# of note

What are the options for **sugar replacers?**

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From the Scientific Advisory Committee on Nutrition (SACN) recommendations to Public Health England guidelines and the Soft Drinks Industry Levy, multiple factors have driven sugar reformulation up the agenda. But simply decreasing or removing sugar is rarely the answer. It's a multifunctional ingredient, which can affect structural as well as sensory properties. Sugar replacers are one of the tools product developers can use to reduce sugar, but which is the best choice? Kathy Groves and Jenny Arthur examine the options.

More than sweet

The food and beverage industry is under mounting pressure to reduce its use of sugars and added sugars due to their association with health issues such as obesity, type 2 diabetes and dental problems. Public Health England's 2017 challenge for manufacturers to cut sugar in nine food categories by 5% by March 2018 and 20% by 2020 has given this added impetus.

Sugar reformulation is now a high priority for much of the industry. But it is far from straightforward. The term 'sugars' on back-of-pack labels is often used as short form for 'total sugars'. This refers to any mono or disaccharide, whether it's an extrinsic added sugar or intrinsic (naturally present) sugar. What's more, in many cases, adding sugar doesn't simply sweeten a product. As a multifunctional ingredient, it can also impact qualities such as texture, mouthfeel and shelf-life.

There are various ways in which manufacturers can respond to sugar reduction targets. Decreasing portion size and innovations in sugar crystal structure and size have gained much attention. Replacing sugars with alternative ingredients is another effective option. However, it can be highly complex. Functional properties of sugar replacers are just one aspect that needs to be considered. There can also be great variation in regulatory and labelling requirements between different markets.

Product reformulation with sugar replacers needs to be tackled on a case-by-case basis. Understanding the nature of different sugar replacers, and their associated regulatory requirements, can help ensure the process runs more smoothly.

Sugar replacers

The sweeteners used to replace added sugars can vary in terms of functionality, source (natural vs synthetic) and calorific value (nutritive or non-nutritive). There are four main categories, with some interplay between them: bulk sweeteners, intense sweeteners, alternative bulking ingredients and natural alternatives.

i. Bulk sweeteners

These are generally used in similar quantities to sugar, compensating for the bulk that sugar would contribute as well as functional properties such as texture and viscosity. The main group of bulk sweeteners is polyols (sugar alcohols) which are generally less sweet than sugar. Examples include sorbitol, maltitol, lactitol and xylitol. The calorific value of most polyols is 2.4kcal/g (as opposed to sucrose, which is 4kcal/g), so their use can result in significant calorie reduction.

Sugar alcohols cannot be used for sugar replacement in all categories, so regulations need to be consulted. They are predominantly used in confectionery and chewing gum. However, since many polyols have a laxative effect when eaten in quantity, regulations stipulate that a warning needs to be included on the label if they exceed 10g/100g. They are often combined with another sugar alcohol, erythritol, which has no laxative effect and a calorie content of 0.

ii. Intense sweeteners

Used in small quantities, these provide sweetness without adding caloric value or bulk. Examples include steviol glycosides (stevia), saccharin, thaumatin, sucralose and aspartame. They range from 200x (aspartame) to 20,000x (Advantame) sweeter than sugar. Like polyols, intense sweeteners have unique flavour profiles, delivering sweetness at different stages of the eating process. They can be combined to give a balanced flavour profile. Potential disadvantages of intense sweeteners include associated flavours such as bitterness and unpleasant aftertastes.

Intense sweeteners are used in a wide range of products including beverages, dairy products, desserts and confectionery. Their use is subject to legislative restrictions in the country where the product(s) will be sold.

For instance, monk fruit (Luo Han Guo) – a noncaloric sweetener with a potency 160 to 200 times greater than sucrose – has a flavour profile lacking the distinctive bitter aftertaste associated with some sweeteners. It can be used in beverages, dairy and cereal applications across both sugar-free and reduced-sugar formulations. And it's stable in processing and storage over a wide pH range. However, while its use in the USA is increasing, it's not currently approved in the EU.

iii. Alternative bulking ingredients

Additional sugar substitutes include soluble fibres and dextrins (e.g. polydextrose and inulin) which also increase total fibre content. However, their use can sometimes result in reduced-sugar formulations with a higher calorie content than the original product, depending on the type and molecular weight of the fibres being used.

iv. Natural alternatives

Natural sweeteners include sucrose, concentrated fruit juices, honey and fruit syrups (e.g. agave). From a functional perspective, they can be very versatile and effective. For instance, honey works well in moist, dense, full-flavoured bakes. But it's important to remember that these ingredients contain both monosaccharides and disaccharides. They provide the same caloric content as sucrose and are similarly associated with dental issues. What's more, in the context of the PHE sugar reduction technical guidelines, they are classified as sugar.

Some intense sweeteners could be considered natural, but any claims made about them will be subject to legislative restrictions in the country where the product will be sold. For instance, stevia and thaumatin are considered 'natural' in the USA,

but in the EU they are typically declared as 'from natural origin'. To be considered natural in Europe, they need to comply with the processing methods outlined in Table 1.

According to EU legislation, 'natural' additives are ingredients obtained from natural sources (e.g. food or plant) via appropriate physical processing. Approved techniques include distillation and solvent extraction, or traditional food preparation processes as defined by Regulation (EC) No. 1334/2008.

Practical considerations

Traditional food preparation processes	
Chopping	Coating
Heating, cooking, baking, frying (up to 240°C at atmospheric pressure and pressure cooking up to 120°C	Cooling
Cutting	Distillation/rectification
Drying	Emulsification
Evaporation	Extraction (incl. solvent extraction in accordance with Directive 88/344/EEC)
Fermentation	Filtration
Grinding	Infusion
Maceration	Microbiological processes
Mixing	Peeling
Percolation	Pressing
Refrigeration/freezing	Roasting/grilling
Squeezing	Steeping

Table 1: Traditional food preparation processes as defined by Regulation (EC) No. 1334/2008

Before reformulation begins, regulatory restrictions need to be checked from an application and dosage point of view. For instance, the polyols regularly used in confectionery and bakery applications are not permitted in drink formulations due to their laxative effects. It is also advisable to understand the full role of the sweetener in the product, as flavour, texture and shelf life attributes of the product will be affected.

Strategic reformulation

Reformulating products to reduce their sugar content has become 'business as usual' for many manufacturers. It's important to select the most appropriate sugar replacer ingredient early in the process for maximum efficiency and cost-effectiveness. To achieve this, sensory data, food science and regulatory knowledge need to be brought together in a meaningful way.

At Leatherhead, we achieve this via a process called 'blueprinting'. It involves the deployment of various techniques such as consumer testing, sensory science, microscopy and rheology. These can be combined with chemical information, shelf-life studies and regulatory insights to create a complete blueprint which acts as a baseline for product innovation. In the case of sugar reduction, a blueprint acts as a repository of information about the functional and sensory role of sugar in a given product. This enables more objective analysis of sugar replacers to meet reformulation objectives. It eradicates guess-work, ensuring nothing is left to chance.

As manufacturers look to reduce sugar content across a wider spectrum of products, requirements are becoming more complex. Blueprinting is poised to play a fundamental role unravelling this complexity and creating frameworks for efficient reformulation.

Bibliography

FDF Reformulation Guide: Spotlight on sugars (2016) Prepared by Leatherhead Food Research. Accessed: https://www.fdf.org.uk/corporate_pubs/Reformulation-Guide-Sugars-Aug2016.pdf

Sugar reformulation spotlight: cakes

The following example outlines key factors that need to be considered in any sugar reformulation activity.

In cakes, sugar contributes to colour, volume, crumbliness and moistness as well as sweetness. It can also act as a preservative. Intense sweeteners such as sucralose are not permitted for use in cakes. So, selecting a sugar replacer needs to consider multiple factors, including:

Project scope. Is the aim to make a 'reduced sugar' or 'no added sugar' claim?

Texture. The sugar replacer needs to compensate for potential loss of volume as well as sweetness. Bulking agents such as polyols can be used for this purpose, but they are only permitted for use in 'no added sugar' products.

Taste. Sweeteners have different profiles, so the type of cake will influence the most appropriate choice from an organoleptic point of view. The polyol xylitol presents a sweetness similar to sucrose and good humectant properties, enabling it to be used in some 'no added sugar' products – such as moist sponges and muffins – with minimal recipe adjustment. The bulk sugar fructose also presents good humectant properties, and has a sweetening power 80% greater than sugar, making it an ideal contender for 'reduced sugar' products.

Regulatory framework. Permitted dosage levels and applications may differ depending on policies and regulations in countries where the product will be sold. For instance, in the UK, products containing more than 10% added polyols must include a laxative warning on the label.

Consumer acceptance. New formulations should be as close as possible to the original product in terms of organoleptic qualities. This includes visual appearance as well as taste and mouthfeel. Clean labels are another important consideration for consumer acceptability.

Cost. Does the ingredient have a similar price point to sugar, and is it readily available?

Processing conditions. Different sugar replacers exhibit different responses to processing. For instance, the heat stability of polyols means that products containing them develop less of the desired 'browning' traditionally associated with baked goods.

Stability and shelf-life. It's important to consider the core properties of the sugar replacer, and whether the change in sugar content will affect the shelf-life of the final product.

How Leatherhead can help ¬

At Leatherhead Food Research we have extensive experience in the reformulation of food and beverage products. We work closely with manufacturers to meet strategic goals, such as reducing or replacing sugar as well as reducing salt and fat, without compromising consumer enjoyment.

Our innovative blueprinting method blends technical and scientific understanding to achieve results more quickly and effectively. Insights derived from areas such as microscopy, rheology and sensory science are combined to deliver successful reformulation outcomes.

About the authors ¬

Prof. Kathy Groves, Head of Microscopy

In a career spanning more than three decades, Kathy has pioneered the use of microscopy for food structure analysis and quality assessment. She has applied her expertise across multiple categories including snacks, confectionery and beverages, as well as numerous research areas including protein functionality, starch and fat interactions, meat quality and emulsions. Kathy has a degree in Biochemistry, is a Fellow of the Royal Microscopical Society and a member of IFST. She is also a Visiting Professor at the University of Chester and has presented on nanotechnology and food to the Government's House of Lords Science and Technology Select Committee.

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Leading Leatherhead's provision of integrated nutrition solutions for members and clients, Jenny is a nutritionist and marketer by training. She specialises in developing and implementing nutrition and health strategies for the food industry. During her time at Leatherhead, Jenny has overseen a team of scientists developing new sensory methodologies as well as conducting research into market and product trends. Recent achievements include evolving our nutrition offering to focus on nutrition intelligence, desk-based research and glycaemic index/response studies. She is also responsible for driving cohesive and integrated solutions for clients.

About Leatherhead Food Research

Leatherhead Food Research provides expertise and support to the global food and drink sector with practical solutions that cover all stages of a product's life cycle from consumer insight, ingredient innovation and sensory testing to food safety consultancy and global regulatory advice. Leatherhead operates a membership programme which represents a who's who of the global food and drinks industry. Supporting all members and clients, large or small, Leatherhead provides consultancy and advice, as well as training, market news, published reports and bespoke projects. Alongside the Member support and project work, our world-renowned experts deliver cutting-edge research in areas that drive long term commercial benefit for the food and drink industry. Leatherhead Food Research is a trading name of Leatherhead Research Ltd, a Science Group Company.

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Leatherhead Research is a Science Group (AIM:SAG) company. Science Group plc offers independent advisory and leading-edge product development services focused on science and technology initiatives. Its specialist companies, Sagentia, Oakland Innovation, OTM Consulting, Leatherhead Food Research and TSG Consulting collaborate closely with their clients in key vertical markets to deliver clear returns on technology and R&D investments. Science Group plc is listed on the London AIM stock exchange and has more than 400 employees, comprised of scientists, nutritionists, engineers, mathematicians and market experts.

Originally founded by Professor Gordon Edge as Scientific Generics in 1986, Science Group was one of the founding companies to form the globally recognised Cambridge, UK high technology and engineering cluster. Today Science Group continues to have its headquarters in Cambridge, UK with additional offices in London, Epsom, Boston, Houston, San Mateo and Washington DC.

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