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# Wheat Proteins—The Foundation of Breadmaking

A common starting point for any treatise on breadmaking is a discussion on the nature of wheat proteins and their rare ability to form gluten. The fundamental role that proteins play in breadmaking has probably led to more research on them than on all other aspects of breadmaking combined. The research often focuses on the genetic basis of protein contributions to various bread characteristics, most notably volume, which is one of the key characteristics that bakers seek to control. Volume is key, in part, because breads with a larger volume have a softer crumb—a characteristic sought by many consumers around the world.

Before pressing on with my message, I would like to clarify my own position with respect to use of the terms protein and gluten. For me there are only proteins in flour, and it is not until these proteins are hydrated and "worked" by mixing that gluten is formed. It is unfortunate that people refer to the gluten content of wheat and flour as though such a substance actually exists in the grain. We are where we are, however, and like everyone else I'll just have to live with the nomenclature currently in common use.

At the macroscopic level bakers are concerned with protein (gluten) content and quality. The former is relatively easy to measure, and its relationship with bread quality is easy to define. In broad terms more protein yields a larger bread volume. Protein quality, on the other hand, is harder to define because it depends to a significant extent on the manner in which the bread is prepared and is often linked with another ill-defined term—dough development.

## Protein Quality

In simple terms, quality can be defined as "fitness for purpose," so we can accept then that protein quality for long-fermentation breadmaking systems has to be different than that for sponge and dough systems and different again for no-time dough-making processes. In different breadmaking processes the methods for mixing and processing dough vary and, in principle, so should the qualities of the proteins present in the flour.

Over the years this has led us to a position from which it is difficult to define protein quality and has resulted in the development of a range of testing methods based on different machines and processes. In part, the plethora of testing methods developed for determining protein (gluten) quality has its origins in the varied breadmaking processes that have evolved in different parts of the world. In addition, testing procedures often have been designed to mimic some aspect of kneading and stretching the dough by hand. This led to complications in information exchange and wheat trading, and the principle of the "approved" or "standard" method has evolved to address these challenges.

However, we need to be clear about what we have achieved with the development of standard methods. We now have common methods that allow us to compare flours derived from different sources and to predict to a degree how such flours will perform in a particular baking scenario. What we have not developed is a means by which we can predict from a protein quality test alone what the final bread quality will be. Despite our ability to extract correlations between flour and bread quality there is no universal test method that tells us all we need to know about the relationship between flour and bread quality, and there is not likely to be one developed in the immediate future, not least because of the variety of breadmaking processes in use.

## Protein and Bread Quality

I do not make these points because I wish to decry the efforts of many cereal scientists over the last hundred years or so. I too have published work correlating flour and bread properties, but increasingly I have realized that such work is only indicative of "quality" (as in fitness for use) rather than deterministic for the reasons discussed above. Flour proteins and gluten quality are the fundamental building blocks of bread quality, but only if we can understand the context in which they are placed.

Last year was the 50th anniversary of the introduction of the Chorleywood bread process (CBP) in the United Kingdom and around the world. The essence of the process is the use of mechanical energy to defined levels in order to develop dough in the mixer so that bulk fermentation (floor time) is eliminated. Having co-written the most recent book on CBP (1), it was my telephone that kept ringing last year with requests from the press and media. A lot of my conversations were about debunking the myths behind the development and application of CBP.

The one myth that stands out from all others is related to flour protein. When CBP was introduced, the United Kingdom imported large quantities of wheat from Canada and the United States; it still does but not to the same extent. The inventors of CBP found that if they used the same flour as was being used in U.K. bakeries at the time the bread they made was too large to fit into the bread bag. To compensate, they used the traditional baker's approach of lowering the protein content by about 1%. This in turn meant that more U.K. and less imported wheat could be used in the milling grist. However, over time the "popular" view became that CBP was invented to increase use of U.K. wheat, and it was not just journalists who made the mistake—it was made by quite a number of cereals scientists and bakery technologists.

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## Dough Rheology and Bread Structure

Technology has moved on since 1961 and so has our understanding of the role that protein (gluten) quality plays in bread quality. The assessment of dough rheology lies behind many of our testing methods and helps us anticipate characteristics like volume. In addition to being linked with bread volume, gluten rheology (I use the term now since I am referring to dough) plays a part in the formation of the cell structure of the baked product. There is a particular role that gluten rheology plays as the dough is processed during dividing and molding.

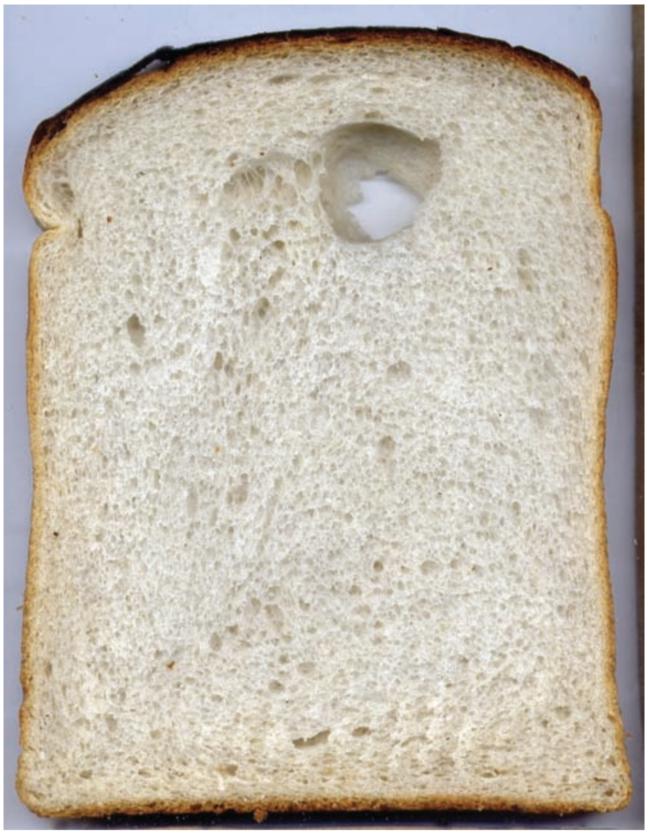

**Fig. 1.** Dough damage and hole formation in pan bread.

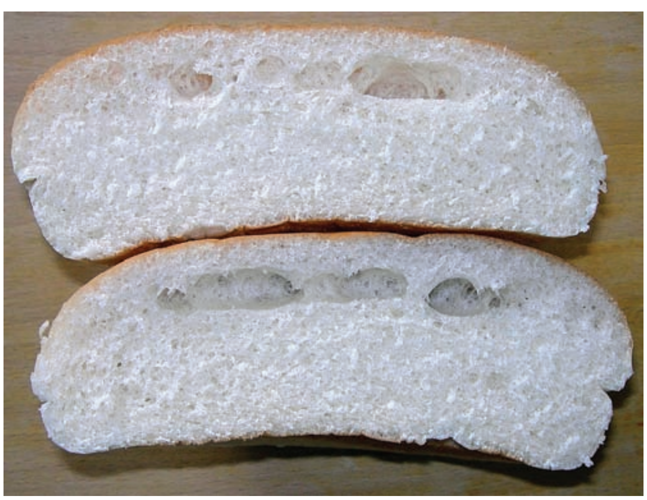

**Fig. 2.** "Unzipped" holes in hamburger buns.

A key role of the gluten network in bread dough is the ability to stretch as the gas bubbles inside the fermenting dough expand. Eventually the expanding gas bubbles will touch, and coalescence of the bubbles can occur. The rate and extent to which such coalescence occurs is controlled to a large degree by the rheological properties of the gluten network. Premature coalescence can result in larger cell sizes (more open structure) in the baked product. Perhaps more critically, damage to the gluten network during dough processing can result in the formation of unwanted features, such are large holes.

The bulk rheology of dough can be quite deceptive; when handled we think of a well-developed dough as being resilient and robust. However, the mechanical processing of dough subjects it to severe stresses and strains, something we try to replicate in our flour and dough testing methods. The gluten network is relatively delicate at the microscopic level and needs to be treated with care. Bill Collins (one of the inventors of CBP) described the gas bubbles in bread dough as being "like a bag of eggs" and believed that the object of dough processing should be to convey those eggs to the proof box unbroken—if only that were possible.

## Formation of Holes in Bread

The formation of large holes and areas of coarse cell structure in a bread loaf are the most common manifestation of "broken eggs," to use Bill's analogy. Often there is a close relationship between large holes and dough damaged during molding. One such example is illustrated in Figure 1, in which a dark patch of coarse cell structure sits adjacent to the large hole in the bread slice. Originally the large hole was a small trapped gas pocket, but carbon dioxide gas leaking from the prematurely ruptured structure migrated into the trapped gas pocket (because of its low internal pressure compared with other cells forming in the crumb) and expanded it further.

The relationships between dough processing damage and the formation of unwanted holes can be seen in any number of bread products. Figure 2 shows an example observed in hamburger buns. In this case the quality defect is seen as a series of small linked holes that exploit the damage caused when the dough pieces were pinned to shape and gas pressure caused the bubbles in the dough to "unzip." In more severe cases, one large hole or blister may form and protrude through the surface.

It has long been known that flour (gluten) content and quality underpin bread quality, but we are still learning about the microscopic processes that ultimately control bread quality. The relationship between flour characteristics and bread volume has understandably been a key area of study, but perhaps we should be paying more attention to the interactions between dough and the processing methods used to turn dough into bread. As the few examples I have given show, flour protein has many different roles to play in delivering the bread quality that bakers and consumers seek. Flour protein is vital to breadmaking, and we must understand how to use it wisely.

**Reference**

1. Cauvain, S. P., and Young, L. S. *The Chorleywood Bread Process*. Woodhead Publishing, Cambridge, U.K., 2006.