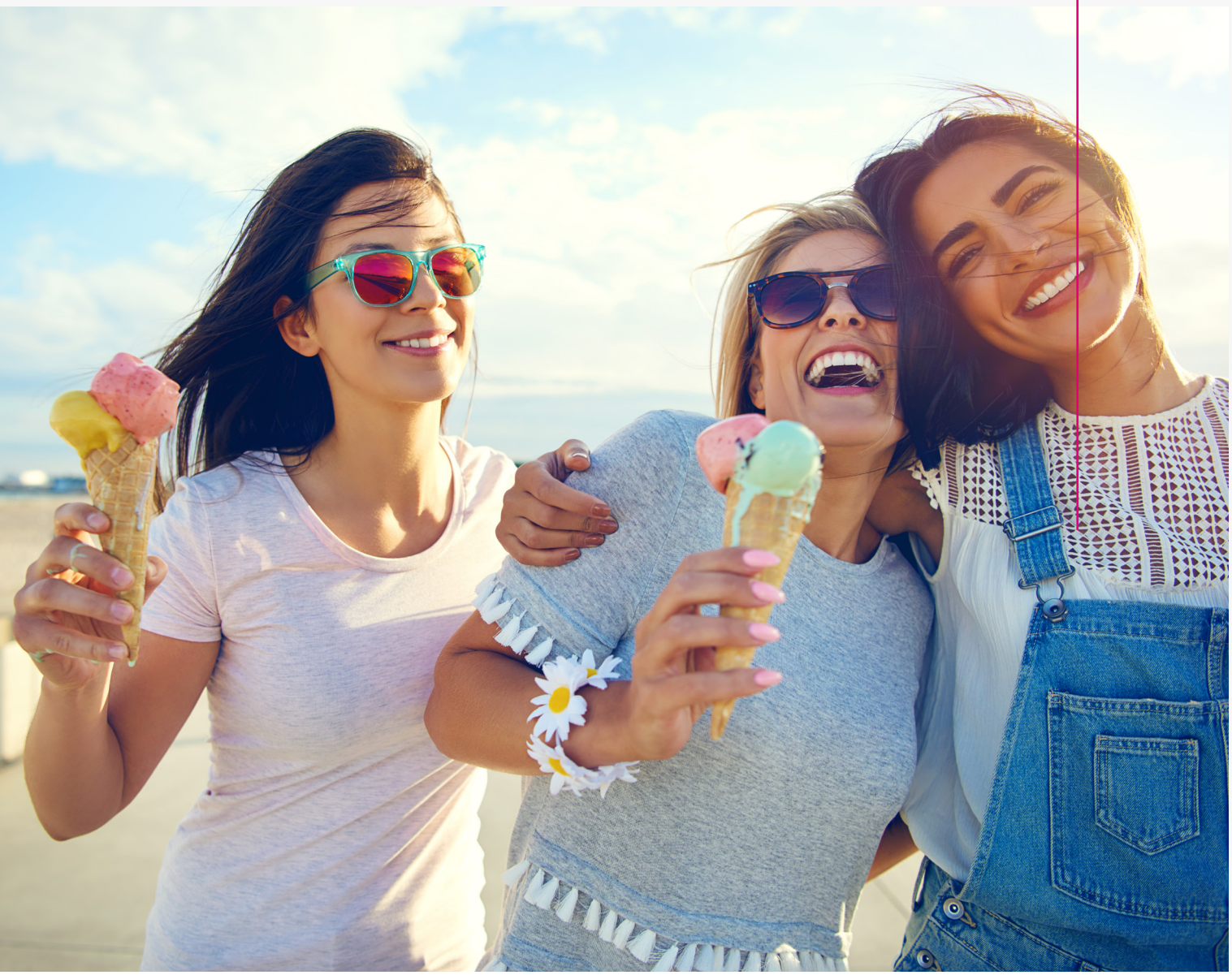
Ingredient Solutions for Sugar Reduction

White Paper

Author: Carole Bingley
Technical Specialist



Abstract

Food and drink producers are under increasing pressure to support ambitious legislative targets for a reduction in sugar intake, however, translating this directive into a commercially-viable reality is a challenge for product developers. The multi-faceted role of sugar means it can't be substituted on a like-for-like basis. So although there are a growing number of alternative ingredients, each must be evaluated in terms of its strengths, weaknesses and limitations in the required application. Here we review the options from a technical, regulatory and consumer perspective – and explain why understanding these dynamics is essential to finding the right solution.

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Introduction: the sugar fix

Linked to obesity, heart disease, diabetes and tooth decay, excessive sugar consumption has become the nemesis of health and wellbeing. Governments, NGOs, public health bodies and consumer organisations are all taking action to help reduce intake in adults and children alike.

The scale of the issue should not be underestimated. According to a recent report from the World Health Organisation, the amount of free sugars consumed in Europe far exceeds recommended levels, with a significant proportion coming from manufactured foods such as baked goods, breakfast cereals and sugary drinks. In the UK, for example, the average take home shopping is estimated to contain over 60% more sugar than the 30g per day guideline set by Public Health England.[1]

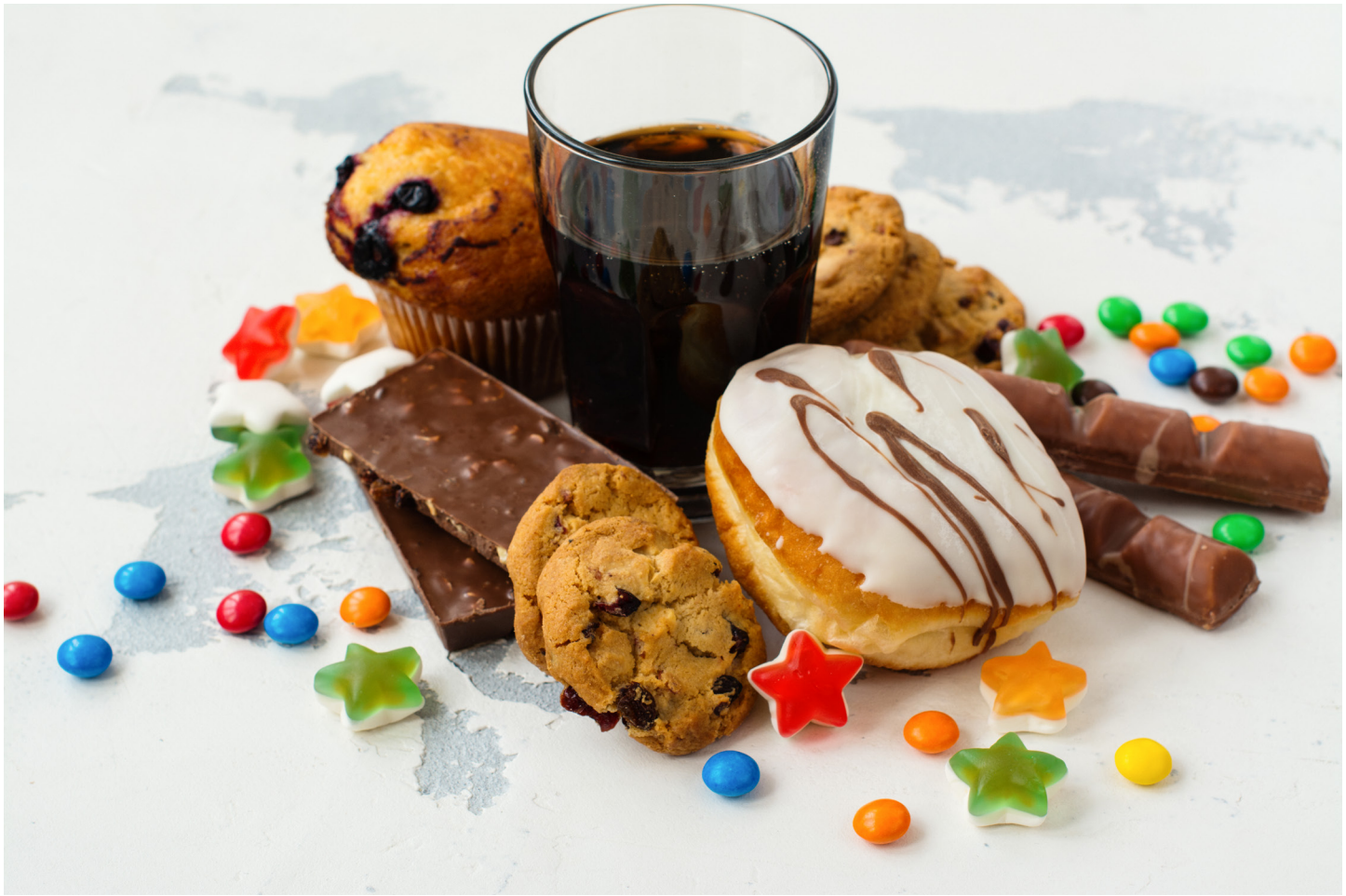
Free sugars have been defined by the Scientific Advisory Committee on Nutrition (SACN) as follows:
'Free sugars' comprises all monosaccharides and disaccharides* added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices. Under this definition lactose (the sugar in milk) when naturally present in milk and milk products and the sugars contained within the cellular structure of foods (particularly fruits and vegetables) are excluded.*

**Monosaccharides are single sugar units (glucose and fructose) and disaccharides are two single units joined together (sucrose).*

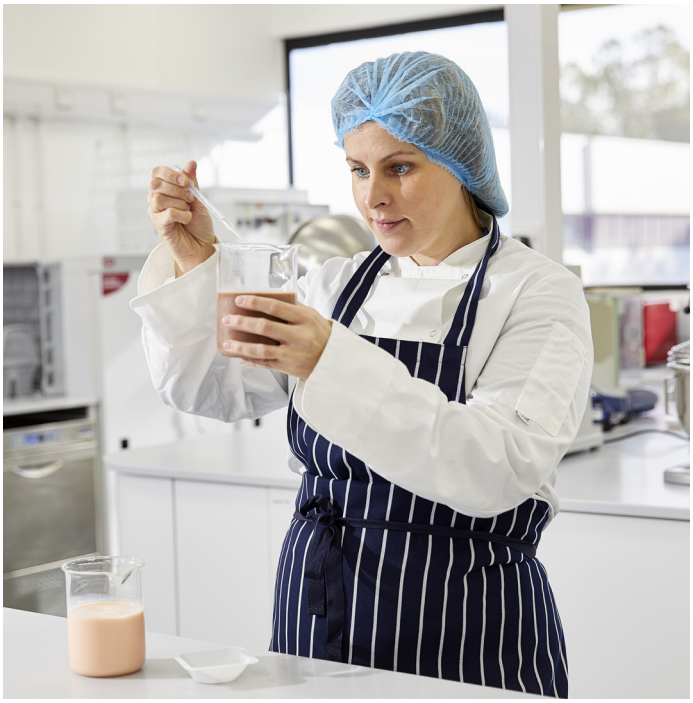
However, a concerted effort is being made to improve this picture. High profile media coverage and stakeholder campaigns are fuelling consumer awareness and concern. Not surprisingly, much of the attention is focused on the food and drink industry which is expected to play its part.

Consumer	Average intake of free sugars (g/day)	% of energy intake
Children aged 4-10 years	47.3 g	12.1%
Children aged 11-18 years	54.8 g	12.3%
Adult women	44.0 g	11.8%
Adult men	55.5 g	12.4%

Table 1. Average intake of free sugars (UK)
National Diet and Nutrition Survey (2016/2017–2018/19)



Manufacturers are actively evaluating options for reducing sugar in their products. Sugar reduction is reportedly the top area of focus for companies surveyed by insights specialist, IGD – ahead of both fat and salt – and there is a regular stream of corporate announcements outlining nutritional improvements in products ranging from chocolate biscuits to breakfast cereals and cooking sauces.



The good news is that consumers also appear to be taking notice. In fact, 38% of shoppers in a recent survey conducted by IGD, indicated they are making efforts to reduce the amount of sugar[2] in their diet. There is also general public approval of moves to reformulate products, albeit with an underlying stipulation, 77% of consumers questioned in the same survey are happy for food companies to make changes provided products remain just as tasty.

There's no doubt that this is a difficult balancing act. Addressing the technical complexities of formulation and consumer expectations is no easy task – but it is one which can be negotiated with the right approach.

It also requires a clear strategy in terms of product positioning but this must be aligned with strict legislation governing on-pack labelling. Claims in Europe, for example, must comply with the Annex of EC Regulation 1924/2006 on Nutrition and Health Claims Made on Foods. In basic terms, this means that a 'reduced sugar' product would need to have a third less sugar than a similar product. A 'sugar free' message can only be considered if the product contains no more than 0.5g of sugars per 100 g/ml, while the use of 'no added sugars' means that the product can only contain sugars naturally occurring in ingredients such as milk or fruit.

This means that a vital part of the process for formulators is to consider alternative ingredients not only in terms of functional performance, but also in the wider context of marketing platform,

High Potency Sweeteners	E-Number	Sweetness Potency	Year of Approval
Saccharin & its salts	E954	300-600	1977
Aspartame	E951	180-200	1984
Acesulfame-K	E950	200	1984
Cyclamates	E952	30-40	1984
Thaumatin	E957	2000-3000	1984
Neohesperidine DC	E959	1800	1988
Aspartame-acesulfame salt	E962	350	2000
Sucralose	E955	600	2000
Neotame	E961	8000	2009
Steviol glycosides	E960	50-400	2011
Advantame	E969	20000	2014

Table 2: EU Approved High Potency Sweeteners

desired claims, brand values and overall costs. This understanding will help to inform the direction of product development and guide successful formulation decisions.

Ingredients for sugar replacement

Such is the importance of sugar reduction – both for reformulation and new product development – that established alternative ingredients are now being looked at with fresh interest and suppliers are investing in new innovative sugar substitutes.

It is a complex environment where taste may be the most influential driver in terms of consumer purchasing decisions, but this cannot be prioritised at the expense of other important parameters such as compliance, tolerance and appearance.

Current ingredient options are reviewed below from a technical, regulatory and consumer perspective.

High potency sweeteners (HPS)

Long dominated by artificial sweeteners, the rapid rise of naturally derived alternatives looks set to revolutionise the high potency sweetener category. The high potency sweeteners currently approved in the EU and UK are presented as Table 2 above[3].

Synthetic sweeteners

This group of low calorie ingredients provide an intense sweetness at very low usage levels. From the most established saccharin, sucralose, aspartame and acesulfame-K, to the less widely-used neotame and advantame (among others) – each has its own set of characteristics in terms of taste, stability, solubility, permitted usage levels and synergy with other sweeteners.

In particular, formulators need to consider:

- **Compliance:** not all artificial sweeteners are approved for global use.
- **Sensory characteristics:** it is never easy to replicate the mouthfeel of a full sugar product; it often requires a careful blend of sweeteners alongside flavour and texture enhancing ingredients, depending on the application.
- **Taste profile:** these ingredients do not deliver exactly the same profile as sugar; making them better suited to some applications than others. For example, the longer lasting sweetness profile means that these ingredients are particularly well suited to sugar free chewing gum.

These synthetic ingredients can also be an effective option for manufacturers facing new taxes on sugary soft drinks – a major source of sugar intake for children and teenagers. A blend of HPS and water can be used to replace the added-sugars and so take the product below legislative thresholds. Britain, for example, introduced a Soft Drinks Industry Levy. The so-called "sugar tax" affects beverages containing 5g (or more) sugar per 100 ml, with a sliding scale upwards for those with over 8g/100ml. The move follows Finland, France, Hungary and Mexico who have all imposed taxes on soft drinks in various forms.

Equally suitable applications include reduced-sugar variants in categories where structure and shelf life are less of an issue. Lending a sweet taste to sauces, dairy desserts and milkshakes, for example, where any texture requirements can be addressed with the addition of ingredients such as hydrocolloids or starches.

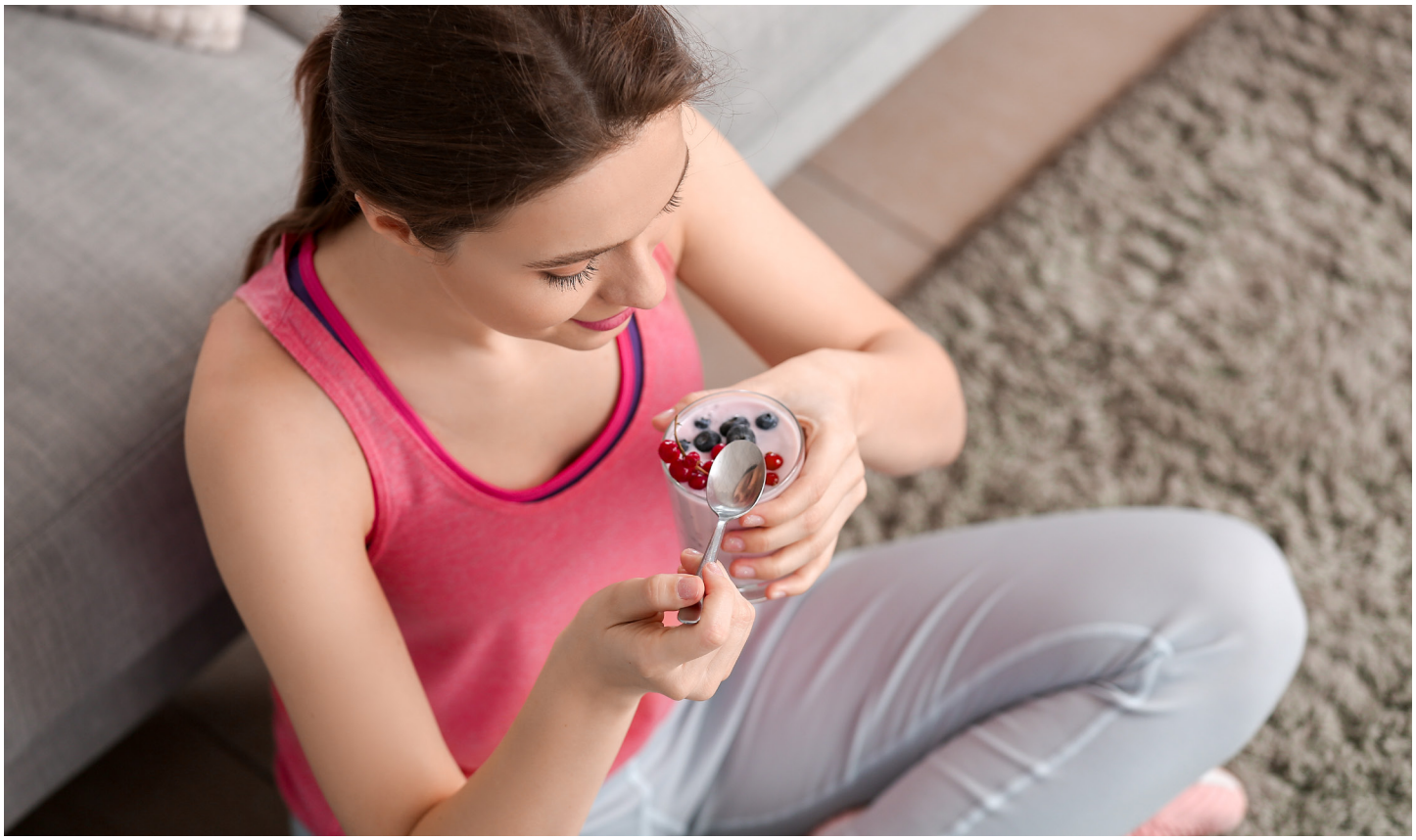
However, recent negative media coverage around the reported negative effects of artificial sweeteners – particularly aspartame – has fuelled consumer health concerns. This is despite the lack of scientific evidence to support the claims and re-evaluation by the European Food Safety Authority (EFSA) which concluded that; "Aspartame remains safe for human consumption and there is no scientific basis for reconsidering its use in food." The only exception is in the case of people who suffer from the inherited disease phenylketonuria (PKU), who are unable to metabolise phenylalanine.

These synthetic sweeteners are also at odds with the consumer trend for wholesome and natural ingredients. If a clean label and kitchen-cupboard ingredients are an intrinsic part of brand values, formulators need to consider a different approach.

Naturally-derived sweeteners

For applications requiring a sweet taste and consumer-friendly label, there are a range of naturally-derived ingredients which can be used to replace sugar.

Steviol glycosides are one of the most commercially successful natural sweeteners with the most commercially available extracts being based on Rebaudioside A and Stevioside (the two most abundant steviol glycosides in Stevia rebaudiana). Calorie-free, this plant extract can taste up to 400 times sweeter than sucrose – meaning far less is needed in formulations and the sugar content can be significantly reduced. A powerful combination of benefits, which tick a number of boxes in terms of its consumer appeal. But steviol glycosides are not without drawbacks. Higher cost in use compared to conventional HPS is a key issue, but the taste profile can also pose a challenge to product developers.



Although improving, the more widely used steviol glycosides tend to leave a bitter or liquorice aftertaste which is difficult to mask. It's also hard to achieve the level of sweetness intensity that consumers expect due to the 'plateau effect' and the maximum permitted use level. Addition of fruit juice is one way to resolve the issue in lightly sweetened soft drinks, but is not a suitable course of action for every application. For products needing greater flavour impact, exploring a partial sugar reduction approach may be the best option – although compromises may then need to be made on calorie content.

A number of suppliers have started to market extracts based on some of the minor steviol glycosides, namely Rebaudioside M and D. These are claimed to have a much cleaner aftertaste than Rebaudioside A which should enable the formulation of products with a great reduction in sugar and overall improved taste profile.

There are some questions about the credibility of stevia's 'natural' claim from some pressure groups. Although sourced from the species of plant known as Stevia rebaudiana, the purification process needed to produce the extract means that the final ingredient is not exactly the same composition as is found in nature.

Thaumatin is approved as a sweetener in the EU and UK but tends to be used as a flavour modifier rather than a sweetener. Used in low levels it can round out flavours, such as the bitterness in stevia; however, it cannot be used alone to add sweetness, as the higher quantities required leave an unpleasant, lingering aftertaste.

Bulking agents

Replacing the sweetness of sugar is only part of the reformulation story. Sugar also acts as a preservative, stabiliser, thickener and fermentation substrate in a range of different products. Plus, it can create flavour and colour through caramelisation or the Maillard reaction. Attributes which can't be replicated by the use of sweeteners alone – whether artificial or natural.

For categories such as confectionery and baked goods, where sugar makes up a significant part of the formulation and water certainly can't be added, bulking agents become part of the equation. This brings a new set of challenges for formulators which are outlined overleaf.

Polyols

From a technical point of view, polyols are a highly effective group of bulk sugar replacers. This group of ingredients includes maltitol, isomalt, sorbitol, mannitol, xylitol, lactitol, isomalt and erythritol.

All work well in terms of providing structure and some sweetness, but each performs slightly differently in application. These variations in functional characteristics – such as calorie content, stability, taste profile compared to sucrose, degree of hygroscopicity and humectancy, as well as costs – all need to be reviewed on a case-by-case basis to determine selection.

Moreover, there are a number of guiding principles which formulators must also bear in mind:

- **Regulations:** European legislation states that polyols can only be used as a sweetener if the product also has a total energy reduction of 30% or is sugar free/no added sugar. This is not an issue for some applications where sugar content can be significantly reduced or even removed – such as chewing gum. However, achieving a 30% calorie reduction is difficult in products such as cakes and biscuits, where the majority of the calories come from fat and flour.
- **Laxative warning:** polyols are known to have a laxative effect and any products containing more than 10% are required to carry a corresponding warning on pack (Reg. (EU) 1169/2011, Annex III, 2.4). This means average consumption rate and quantity of the product in question is key. Hard boiled candy, for example, is usually eaten slowly over time so is less of a problem, but for jelly varieties which are often consumed in large volumes, there is a higher possibility for some digestive issues.

Soluble fibre-based solutions

Soluble fibres are suitable for use in reduced sugar formulations as there is no requirement to meet 30% calorie reduction. Some also offer a label-friendly alternative to synthesised polyols. On the other hand, gastro-intestinal tolerance and a lower sweetness profile are issues which must be taken into account when formulating with these ingredients.

- **Fructo-oligosaccharides and inulin:** these ingredients are found naturally in a range of vegetables including Jerusalem artichokes and onions, they are extracted commercially from chicory root. Fructo-oligosaccharides are obtained from the partial enzymatic hydrolysis of inulin. The clean extraction process means that it is possible to label it as chicory root extract or chicory fibre.
- **Soluble corn fibre / maize dextrin / resistant (malto) dextrin:** these ingredients are usually produced by enzymatic or chemical treatment of corn starch to produce a highly branched structure which is only partially digested by human digestive enzymes resulting in a caloric value of 2kcal/g. A number of labelling options are recommended by suppliers of these ingredients.
- **Polydextrose:** a low molecular weight randomly bonded polysaccharide of glucose. Polydextrose provides 1kcal/g when used as a bulking agent and is labelled as polydextrose or E1200.

Carbohydrate-based solutions

Carbohydrate-based ingredients are well tolerated, fully digested and are not required to be labelled as sugar on pack – but they do not provide the cut in calories that consumers expect in reduced sugar products.

So given that they provide the same 4 kcal/g as sugar and have a similar, or sometimes higher, glycemic response, these ingredients are generally not the first choice when it comes to sugar reformulation.

- **Low DP1 and 2 glucose syrups and maltodextrin:** the glucose chains are comprised of three or more glucose molecules meaning that technically these carbohydrate-based ingredients are not required to be declared as part of the 'which sugars' nutrition panel – this only refers to mono- and di-saccharides (e.g. glucose, fructose, sucrose, etc). They are, however, equally calorigenic as sugars with a lower sweetness profile.

- **Starches:** native starches are widely used for their bulking properties. Generally labelled as rice starch, corn starch, corn flour or rice flour, they are a consumer-friendly option but of no benefit in terms of reducing overall calorie content.
- **Honey, brown rice syrup and agave nectar:** these ingredients are viewed positively by consumers but will not reduce the total amount of sugar on the nutrition panel.
- **Coconut sugar:** made from the flowers of the palm tree, it has a caramel flavour and the added benefits of a low glycaemic index as well as trace amounts of vitamins and minerals – giving it a comparably better nutritional profile than sucrose, although by only a slim margin.

Up and coming ingredients

With reducing sugar intake continuing to dominate the health agenda, it is not surprising that activity among leading ingredient suppliers is high. There has been a noticeable push to expand the ingredient toolbox with a raft of new innovations for formulators.

Allulose

An ultra-low-calorie sugar found naturally in low concentrations in foods such as jackfruit and raisins. Allulose provides 70% of the sweetness of sucrose and has similar properties in terms of texture and bulk, but at 0.2 kcal/g slashes overall calorie content in products.

Points to bear in mind include:

- **Reactivity:** it is quite reactive at high temperatures and browns during baking – although this natural colouring may be a benefit in certain applications.
- **Compliance:** achieved GRAS (Generally Recognised as Safe) status in the US but is not yet approved for use in Europe.
- **Labelling:** allulose is currently considered as a sugar when it comes to the on-pack nutrition label, according to US FDA regulations and must be listed as such – meaning manufacturers are unable to differentiate between product formulations.

The FDA decided in 2019 to exempt allulose from 'added sugar' labelling because it is metabolized differently than sucrose and contributes significantly fewer calories.

Naturally-derived sweeteners

Stevia may currently be leading the way in this burgeoning category, but there a number of other ingredients which are seen as ones to watch.

- **Monkfruit** (also known as Luo Han Guo): approved for use in USA and is currently under evaluation by the European authorities, it has gained some traction but issues around scalability may limit its potential.
- **Brazzein:** found in a West African fruit, this protein sweetener shows promise but is yet to gain regulatory approval.
- **Monatin:** a plant based extract found in the root of a South African shrub, it is not currently under development.

Fermented stevia

As one of the most widely adopted naturally-derived sweeteners, stevia is the subject of extensive R&D to further improve its performance. Efforts to address its bitter aftertaste – a major obstacle for consumers – have led to the development of so-called fermented stevias.

This innovation is based on the finding that some of the minor steviol glycosides in the stevia plant – specifically rebaudioside M and D – have a better taste profile than the major components discussed earlier. As they are only present in low levels, extraction is difficult and this has led to steps being taken to either breed stevia with naturally higher levels or establish a biotech approach to production. Although not yet approved in Europe, one proprietary fermented stevia ingredient has achieved GRAS status in the US.

Conclusion

The backlash against sugar has proved a driving force for exciting ingredient innovations in the field of sugar reduction. Keeping pace with these developments requires a detailed understanding not only of the technical issues, but also consumer expectations, the regulatory environment and wider market trends.

One thing is certain, food manufacturers urgently need to have a reformulation strategy in place to demonstrate commitment to the cause. But it is a challenging balancing act. Reducing sugar in a product may tick a box and win approval from government and health bodies, but this success will be short lived if consumers don't buy it. Ultimately, whether a product succeeds or fails comes down to taste – a guiding principle no matter which route is taken.

References

1. Kantar Worldpanel; Sugar Summit, November 2017
2. IGD; Sugar Summit, November 2017
3. Adapted from Logue et al., (2016)

How RSSL can help

RSSL is an established expert in sugar reduction. Our Product and Ingredient Innovation Team will work with you to ensure that food product formulations are optimised to bring out the desired flavour and texture in order to achieve a high standard of consumer acceptability whilst replacing or reducing sugar. We have a broad range of knowledge and expertise in sugar replacers and sweeteners, including natural sweeteners, and have experience in reducing sugar or calories in a variety of food categories.

To find out more, please contact us on:
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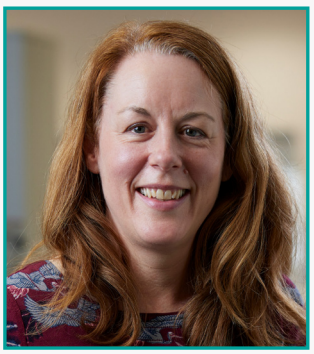

About the author

Carole Bingley
Technical Specialist, Product and Ingredient Innovation

Carole is a Technical Specialist working in the Product and Ingredient Innovation Team at RSSL. She holds a Bachelor of Science in Food Science and a Master of Science in Nutritional Medicine. Carole has worked with a wide range of sweeteners and bulking agents across many food categories during her 30 years in the food industry.

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Our clients trust us to deliver innovative solutions to real-world problems facing the global food and consumer goods industries.

From our state-of-the-art facilities in Reading, UK, our multi-disciplinary team of >350 scientists, professional chefs and regulatory experts work hand in hand with our clients to scope, develop and manufacture products that are not only innovative and relevant to customer needs but are also trusted for their safety, quality and sustainability.

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Contact us to find out how we can support your sugar reduction goals.

Reading Scientific Services Ltd
The Reading Science Centre,
Whiteknights Campus,
Pepper Lane,
Reading,
Berkshire RG6 6LA

Tel: **+44 (0)118 918 4076**
Email: **enquiries@rssl.com**
Web: **www.rssl.com**