

Tips for Reducing Sugar in Frozen Dairy & Novelty Desserts

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The products in question

- ▶ Ice Cream Type

Actively frozen



- ▶ Frozen Dessert

- ▶ Quiescently frozen



Sugar's function in frozen desserts

- ▶ Freezing and melting characteristics
- ▶ Sweetness
- ▶ Viscosity, mouthfeel, texture
- ▶ Color and secondary flavor (non enzymatic browning)
- ▶ Excipient (filler and dispersant)
- ▶ Glass former (actually viscosity at low temperature)

The products in question, sugar functionality

▶ Ice Cream Type

Consumption

sweetness

texture

thermal experience

Production

Freezing

Freezing profile

Shelf life

Freezing profile

glass transition and viscosity

Crystallization

Sugar Migration

▶ Quiescently Frozen Desserts

▶ Consumption

▶ sweetness

▶ Texture

▶ Thermal experience

▶ Production

▶ Freezing

▶ Freezing point

▶ Shelf Life

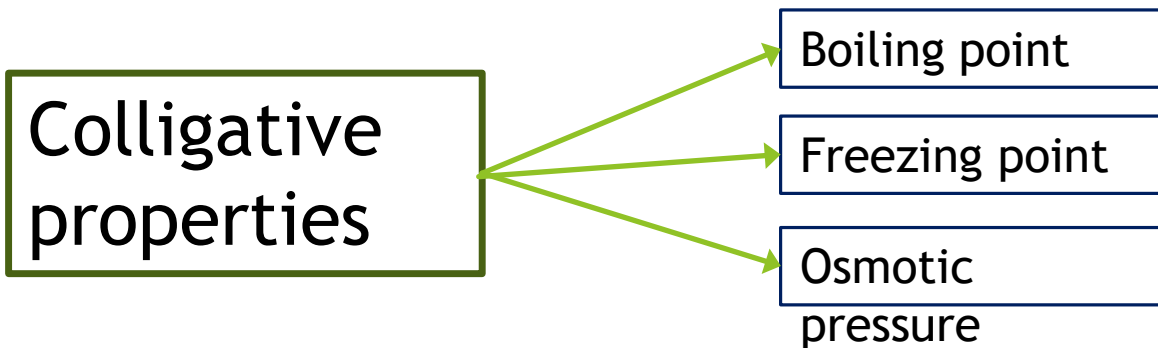
▶ Melting point

▶ Sugar migration & viscosity

▶ Crystallization

Colligative properties

- ▶ The freezing point depression is proportional to the number of solute molecules not the percentage of solute.
 - ▶ for a given percentage of a solute, smaller molecules will have a larger number than for bigger molecules
 - ▶ a molecule of starch for instance will have many thousands of glucose moieties in each molecule. A given percentage of glucose will have a huge effect on the freezing point of a solution while the same percent of starch will have almost no effect on the freezing point.



$$\Delta T = \frac{1.86 * 1000 * W_2}{M_2 W_1}$$

ΔT - freezing point depression
 W_1 - weight of solvent (liquid water)
 W_2 - weight of solute
 M_2 - molecular weight of solute

Sweeteners

Sweetener	% Sweetness relative to sucrose	Average molecular weight
Sucrose	100	342
Fructose	173	180
Glucose (dextrose)	74	180
Lactose	16	342
Galactose	32	180
Invert sugar	95	~270
Honey	75	~270
Erythritol	70	122
Sorbitol	60	182
Maltitol	68	344
Stevia	30000 to 150000	~318
Saccharin (Na)	30000	183
Acesulfame (K)	20000	201
Sucralose	60000	398
Neotame	800000	378
Glycerol	~80	92
Salt	0	58
Ethyl Alcohol	0	46

What happens when we remove sugar and add intense sweetener

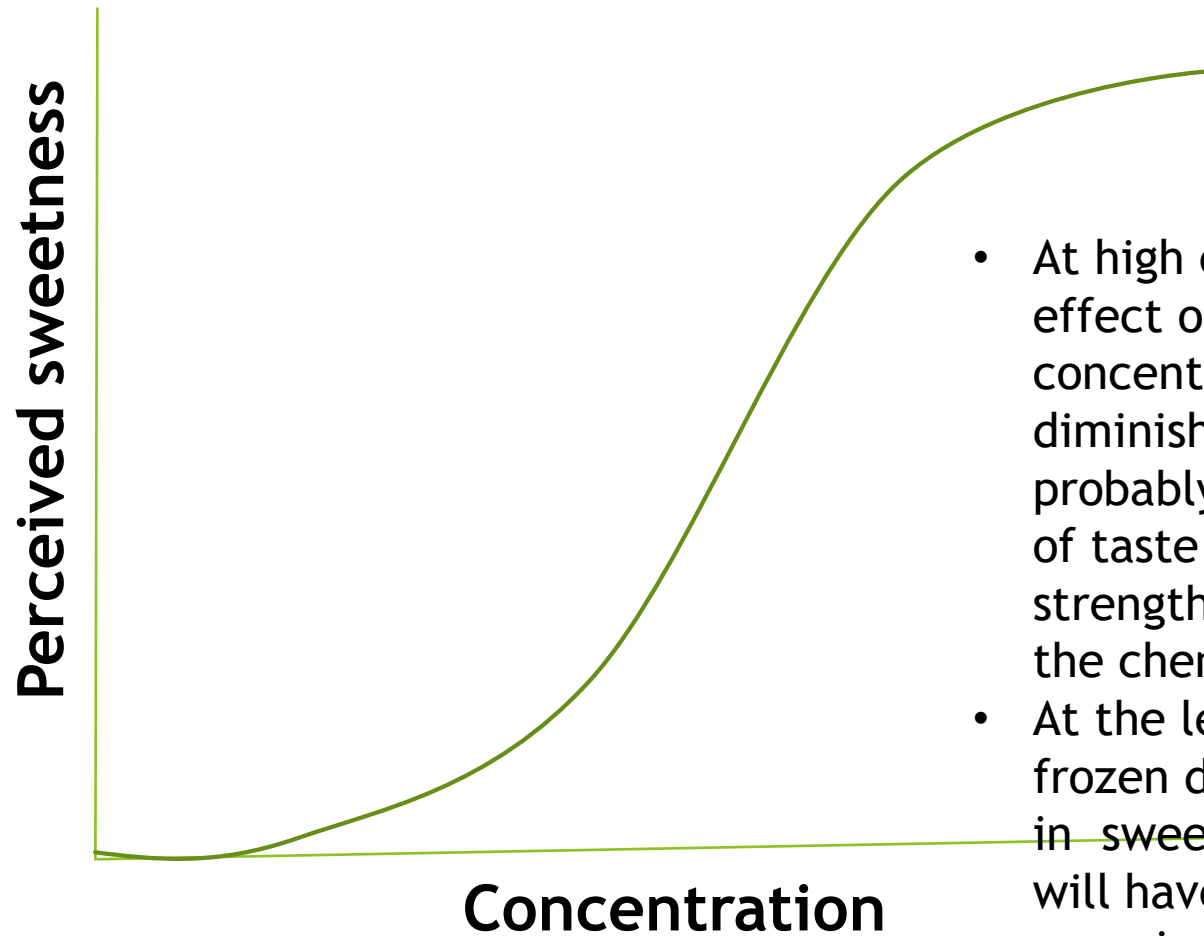
Actively frozen desserts

- ▶ Freezing point increases
 - ▶ More water frozen throughout freezing curve
 - ▶ Product gets harder at consumption
 - ▶ Product gets chunkier at freezing
 - ▶ Product gets icier during shelf life
- ▶ The product gets less viscous
 - ▶ Product gets icier and less smooth
 - ▶ Liquid drainage during shelf life
 - ▶ Mottling of colors
 - ▶ Difficulty holding overrun

Quiessently frozen desserts

- ▶ Freezing point increases
 - ▶ More water frozen
 - ▶ Product is harder and more ice cube like especially at lower temperatures
 - ▶ Lower viscosity
 - ▶ Color leaching
 - ▶ Mottling of colors

It is helpful to consider



- At high concentrations the effect of reducing sugar concentration will have diminished effect this is probably due to the number of taste receptors and the strength of the response to the chemical.
- At the level of sweetness in frozen desserts small changes in sweetener concentration will have negligible effect on perceived sweetness.



Strategy 1 - actively frozen desserts

- ▶ Remove sugar and replace with a sugar alcohol
 - ▶ Maltitol, sorbitol, Erythritol
 - ▶ Keep the freezing point in mind for example erythritol has a low molecular weight and is 70% as sweet as sugar. You might want to replace 10 percent of sugar with erythritol and keep the sweetness the same. This would require 14% erythritol but erythritol's molecular weight is 122 this would drop the freezing point three times as much as an equivalent amount of sucrose. Maltitol may be a better choice
- ▶ Advantage
 - ▶ Relatively easy to do
 - ▶ 1 for 1 ingredient substitution (maltitol)
 - ▶ No patents involved
- ▶ Disadvantage
 - ▶ Complex sounding names
 - ▶ May need a bulking agent

Strategy 2 - actively frozen desserts

- ▶ Remove sugars and add small molecular weight ingredients and intense sweeteners
 - ▶ Erythritol, glycerol, fructose
 - ▶ Aspartame, Acesulfame K, Stevia
- ▶ Advantage
 - ▶ Relatively easy to do
 - ▶ No patents involved
- ▶ Disadvantage
 - ▶ At least two ingredients for the one being replaced
 - ▶ Complex sounding names
 - ▶ May need a bulking agent such as maltodextrin

Strategy 3 - actively frozen desserts

- ▶ Remove Lactose by ultrafiltration and add a low molecular weight sweetener like fructose, dextrose glycerol or erythritol
- ▶ Advantage
 - ▶ Relatively easy to do
- ▶ Disadvantage
 - ▶ May run into patent issues. Always check this for any formula or process change
 - ▶ May need to add a bulking agent like maltodextrin
 - ▶ Equipment is expensive.
 - ▶ Cost of production

Strategy 1 - quiescently frozen desserts

- ▶ Remove sugar and replace with a sugar alcohol
 - ▶ Maltitol, sorbitol, Erythritol
- ▶ Advantage
 - ▶ Relatively easy to do
 - ▶ 1 for 1 ingredient addition possible
 - ▶ Freezing point not as critical
 - ▶ No patents involved
- ▶ Disadvantage
 - ▶ Complex sounding names
 - ▶ Bulking agent like maltodextrin may be necessary

Strategy 2 - quiescently frozen desserts

- ▶ Remove sugar and replace with juice and a bulking agent
- ▶ Advantage
 - ▶ Relatively easy to do
 - ▶ Juice on label
- ▶ Disadvantage
 - ▶ Complex sounding names (maltodextrin)
 - ▶ Adding more juice than found in 100% juice will probably require labeling as added sugar. Most juices have insufficient sugar.
 - ▶ Claiming all fruit juice may become a regulatory nightmare

Strategy 3 - quiescently frozen desserts

- ▶ Just remove some sugar and leave it like that
- ▶ Advantage
 - ▶ Very easy to do
 - ▶ No patents involved
- ▶ Disadvantage
 - ▶ Poor product texture

No sugar added ice Pop EXAMPLE - SWEETENERS

Water, Strawberries, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Citric Acid, Beet Juice Color, Ascorbic Acid (Vitamin C), Guar Gum, Carob Bean Gum, Strawberry Juice from Concentrate (Water, Strawberry Juice Concentrate), Natural Flavors, Acesulfame Potassium, Sucralose, Turmeric Oleoresin Color. Tangerine: Water, Sorbitol**, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Maltodextrin, Glycerin, Tangerine Juice from Concentrate (Water, Tangerine Juice Concentrate), Polydextrose, Natural Flavor, Citric Acid, Orange Pulp Cells, Ascorbic Acid (Vitamin C), Guar Gum, Tangerine Oil, Carob Bean Gum, Sucralose, Acesulfame Potassium, Gum Arabic, Turmeric Oleoresin Color, Beta Carotene (Color), Isomalt**, Modified Corn Starch. Raspberry: Water, Red Raspberry Puree, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Natural Flavor, Elderberry Juice from Concentrate (Water, Elderberry Juice Concentrate), Citric Acid, Ascorbic Acid (Vitamin C), Guar Gum, Carob Bean Gum, Sucralose, Acesulfame Potassium. **Sensitive individuals may experience a laxative effect from excess consumption of this ingredient.

EXAMPLE - Bulking Agents

Water, Strawberries, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Citric Acid, Beet Juice Color, Ascorbic Acid (Vitamin C), Guar Gum, Carob Bean Gum, Strawberry Juice from Concentrate (Water, Strawberry Juice Concentrate), Natural Flavors, Acesulfame Potassium, Sucralose, Turmeric Oleoresin Color. Tangerine: Water, Sorbitol**, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Maltodextrin, Glycerin, Tangerine Juice from Concentrate (Water, Tangerine Juice Concentrate), Polydextrose, Natural Flavor, Citric Acid, Orange Pulp Cells, Ascorbic Acid (Vitamin C), Guar Gum, Tangerine Oil, Carob Bean Gum, Sucralose, Acesulfame Potassium, Gum Arabic, Turmeric Oleoresin Color, Beta Carotene (Color), Isomalt**, Modified Corn Starch. Raspberry: Water, Red Raspberry Puree, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Natural Flavor, Elderberry Juice from Concentrate (Water, Elderberry Juice Concentrate), Citric Acid, Ascorbic Acid (Vitamin C), Guar Gum, Carob Bean Gum, Sucralose, Acesulfame Potassium. **Sensitive individuals may experience a laxative effect from excess consumption of this ingredient.

EXAMPLE - thickeners

Water, Strawberries, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Citric Acid, Beet Juice Color, Ascorbic Acid (Vitamin C), **Guar Gum, Carob Bean Gum**, Strawberry Juice from Concentrate (Water, Strawberry Juice Concentrate), Natural Flavors, Acesulfame Potassium, Sucralose, Turmeric Oleoresin Color. Tangerine: Water, Sorbitol**, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Maltodextrin, Glycerin, Tangerine Juice from Concentrate (Water, Tangerine Juice Concentrate), Polydextrose, Natural Flavor, Citric Acid, Orange Pulp Cells, Ascorbic Acid (Vitamin C), **Guar Gum**, Tangerine Oil, **Carob Bean Gum**, Sucralose, Acesulfame Potassium, Gum Arabic, Turmeric Oleoresin Color, Beta Carotene (Color), Isomalt**, Modified Corn Starch. Raspberry: Water, Red Raspberry Puree, Sorbitol**, Maltodextrin, Glycerin, White Grape Juice from Concentrate (Water, White Grape Juice Concentrate), Polydextrose, Natural Flavor, Elderberry Juice from Concentrate (Water, Elderberry Juice Concentrate), Citric Acid, Ascorbic Acid (Vitamin C), **Guar Gum, Carob Bean Gum**, Sucralose, Acesulfame Potassium. **Sensitive individuals may experience a laxative effect from excess consumption of this ingredient.

No sugar added ice cream EXAMPLE - SWEETENERS

non-fat milk, cream, **maltitol syrup**** , maltodextrin, polydextrose** , whey protein, **glycerin**, natural flavor, propylene glycol monostearate, guar gum, monoglycerides, sorbitol** , **sucralose**, citric acid, xanthan gum, carrageenan, annatto color, acesulfame potassium, vitamin A palmitate. contains: milk ingredients. **sensitive individuals may experience a laxative effect from excess consumption of this ingredient

EXAMPLE - Bulking Agents

non-fat milk, cream, maltitol syrup**, maltodextrin, polydextrose**, whey protein, glycerin, natural flavor, propylene glycol monostearate, guar gum, monoglycerides, sorbitol**, sucralose, citric acid, xanthan gum, carrageenan, annatto color, acesulfame potassium, vitamin A palmitate. contains: milk ingredients. **sensitive individuals may experience a laxative effect from excess consumption of this ingredient

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