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The holy grail of sweetness without the calories

Food and beverage sugar reduction strategies

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A Leatherhead Food Research white paper

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The holy grail of sweetness without the calories

Ever been asked to deliver the impossible? In this white paper, Kathy Groves considers the options available to product developers who are trying to reduce the sugar and calorie content of their products, without compromising on sensory quality.

Is your objective sugar reduction or is it, in fact, calorie reduction? Delivering sugar reduction in reality is often code for calorie reduction and removing sugars from a recipe may not automatically deliver this reduction in calories. Additionally, there are technical and food safety implications to consider. Sugars, commonly in the form of sucrose, for example, do not only contribute flavour and taste to a product but also bulk and textural properties.

Sugar-free and sugar-replaced products can behave differently over shelf life compared with conventional products containing sugar, impacting on consumer acceptance. It is, therefore, important to evaluate a number of reformulation scenarios in order to consider all your options. Here Leatherhead considers the use of science in reformulation, substitutes for sugars, the opportunities for new technologies and how to ensure consumer satisfaction.

Understanding the role of sugar in your product

Before beginning on the reformulation journey, it is vital to understand what function sugar is serving in your product. Is it giving your product a complex flavour in combination with other ingredients? Is it giving textural properties? Understanding the interplay of ingredients is vital. Leatherhead Food Research recommends using scientific disciplines, such as microscopy, rheology (the deformation and flow of matter) and sensory science to understand better the role sugar is playing in the product.

Taking a biscuit as an example, the crumb is an indication of texture and using simple light microscopy, this can be clearly seen. Figures 1 and 2 show a comparison between a standard biscuit and a sugar-free version. The sugar-free biscuit did not expand during the baking as much as the standard biscuit and has dense areas of crumb. This clearly demonstrates how substituting sugar impacts properties beyond the taste.

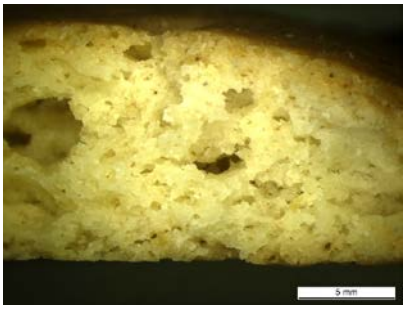

Fig. 1: Standard sugar biscuit

Fig. 2: Biscuit made with bulk sweetener

The ingredient tool kit

Generally, sugars will need to be replaced with lower calorie alternatives rather than simply being removed from the recipe. Ingredients such as fruit juices, fruit purees and honey are often used to impart sweetness and are perceived by consumers to be more natural and therefore more acceptable than sucrose. However, these will contribute to the total sugars in a product and are unlikely to help significantly in calorie reduction.

There are a wide range of sweeteners available which fall into bulk sweeteners (used in large quantities) and intense sweeteners (used in very small quantities). There are restrictions on the use of sweeteners, relating to type of product, dosage levels allowed and labelling requirements.

Polyols, often referred to as sugar alcohols, are bulk sweeteners. They are derivatives of sugars, either occurring naturally or made by hydrogenation. The calorific value of polyols is lower than that of carbohydrate sugars; they can therefore be used to achieve a significant reduction in calorie content when permitted, to achieve a high level (up to 100%) of substitution for sugars.

Intense sweeteners provide the sweetness without providing bulk or contributing to calories as they often have zero calorific value and are used in very low doses in products. Intense sweeteners from natural sources, such as stevia (steviol glycosides) and thaumatin, are generally more favoured by consumers but still have a lingering aftertaste which needs to be overcome.

Other ingredients such as soluble dietary fibres and dextrins (inulin, oligofructose, polydextrose) are commonly used to replace sugars and achieve a reduction in calories. These ingredients provide bulk and can have the added benefit of improving nutritional content by increasing the dietary fibre in products. These ingredients are less well understood by consumers, suggesting opportunities to be exploited.

There is yet another approach that is beginning to be exploited which is to creatively use other ingredients in the product to mask bitterness and enhance sweetness. This requires the product developer to take a more holistic approach to sugar reduction, considering the functionality and interaction of all the ingredients in a product.

Master blenders

In many cases, the optimum product properties are derived from a combination of different approaches, including the use of a blend of sweetening agents. For example, polyols are generally less sweet than sucrose and are often used in combination with high-intensity sweeteners that have little or no calorific value to create the desired level of sweetness. Blends of two or more intense sweeteners can also work in a synergistic manner, with one compensating for any unacceptable flavouring notes of the other.

Turning to technology

If you want to reduce sugar and maintain sweetness perception in products where the sugar remains in its solid crystalline state, without the use of bulk or intense sweeteners, then changing the sugar crystal size, shape and density may offer a solution. Solid products at the point of swallowing often have a large quantity of sugar still intact in the

product matrix. It is possible to manipulate the product structure to enhance sugar dissolution in the mouth and rapid flavour release can allow a means of reducing sugar in the product. A range of sugar crystal sizes are already available for use in products.

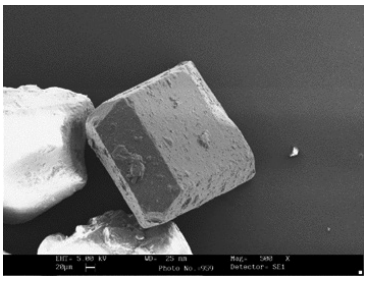

Fig. 3: Sugar crystal through electron microscope

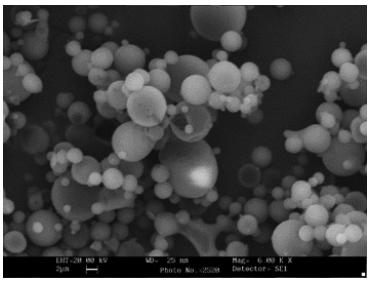

Fig. 4: Spray dried sugar particles through electron microscope

Emerging technologies that will produce hollow sugar ‘crystals’ or thin coatings of sugar around an inert low calorie ingredient (such as calcium carbonate) could be an option to deliver a sweet taste at lower sugar levels. A typical sugar crystal (solid and irregular) and a spray dried sugar (hollow and thin walled), as seen in the electron microscope, are shown in figures 3 and 4 above.

Hitting the sweet spot with the consumer

A new set of consumer methodologies called temporal methods which measure the sensory profile of a product as it changes during consumption are helping manufacturers to achieve a detailed sensory profile of their products. This knowledge will help product developers who are aiming to formulate a sugar-reduced or sugar-free product that closely matches the sensory perception of the original product containing sugar. It will help them understand where they need to focus their reformulation efforts, for example whether they need to mask a bitter taste perceived only at the ‘finish’ of the product or to increase the sweetness of the product at ‘first bite’.

The growing range of reformulation options to the product developer demonstrates that innovation flourishes in challenging times. While reformulation does obviously cause headaches, it is also true to say that it’s an exciting time to be a product developer!

How Leatherhead can help

Leatherhead has expertise in ingredient behaviour, product formulation, food structure, food safety, sensory testing and food regulations and is therefore ideally placed to help companies with product development and reformulation to reduce sugar and create healthier products for specific target groups and markets.

About the author

Professor Kathy Groves is Head of Science & Microscopy at Leatherhead Food Research. Kathy has over 35 years' experience in food microscopy and product development where she 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, and 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 Visiting Professor at the University of Chester and has presented on nanotechnology and food to the Government's House of Lords Select Science Committee.

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.

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