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Keeping it clean, safely

How to achieve clean label products without compromising safety

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A Leatherhead Food Research white paper

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Keeping it clean, safely

The consumer call for natural, minimally processed products which contain as few ingredients as possible has set a challenge to new product developers. Yet removing a single ingredient can upset the delicately-balanced ecosystem within a product and throw up safety and quality issues. In this white paper, Peter Wareing and Kathy Groves look at the safety and quality tools available to innovation teams to reformulate with confidence.

Coming clean about 'clean labels'

The term 'clean label' has no legal definition, and means different things to different people. The concept has evolved over time, driven largely by consumer demand, and is now often taken to mean, variously:

- Natural (both ingredients and processes)
- Free-from (e.g. allergens, GMO)
- No artificial additives or preservatives
- Using ingredients readily available in the home or 'kitchen cupboard'

Lightly processed products may be perceived by consumers to be healthier, and have a higher nutritional content (than more processed versions), but it can also mean microbes are more likely to survive. The challenge for industry is how do you produce 'clean label' products that achieve the desired shelf life and most importantly are safe for consumption?

Case study: Confectionery under the microscope:

An enrobed chocolate product became mouldy, with prominent mycelial growth on the surface. The investigation showed that the mould started growing within the product, not at the surface. A change to the emulsifier had caused poor mixing of the fat within the filling, leading to pockets of higher water activity within the product, allowing xerophilic moulds to grow. This is an example of the potential for changes to the distribution of ingredients at the microstructural level to influence microbial growth in a food product.

Case study: Beverages under the microscope:

Changing the sweetener and flavour combination in a soft drink from sucrose and fruit flavours, to fruit juice and glucose, allowed a fructophilic yeast, *Zygosaccharomyces rouxii*, to grow vigorously and cause fermentation to occur, leading to blown bottles. This yeast grows and ferments fructose preferentially to sucrose and is an example of how what appears to be a safe change can have a negative and unforeseen outcome.

What are the 'go-to' ingredients for clean label?

Generally when companies try to make clean label products, they are trying to remove any ingredients which could be perceived by consumers to be artificial, while also trying to reduce the number of ingredients in the product overall.

If only it were as simple as simply swapping an artificial ingredient for a so-called natural ingredient. Aside from the fact that ingredients serve particular technical functions in a product, there is the question of what exactly is a natural ingredient? And perhaps what is more relevant is whether the consumer perceives the ingredient to be natural.

Figure 1 below shows the types of ingredients which are generally perceived to be 'clean' or 'not clean'. Usually, natural ingredients are from a natural rather than a synthetic or man-made origin and have only gone through simple processing. Synthetic or highly-processed ingredients fall on the other end of the spectrum. There are a whole host of ingredients which do not fit neatly into either camp, including natural sweeteners and natural colours.

Also, consumer perception is important here – many natural ingredients have E numbers (it's part of EU Law, to show that safe and approved additives are being used), yet many consumers believe E numbers to denote artificial ingredients. Therefore it is not only important to choose an ingredient which is natural, but also one which has the appearance to consumers of being natural too.

What are the implications of moving to clean label?

Removing any ingredient from a product poses a number of problems, because ingredients all serve a function in a product. By removing even one ingredient, you are disrupting the fine balance or ecosystem in the product. It is possible that ingredients may be interacting in the product in a certain way or in ways you were not even aware of, to deliver a certain taste to the consumer or even to form a safety or shelf life function.

A change in a single ingredient can bring about a change in the functionality, safety and shelf life of your product that must be understood and potentially overcome in order to compete in the market place.

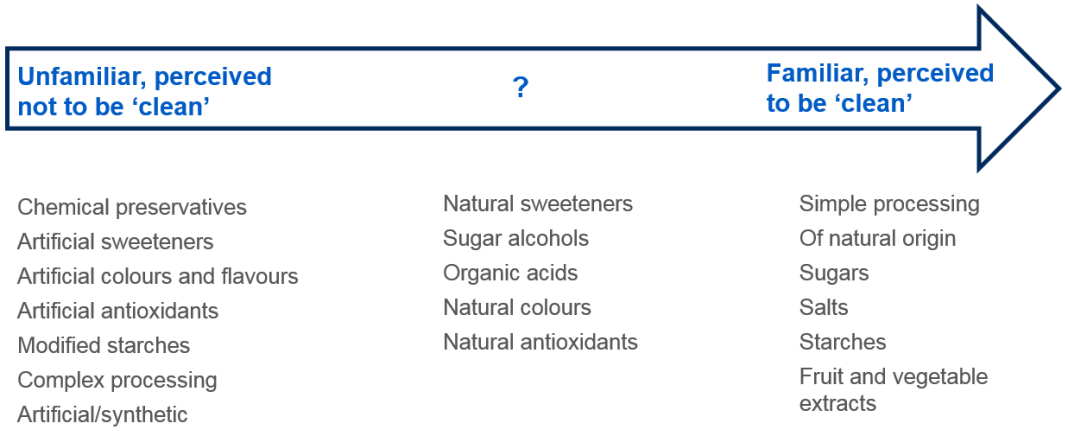

Fig. 1: Perception of ingredients on the 'clean label' spectrum

Functionality

Each ingredient plays an important role in the sensory, texture, flavour and microstructure of a product. These can be considered as forming the blueprint of a product which is a technical 'map' of the properties and ingredient distribution. Using science to understand the blueprint can allow manufacturers to make modifications, such as changing to natural or clean label, and remain confident they are producing the same desirable product for the consumer. More information can be found in Leatherhead's white paper on blueprinting, using sugar reduction in biscuits as an example.

Safety and quality

The removal or reduction of existing control factors (ingredients added to control microbial growth or pH or water activity) may make products less safe or stable by affecting:

- Water activity, particularly in the microenvironment in areas of the product
- Structure, for example by producing a more or less open crumb structure in bakery products
- The pH/buffering capacity of the product (the ability for the product to resist pH changes)
- The preservative status

What are the alternative control methods if shelf life is to remain the same?

Sometimes consumers call for natural while at the same time expecting the shelf life of the product to remain unchanged. What can be done in these instances? The options available to the product developer encompass both the product and the process, by reducing

Fig. 2: 'Clean label' product options

Fig. 3: 'Clean label' processing options

or removing preservatives from the product, or using lighter processing methods. Figure 2 gives some product options available to the product developer who is trying to make their product 'clean label' and figure 3 discusses some of the processing options. It should be noted that none of the processing options above are effective against bacterial spores.

If I move to clean label, how do I verify the safety of my products?

There are a range of tools in the food safety toolbox, including risk assessments, modelling, challenge testing and shelf life studies. In an ideal scenario, for a new or modified product, all these tools are used. The steps involved should be:

1. A risk assessment of the new ingredients, or ingredient source, and the process
2. Mathematical modelling to provide initial evidence of the effects or otherwise of the new formulation
3. A challenge test, where the product is inoculated with key microorganisms that could be a food safety or significant spoilage hazard, if they occurred in the product
4. Ongoing shelf life testing to show how the safety or stability of the product changes after a significant production period has elapsed

Leatherhead recommends companies carry out challenge tests, because they can throw up different answers to risk assessments or models; safety issues can go under the radar if challenge testing is not conducted. This is because:

- There are unknown intrinsic food safety factors which can only be identified when challenge testing is conducted
- There are microstructural implications of removing an ingredient which affects the microbial growth
- Models are not all-encompassing; the lower and upper limits for parameters are narrower than indicated by actual experimental data

Vitally important is for innovation and quality to be considered together. NPD, Safety and Regulatory teams may work in silos, so that the food safety implications of processing or ingredient changes are not considered. NPD ideas are not tested for safety initially, leading to a wasteful use of product development time. Conversely, the Food Safety team may not consider the implications on quality of control treatments.

Work together to prepare for the 'known unknowns'

It is essential not to underestimate the complexity of moving to 'clean label'. It requires food safety and product development teams to work together in an integrated way to consider the safety and quality of the product from the very beginning of a project.

It will involve making a decision about how consumer demand for clean label can be best delivered. It raises important questions such as: which are the natural ingredients that have consumer approval? How do those ingredients impact on the safety of the product? What is the best shelf life for that new product? Is a long shelf life really achievable or even desired by the consumer?

The new version of the product must undergo a strict safety programme, including risk assessments, modelling, as well as challenge testing and ongoing shelf life testing, to determine if environmental effects come into play as production is extended. Making a single change to a product can have unforeseen implications – that's why a key element of Leatherhead's approach to clean label reformulation involves monitoring potential effects of product structure on microbiological stability.

How Leatherhead can help

We can help with:

- Risk assessments of ingredients and processes
- Modelling where applicable
- Shelf life studies – organoleptic and microbiological
- Challenge testing
- Helping to identify in-production issues
- Developing blueprints of your product

About the authors

Dr Peter Wareing is a Food Safety and Manufacturing Consultant at Leatherhead. He obtained his B.Sc. in Agricultural Science from the University of Leeds, and a Ph.D. in Plant Pathology from the University of Hull. Before he joined Leatherhead Food Research in 2001, he worked for the Natural Resources Institute undertaking development work on food processing and food security projects in Central and South America, Africa and South East Asia. Peter has many years' experience working in microbiological research, development and training. His specialist areas are food safety systems including HACCP, microbiology and mycology, and he is particularly interested in confectionery and snack foods, sauces and dressings, soft drinks and dried foods. At Leatherhead, Peter undertakes troubleshooting audits and investigations for clients, is an expert witness and delivers food safety-related sessions on training courses.

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. Leatherhead Food Research is a trading name of Leatherhead Research Ltd, a Science Group Company.

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