

Welcome



Beyond Sweetness The Functional Roles of Sugar in Foods And the Challenges in Replacing/Reducing it

Time: Thursday, February 04, 2016 at 1:00-2:00 PM EST

Speakers:



Prof. Douglas Goff



Prof. Julian Cooper

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Beyond Sweetness: The Functional Roles of Sugar in Foods and the Challenges in Replacing/ Reducing It

Prof. H. Douglas Goff
Dept. of Food Science
University of Guelph



UNIVERSITY
of GUELPH

CHANGING LIVES
IMPROVING LIFE

“Sugar”, Sugars and Sweeteners

Monosaccharides

- **Glucose, Fructose and Galactose**

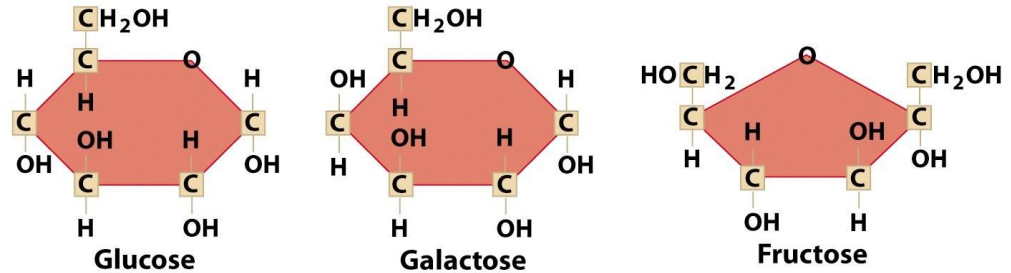


Figure 4-4 Nutrition: Science and Applications, 1/e
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Disaccharides

- **Sucrose (“sugar”), Maltose and Lactose**

Sugar Alcohols

- **Sorbitol, Xylitol and Erythritol**
- **Maltitol and Lactitol**

High-potency Sweeteners

- **Aspartame, Acesulfame K, Sucralose, Saccharin, Stevia**

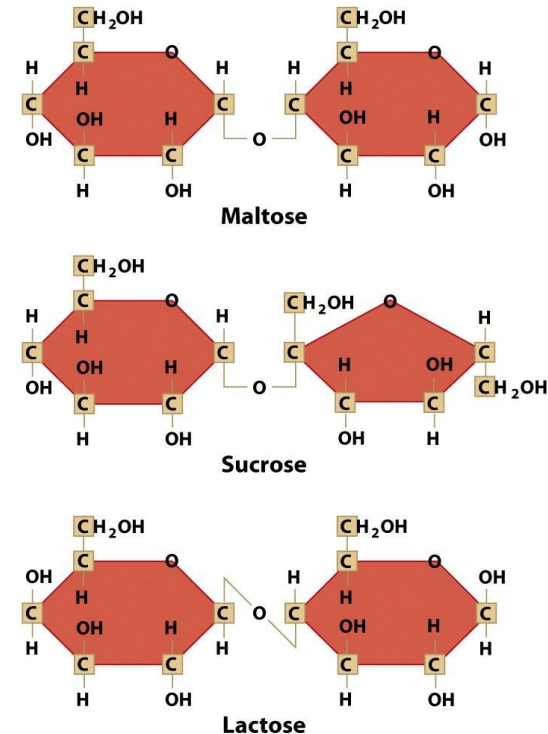


Figure 4-6 Nutrition: Science and Applications, 1/e
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Functional Properties of Sugar in Foods

Sensory

- Sweetness and flavour perception and enhancement
- Texture and appearance

Microbial

- Preservation
- Fermentation

Chemical

- Caramelization
- Maillard Browning
- Plasticization of polymers

Phase Transitions

- Crystallization and candies
- Freezing point depression



Functional Properties of Sugar in Foods

Sensory

- **Sweetness and flavour perception and enhancement**
 - **Sweetness time-intensity profile of sugar is the standard**
 - **Flavour modification and perception: e.g., releasing aromas, balancing the bitterness of cocoa in chocolate, the sourness of yogurt, the acidity of tomatoes**



Functional Properties of Sugar in Foods

Sensory

- Sweetness and flavour perception and enhancement
- Texture and appearance
 - Interaction of sugar with water to create viscosity
 - “Syrupy” mouthfeel
 - For example, juice and other sugar-sweetened beverages, low calorie vs. regular jello.



Functional Properties of Sugar in Foods

Microbial

• Preservation

- Lowering “water activity” (the availability of water to support microbial growth) and thereby reducing microbial growth potential and increasing ambient-temperature shelf-life
- e.g., strawberry jam, fruit cakes, sweetened condensed milk



Functional Properties of Sugar in Foods

Microbial

- Preservation
- Fermentation
 - Growth substrate for microorganisms in various foods (e.g., bread and yeast-leavened baked products)
 - Sugar produces carbon dioxide



Functional Properties of Sugar in Foods

Chemical

•Caramelization

- Heat causes the formation of brown colours and different flavours
- E.g., peanut brittle, caramels and toffees, molasses, also hints of caramelization in many other heated foods



Functional Properties of Sugar in Foods

Chemical

- **Caramelization**
- **Maillard Browning**
 - Colour and flavour changes with heat and amino acids (sucrose conversion to glucose initiates Maillard reactions)
 - Occurs in bread and bakery products (crusts or making toast) and many whole foods that are heated



Functional Properties of Sugar in Foods

Chemical

- Caramelization
- Maillard Browning
- Plasticization (“softening”) of polymers
 - **Modifies water absorption and mobility characteristics, e.g., the effects of sugar on starch gels or gluten networks**



Functional Properties of Sugar in Foods

Phase Transitions

- **Crystallization and candies**
 - Confectionery industry based on controlled crystallization of sugar to give different textures, e.g., smoothness of fondants and fudge
- Amorphous sugar glasses, e.g., hard candies



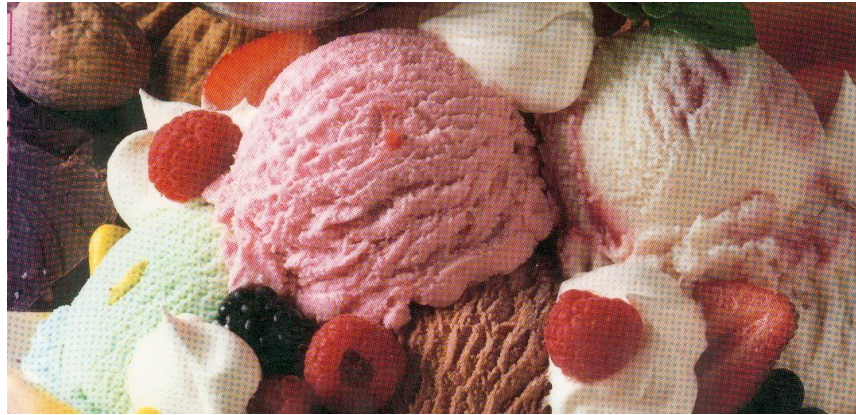
Functional Properties of Sugar in Foods

Phase Transitions

- **Crystallization and candies**
- **Freezing point depression**
 - **Colligative property based on molecular weight of the sugar and its concentration**
 - **Results in “unfrozen phase” in sugar-containing foods at freezer temperatures, which can affect stability and shelf-life**
 - **Softness and scoopability in ice cream**



Example of Sugar Reduction Challenge: Ice Cream/ Frozen Desserts

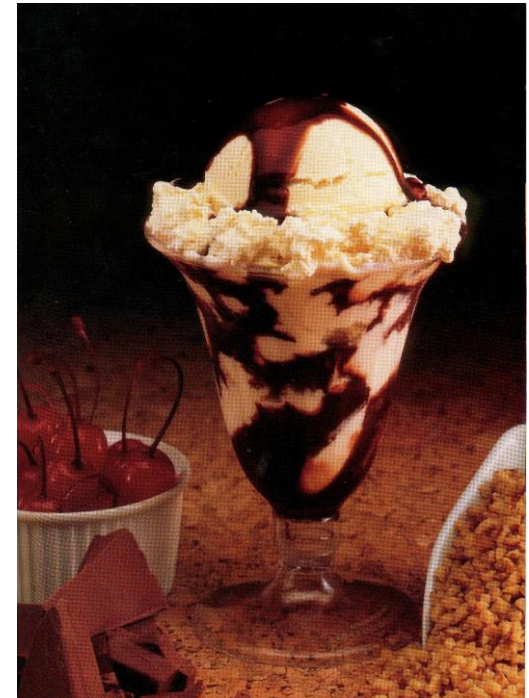


Global Diabetes trend suggest the market for low Glycemic Index (GI) Products should be strong and growing

In this example, maltitol (disaccharide) provides the freezing characteristics of sugar but at a lower glycemic index. Sucralose is needed to boost the sweetness of maltitol to sugar-equivalence. But, no reduction in calories.

Ice Cream Mix Composition

- **(Milk) fat** (4-8) - >10% - 16%
- **Milk solids-not-fat** 9% - 12%
- **Sweeteners**
 - **Sucrose** 10% - 14%
 - **Corn syrup solids (Glucose solids)** 4% - 5%
- **Stabilizers** 0% - 0.4%
- **Emulsifiers** 0% - 0.25%
- **Water** 55% - 64%



In determining appropriate blend of sweeteners for ice cream

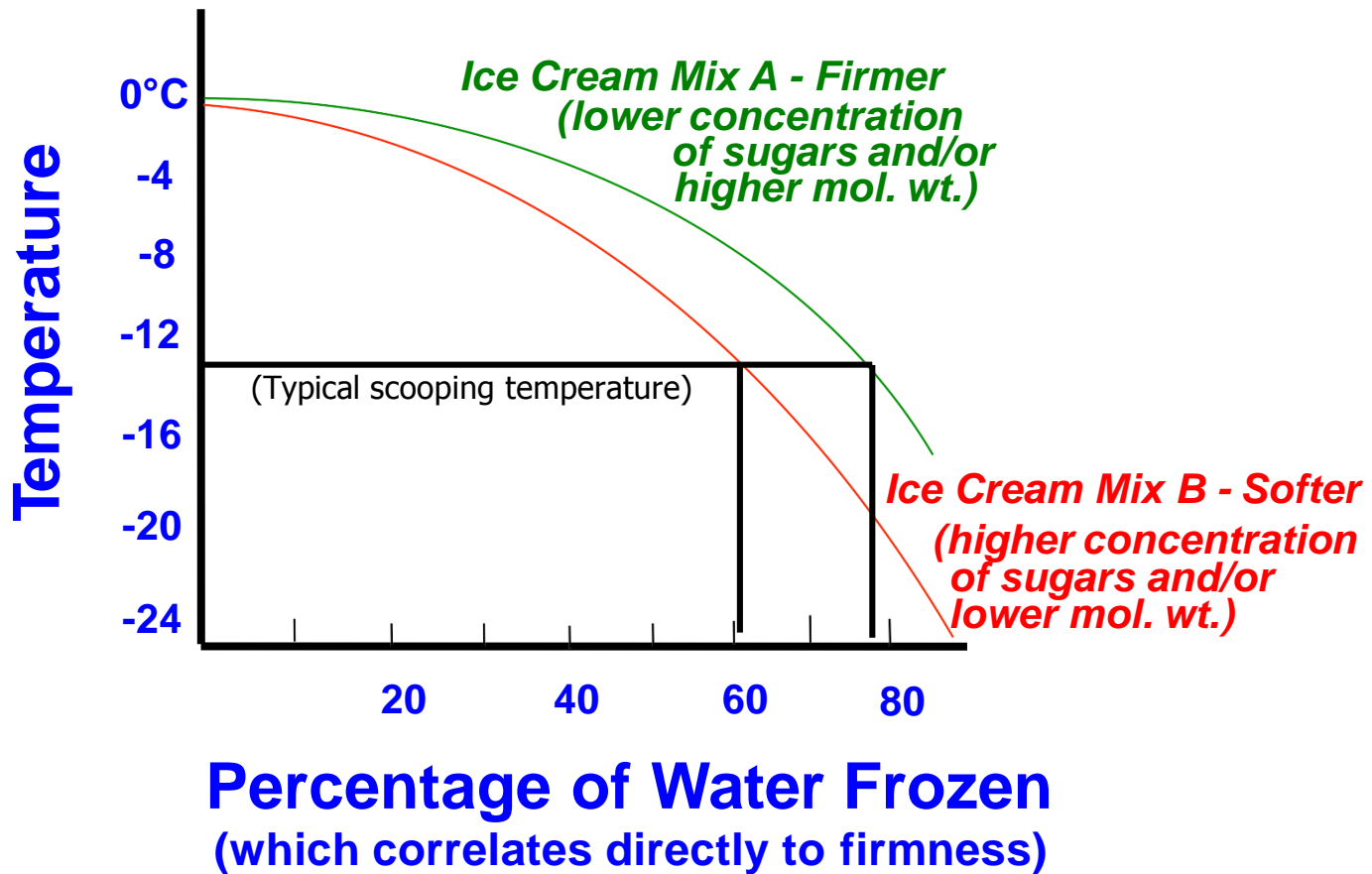
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You have to consider:

- n Sweetness
- n Freezing pt. depression, which leads to softness/scoopability
- n Total solids/water level desired in the formulation

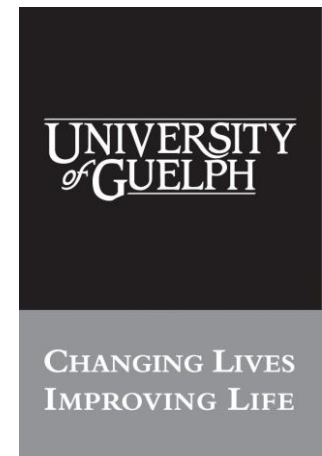


Ice Cream Freezing Curves



Conclusions

- **Sugars contribute many functional properties to foods beyond sweetness; the high-potency sweeteners are not an option in many cases.**
- **Sugar reduction/replacement is an application-specific product development challenge that in many cases is difficult to overcome.**
- **Another important consideration: what is sugar being replaced with and, in the end, what has been accomplished?**





Dr. Julian Cooper

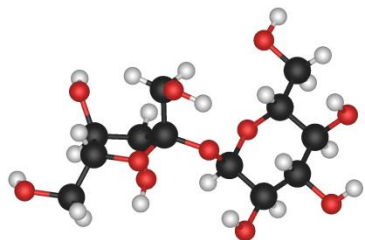
Professor

University of Reading

Fellow of the Royal Society of Chemistry, UK

Fellow of the Institute of Food Science and Technology, UK

- Internationally renowned sugar and carbohydrate expert in process and product development, carbohydrate chemistry, product reformulation and research and development in the food sector



Sug

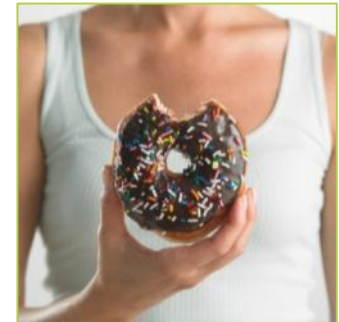
Reformulation Challenge

CS Webinar
4 February 2016

Professor Julian M Cooper

Sugar & the Reformulation Challenge

1. What does sugar deliver?
2. Why Reformulate?
3. How can the multi-functionality of sugar be replaced?
4. Reformulation considerations



What does sugar deliver?

- Recognised, natural, traditional ingredient
- Multifunctional
- Clean label – sugar
- 4 calories/g (fat 9 calories/g)
- Medium glycaemic index (65)



Why Reformulate?

- Replace/reduce certain ingredients
- Develop 'functional' products
- Provide choice for consumers
- Develop new products - innovation
- Reduce energy density in products
- Reduce calories in products

Replacing Sugar functionality – What can I use?

Sweetness —————> High intensity sweeteners, polyols

Mouth feel/Texture —————> Hydrocolloids, polyols, sugars

Structure —————> Bulking agents, polyols, fibres

Colour —————> Colours

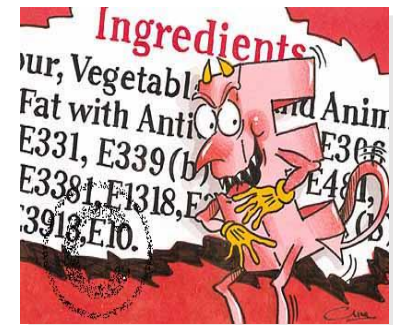
Flavour —————> Flavours

Stability/Preservation —> Preservatives



Considerations when replacing/reducing sugar

- Multiple ingredients
- Increased labelling/warnings (e.g. polyols, aspartame, etc.)
- Gastro-intestinal consequences (polyols, etc.)
- Food safety may be compromised
- Reducing sugar may increase calories (energy density)
- Taste and Consumer acceptance (manufacturer)



Regular Jam vs Sugar Free Preserve

- **Regular Jam**
- Strawberries, sugar, glucose, glucose-fructose, pectin, citric acid

- **Sugar Free Preserve**
- Water, strawberries, polydextrose, maltodextrin, locust bean gum, natural flavour, citric acid, potassium sorbate, sucralose, calcium chloride, Red 40 (colour)



Regular Jam vs Sugar Free Preserve



Regular Jam	Functionality	Sugar Free Preserve
Strawberries, sugar, glucose, glucose-fructose	Sweetness	Strawberries, sucralose
Strawberries, sugar, glucose, glucose-fructose, pectin	Bulk	Strawberries, water, polydextrose, fruit pectin, locust bean gum
Pectin, sugar, glucose, glucose-fructose	Gelling	Fruit pectin, calcium chloride
sugars	Preservative	Potassium sorbate
Citric acid	Acidity	Citric acid
sugars	Flavour	Natural flavour
sugars	colour	Red40

Increased Energy Density (Calories/100g)

Regular cake

'Cal reduced' cake

Wt(g)	Cals	Ingredient	Wt(g)	Cals
100	900	Fat	100	900
100	400	Sugar	50	200
100	400	Flour	100	400
300	1700	Totals	250	1500

Increased Energy Density (Calories/100g)

Regular cake

'Cal reduced' cake

Wt(g)	Cals	Ingredient	Wt(g)	Cals
100	900	Fat	100	900
100	400	Sugar	50	200
100	400	Flour	100	400
300	1700	Totals	250	1500
	567	Calories increase/100g		600

Stepwise Reduction

Shortbread recipe

Butter 110g; Flour 175g; Caster sugar 50g

Weight of sugar g	'Calories reduced'	Sugar g/100g	
50	0	14.9	
45	20	13.6	
40	40	12.3	
35	60	10.9	

'Calories reduced' = wt of sugar removed x 4cals

Stepwise Reduction

Stepwise sugar reduction					
Shortbread					
Recipe		Fat g	Carb g	Protein g	Sugars g
Butter	110	88			
Flour	175		122.5	17.5	
Sugar	50		50		50
% composition		26.3	51.5	5.2	14.9
Total Recipe Wt g	335				
Calories		792	690	70	
Total Cals	1552				
Cals/100g	463				

Stepwise Reduction

Shortbread recipe

Butter 110g; Flour 175g; Caster sugar 50g

Weight of sugar (g)	'Calories reduced'	Sugar g/100g	Actual Calories/100g
50	0	14.9	463
45	20	13.6	464
40	40	12.3	465
35	60	10.9	466

'Calories reduced' = weight of sugar removed x 4 Cals

Reduced Sugars – Cereal Products

‘Reduced Sugar’ products



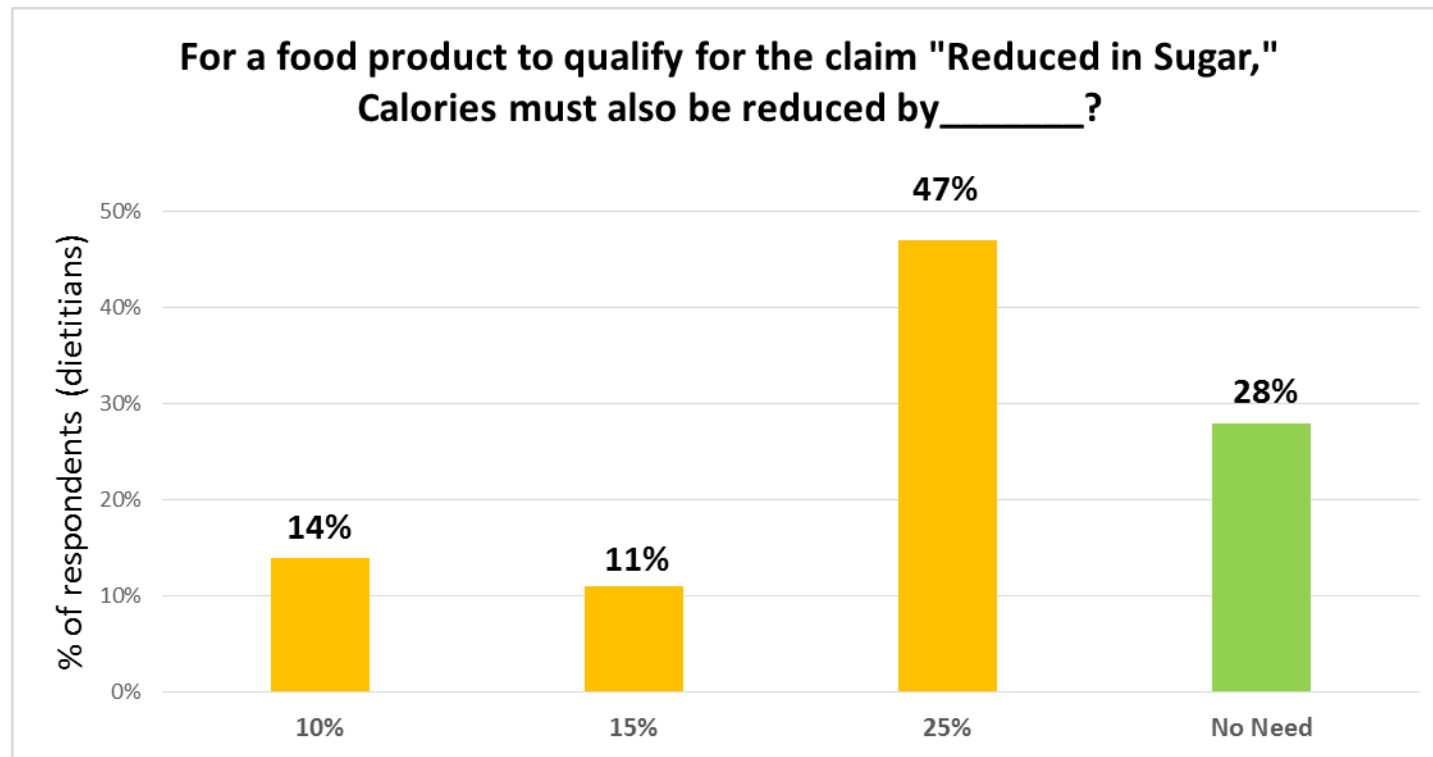
Product	Sugar g/100g	Energy cal/100g	Salt g/100g	Fat g/100g
Regular Sugar coated Product	37	371	1.15	0.6
‘Reduced Sugar’ Product	25	369	1.4	0.6
Regular Product	8	373	1.75	0.9

Consumer Expectations

- Research at Leatherhead Food Research
 - Consumer focus groups and web questionnaire
 - Good awareness of product claims eg 'no added sugars' etc
 - Little awareness of the level of reduction or the associated calorie reduction
 - Expect a reduction in sugar content to deliver a reduction in calorie content
 - Consumer confusion around calorie content of different nutrients
-
- Ref: Consumer understanding of sugars claims on food and drink products N J Patterson, M J Sadler & J M Cooper. British Nutrition Foundation Nutrition Bulletin **37**, 121 – 130, 2012

Consumer Expectations—cont'd

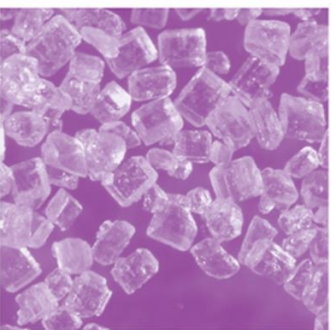
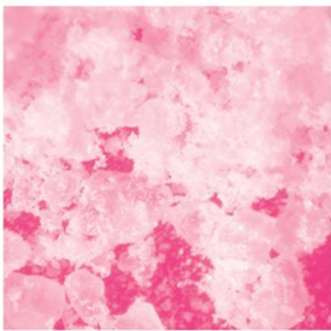
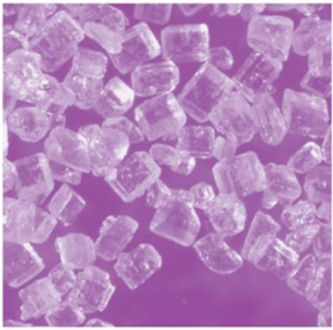
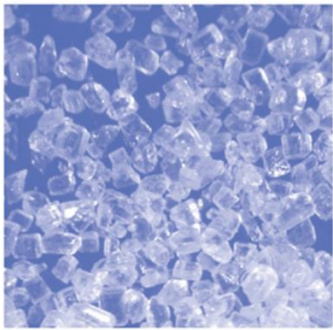
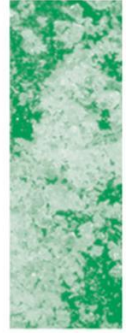
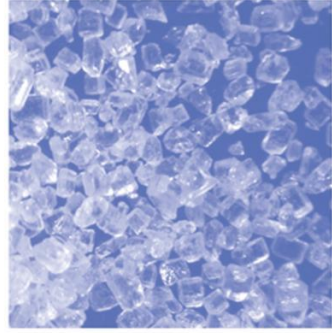
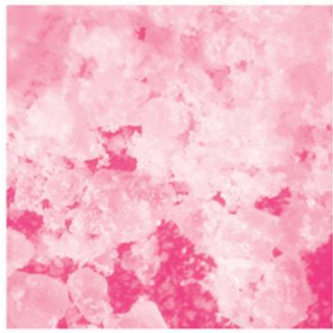
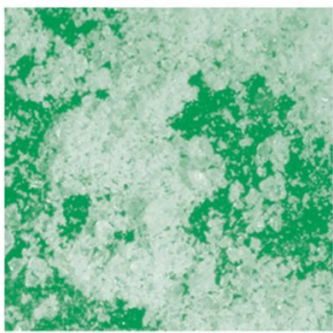
- A survey among Canadian dietitians (n=140) revealed similar expectations of Calorie reduction in products carrying the claim “Reduced in Sugar”



Ref: Brisbois T et al. Front-of-pack sugar claims: health professionals' understanding compared with marketplace practice. Appl. Physiol. Nutr. Metab. Vol. 38, 2013: 445.

Summary

- Sugar - natural, traditional, multifunctional ingredient
- “Sugars” on nutrition labels are not just sugar
- No unique sugar replacer for all applications
- Reformulation must deliver improved nutrition profile and preferably reduction in calories
- Stepwise reduction may have unintended consequences



THANK YOU

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Questions?

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Thank you



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