

## Technical Briefing Gluten Free



starches



flours



fibres



proteins

## Gluten Free

**A**ccording to Mintel, 12 per cent of new food products launched in the UK in 2015 carried a **gluten-free claim**, up from 7 per cent in 2011. That's a huge rise in gluten free product innovation, and it's showing no signs of slowing down any time soon.

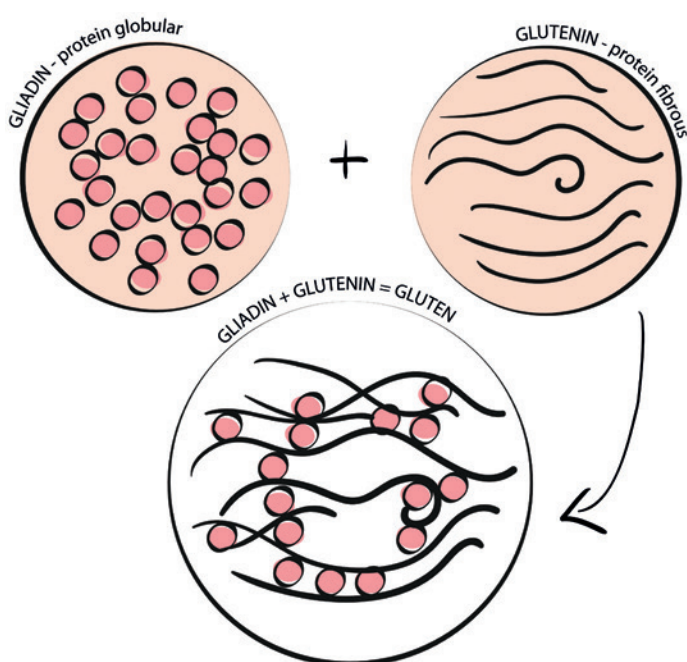
Gluten is a highly functional and unique protein which makes it exceptionally difficult to match and replicate in application. When removing gluten, the role of starch for providing structure and texture becomes far more prominent in a product.

For example, gluten is responsible for the protein network found in bread which retains the CO<sub>2</sub> in dough during proofing. It is gluten which gives the basis for the development of loaf volume and crumb structure and is what holds the dough in shape throughout the whole baking process.

### So, what is gluten?

Gluten is a water insoluble protein, comprised of glutenin and gliadin. These proteins can be found in wheat, rye and barley.

Figure 1:



*Gliadin and glutenin forming gluten*

Gluten cannot be found in nature; it is formed when flour is mixed with water and the glutenin and gliadin proteins present in the flour bind with each other to form a strong, elastic mesh type structure in the dough. This mesh structure traps gases, water and starch molecules in the dough and as it is kneaded and left to prove and then bake, is what helps to give a soft, fluffy, risen product. The more available water there is, the easier it is for the glutenin and gliadin to bind.

The viscoelastic properties of the bread dough are highly dependable on the glutenin/gliadin ratio. In general terms, better dough strength is provided with a higher ratio of glutenin. When there is a higher level of gliadin, the gluten is sticky, weak and inelastic.

Glutenin	Gliadin
Insoluble	Soluble
Polymers	Monomers, mostly
Dough strength and elasticity	Allows for bread to rise properly during baking

Glutenin proteins contain sulphur containing amino acids at each end which is why they are able to form strong disulphide bonds with each other. The glutenin re-orientates as the gliadin interacts with it, in the presence of water, forming a cross-linked polymer attached to gliadin. This disulphide crosslink structure forms the "backbone" of the gluten molecule on which other interactions occur. It is these other, non-covalent, weaker interactions (hydrogen bonding mainly) which gives gluten its unique functionality.

Non covalent bonds such as hydrogen bonds, ionic bonds and hydrophobic bonds are important for the aggregation of gliadins and glutenins, which in turn implicates the structure and physical properties of the dough. Hydrogen bonds are much weaker than covalent bonding but are a significant strength when in high numbers, like they are found in gluten.

## So, how does this give functionality when baking bread?

Gluten behaves the opposite to many other compounds when baked; setting solid at high temperatures and being more fluid at lower temperatures. This unusual behaviour is what gives gluten its complex functionality and is what makes it so hard to replace with just a single ingredient.

There are four main functionalities which gluten provides in baking:

1. Binding
2. Structure
3. Elasticity
4. Moisture retention

### Structure

Gluten development occurs in the mixing and kneading stages of bread making; forming a strong mesh structure. Here, air and starch are trapped within the developing network; helping to give soft, springy bread after baking.

The trapped air expands when heated but cannot escape the gluten network so this gives the loaf volume and height in addition to softness.

However, due to the strength of the gluten network and hardening of the gluten at high temperatures, the extent of volume expansion is limited.

### Elasticity

As described previously; it is the glutenin which gives the dough strength and elasticity. Glutenin can come in different levels of polymerisation, the more highly polymerised glutenin molecules tend to give more elastic properties. The less polymerised molecules of glutenin give viscosity.

### Moisture retention

Gluten free products are notorious for their short shelf-life, due to the lack of moisture retention over life compared to a standard loaf. This comes from the rapid rate of staling (becoming stale). The rate of staling of the bread increases with each decrease in the loaf volume.

Staling occurs when starch retrogrades forming a more crystalline structure. This retrogradation can be slowed by the correct ratio of starch to protein present in a product. It is these starch protein interactions which inhibit the retrogradation process and hence delay the rate of staling.

By knowing which type of starch to use, depending on amylose and amylopectin levels (starch retrogrades at different rates) and by using a higher protein content, the rate of staling can be slowed.

As well as controlling which starches are used and the protein levels to prolong shelf-life, fat can be used to add moisture.

Many bread recipes call for the addition of fat, wheat gluten, and high protein flour. Obviously for gluten free bread recipes the choices are limited to fat or alternative protein sources; though not every type of protein is suitable for use in bread. The addition of fat to increase shelf-life is what is partly responsible for the poor nutritional profile for gluten free bread in most cases.

## So how does this impact the product when gluten is removed?

The whole dough rheology is changed dramatically when gluten is removed. This causes issues for production, processing and final product quality. In most cases, batter is a better description for gluten free dough due to the sticky, inelastic and smooth dough. This makes it very hard to handle and is what contributes to the processing difficulties.

When gluten is removed from bread, starch becomes the main component which gives the product structure, replacing some of the functionality which gluten gives. Different starches behave in different ways (different gel points, rates of retrogradation, viscosities, etc). It's these differences which affect the end quality of the bread. Starch retrogradation is a major determinant of staling which of course impacts on the shelf life of the product.

It is important to understand the impact of the starches which are being added to the gluten free formulation, how they will interact with other ingredients (fibres and hydrocolloids for example) as well as their individual characteristics (gel point, etc). Functional starch often makes up a significant proportion of gluten free bread due to the structure which it is able to give.

If you were to compare gluten free batter to regular wheat dough, the wheat dough develops an even and homogenous matrix after mixing by the binding of the glutenin and gliadin. The gluten-free batter would give an uneven, heterogeneous structure as the product is baked due to the starch being free to swell and gel.

## So which applications are affected the most by removing gluten?

Gluten gives different functionalities depending on the end application. In flour, there are different grades of flour which contain different levels of protein (gluten) and these are picked depending on the desired functionality needed for a particular application.

For example, in bread you would require a flour with a higher gluten content (strong bread flour), but then for cakes you would want a lower gluten content than regular wheat flour (low gluten cake flours available). Then, there are some applications which are high in fat so even though you don't



want much gluten formation, it doesn't matter which flour is used as the fat inhibits the formation of gluten. It is still important that an appropriate type of flour is used for each application.

In **bread** the final structure is formed when the protein denatures and the starch gelatinises. As the gluten denatures it releases water which is then taken up by the starch as it is gelatinising. Bread is given an elastic texture from the gluten formation.

Fat inhibits gluten formation, whereas water aids it. **Cookies and pastry** are high in fat which inhibits the formation of gluten even though they are high in wheat flour. By the gluten not being able to form; short, crumbly cookies are produced.

Gluten levels	Texture	Application
Low levels of gluten	Flaky, crumbly baked goods	Biscuits Pastry
High levels of gluten	Stretchy, elastic baked goods	Bread Cakes

## Different solutions for different applications

A major limitation in the production of gluten-free products is the lack of protein functionality in non-wheat cereals. Additionally, commercial gluten-free mixes usually contain only carbohydrates, which may significantly limit the amount of protein in the diet. In the recent past, various approaches have been attempted to incorporate protein-based ingredients and to modify the functional properties for gluten-free product development.

Many gluten free products, not just bread, have almost no protein in them. It seems the focus has just been on taking out the protein and replacing it with carbohydrates. Most of the time this has little impact on the overall calories as a mixture of starch and fibre will be used, but launching products which have very little to no protein in this ever-growing high protein society seems like a bad idea. A lot of people who are going "gluten-free" are doing so from a health point of view; these people are most likely wanting to ensure they follow a low carbohydrate, high protein diet too.

There has also been a lot of gluten free products which have moved away from the "clean label" approach with the use of E-numbers and gums (xanthan gum is very popular in gluten free bread to mimic gluten) but these do not give a clean label solution which is in line with the growing health trend around a gluten free diet.

## How U&S can help

Here at Ulrick and Short we have a range of gluten free starches, proteins and fibres which can improve the nutritional profile of a product as well as the quality.

We have a good understanding of what products do individually as well as working on which combination and level of products works best in a gluten free system.

There has been a lot of work to get where we are today with gluten free products, but with the market showing no signs of slowing, we will continue developing our range of gluten free ingredients to give improved eating experiences and nutritional claims in this ever growing sector.





## Starches and Flours

Produced from a range of crops including Tapioca, Wheat, Rice, Sweet Potato, Pea and Waxy Maize.

- Available in 'cook up', 'pre-gelatinised' and 'cold water swelling' formats.
- Heat, pH, freeze/thaw stable versions available with a range of viscosity profiles and a whole palette of textures.
- Thickening, stabilising, fat replacement, sugar reduction, phosphate removal and glazing are only a few of the functions possible.
- Simple, clean and consumer friendly declarations in the following key application areas:
  - Bakery
  - Processed meats
  - Sauces
  - Ready meals
  - Desserts
  - Snacks



## Fibres

Produced from a range of crops including Wheat, Oat, Bamboo, Flax and Pea.

- Insoluble fibres with high water binding capacity in a range of fibre lengths, giving full control over the desired texture.
- 'Source of' and 'high in' claims for fibre and omega 3 achievable.
- Shear, acid, heat and freeze/thaw stable.
- Key application areas:
  - Bakery
  - Processed meats
  - Sauces
  - Performance foods
  - Sports nutrition
  - Snacks
  - Breakfast cereals



## Proteins

Produced from a range of crops including Wheat, Pea and Rice.

- A range and variety of protein content.
- Can be used as effective binders and emulsifiers.
- Nutritionally enhance foods and boost amino acids.
- Easy to apply and use in the following key application areas:
  - Processed meats
  - Bakery
  - Sports nutrition
  - Infant formulas
  - Functional foods



## Clean & Clear Label

Starches | Flours | Fibres | Proteins

- ✓ Non-GM
- ✓ Additive free
- ✓ Wide range of crops and functionalities
- ✓ Allergen free options
- ✓ Simple consumer friendly declarations
- ✓ Enhanced nutritional profiles
- ✓ Quality assured from field to fork
- ✓ Fully accredited including BRC, Kosher and Halal approved

All backed up by onsite technical support.



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