Creating a blueprint
of your product to innovate with greater precision

By Professor Kathy Groves, Head of Science & Microscopy, Leatherhead Food Research

Professor Kathy Groves

Whether building a new house, bridge, road or factory, the project cannot progress without a blueprint or technical plan to ensure everyone knows the end-goal and how to get there. In this article, Professor Kathy Groves, Head of Science & Microscopy at Leatherhead Food Research, argues for the use of blueprints in food and beverage product innovation. Instead of detailing the infrastructure of a building, a blueprint for a product shows the architecture or structure of that foodstuff. She demonstrates how blueprints can be put to practical use during a sugar reduction exercise for a biscuit product.

Food manufacturers and retailers are constantly innovating to respond to or set trends. Successful innovation can often be the difference between growth and failure for a company. A blueprint of a product is essentially a map showing the ingredients in that product, the state of those ingredients, how they are distributed throughout the product and which ingredients are creating the product properties. Armed with this knowledge, the manufacturer can set baselines for innovation and carry out a number of important activities with confidence, including:

- Reformulating to respond to trends such as 'natural', 'clean label' and healthier foods
- Producing a consistently high quality product anywhere in the world by understanding the effects of the ingredient supply chain
- Responding to new developments in manufacturing processes, packaging or preservation methods
- Conforming to different regulatory requirements country by country.

THE ITERATIVE METHOD VS. THE SCIENTIFIC METHOD

Setting out to create a new product, or modify an existing one, for example in response to the demand for healthier foods, the knowledge of the product developer and the ingredients supplier is typically combined to create the first prototype product. Invariably the product will need further development and this is done by adding or changing ingredients, or refining the process. The second and any subsequent iterations are usually evaluated by tasting. This iterative process is also a feature of development at the full manufacturing site, as there are inevitably points during the manufacture where the process needs 'tweaking' using the experience of key staff.

In both of these cases there is a better way to innovate, and this is to create a science-based blueprint of the product. By creating a blueprint, the properties of the ingredients in the product are known, and when changes are made to the product, the effects can be anticipated. This process allows the product developer to not only get to the desired end-product quicker, but also with a clear understanding of how they got there.

So why don't manufacturers use the scientific method all the time? It is because creating a blueprint is not easy. It involves using several specialist techniques to develop the information for the blueprint – this is often outside the company's expertise and timeframe. However, the alternative, iterative method only appears easier. In fact, the iterative method takes longer since the end point is not defined, and in the long term is more costly to the company since the effects of the changes are not understood. When manufacturing is not understood it can lead to catastrophic failure of the product, but also more importantly does not allow the company to respond to changes quickly.

BUILDING THE BLUEPRINT

A number of techniques are used to develop a blueprint for a product. Techniques which are key to building the blueprint are microscopy, rheology and sensory. The crumb of a biscuit is key to the texture and using simple light microscopy; this can be clearly seen. More information on the nature of the ingredients and their distribution can be obtained by cutting thin slices through the biscuit and using polarised 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 manufacturing process and as such is key to delivering the blueprint of the product.

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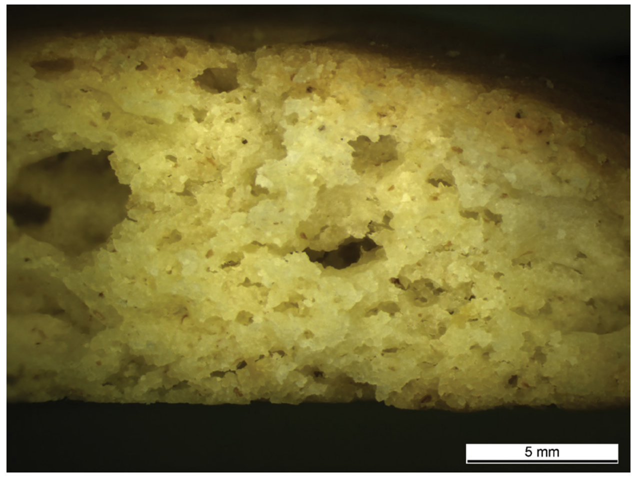

Figure 1a standard sugar biscuit

Figure 1b biscuit made with bulk sweetener showing reduced expansion and uneven crumb

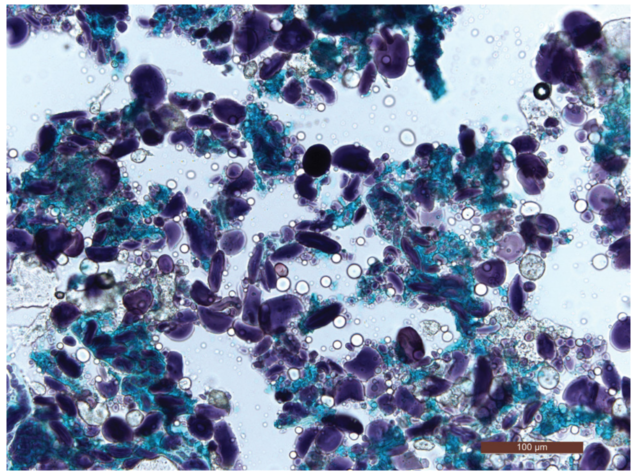
Figure 2a showing the starch (purple) and protein (green) in the standard biscuit

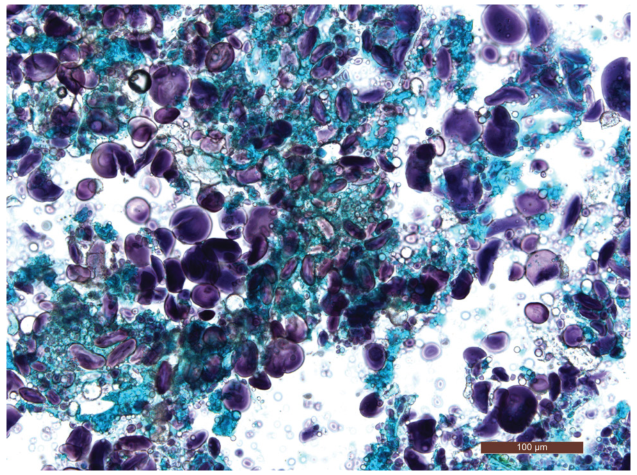
Figure 2b showing the different starch and protein distribution in the softer sugar-free biscuit

Instrumental texture analysis provides quantitative information on properties such as the hardness, brittleness and elasticity of products. This technique is ideally combined with sensory profiling to give a descriptive map of the important sensory attributes that the microstructure is related to.

These techniques should be combined with chemical information, shelf life studies, sensory profiling and more in-depth rheology on the ingredients to provide a more complete blueprint, but the example here is designed to show some of what can be learned. Once you have the blueprint, if changes need to be made to the product, then the blueprint can act as the baseline for your innovation.

PUTTING THE BLUEPRINT TO WORK

As an example of a reformulation exercise using the biscuit blueprint above, several different formulations were prepared to show the effects of changing the ingredients. In one example, the sugar was completely replaced by a bulk sweetener typically used in sugar-free products. Under the microscope the crumb was different in the sugar-free biscuit, having an uneven distribution of air and a change to the interaction between the starch, fat and sugar.

Figure 1 shows a comparison between the standard biscuit and the sugar-free version. The sugar-free biscuit did not expand during the baking as much as the standard biscuit and had dense areas of crumb, as well as large air pockets. Sections through the biscuits showed a difference in the interaction and distribution of the starch and protein (Figures 2a and b). Texture analysis of the two showed that the sugar-free biscuit was in fact softer.

So a simple exchange of sugar for sweetener altered the colour, structure and texture of the biscuit, as well as the distribution of fat, starch and protein.

These changes can be mitigated to some extent, but to produce a sugar-free product which has the same texture and properties as the standard biscuit requires an understanding of why changes to the product's properties have occurred. Once these are known, then possible causes of these differences can be listed and methodically eliminated to understand the causes of the changes

We expect to see those companies using the blueprint as a development and/or quality tool to make some significant advancements over those that don't in the next few years. The increased understanding of product behaviour builds rapidly with the application of these methods and with that, a culture of seeking answers follows; as does the ability to make very specific improvements to products and anticipate the consequence of formulation changes.

The scientific method of creating product blueprints takes the guess-work out of innovation. While on the face of it, it may seem like a time-consuming exercise, in the long term it will save time and money. And the real value of using the blueprint method, is that the more it is used, the more useful it becomes. Manufacturing processes and ingredient functionality can be understood to a greater extent, freeing up the product developer to focus their time and energy on new product innovations. ■

> **"The scientific method of creating product blueprints takes the guess work-out of innovation."**

ABOUT THE AUTHOR
Professor Kathy Groves, Head of Science & Microscopy, 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.

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