

white paper



REAL Eggs Make a Real Difference

There is no single one-to-one substitution that can replace the multiple functional and synergistic properties supplied by REAL egg ingredients. The flavor, functionality and appeal of REAL eggs delivers the gold standard formulators expect and consumers demand. It is a gold standard product — measured by taste, texture and appearance — that prompts repeat purchases and results in market success. Formulators can achieve this with REAL egg ingredients.

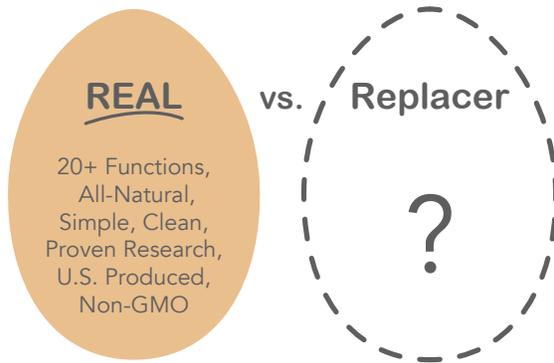
incredible!



American Egg Board

Myths about food and nutrition abound. What might be called the “mis-information superhighway” is filled with contradictions. Often rumors spread faster than factual, scientifically backed information, which makes it difficult for consumers and professionals alike to discern the truth.

Proponents claim superiority of egg-substitute ingredients compared to egg ingredients for formulation. **While these alternatives function on a basic level, the question is, will they produce the gold standard products consumers expect?**



Egg ingredients provide the function, flavor, nutrition and overall performance expected in multiple applications, including baked goods, pasta, desserts, hand-held sandwiches, prepared meals and other product categories.

One Basic Ingredient, Essential Benefits

Egg ingredients supply more than twenty functional properties to foods, including aeration, binding, coagulation, emulsification, foaming and whipping, to name just a few. They perform these functions well under rigorous processing conditions, such as high shear and high temperature, proving their reliability through decades of modern food manufacturing.

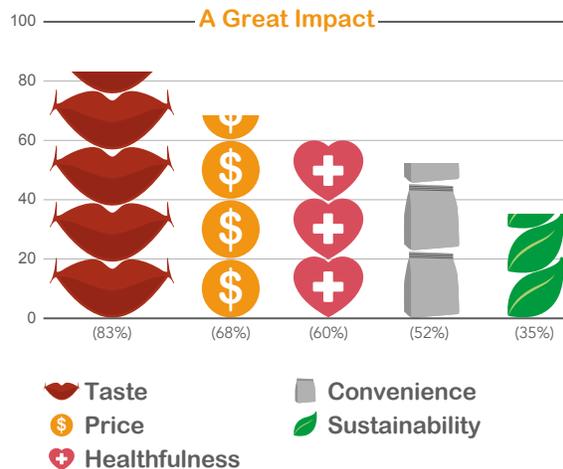
Alternative ingredients have limited functionality, and can contribute to off flavors in the final products. In order to achieve full functionality and an

appearance, taste and texture similar to the original formulation with eggs, an egg substitute may also require the addition of emulsifiers, oils, gums, polysaccharides, acids, enzymes, colorants or flavoring agents. This can create a lengthy label statement and result in a product that falls short of expectations for taste, texture or appearance.

Taste Ranks Number One

Taste still trumps any other measurement for product success. The International Food Information Council (IFIC) Foundation 2015 Food & Health survey reported taste as the top factor influencing consumer’s food and beverage purchases, with taste selected as a primary purchase factor by 83 percent of those surveyed. Many manufacturers of ingredients positioned as egg replacers suggest incorporating their ingredients into products with a strong flavor, to mask off notes. Real egg ingredients allow formulators to create products without worrying about off-flavors.

IMPACT ON FOOD & BEVERAGE BUYING DECISIONS



Egg replacers are generally divided into three categories: plant-based replacers derived from soy, wheat, pea, etc.; whey protein-based; and

carbohydrate or gum-based. Each has a unique set of characteristics that formulators must take into consideration. For example, some egg replacements do not emulate the sensory profile of REAL eggs and/or may contain a strong flavor. For others, the functional range may be limited.

Egg ingredients can offer formulators better taste and a broader range of effective functional attributes from a single ingredient that does not need to be combined with other ingredients for efficacy.

Complementary or Complete Protein?

Just as functional differences exist between proteins, nutritionally not all are the same either. There are complementary or incomplete proteins and complete proteins. Plant-based proteins for example, would be considered incomplete or complementary because they would lack one or more of the nine essential amino acids in the proportion and/or the amount required by the human body. Complementary pairings ingested within a certain time frame must attempt to supply the complete set of essential amino acids the human body requires.¹

Eggs are a high-quality protein, and considered complete because one egg supplies nine essential amino acids (EAA). These EAA are found in

greater amounts in eggs than in vegetable-based proteins.² Eggs contain the EAA leucine, which stimulates muscle protein synthesis in the body. Because of their EAA profile and high digestibility, eggs have traditionally been used as the standard of comparison for measuring protein quality. In addition to its high-quality protein, one standard large egg supplies 13 other essential nutrients for a nutrition profile not found in any single substitute ingredient.³

Substitute ingredients have an amino acid content suppliers might describe as “complementary,” which means more than one type of protein must be used in formulation to supply a complete amino acid profile. Companies that manufacture these products sometimes identify the other ingredients a formulator might need to add to an application in order to create a complete protein. Instead of combining different ingredients, formulators can choose to use REAL eggs.

Sustainability

The protein source, whether animal- or plant-based, does affect sustainability. While plants produce a lower amount of greenhouse gases than animals, there are additional factors to consider when evaluating sustainability of a protein source. A landmark study that examined U.S. egg production practices over the last fifty years detailed the egg industry’s successful efforts to reduce its environmental footprint. Improved hen feed, better disease control and reduced use of natural resources have benefited the environment as well as improved animal health. The study found that the U.S. egg industry lowered its greenhouse gas (GHG) emissions by 71 percent and improved water use efficiencies by 32 percent during that time. The industry also met the needs of a U.S. population that grew by 72 percent over the last fifty years, while increasing the hen supply by just 18 percent.^{4,5}

New studies take a different view of the greenhouse gas comparisons of foods by factoring in nutrient density, or the nutritional value a food offers. Drewnowski noted, “The American diet is said to be increasingly energy-rich but nutrient-poor.”⁶

A study published in 2015 compared the energy and nutrient density of foods in relation to their carbon footprint or GHG score.⁷ While sugar, sweets and grains exhibited the lowest GHGs, study authors stated they have “high energy density and a low nutrient content.”

The most nutrient-dense foods in the study had the highest GHG scores. However, GHG scores of individual foods differed depending on whether the score was made on a per weight basis, per energy basis or per nutrient density. Animal-based proteins typically offer a greater nutrient density than plant-based foods. The authors recommended further study saying, “Consideration of the environmental impact of foods needs to be linked to concerns about nutrient density and health.”

Eggs’ nutrient density is often overshadowed by concerns over the cholesterol content of egg yolks and the belief that consuming them will contribute to increased blood cholesterol levels and ultimately heart disease. However, clinical studies have shown that the majority of the population does not experience significant increases in plasma cholesterol even after an extended increase in dietary cholesterol.^{8,9} One recent study from 2013 examined the health effects of REAL eggs versus yolk-free egg substitutes in individuals diagnosed with metabolic syndrome. The results showed that a diet with moderately restricted carbohydrates that included three whole eggs per day actually improved lipid metabolism and insulin resistance in these individuals to a greater extent than the diet using egg substitutes.¹⁰

The nutrient density of an egg yolk can help contribute to a healthy diet.

Eggs supply 13 essential vitamins and minerals and are one of the few food sources naturally containing vitamin D.

In addition, egg yolks contain docosahexanoic acid (DHA) and arachidonic acid (ARA), essential nutrients for infant or adult neural development and maintenance.^{11,12}

Allergy News

The prevalence of food allergies in the U.S. is increasing and no one disputes the serious nature of foodborne allergies. However, while an average of two percent of the population under age five is allergic to eggs, studies suggest that most children appear to outgrow their egg allergy by late childhood.

Recent studies find that changes in the protein structure of eggs, resulting from cooking, can make them safe for the majority of children with egg allergies. In one study, researchers discovered that initiation of a baked egg diet accelerates the development of regular egg tolerance compared with strict avoidance.¹³

In another study researchers served participants standard cake/bread recipes that used eggs as ingredients, in a preparation baked at 350° F for 30 minutes. It found that more than half of the children in the study (56 percent) could tolerate the egg baked in the cake or bread product.

Children who can tolerate heated egg products appear to outgrow their allergies to eggs at an accelerated rate, compared with children with an egg allergy who maintain strict avoidance of eggs.

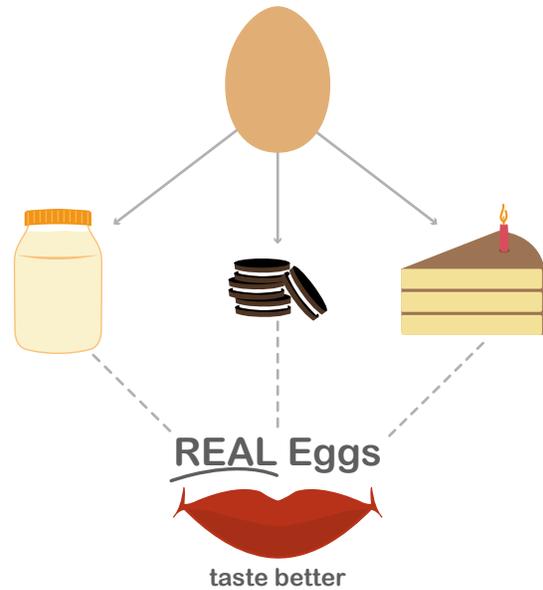
A presentation at the American College of Allergy, Asthma & Immunology 2012 Annual Scientific Meeting featured results of a survey of more than 40,000 children to find that of the eight most common food allergies in the U.S., egg allergy was the most likely for children to outgrow. Fifty-five percent of egg-allergic children ultimately developed a tolerance for eggs. Those who were diagnosed with an egg allergy before age ten were the most likely to go on to outgrow their allergy.¹⁴ The researchers said this evidence of outgrowing a food allergy could lead to these individuals being able to enjoy a much more diverse diet.

Formulating with Eggs

The functional properties that egg ingredients provide to product formulations vary depending upon the application. However a few categories stand out.

Egg white added at 2-7 percent to pasta helps strengthen and improve pasta texture, bite and appearance, allowing for its use in a wide variety of environments, from steam tables to frozen prepared meals.

The quality and sensory properties of egg noodles declines when attempting to replace whole egg with substitute ingredients. Researchers testing cooking quality parameters, texture and color while experimenting with various substitutes found whole-egg noodles had less cooking loss and firmer texture compared with noodles prepared with substitute ingredients. And “none of the egg substitute’s studies could totally replace whole egg in the egg noodles without resulting in some loss of quality.” Further, the study said, “Noodle cooking quality is not strongly affected by the difference in protein content in egg substitutes. The results suggest that the chemical composition of the egg alternatives has more influence on the noodle quality than the protein content does.”¹⁵



Mayonnaise

In reviewing research efforts to reduce fat and cholesterol contents in salad dressing and mayonnaise, Ma and Boye¹⁶ reported the possibility of using plant-based ingredients or reduced-cholesterol egg yolk in the formulation of mayonnaise. They suggested that other ingredients with different functional roles, such as gums, starches, emulsifiers, stabilizers and fat replacers must be used to maintain the original viscoelastic properties of dressing and mayonnaise. The studies examined by the authors evaluated the behavior of using plant-based proteins, such as soybean, lupin, pea and wheat proteins as emulsifiers to replace yolk. However, formulators might need to use multiple ingredients in order to compensate for the absence of egg’s functionalities. These additions can create labeling issues that conflict with the “Clean Label” consumer trend.

Cookies

In the baking industry in particular, eggs supply binding, leavening, tenderizing, volume, texture, stabilization, emulsification, foaming, coagulation,

flavor, color and nutritional value, with texture and sensory qualities as key parameters. Such a unique and extensive concentration of functional contributions is not likely to be found in a single substitute for eggs as an ingredient.

A test conducted using egg replacers in sugar cookies and peanut butter cookies found that a trained tasting panel rated the eggless cookies as significantly less acceptable than all other peanut butter cookies, judging them as unacceptable. Overall, cookies made with whole egg and egg white were ranked as significantly more acceptable than cookies made with an egg replacer. The researchers suggested that the omission of egg might have eliminated a major hydrating and binding agent in the dough, resulting in dry cookies with altered texture and flavor. The sugar cookie dough was, in fact, considered “not workable.” The researchers suggested “omitting egg from peanut butter or sugar cookies is not a viable alternative.”¹⁷

Cakes

In a study conducted in 2013, researchers tested emulsifiers with different structures and functionalities. Seven eggless cakes containing soy milk were baked to determine the optimal proportions of emulsifiers necessary to produce an eggless cake sample. These included physical properties of cake batters (viscosity, specific gravity and stability), cake quality parameters (moisture loss, density, specific volume, color, texture, etc.) and sensory attributes. They then compared this with a control cake that contained egg. “Almost in all cases emulsifiers, compared to the control cake, changed properties of eggless cakes significantly,” the study concluded.¹⁸

Even in studies designed with the goal of proving that an egg replacer will work properly, the authors sometimes admit that eggs contribute “high nutritional value and multifunctional properties, including emulsification, coagulation, foaming and flavor,”¹⁹ and “because of the functional roles of egg in cake production it would be difficult to reduce or substitute egg in cake completely.”²⁰

A 2011 study assessed muffins made with egg replacers representative of the three types of replacers available in the marketplace. A replacer containing a mixture of soy flour, wheat gluten, corn syrup solids and alginate; a fiber type of replacer containing sugar cane fiber, xanthan gum and guar gum; and a whey protein concentrate replacer. The soy flour produced muffins with the most intense aftertaste and least desirable overall flavor. The researchers found none of the replacers produced an acceptable product at 100 percent replacement and maximum replacement levels did not exceed 75 percent.²¹ Overall, the findings revealed that egg as an ingredient was critical to obtaining the desired product quality characteristics, as replacers altered moisture retention, bulk density, color, texture and flavor.

Kevin Keener, Ph.D., P.E., professor of food science and food process engineering at Purdue University, West Lafayette, IN, pointed out that in an eggless cake comparison, while the egg is the most costly ingredient, it provides significant nutritional content and serves a variety of functional roles, including emulsification, coagulation, foaming, flavor and color development during baking. Keener said, “These functional roles are derived by the unique set of proteins present in the egg white and the lipoproteins in the yolk. The variety and content of the proteins and lipoproteins in the egg contribute to its unique ability to successfully function across a wide range of food applications.

“There have been many attempts to replace eggs with blending of lower cost plant and animal proteins and emulsifiers. The challenge is the egg protein functionality is a collective effect from a diverse set of the proteins and lipoproteins that exhibit functionality across a wide range of temperatures, storage conditions, baking conditions and food compositions. To date, all of the known animal and plant protein combinations that position themselves as egg replacers fall short in a number of roles. Thus, one can find a suitable substitute for achieving some desirable properties, but not all,” said Keener. Egg alternatives fall short of the formulation

benefits found with REAL egg ingredients. Eggs' versatile functional and nutritional properties make it difficult, if not impossible, to replace them with any single substitute.

Manufacturers can rely on REAL Egg ingredients to help create successful formulations.

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