Recent advances by food scientists promise gluten-free breads that are more affordable, nutritious, and flavorful!

Against the Grain

by Dayna Gallagher & Jenn Feigin

Human beings have been eating gluten-containing wheat products for thousands of years. However, for the 1.8 million Americans with Celiac disease, the tiniest exposure to gluten can trigger an immune reaction powerful enough to cause extensive damage to the intestines. People with Celiac disease have to be alert around food all the times; they have to be able to spot potential hazards in common products and on restaurant menus. In recent studies, six percent of Americans reported that they regularly experience less-extreme version of digestive distress after eating glutinous foods, and thirty five percent of Americans said that they are trying to eradicate gluten from their daily food intake altogether. If you are one of the estimated 20 million gluten-sensitive Americans, you too might seek gluten-free alternatives to your lamented love, your beautiful betrayer– Bread.

Gluten is one of the most heavily produced, marketed, and consumed proteins on the planet. Most often, we encounter a concentrated form of gluten in bread, though it does pop up in surprising places (check your pickles!). The term "gluten" refers to proteins that occur naturally in wheat, rye, barley and hybrids of these grains. Gluten is formed when two water insoluble molecules (gliadin and glutenin) form a bond. Through the process of kneading dough, that bond creates an elastic membrane, which gives bread its chewy texture and allows chefs to toss and twist the dough. Gluten also traps CO_2 , which adds volume to the bread loaf as it ferments.

For those with Celiac disease, gluten-free products are necessary alternatives to avoid the serious health risks of consuming gluten, including nutritional deficiencies, osteoporosis, and intestinal cancers. Though the risks of this disease only impact a portion of the total population, gluten-free alternatives have become popular with the larger consumer public. According to Mintel, a market research firm, gluten free products had total sales of $10.5 billion in 2013 and are expected to account for more than $15 billion in revenue by 2016. With everything from vodka to cookies being marketed as gluten free, there is some confusion over what exactly the term means.

In August 2013, the U.S. Food and Drug Administration (FDA) strictly defined the term "gluten free" and has mandated that in order to use the term "gluten-free" on its label, a food product must meet all of the requirements of the definition, including that it must contain less than 20 ppm of gluten. The rule also requires foods with the claims "no gluten," "free of gluten," and "without gluten" to meet the definition for "gluten-free." Food manufacturers have responded to this increased demand and stricter labelling, much to the delight of Celiac sufferers, by formulating a vast collection of gluten-free foods.

To address the gluten-free community's nutritional needs, food technologists seek to develop foods that are not only gluten-free, but similar in character to gluten-containing products. However, as O'Shea et al. (2014) point out in their survey of gluten-free research, the quality of these products is still notably lackluster. Although gluten-free alternatives are readily available on the shelves of many grocery stores, these products are often crumbly and brittle, and are perceived as being of inferior quality compared to the wheat products they aim to substitute. In addition to these deficits, gluten-free foods have also often been found be lacking in nutritional quality. They

have been reported to contain lower levels of essential nutrients such as types of vitamin B, iron and fiber, than are found in wheat-containing products. This is mainly due to the fact that gluten-free products are generally formulated with starches and refined flours, and are not usually fortified. It's no wonder, then, that food scientists describe the gluten-free breads of the past as having a low volume, pale crust, and bland flavour. O'shea *et al*. discuss the recent advances in developing foods that are gluten-free, focusing on ingredients and processing methods documented to improve the processing characteristics and nutritional properties of gluten-free products.

According to the authors, research has addressed some of the nutritional needs of those with Celiac disease by formulating palatable, gluten-free breads with enhanced nutritional properties. Most have focused on using the so-called 'pseudo-cereals': amaranth, quinoa and buckwheat to replace wheat in bread formulations. "These cereals are gluten-free, and are also rich in nutrients; therefore, their incorporation in the gluten-free diet not only adds variety but improves nutritional quality."

Another interesting approach makes use of lactic acid bacteria and yeasts (sourdough) as bio-processing ingredients in gluten-free formulations. According to O'Shea et al., "One potential benefit for gluten-free formulations is the sourdough starter's ability to generate enzymes (peptidase) with the capacity to detoxify wheat and rye peptides (responsible for the immune response developed from celiac disease);" this indicates the possibility of using cheaper, traditional flours in gluten-free baking. A second area of research that the articles covers, notes that lactic acid bacteria fermentation requires particular pH conditions which degrade phytic acid—an anti-nutritional factor known for binding essential minerals, such as, calcium, iron, and potassium—and the exploitation of this could increase the nutritional content of gluten-free breads. Additional conclusions in this area of research include: the growth of lactic acid bacteria controls the growth of any other organism present, increasing the shelf-life of the product; the inclusion of sourdough into a gluten-free formulation enhances the flavor profile of gluten-free bread; and certain lactic acid bacteria strains can produce long chain sugar polymers, which have the ability to act as a hydrocolloid replacements in gluten-free formulations, creating breads with a softer texture.

So far, however, the best approach to producing a bread of favorable baking characteristics from a highly "visco-elastic" gluten-free batter, research shows, is to use a combination of ingredients. Blends of chestnut flours, chia flours, and various hydrocolloids have had some success in replicating wheat flours. Other unique flours food scientists investigated include: carob germ flour, tiger-nut flour, lupin seed flour, and various vegetable flours. Scientists have examined additional ingredients to address common problems of gluten-free products, such as their inability to retain CO2, dense crumb grain, and poor nutritional content. Supplementary ingredients include shortenings, whey proteins, and hydrocolloids, as well as calcium and iron.

Other scientists work with glutenin, the other important protein in wheat gluten. Not all glutenins, it turns out, are created equal. A team of chemists at The Bread Lab, part of the Washington State University-Mount Vernon Research Center plant breeding program are exploring the structure of glutenins of assorted molecular weights, shapes, and sizes. The research could help in the genetic engineering of glutenins that can outperform those of today.