

Gluten-Free: No Longer a Challenge

Egg products help provide the functional and nutritional profile in gluten-free food formulations.



The incredible edible egg™
American Egg Board

Egg Products = Gluten Solutions

Time and again, egg products have proven their versatility and multi-functionality in both regular and specialty foods, no more so than in gluten-free formulations, a growing product category that serves people diagnosed with celiac disease.

Although on the surface celiac disease appears most closely linked with carbohydrates – after all, people diagnosed with this disorder avoid wheat – in actuality, formulating products for celiacs involves careful selection of ingredients to replace the protein ‘gluten.’

The term ‘gluten’ is in a sense, a generic term for the storage proteins that are found in grains. In reality each type of protein, gliadin in wheat, secalin in rye, hordein in barley, avenin in oats, zein in corn and oryzenin in rice, is slightly different from the others when broken down into its basic amino acid structure. The gluten in wheat, rye, barley and in a much lower amount, oats, contains particular amino acid sequences that are harmful to person with celiac disease. The damaging proteins are particularly rich in proline and glutamine. As peptides, some such as 33-MER cannot be broken down any further. In people diagnosed with celiac disease 33-MER stimulates T-cells to produce antibodies. The antibodies, in turn, attack the villi in the small intestines.¹

This autoimmune response also helps distinguish between those individuals who are gluten sensitive and those who actually have celiac disease. According to the William K. Warren Medical Research Center for Celiac Disease associated with the University of California San Diego, in La Jolla, “There is a major difference between gluten sensitivity due to allergic reactions to wheat proteins and the immune reaction in the intestinal tract to gluten that occurs due to celiac disease.” Some research indicates that as much as 15% of the population might have gluten sensitivity, while less than 3% of the total population is diagnosed with celiac disease. (<http://celiaccenter.ucsd.edu/aboutcdadults.shtml>)

A diagnosis of celiac disease requires biopsy evidence of intestinal villous atrophy. Gluten sensitivity refers to those who have an adverse immunological response to dietary gluten, or an allergic reaction to wheat gluten, but do not show biopsy evidence of villous atrophy. Celiac disease involves an IgA or IgG immune system response to dietary gluten, while a classic allergic reaction involves an IgE response.

At the heart then, it is this protein, found in certain grains, that stimulates a negative autoimmune response.² Gluten-containing flours and ingredients removed from a food product’s formulation must be replaced with highly functional ingredients that mimic the structure gluten provides.

Egg products, due to their highly functional proteins, play this role with finesse. Egg protein is easily digestible, is not a trigger for celiac disease, and contributes essential functional and nutritional properties to gluten-free foods.

Simply dropping gluten from the diet could cause an unbalanced diet lacking in essential nutrients, according to “The Gluten-Free Diet: An Update for Health Professionals,” *Practical Gastroenterology*, September 2006. Eggs are a complete protein food because they contain all

nine essential amino acids, as well as nine nonessential amino acids. The essential amino-acid composition of egg protein is similar to the human body's requirement, allowing the body to use the protein more efficiently for growth. Using protein's biological value (BV) scale, with 100 representing top efficiency, whole-egg protein has a BV of 93.7 as compared to milk (84.5), fish (76.0), beef (74.3) and soybeans (72.8).

In addition to proteins, other components found in eggs such as lipids, lipoproteins and phospholipids serve as key functional ingredients in many products. Eggs provide foaming, emulsification and coagulation properties in addition to contributing to crystallization control, texture, binding, color, flavor and nutrition.

This wide range of functional attributes is vitally important in gluten-free formulating because it isn't the bread aisle alone that causes celiac sufferers problems. And not just any protein substitution is best for a celiac consumer. For example, supplementation of gluten-free breads with high lactose-content powders is not suitable for celiacs with significant damage to their intestinal villi because this population could be intolerant to lactose due to the absence of the lactase enzyme, which is generated by the villi.³

A gluten free diet excludes foods made with wheat, rye, barley, triticale, dinkel, kamut and oat flour as well as by products made from these grains. Other excluded foods are those that use derivatives of these grains for thickeners and fillers in hot dogs, salad dressings, canned soups or dried soup mixes, processed cheese and cream sauces. Often these fillers comprise a tiny percentage of the overall formulation and could be substituted with more 'gluten-friendly' ingredients. Generic terms on a product label such as 'modified food starch' also serves as a warning sign to those with celiac disease, unsure of whether or not that modified food starch is corn- or wheat-based.

A Disease, Not an Allergy

Celiac disease is not a food allergy, but a lifelong disorder found in genetically susceptible individuals. In addition to gastrointestinal upset and other physical responses, it is a serious condition that if ignored or left untreated can cause an increased risk of associated disorders both nutritional and immune related. The only choice for a healthy lifestyle for this population is a strict, gluten-free diet. This is where formulators can step in to help.

The level of gluten tolerable for individuals with celiac disease has been the subject of debate for many years. Research establishing a safe threshold of gluten consumption for those with celiac disease was recently published in the American Journal of Clinical Nutrition. The study, sponsored by the American Celiac Disease Alliance (ACDA) at the University of Maryland, concludes that celiacs can safely tolerate up to 20 parts per million (ppm) of gluten in food.⁴

In 1976 the Codex Alimentarius Commission of the World Health Organization (Geneva, Switzerland) and the Food and Agricultural Organization (Rome, Italy) adopted The Codex Standard for gluten-free foods. Now, the Food and Drug Administration⁵ (FDA) is proposing to define the term "gluten-free" for voluntary use in the labeling of foods, with the regulation scheduled for publication by August 2008. It dovetails with the research report in its key recommendation that any food labeled 'gluten free' must not contain more than 20 ppm of gluten.

Good Form

Formulators can select from among dried, liquid and frozen egg products available in whole egg, yolks and whites, with and without additional ingredients added for shelflife and enhanced functionality. Egg products assist in emulsification, increasing volume, improving machineability, while providing consistency in measurement and ensuring quality. Quality control managers can be assured that all egg products are pasteurized to destroy *Salmonella* and other bacteria. And, of course, egg products are label-friendly.

Market Potential

The National Institutes of Health estimates approximately 1 in 133 people have celiac disease, with 97% remaining undiagnosed.

According to information from the Packaged Facts report “Gluten Free Foods in the U.S.,” it estimates the number of known celiacs will increase worldwide by a factor of 10 during the next few years. In this same report the company listed gluten-free food sales of almost \$700 million in 2006. Growth projections indicate possible sales of \$1.7 billion by 2010.

This is reflected in the number of new products introduced in the past few years that fit the gluten-free label. Mintel’s New Products Database lists 2,015 wheat-free products introduced since 1997. In particular, in 2007 and 2006 companies launched a total of 268 new bakery products with gluten-free claims, a significant jump compared to records from previous years.

Holding it all together

Baked goods comprise a good portion of gluten-free products because, as one marketer explained, “We concentrate our product line on items that are ‘wheat heavy,’” says Stephanie Robbins, director of marketing for Pamela’s Products, Inc., Ukiah, California. Food items such as bread, cookies, cakes and biscotti take center stage.

“We know there is a strong emotional connection between people and the foods they eat and primarily, the food has to taste good. Pamela Guisto-Sorrells is the founder of Pamela’s Products and she personally formulates all of our products,” says Robbins. “She was one of the first formulators to try to ensure ‘health foods’ also tasted great,” she says. Pamela’s Products, celebrating its 20th anniversary this year, creates an extensive line of gluten-free cookies, biscotti and baking mixes, including flavors such as Almond Anise Biscotti or Peanut Butter cookies.

The gluten matrix provides dough with extensibility, resistance to stretch, mixing tolerance and gas-holding ability. This matrix encloses the starch granules and fiber fragments, acting as the structural protein in bread. Its absence often produces a liquid bread batter rather than dough. When formulating with gluten-free flour, moisture content is a critical aspect. If the formulator is baking an item that is expected to rise and the dough is dry, it will be too dense. If the dough is too moist, the rise will be good, but will collapse during the baking period. The common complaint with gluten free baked goods such as cookies or sandwich bread is they crumble easily. Therefore binding properties as well as textural qualities are vitally important in ingredient selection. Egg yolks can act as a lipid source in foods by softening a product’s texture.

And not surprisingly, when bakers look to alternative flours for gluten free formulating, the protein content of the replacement flour is a key factor. According to one expert, the flour's protein level should be near the 10% typical of wheat flour, plus or minus a few points depending on whether the end product is bread, pastry or pasta. Most alternatives top out at about 5%. Rice flour might have a bland flavor, however corn, soy and potato flours all carry a more distinctive taste and are detectable in a product trying to pass itself off as a wheat alternative. A protein source that helps with functionality and itself possesses a bland flavor is invaluable in gluten free formulating.

“Eggs and egg products really come into play for certain effects during the baking process,” says Robbins. “Our white cake mix, for example, relies on eggs for their foaming ability. This is imperative for obtaining the fluffy, light texture traditional to that form of baked good.”

An angel food cake, as one example, is dependent on the foaming properties of unique egg white protein fractions. Heating egg white proteins promotes protein aggregation by formation of hydrophobic bonds, hydrogen bonds and disulfide bonds. The foaming ability of the egg albumen is dependent on the quality of albumen proteins, one reason why gluten-free baking formulators should request a foaming-type egg white product (dried or liquid).

In terms of gluten-free baking, cakes might actually prove easier to formulate than bread. While temperatures rise, the egg proteins are forming bonds with one another, or coagulating. Sugar molecules, generally present in greater quantities in cake than in bread, raise the temperature at which egg proteins will form these bonds, allowing for more and larger air cells to form, which creates the light, fluffy texture anticipated from such a confection. The cellular structure of certain cakes, typically white, yellow or angel food depends on egg protein.

In bread and other baked goods, eggs help with humectancy, holding moisture in to help extend shelf life, to keep baked goods fresh. The xanthophyll pigments in egg yolks contribute a pleasant color in certain white breads, yellow cakes, muffins and breakfast breads.

For the biscotti or cookies, Robbins says eggs play the traditional role they would in any such baking environment, assisting with proper formation of the dough and to help bind some of the dry ingredients.

Another key ingredient, says Robbins, is patience. “Gluten-free formulating is not a simple 1:1 substitution,” she says. Pamela spent eight years perfecting her bread mix, after spending eleven years prior to that formulating gluten-free foods. “Natural ingredients of the highest quality obviously help, but it still requires a certain expertise,” says Robbins.

Simplifying Savory

Although the vast majority of foods introduced for gluten-free consumers fall into the baked goods or dessert categories, companies can take steps to ensure that savory foods can earn the gluten-free label as well, expanding the marketing possibilities to this special group of consumers.

Egg protein can provide structure and coagulative properties to bind food products such as snacks, processed meats, and prepared entrees. They can coagulate and create gels, readily replacing the gluten-containing ingredient typically used in the manufacture of frostings, custards and fish surimi. Egg products can step up to the plate in products that utilize a small amount of wheat or wheat-based starch for structure, such as crab cakes or meatballs, helping bind other ingredients together.

Egg proteins can improve the mouthfeel of sweet goods and puddings by providing substantial body and smoothness. They can be used to thicken sauces, gravies, smoothies and other viscous products that normally rely on wheat-based starch ingredients, according to Glenn Froning, Ph.D., food technology advisor for the American Egg Board, and professor emeritus at University of Nebraska's food science department. This category in particular is one that would need minor modifications to open up entire product categories to those with wheat sensitivity. Sauces and gravies are often utilized in frozen prepared meals, for example, and the component most likely to contain a wheat- or gluten-based ingredient.

Another winning feature about eggs, according to Froning, is that they are bland. They mix well into products so other flavors play the hero. In mixing with gluten-free flours, they lend moistness and rise, "particularly in a pizza crust, I believe they could operate well in that environment," says Froning.

George Chookazian, Foods by George, LLC, Mahwah, NJ, might well agree, having introduced an award-winning pizza at the Natural Products Expo East in 2005 that utilizes egg white for a crisp, tasty crust. He strives to make every product at his firm as close to the original wheat-based version as possible. "I've been asked why I don't make brown rice crust. People don't typically go into the pizzeria to ask for a whole wheat crust pizza. Our crust is crispy, not grainy or doughy."

One of his challenges is delivering a consistent product without using all the "fake ingredients that you see a lot on the commercial side of baking industry," says Chookazian. He prefers fresh whole eggs or egg whites, noting that he uses his stock of ingredients too quickly on a daily basis to thaw frozen product. "That also means there is less tolerance for error, so you have to have tight quality controls and tight specifications and parameters."

Keeping it Clean

"In terms of the celiac consumer they are even more educated than your average consumer in terms of reading labels," says Robbins. "They have had to deal with so much in their bodies they are aware of product sourcing and ingredient lists far more than your average consumer."

Listing eggs on the ingredient label keeps it short, familiar and non-threatening to the celiac consumer. In addition, most egg products add essential proteins to the nutritional value of the food and proper nutrient intake is of utmost importance to this population.

Fun Foods a Formulary Challenge

Imagine making breaded chicken or a corn dog . . . without gluten. Bill Pinkerson, president of S'Better Farms, Carson City, Nevada, has created fun foods that seem to defy the impossible.

“Gluten is a wonderful thing, if you throw a pizza skin up into the air, it stretches and flies around, holding everything together. Gluten-free formulating is very touchy. It is difficult to make fried and battered foods without gluten,” says Pinkerson.

Pinkerson says his company utilizes eggs as a binder to help the coating adhere to products like chicken fingers, or the corn based wrap around his corn dogs. “We use it to add richness to the product as well.”

Pinkerson was inspired to try his gluten-free formulating after having friends over for a traditional kosher Friday night dinner and discovering some of the family members were diagnosed with celiac.

“I started thinking about it from the mother’s perspective of having to prepare two meals or having one child with celiac and one without. Chicken fingers and corn dogs are fun foods. We’re trying to make something normal to eat that just doesn’t have gluten in it.”

“Our chicken fingers are so much better than the competition because we use whole muscle and quality, natural ingredients in the production line.” Starting his business as a caterer in an exclusive section of the country, Pinkerson says, “We take the same care, use the same quality ingredients that we would use for a catering event at the Four Seasons, but you can buy it in the grocery store for an affordable price.”

Normal foods for reasonable prices that taste good – not an impossible feat in the gluten-free market with the right ingredients. Egg products perform superbly in gluten-free foods with a functional and nutritional profile that helps these specialty foods retain a ‘normal’ profile, structure and taste.

¹*The Journal of Immunology*, 2004, 173: 1757-1762.

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Antigen Presentation to Celiac Lesion-Derived T Cells of a 33-Mer Gliadin Peptide Naturally Formed by Gastrointestinal Digestion

²The autoimmune response is stimulated by proteins found in wheat (including durum, semolina and spelt), barley, rye, cross-contaminated oats and related grain hybrids such as triticale and kamut.

³ Trends in Food Science & Technology, Volume 15, E. Gallagher¹, T.R. Gormley¹ and E. K. Arendt², Recent Advances in the Formulation of Gluten-free Cereal-based Products, Pages 143-152.

⁴American Journal of Clinical Nutrition 2007 185:160-165. A prospective, double-blind, placebo-controlled trial to establish a safe gluten threshold for patients with celiac disease.

⁵Federal Register Volume 72, No. 14, Department of Health and Human Services, Food and Drug Administration, 21 CFR Part 101, “Food Labeling: Gluten-Free Labeling of Foods.”

“Functionality of Eggs in Baked Goods,” Shelly McKee, American Egg Board.