (Cerullo et al., 2020) and performance (Oöpik et al., 2003), while potassium contributes to increased energy expenditure (James et al., 2015) and decreased muscle contractions (Maughan et al., 2009). Maple syrup contains potassium (50-81 mg/L) in addition to calcium (35-75 mg/L), magnesium (3.9-8.1 mg/L), manganese (1.7-5.5 mg/L), and trace amounts of other minerals (Perkins & van den Berg, 2009). Sports medicine research recommends supplementing sodium at a rate of 230 to 690 mg/L (Maughan et al., 2009) and potassium at 117 mg/L (González-Alonso et al., 1992). Sodium citrate and potassium chloride are easily accessible and valuable sources of these electrolytes.

Glycerol is naturally occurring in the body; multiple studies have reported benefits when consumed before, during, and after physical activity. It helps to maintain a lower heart rate, lower core temperature, and helps with hydration (Anderson et al., 2001; Maughan et al., 2009). The current recommendations for rehydration are 46 to 60 g/L of glycerol in water for a 150 to 200 lb individual (van Rosendal et al., 2010).

Carbohydrates serve as fuel for the muscles and brain. Sports drinks contain 4 to 8% (40-80 g/L) carbohydrates. This low concentration is quickly absorbed as energy, while a higher concentration slows hydration (Coombes & Hamilton, 2000).

Maple syrup is a healthy carbohydrate compared to refined sugar due to the presence of organic acids, amino acids, minerals, and phenolic compounds (Perkins & van den Berg, 2009; St-Pierre et al., 2014). Each compound benefits overall human health, but phenolic compounds are noteworthy for their antioxidant properties, including reduced inflammation (Legault et al., 2010; Theirault et al., 2006). These beneficial compounds are removed during high fructose corn syrup and cane sugar processing.

Recipes

Each recipe yields 500 mL of sports drink.

Tart Cherry Maple Sports Drink

Ingredients¹

450 g Filtered water (approximate)
16 g Dark or Very Dark maple syrup²
6.9 g Tart Cherry juice concentrate³
25 g Glycerol
0.7 g Malic acid
0.186 g Potassium chloride
0.11 g Sodium citrate

Tangerine Maple Sports Drink

Ingredients¹

450 g Filtered water (approximate)
14.6 g Dark or Very Dark maple syrup
14.9 g Tangerine juice concentrate⁴
25 g Glycerol
0.7 g Malic acid
0.186 g Potassium chloride
0.11 g Sodium citrate

¹The carbohydrate content in all recipes is 3 to 4% of the total solution. ²The initial Tart Cherry recipe uses 14.6 g maple syrup. See the “Consumer Evaluations” section to learn more. ³Tart Cherry juice concentrate contained 68 °Brix. ⁴Tangerine juice concentrate contained 65 °Brix.

Directions

1. Weigh out individual ingredients, except for water.
2. Add maple syrup, juice concentrate, and glycerol to a 500 mL container. Rinse the containers used to measure each wet ingredient with filtered water, and add this rinse to the 500 mL container.
3. Stir the drink solution until ingredients are combined.
4. Add malic acid, sodium citrate, and potassium chloride powders to the solution.
5. Bring the volume of the solution to 500 mL by adding filtered water.
6. Stir the solution until particles dissolve.
7. Refer to the “Preserving Product Quality” section for preservation and storage options.

Preserving Product Quality

Regulation Requirements

To produce this product commercially, a process approval from a processing authority and a 20-C Food Processing Establishment License from New York State Agriculture and Markets must be acquired as well as completion of an FDA approved Acidified Foods Course, such as the Better Process Control School (Thermal Processing, 2022; Personnel, 2022). Individuals interested in wholesale must also register with the United States Food and Drug Administration (FDA). Please contact a local Agriculture and Markets inspector or reach out to the Cornell Maple Program for assistance.

Process approvals are required for any food or beverage product manufactured in New York State for which a critical control point (CCP) is necessary to address any or all health hazards. The Cornell Food Venture Center offers process approval services which provide information on procedures to produce a safe product, record keeping requirements, and information on licenses and registrations required to produce said product. The information presented below is for general informational purposes only.

Refrigerated or Shelf-stable Product

For a refrigerated product, ensure pH is <3.8. The pH can be lowered using malic acid, citric acid, vinegar, or other acidic ingredients. Cool the sports drink to <41°F within 4 hours of manufacturing. Fill sanitized bottles with the cold sports drink and seal immediately. Store at <41°F. Bottles must be labeled with "Keep Refrigerated" and "Must be used by [date 10 days after manufacturing date]". Before distribution, check the pH of a bottle within each batch to ensure it is <3.8. Distribute, store, and sell product under refrigerated conditions.

For a shelf-stable product, select *one of the two* preservation procedures listed below. Additionally, ensure the product's pH is 3.8 or lower prior to pasteurization or addition of preservatives. The pH can be lowered using malic acid, citric acid, vinegar, or other acidic ingredients.

1. Pasteurization: Pasteurize by heating the sports drink to >180°F for a minimum of 5 min. Fill sanitized bottles with hot sports drink, cap, and invert for a minimum of 2 min. Reposition bottle with the cap up, and allow the sports drink to cool at ambient temperature for 3 min before force cooling. Store at ambient temperature. Bottles must be labeled with "Refrigerate after Opening". Before distribution, check the pH of a bottle within each batch to ensure it is <3.8.

2. Preservatives: Add sodium benzoate at 0.1% per weight of solution (e.g. 5 g in a 500 mL solution) and potassium sorbate at 0.1% per weight of solution. Mix until particles are

dissolved. Check pH to ensure it is <3.8. Fill sanitized bottles with the sports drink and store at ambient temperature. Bottles must be labeled with "Refrigerate after Opening". Before distribution, check the pH of a bottle within each batch to ensure it is <3.8.

Food Additives

Sodium benzoate is a salt of benzoic acid. Benzoic acid occurs naturally in agricultural commodities such as plums, tomatoes, cinnamon, cloves, and apples (Shahmohammadi et al., 2016). For commercial use, it is produced synthetically and acts as an antimicrobial by preventing bacteria and yeast growth and some mold growth. It is an effective inhibitor for products with a low pH (<4.5) and is ineffective at neutral pH and above (>7) (Chipley, 1983). Sodium benzoate is considered a "generally recognized as safe" (GRAS) food substance by the FDA. The maximum level permitted in the United States is 0.1% (Sodium Benzoate, 2022).

Potassium sorbate is a salt of sorbic acid, which occurs naturally in some berries, particularly mountain ash tree berries (Alrabadi et al., 2013). The commercially available potassium sorbate is synthetically produced and acts as a preservative by preventing mold growth. It helps to maintain quality by slowing color, flavor, and textural changes in food products. Potassium sorbate is also considered a GRAS food substance. There are no limitations set by the FDA on the amount added to food products (Potassium Sorbate, 2022).

Packaging

Table 1. Packaging Examples and Characteristics for Maple Sports Drink.

Packaging Material	Plastic Code	Characteristics	Temperature Limitations	Common Uses
Glass ^{1,2}	N/A	Stiff, high moisture and gas barrier	Varies with glass type	Beverages, condiments
Aluminum ² alloy 3004	N/A	Corrosion resistant; Air, moisture, and chemical barrier	<372 °F ³	Beverages
Polyethylene Terephthalate (PETE or PET) ²	1	Stiff, good moisture and gas barrier	-76 to 392 °F	Sports drink bottles, snack food wrappers
High Density Polyethylene (HDPE) ²	2	Stiff, high moisture barrier, very low gas barrier	-40 to 248 °F	Milk bottles, water bottles, margarine tubs

¹Soda-lime glass is a cost efficient glass type commonly used for beverages. Borosilicate glass has higher shock resistance than soda-lime and can withstand temperatures of about 300 °F (Singh et al., 2017). ²Packaging characteristics, temperature limitations, and common uses reported from Singh et al. 2017. ³AZO Materials 2012.

The sports drink market uses glass, aluminum cans, or polyethylene terephthalate (PET) (Fortune Business Insights, 2021). Each can withstand high temperatures, particularly glass and aluminum. Further, aluminum cans are lightweight and corrosion resistant, while PET has low production costs.

Market Projections



Health-conscious purchases are increasing, leading to an integration of functional beverages in the sports drink market. In 2020, the revenue for sports drinks was \$7 billion in the U.S. (Beverage Industry Magazine, 2020). Gatorade and Powerade account for 97% of this

market (Trefis Team & Great Speculations, 2015). Their parent companies, PepsiCo and The Coca-Cola Company, have invested in and sometimes acquired (e.g., BodyArmor) smaller functional beverage companies that promote themselves as natural, healthy alternatives to their competitors. The market value of sports drinks labeled as “Naturally Sweetened” has grown 8% from 2021 to 2022 (Sabetta, 2022).

Maple syrup is an ideal sweetener for this growing sector of natural, healthy alternatives. It is a forest-sourced commodity that undergoes minimal processing, contains higher total antioxidants than honey, agave, raw cane sugar, and other sugars (Phillips et al., 2009), and it fits consumer preferences for a clean-label product.

Consumer Evaluations

To assist with marketing Maple Sports Drinks, the Cornell Cross Country and Track and Field athletes assessed Tart Cherry and Tangerine flavors immediately following exercise. They evaluated both flavors for overall liking and provided insight into their purchase intent.

Overall, the Tart Cherry version was liked by 70% of panelists ($n=70$), while the Tangerine version was liked by 88% of panelists ($n=41$) (Figure 1). For the Tart Cherry version, 48% of the 70 panelists requested increased flavor intensity. An in-house sensory evaluation was conducted to assess this alteration and a 10% increase in maple syrup (16 g per serving) resulted in an improved, slightly sweeter flavor compared to the initial formulation (14.6 g per serving). The updated recipe is presented in the "Recipe" section.

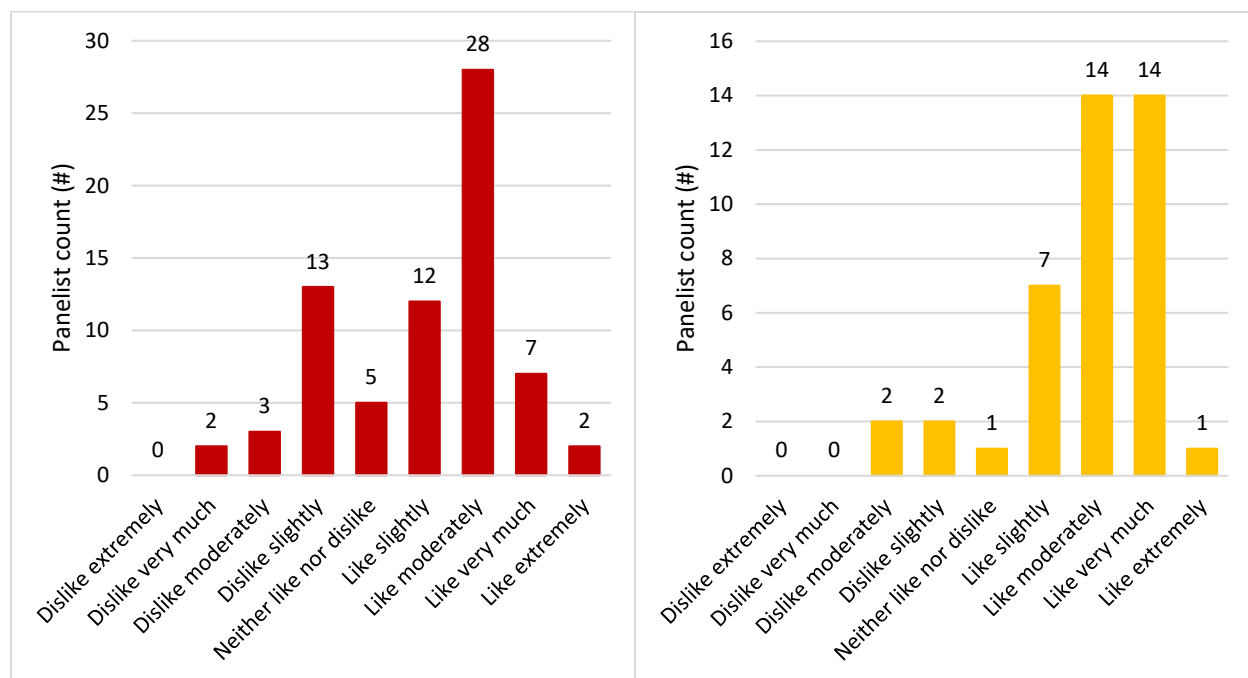


Figure 1. Overall liking of the initial formulation of Tart Cherry (left) and Tangerine (right) Maple Sports Drink samples given to athletes immediately following exercise.

To assess purchase intent, athletes were informed of Gatorade prices (at the time of study, \$1.99 for 24 oz) and were asked how much they would spend on the Tangerine Maple Sports Drink, knowing that it was made with all-natural ingredients, including maple syrup. For athletes who consume sports drinks at least once per week (80.5% of 41 panelists), 76% said they would pay \$1.99 for a 24 oz Tangerine Maple Sports Drink, 57% would pay \$2.49, and 30% would pay \$2.99 (Figure 2). The cost of ingredients for the Tangerine Maple Sports Drink used in this survey was \$1.03 per 24 oz. This cost would decline if ingredients were purchased in bulk and sourced for competitive pricing. (For reference, the ingredient cost for the Tart Cherry Maple Sports Drink was similar at \$1.02 per 24 oz, but athletes were not surveyed for purchase intent for this version of the product.)

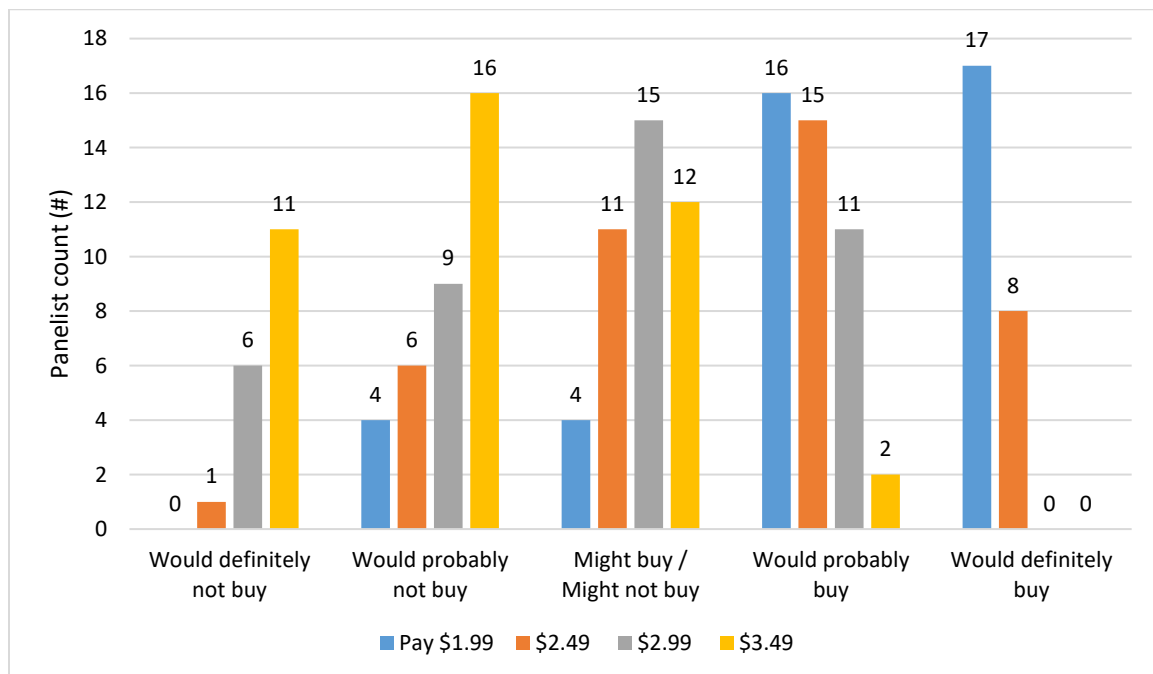


Figure 2. Purchase intent of Tangerine Maple Sports Drink, with knowledge of ingredients. Panelists (n=33) consume electrolyte beverages at least once per week.

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