Food Reformulation for Sugars

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What are sugars?

Sugars are the basic building blocks of carbohydrates found in nature. The most common ones found in foods are single sugars (monosaccharides) e.g. glucose, fructose, galactose, and double units (disaccharides) e.g. sucrose (table sugar) lactose (milk sugar), maltose. Many terms are used to differentiate between sugars naturally present in foods and those added during food preparation. Pack labels state 'Carbohydrate, of which sugars', defined as total sugars which includes all mono- and disaccharides present, irrespective of source. Free sugars ('added sugars') defines sugars added by the manufacturer, chef or consumer and can include other sugar-containing materials, e.g. syrups. It is not possible to distinguish analytically between sugars naturally present in foods and those added in manufacture, which our bodies use identically, irrespective of the source.

Where do sugars in the diet come from?

The dietary sources are diverse and multifaceted. Single sugars are intrinsic components of fruits and dairy products, supplying vital nutrients alongside inherent sweetness. A considerable portion of dietary sugars are attributed to free sugars, incorporated during food processing or preparation. These free sugars are used widely in processed foods, including beverages, baked goods, confectionery, and sweetened breakfast cereals, contributing to overall sugar intake. Sauces, dressings, and savoury snacks are further sources. Table sugar (sucrose), glucose syrup, high-fructose corn syrup, glucose-fructose (invert and isomerised) and fructose-glucose syrups, honey, maple and agave syrups, may also be used to enhance the palatability of foods and beverages [1], [2], [3].

Why are they a concern in the diet?

There are several concerns regarding the over-consumption of sugars [1, 3], principally excess calories leading to obesity, which causes increased risk of development of type 2 diabetes and cardiovascular disease. Additionally, dental health and frequent consumption of fermentable carbohydrates, including sugars, causing dental caries. Consumption as part of a healthy balanced diet, and according to recommended maximum levels, is not a major concern. The focus of sugars reformulation is primarily aimed at reducing dietary calories. The UK Government recognised the impact in soft drinks and introduced the Soft Drinks Industry Levy in 2018 [4]. There is some evidence that it promoted reformulation without significant impact on sales, however the overall impact on calorie intake is more difficult to determine.

What do sugars do in foods and what can I use to replace the functionality?

Sugars are not only sweet, they also deliver many and varied properties that are desirable in different food products. Some of the key functionalities delivered by sugars in different food products are highlighted in Table 1. The interaction of sugars with the other ingredients present is fundamental and generates the traditional colours and flavours expected in many products. In products where sugars are reduced, the impact on many of these properties can be significant.

Table 1 - Sugars Functionality in Food Products

Functionality	Product types						
	Baked goods	Breakfast cereals	Confectionary	Dairy	Frozen desserts	Jams & preserves	Soft Drinks
Sweetness	✓	✓	✓	✓	✓	✓	✓
Mouthfeel				✓	✓		✓
Flavour: enhancement, formation, release	✓	✓	✓	✓	✓	✓	✓
Bulk	✓	✓	✓		✓	✓	
Preservative			✓				

Table 1 - Sugars Functionality in Food Products (continued)

Functionality	Product types						
	Baked goods	Breakfast cereals	Confectionary	Dairy	Frozen desserts	Jams & preserves	Soft Drinks
Humectancy	✓		✓				
Colour	✓	✓	✓			✓	
Solubility			✓				
Crystal and 'glass' formation		✓	✓				
Crunchiness - breakfast cereal 'bowl life'		✓	✓				
Texture modification	✓	✓					
Coating and glazing	✓						
Fermentation Substrate	✓						
Structure Formation		✓					
Preservative - synergy with other ingredients						✓	
Freezing point depression					✓		

There are many ingredients that can replicate some of the properties of sugars, however typically they only replicate one or two properties, and thus several combinations of these ingredients are required to replace sugars. There is no universal sugar replacer that can apply to all food applications. Such alternative ingredients are highlighted in Table 2.

Table 2 - Ingredients that could replace some of the functions of sugars

Function	Alternative Ingredients	Examples
Sweetness	High potency sweeteners Polyols Flavourings (amplifiers and modifiers)	Aspartame (E951) Xylitol (E967) Vanilla
Mouthfeel/texture	Gums Thickeners Polyols	Xanthan gum (E415) Gelatine Xylitol (E967)
Bulk	Bulking agents	Polydextrose (E1200)
Appearance - colour	Colours	Caramel (E150a)
Flavour	Flavourings	Vanillin
Preservation	Preservatives	Sodium benzoate (E211)
Humectancy	Humectants	Glycerol (E422)

Technical strategies to reduce sugars in foods

Sugars have various functions in different foods (Table 1), hence many strategies and ingredients can be employed to reduce or replace them, from the simple removal to more complex systems employing multi-ingredients and processes.

Reduce/remove: simply removing, either completely or in steps, may seem to be a logical approach which works with other ingredients, e.g. salt, however, if the aim of sugar reformulation is to reduce calories, then this approach may not deliver the intended result. If products have low moisture contents, and contain other ingredients, e.g. starch and/or fat, then removing sugars has an insignificant impact, and in some products the calories may increase.

Sugar replacers: using other ingredients that can substitute for some of sugar's properties. The most successful approach is the use of high potency sweeteners in soft drinks. These replace the sweetness and water replaces the bulk, resulting in a significant calorie reduction. However, the same strategy does not work with all products and so different approaches must be employed.

Replicate functions: multiple ingredients can be used to match the functionalities of sugars, e.g. sweeteners to deliver sweetness and fibres to deliver bulk and reduce calories. However, to deliver characteristic colour and flavour, additives are usually employed, e.g. colours, flavourings. Also, when sugar is reduced, it can impact food safety. The use of multiple ingredients can impact on clean labelling and may lead to increased warnings on pack.

Modifying properties: involves using ingredients which modify the taste of sugar to amplify its properties. By delivering an increased perception of sweetness, the amount of sugar employed can be reduced. Again, consideration should be given to the sugar reduction and impact on total calories in the finished product.

Major challenges – where are we now?

As highlighted in Table 1, sugar delivers different functions. Whilst some are common across several categories, many are unique to specific ones. Specificity of functionality means that replacing sugar can require a number of different ingredients (Table 2). Some of the current major challenges in this area are highlighted in Table 3.

Table 3 - Major challenges

Summary
Multiple ingredients
Impact on clean label
Increased warnings
Calories are not reduced significantly
Impact on food safety/shelf life
Impact on taste, cost and manufacturing

Flavour, sweetness and mouthfeel: broadly related to organoleptic properties of foods and drinks. Sugar-free or reduced beverages is a mature category, with a broad range of solutions to deliver high quality products, utilising different ingredient strategies to replace the sweetness and bulk sugar. The adoption of these strategies for other products is not as easy, given the significant variation in complexity of foods compared to liquid beverages.

Unique functionalities: same as for common ingredients, manufacturers want to keep the properties of their finished products as close as possible to their intended design, so replacement of the function of sugar can be challenge. It also means that there are no universal sugar replacers, as what works for a beverage will not work for a baked product, and vice versa.

Ingredient declaration complexity: most of functionality sugar delivers can be replaced (Table 2). However, separate ingredients are often required for each of these functions, which can mean that a single ingredient (sugar), is replaced with up to six different ingredients. This can have a negative effect on consumer options, as they are unfamiliar with the replacement ingredients, as well as having a significant impact on the cost and complexity of a product and may also impact on manufacturing e.g. change in bulk density.

Consumer experience: communicating how sugar has been reduced is challenging. Often consumers will avoid sugar reduced products, especially in categories that are seen as treats, such as sweet bakery, confectionery and desserts.

Food safety and shelf life: plays a critical role in ensuring the preservation of food products by reducing Aw. In some products, such as chilled, short shelf-life foods, this can also be a critical hurdle for ensuring safety. Reducing sugar in these products may impact on food safety and/or shelf life.

The future – where do we go from here?

There have been many successes in sugars reformulation, notably in soft drinks both pre- and post the soft drinks industry levy, where the replacement/reduction of sugars with high intensity sweeteners can deliver a significant calorie reduction. Similarly, the replacement of sugar in chewing gums with polyols, notably xylitol, has a significant impact on reducing fermentable carbohydrates and thus has a major benefit in dental health. In the future the quest to reduce calories by reduction or replacement will continue but a major target, e.g. low moisture foods, are a greater challenge. Future developments should also consider the sustainability impact of ingredients and the repurposing of agrifood-wastes for additional benefits.

Consumer preferences for ethically sourced foods are driving the sugar industry towards prioritising local procurement and streamlining processes. Sustainable sugar production involves sourcing sugars locally to mitigate transport related emissions. The focus on supply chain transparency and social responsibility aids in mitigating environmental impact. Processed foods are a major area being highlighted and reformulation should consider the re-introduction of texture/structure into foods to deliver satiety. There is no simple solution for sugar reformulation, it is more like a 'renovation' where the desired functional properties of sugar are considered for each product and the optimum use of all ingredients is considered to deliver the final product in a cost-effective manner.

References

1. SACN report https://assets.publishing.service.gov.uk/media/5a7f7cc3ed915d74e622ac2a/SACN_Carbohydrates_and_Health.pdf

2. BNF https://www.nutrition.org.uk/healthy-sustainable-diets/starchy-foods-sugar-and-fibre/sugar/?level=Health%20professional

3. WHO https://cdn.who.int/media/docs/librariesprovider2/euro-health-topics/obesity/sugars-factsheet.pdf?sfvrsn=d5b89d5f_3&download=true

4. GOV.UK https://www.gov.uk/government/collections/soft-drinks-industry-levy-detailed-information

Further reading

• IFST Information Statement on Sugars Sugars | Institute of Food Science and Technology (ifst.org).

• IFST Food Science Fact Sheet on Food Additives https://www.ifst.org/sites/default/files/Food%20Additives.pdf

• IFST Food Science Fact Sheet Sugars https://www.ifst.org/sites/default/files/Sugars.pdf

• IFST Technical Brief on Food Reformulation for Salt https://www.ifst.org/sites/default/files/Food%20Reformulation%20for%20Salt_1.pdf

• Julian Cooper. Reformulation – challenges and practical approaches. Examples of Sugar reformulation. https://theifst.sharepoint.com/:p:/s/ReformulationforSugarsinFood2/ETwrZdoFdx5LhR-sLwfZhjYBXMgcBhskKJsNty4wiy5QDg?e=JDpyPn

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• IGD Sugar Reformulation Guide https://www.igd.com/Portals/0/Downloads/Charitable%20Impact/Reformulation/Sugar-Reformulation-Guide.pdf