white paper

Gluten-Free Solutions Begin with REAL Eggs

Texture, chew, crumb, crust, taste and appearance — these are some of the hallmarks of a quality baked product in the eyes (or mouths) of a consumer, but devilishly tricky to recreate in a gluten-free version. Bakery items might comprise the majority of a gluten-free product line, but it also can include pasta, sauces, snacks, meats, desserts and even condiments.

incredible!

American Egg Board

However, formulators find baked goods a particular challenge due to the amount of gluten in traditional breads, cookies, muffins and the like. Other product categories generally rely less heavily on gluten with the possible exception of pasta. Even so, there is no single, drop-in ingredient solution that transforms a traditional formulation into gluten-free.

Fortunately there are certain tried and true ingredients that can assist with gluten-free formulating. One vital contributor is the egg. Egg ingredients supply more than 20 functional benefits to food formulators and can play a critical role to achieve proper form, function, appearance, taste, texture and shelf life. In their natural state, in the shell, eggs are completely free of gluten as are most of the further processed egg ingredients, such as liquid whole eggs, egg yolks and egg whites.

New Labeling Regulations

Each component of a gluten-free formulation matters because even miniscule amounts of gluten can add up collectively within the formulation. For example, unexpected sources of gluten can include spices or fermented ingredients such as enzymes, according to Joe Baumert, Ph.D., professor in the Department of Food Science and Technology, University of Nebraska, Lincoln, who spoke at the Institute of Food Technologists Annual Meeting and Food Expo in 2014. And in a facility that processes both traditional and gluten-free products, bakeries in particular can experience cross-contamination.

These unexpected sources of gluten or cross-contamination scenarios can affect a product's labeling status.

Different governing bodies around the globe have varying thresholds for gluten-free product definitions and labeling. Australia, New Zealand, the European Union, Canada, the United Kingdom and certain South American countries all have an official position for testing and detection levels of gluten that a manufacturer must meet in order to label a food gluten free.

While the term "gluten-free" implies no gluten at all, global standards generally accept a level of 20 parts per million (ppm).

In the United States in August 2014, the Food and Drug Administration (FDA) established formal standards for gluten-free labeling:

- Product must contain less than 20 ppm detectable level of gluten
- Product does *not* contain wheat, rye, barley or crossbred hybrids such as triticale
- Product contains a gluten-containing grain or ingredient derived from a gluten-containing grain that has been processed to less than 20 ppm (Note: Oats that contain less than 20 ppm of gluten may be labeled "gluten-free" but do not need to be certified as gluten free)
- Products naturally gluten free such as bottled water or fresh produce

The ruling covers all FDA-regulated foods, dietary supplements and any imports subject to FDA regulations.

What is gluten and how does it affect gluten-sensitive individuals?

While gluten is most often associated with wheat, gluten is a protein found in a number of grains in addition to wheat, such as barley, rye, spelt, kamut and triticale. Gluten is an elastic substance that forms when glutenin and gliadin bind with water. It makes dough elastic and stretchy, entrapping gas within baked goods to provide a light airy structure and appropriate crumb and texture. Gluten can be present in many other products including deli meats, soups, sauces, confections or even toothpaste. Some of these are called "hidden" sources of gluten.

A person diagnosed with celiac disease, a small portion of the American population totaling less than one percent, must avoid gluten in order to remain healthy. Celiac disorder involves an IgA or IgG autoimmune response to gluten, leading to antibodies that attack the villi in the small intestines. Long-term abuse of the intestinal tract can lead to cancer, among other harmful consequences.

Although currently under debate, many other individuals claim gluten sensitivity, or an allergic response to gluten without biopsy evidence of villous atrophy. Still another, broader demographic group, has voluntarily decided to follow a gluten-free diet, with a Packaged Facts survey revealing "the conviction that gluten-free products are generally healthier" as the top motivation for purchase.

Gluten-free is a label some manufacturers use to tap into the better-for-you product segment, adding gluten-free to other claims such as soy-free, dairy-free and non-GMO, for example.

Major market research groups use different metrics to measure market size resulting in a wide range of results, with Mintel's $10.5 billion for 2013 on the high end to Euromonitor at $486.5 million on the low end. However, all agree when it comes to market forecasting, that gluten-free products will experience double-digit growth through 2018.

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Evidence in Favor of Eggs

In a traditional wheat-based bread product, the gluten entraps and holds air bubbles. A leavening agent causes the gluten network to expand, the heat causes the bubble to rise and then the structure sets, forming a combination of expansion, elasticity and rigidity. Formulators might work for months or even years to perfect gluten-free bread that has proper structure, crumb, texture, appearance, rise, volume and shelf life. Egg proteins can help in many instances.

As egg proteins are exposed to acid or heat, they break and the protein strand denatures. When they aggregate back together again, they entrap air and moisture. This can provide height, volume and stability to chemically leavened baked goods.

Cakes, cookies, muffins and other sweet baked products benefit further from egg ingredient inclusions, because the sugar within the formulation raises the temperature at which egg proteins coagulate. The egg proteins form more

and larger air cells, creating a light, fluffy texture, particularly appealing in cakes, muffins and other baked items where a certain level of rise and open, airy texture is expected.

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 percent 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 five percent. 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 such as an egg ingredient that helps with functionality and itself possesses a bland flavor is invaluable in gluten-free formulating.

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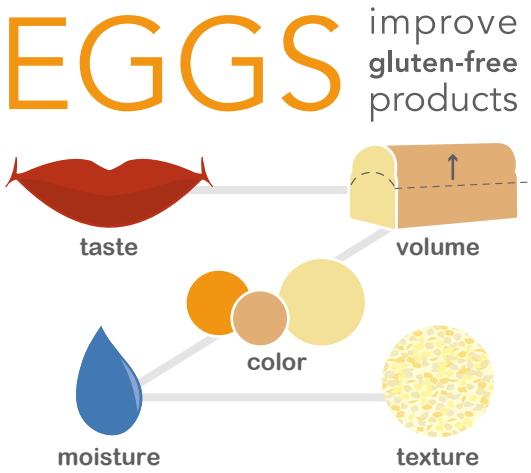
Kansas State University researchers, led by Fadi Aramouni, Ph.D., investigated the use of egg ingredients in gluten-free bread to improve the taste, volume, color, moisture and texture. They presented their findings at the 2013 Institute of Food Technologists' Annual Meeting & Food Expo.



The researchers discovered that whole liquid eggs used in gluten-free sorghum bread at 25 percent on a flour basis exhibited the most favorable impact on the bread flavor, texture, volume and moisture level. According to Aramouni, "The addition of eggs made the texture softer and helped maintain moisture and retard staling, which is important to maintaining shelf life."

Protein Type Makes a Difference

The type of protein selected to replace the wheat protein does play a critical role in product quality,[1] according to a study published in the March 2014 issue of the *Journal of Food Hydrocolloids*. A team of researchers in Spain and Venezuela tested the effects of five different proteins from both animal and vegetable sources on a gluten-free muffin, looking at their impact on dough rheology and

finished product qualities such as volume, color, texture and moisture content.

Egg white protein performed well compared to the other protein sources in the study, contributing positive functional benefits to the batter's rheological characteristics and increasing both height and volume in the finished product.

In general, major technical challenges for food manufacturers attempting to create gluten-free baked goods include dough consistency, dense products, dry crumb structure and shelf life.

Beyond Bread

Egg protein, specifically from egg whites, can help batter and breading adhere to frozen appetizers or foods. The heat causes the egg proteins to coagulate and connect the food components with each other.

For pasta, the egg proteins enhance machinability and the pasta cooking quality, plus lend a desirable texture and color. In general a gluten-free product that includes rice or tapioca flour for example, will be lighter in color than a product with traditional wheat flour. The xanthophyll contained in egg yolks that give them their rich golden color can help add rich color to pasta or breads.

In prepared entrees eggs create gels that thicken, bind and lend structure without gluten. Especially when a small amount of wheat is used to bind products together, such as in pasta fillings or meatballs, egg ingredients can substitute.

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 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. With minor modifications to gravies and sauces, this could open up entire product categories to those with wheat sensitivity. Sauces and gravies are often utilized in frozen prepared meals, for example, and are the component most likely to contain wheat- or gluten-based ingredients.

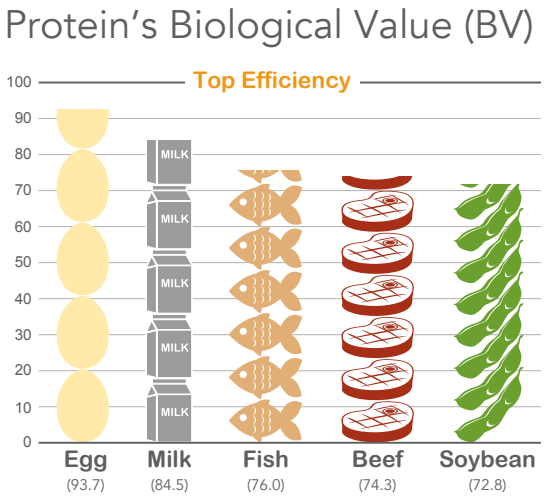
And compared to other protein options, egg ingredients offer a bland flavor that allows the characteristic flavors of the main ingredient "hero" to come through clearly and cleanly.

Nutrition Also a Consideration

Those diagnosed with celiac disease may also be prone to nutritional deficiencies, and when following a gluten-free diet should be aware of the particular vitamins and minerals that might be lacking.[2] Proper advice from a nutritionist can help remedy the situation.[3]

In addition, proper ingredient choices in gluten-free formulating can boost a product's nutritional profile. One whole egg contains six grams of protein with all nine essential amino acids, which are defined as amino acids the human body requires but cannot synthesize. This includes histidine, leucine, lysine, isoleucine, threonine, tryptophan, methionine, phenylalanine and valine. 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).[4] Eggs also are an excellent source of choline, a good source of vitamin D and contain smaller amounts of B vitamins, plus A, E and K, in addition to lutein and zeaxanthin.



Choline, Lutein and Zeaxanthin

Eggs are one of the richest dietary sources of choline, an essential nutrient that plays an important role in fetal and infant brain development, affecting the areas of the brain responsible for memory and life-long learning ability.[5, 6] Eggs also contain small amounts of zeaxanthin and well-absorbed lutein.[7, 8] These carotenoids have been associated with reduced LDL oxidation[9] and a decreased risk of cataracts and macular degeneration,[10] a progressive eye condition that affects 9.1 million people in the U.S. over the age of 40 years.[11] While eggs contain very small amounts of these nutrients, research has shown that the lutein and zeaxanthin in eggs might be more bioavailable than from richer sources like spinach and kale.

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 to provide longer shelf life or enhanced functionality. Egg products assist in emulsification, increasing volume and improving machinability while providing consistency in measurement and ensuring quality. Quality control managers can be assured that all products are pasteurized to destroy *Salmonella* and other bacteria. And, of course, egg products are label-friendly.

Keeping it Clean

Celiac consumers, due to the nature of their disorder are more educated than the average consumer about reading labels, and the average consumer is inspecting product labels today far more than in the past.

Listing eggs on the ingredient label keeps it short, familiar and non-threatening to the celiac consumer.

According to findings from the International Food Information Council (IFIC) Foundation's 2014 survey,[12] 65 percent of consumers check the Nutrition Facts Panel and 52 percent read the ingredients list. Almost three-quarters of consumers or 71 percent of those responding cited healthfulness as a factor impacting their food and beverage purchases.

In addition, most egg ingredients add essential proteins to the nutritional value of the food, and proper nutrient intake is of utmost importance to this population. While machinability and processing will differ for gluten-free compared to traditional formulations, particularly in baking, certain ingredients provide greater benefits than others.

With eggs in the formulation all types of gluten-free foods, including breaded appetizers, pizza, gravies, desserts, cookies and more, function properly and present an appetizing appearance and taste. Egg ingredients exhibit a special affinity for solving formulation issues in gluten-free foods. Choose REAL eggs for a functional and nutritional ingredient that helps these specialty foods satisfy the gluten-free market.

Citations

1. Matos, ME, Sanz T, Rosell, CM: Establishing the function of proteins on the rheological and quality properties of rice based gluten free muffins. *Food Hydrocolloid*, 2014, 35:150-158.
2. Raymond N, Heap J, Case S: The Gluten-Free Diet: An Update for Health Professionals. *J Pract Gastro*, 2006, 67-92(9).
3. Cupples Cooper, C: Gluten free and healthy — dietitians can help reverse nutrition deficiencies common in celiac disease patients. *Today's Dietitian,* 2012, 14(5): 24.
4. Food and Agriculture Organization of the United Nations: The Amino Acid Content of Foods and Biological Data on Proteins. 1971. Nutrition Study #24; Rome, Italy.
5. Zeisel SH: The fetal origins of memory: the role of dietary choline in optimal brain development. *J Pediatr,* 2006, 149: S131-136.
6. Zeisel SH, da Costa KA: Choline: an essential nutrient for public health. *Nutr Rev,* 2009, 67:615-623.
7. Chung HY, Rasmussen HM, Johnson EJ: Lutein bioavailability is higher from lutein-enriched eggs than from supplements and spinach in men. *J Nutr,* 2004, 134: 1887-1893.
8. Goodrow EF, Wilson TA, Houde SC, Vishwanathan R, Scollin PA, Handelman G, Nicolosi RJ: Consumption of one egg per day increases serum lutein and zeaxanthin concentrations in older adults without altering serum lipid and lipoprotein cholesterol concentrations. *J Nutr,* 2006, 136: 2519-2524.
9. Giordano P, Scicchitano P, Locorotondo M, Mandurino C, Ricci G, Carbonara S, Gesualdo M, Zito A, Dachille A, Caputo P, et al: Carotenoids and cardiovascular risk. *Curr Pharm Des,* 2012, 18:5577-5589.
10. Burke JD, Curran-Celentano J, Wenzel AJ: Diet and serum carotenoid concentrations affect macular pigment optical density in adults 45 years and older. *J Nutr,* 2005, 135: 1208-1214.
11. Website MDA: Facts, Figures and Statistics. 2014.
12. IFIC: Food & health survey. 2014. International Food Information Council Foundation, Washington, D.C.

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