Blueprinting for Effective Sugar Reduction

When replacing sugar, product developers must consider the impact on various properties, and assess whether the reformulated product will be acceptable to consumers, regulators and retailers.

by Kathy Groves

Reducing the amount of sugar in food without creating unwanted consequences, is one of the biggest challenges facing the food & beverage industry. One option which has been much discussed in the media is reducing portion size in a process often referred to as "shrinkification." While seemingly straightforward, this can have manufacturing challenges, as food & beverage manufacturers have to reconfigure factory, packaging and distribution processes, in order to achieve it. Alternatively, manufacturers can look at product reformulation. Typically reformulation has been an iterative process; experimenting with different sugar substitutes and proportions to try and arrive at a product that is acceptable to consumers. The difficulty with this approach is that it is time consuming, costly and not without risk. A process known as blueprinting can offer a more scientific approach, allowing for reformulation to occur in a more predictable fashion.

The Regulatory Landscape

Recent announcements, legislation and media attention have ratcheted up the focus on sugar reduction, globally. In the UK, Public Health England (PHE) has launched ambitious targets for sugar reduction across key product categories, augmenting the already announced "sugar tax" on soft drinks, due to come into effect in April 2018. The UK was predated by Mexico, who back in 2013 published a Decree amending several numerals of the Law for the Special Taxation of Products and Services, leading to the taxing of soft beverages and some con-

Table 1: The Key Properties of Sugar Against Product Categories

	Taste	Preservative	Bulk	Texture	Aeration	Fermentation	Visual Appeal
Breakfast Cereals	√		√	√	√		√
Cakes	√	√	√	√	√		√
Biscuits	√		√	√	√		√
Sweet Spreads	√	√	√	√			√
Yogurts	√			√			√
Confectionery	√	√	√	√	√		√
Morning Goods	√		√	√	√	√	√
Puddings	√	√	√	√			√
Ice Creams	√		√	√	√		√

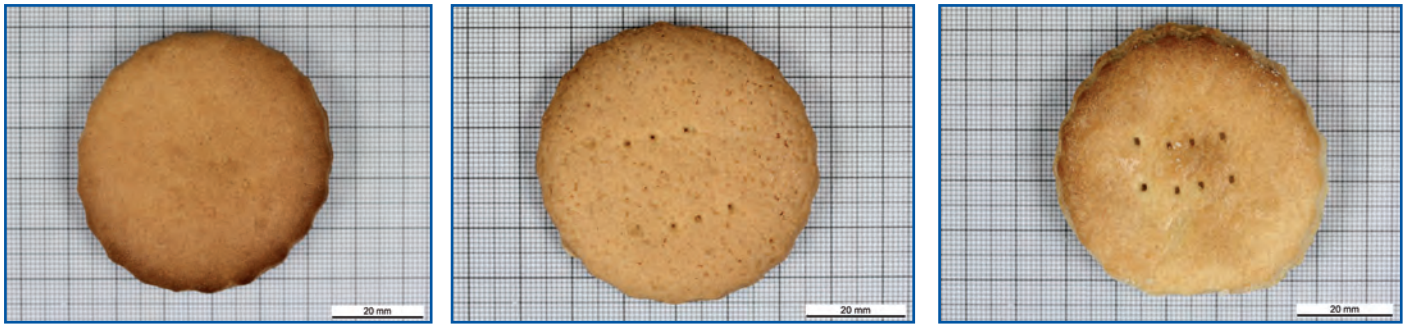

Figure 1: Visual appearance of biscuits. *Left: with sugar. Center: with maltitol sweetener. Right: with no sugar or sweetener (designated "free from").*

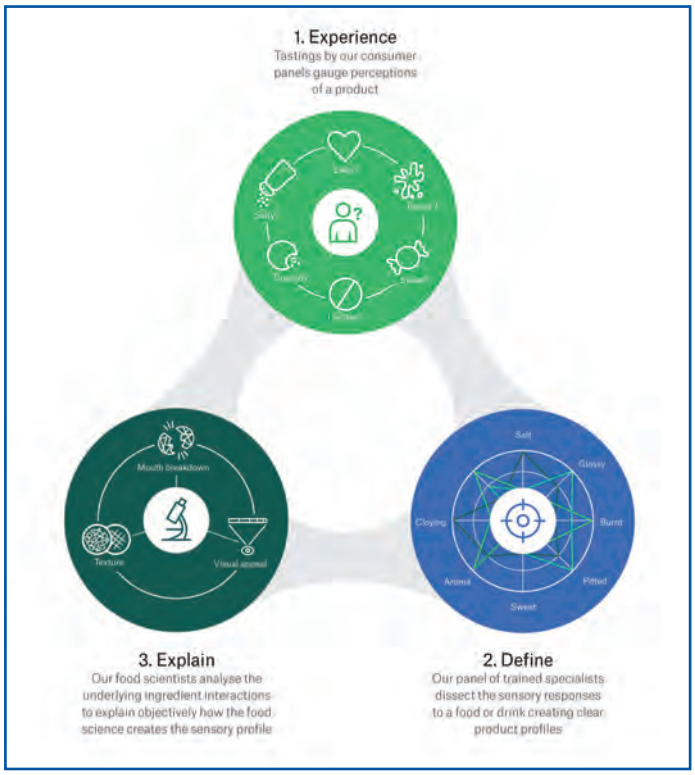

Figure 2: The Blueprinting process
Source: Leatherhead Food Research

fectionery products. In fact, many nations now have guidelines about the consumption of sugars and strategies to improve education of the consumer and put pressure on the industry to reduce sugar.

So, why not just remove the sugar? Because it's not that simple. The most obvious attribute of sugar is sweetness, but sugar also works at a much more basic level – interacting with the other ingredients and altering the very structure of the product. It delivers preservative qualities (which may impact shelf-life), bulk, texture, visual appeal and aeration in some products. Sensory perception provides descriptions of biscuits, sweets and chocolate such as "crunchy", "crispy," "gooey," "shiny," "velvety," "chewy" all of which may be altered by changes in the formulation of the product.

Table 1 maps the key properties of sugar against the product categories identified in the recent PHE (Public Health England) targets – showing which properties of sugar are relevant to each product.

Replacement Options

When replacing sugar, the product developer has to consider the impact of its replacement on all of the properties above, and assess whether the reformulated product will be acceptable to the consumer, regulatory environment and retailers [given that shelf-life, for example, might be affected].

While natural ingredients such as honey could be used, they don't actually reduce the total sugars or the calories in the product, and therefore non-sugar sweeteners may be considered. These fall into two main groups: bulk sweeteners and high intensity sweeteners.

Polyols (sugar alcohols), are bulk sweeteners. 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 in products, regulation permitting (some polyols have a laxative effect above certain levels and so might carry a warning).

Ingredients such as polyols are defined as "additives," however, and therefore need to be declared as such on food labels.

This potentially undermines the aim of manufacturers to achieve clean labels. Ingredients such as soluble dietary fibers and dextrins (inulin, oligofructose, polydextrose) are commonly used to replace sugars and achieve a reduction in calories. They provide bulk and can have the added benefit of improving nutritional content by increasing the dietary fiber in products.

The other main category of non-sugar sweeteners are high intensity, artificial sweeteners, such as acesulfame-K, saccharin or aspartame, which have been used for many years, and new ones continue to emerge.

In terms of the intrinsic sensory properties of these sweeteners, many are known to have metallic or bitter notes, and are generally not perceived to match the rich body, mouthfeel and viscosity that sugar imparts to a food matrix. Natural high intensity sweeteners, such as stevia are gaining ground.

They do however, bring their own taste and textural challenges.

Research has shown that the inclusion of stevia can impart licorice notes, lingering sweetness, and a different behavior during consumption at certain concentrations.

Reformulation in Practice

Leatherhead Food Research undertook a recent trial looking at three product formulations for a biscuit – one which we made following a standard biscuit recipe using sugar, one made with a bulk sweetener (maltitol) and one made with no sugar at all.

Figure 1 shows the visual appearance of each biscuit.

We then undertook a sensory profiling exercise. This involved asking our trained sensory panel to taste the biscuits.

The sensory panel are the sommeliers of the food world: supertasters with strong verbal skills – able to identify and describe accurately the sensory characteristics of a food or drink. They are able to quantify their findings, so as to give an objective profile of a product. The profile yielded some key findings. The "free from" sugar-free biscuit was "glossy," "uncooked" and "cloying." It seemed as if the butter couldn't bind without the sugar to cream it and hence didn't distribute through the product, creating the greasy glossiness on the top.

The maltitol biscuit on the other hand was called out for its "pitted" surface area clearly visible in figure 1. It was also harder and crunchier than the sugar equivalent. Why are these differences occurring?

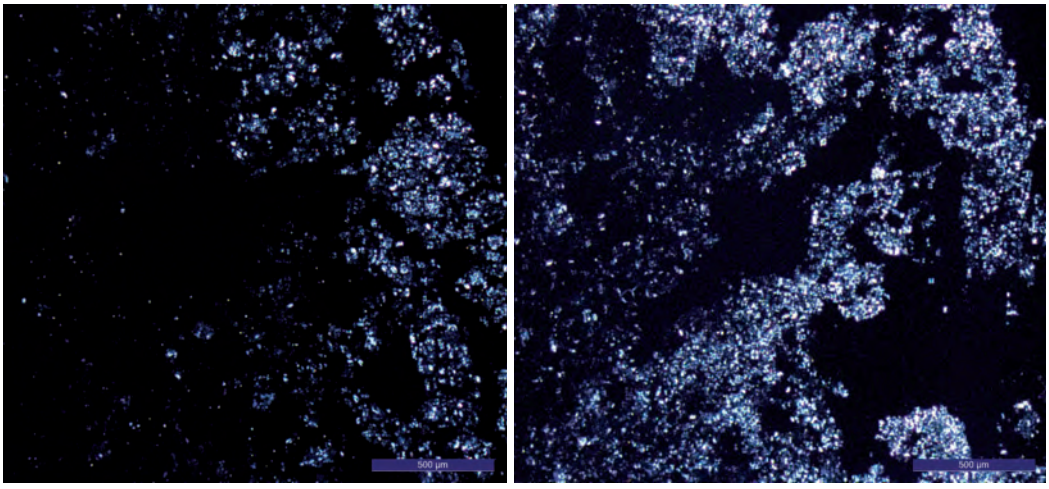

Figure 3: The different functionality of starch in biscuits *Left: with sugar. Right: with maltitol sweetener.*

Science Beneath the Skin

Bringing sensory data together with the underlying food science is crucial to understanding how reformulation impacts a product. We call this blueprinting.

Blueprinting is a three-step process. First, we want the consumer experience of the product to help us understand consumer perceptions and likes and dislikes. Then we seek to define the characteristics underpinning the consumer choices.

The sensory panel undertakes this definition process. Then we try to understand what in the underlying ingredient interaction is creating the sensory profile and to measure and record it (see figure 2). A number of techniques are used to develop a blueprint for a product. Consumer testing, sensory science, microscopy and rheology are key.

These can be combined with chemical information and shelf-life studies to create the complete blueprint. This can then act as a baseline for product innovation, helping product developers make changes with confidence. It can also be extended to relate the findings to the manufacturing process, which is used to make the product; so that the process can be optimized.

Using the example of the biscuits in our experiment, the crumb is key to the texture; this can be clearly seen using simple light microscopy. The sensory panel described the surface of the maltitol biscuit as "pitted." The cause is due to holes formed as the crumb structure is different internally.

Looking at the crumb structure internally under the microscope, it becomes clearer why the sensory panel identify the maltitol biscuit as "hard," as its rise and aeration is quite different from the sugar example. More information on the nature of the ingredients and their distribution can be obtained by cutting thin slices through the biscuit and using polarized light or staining to show the location and state of the ingredients.

Scanning electron microscopy can be used to show the three-dimensional crumb matrix in more detail, and obtain information on the location of ingredients such as fat and salt. The microstructure reflects the result of the formulation and the manufacturing process, and as such is key to delivering the blueprint of the product.

Figure 3 reveals the different functionality of the starch in the example biscuits used. The edge of the biscuit is shown on the right of both images. The images reveal that the sugar becomes more gelatinized (darker) in the bulk of the sugar biscuit, whereas the starch in the sweetener biscuit is less gelatinized (whiter). This will result in a different texture.

The science of rheology brings another layer to the blueprint. Instrumental texture analysis provides quantitative information on properties such as the hardness, brittleness and elasticity of products.

This objective data on how hard or brittle a biscuit is can be used for comparative studies, when changes to formulation are made.

Establish a Baseline

Food manufacturers and retailers are constantly innovating to set, or respond to, trends.

Successful innovation can mean the difference between a company's growth and failure.

Creating a product blueprint is the way to take the guess-work out of innovation, ensuring that none of the innovation process is left to chance.▼

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