

Allergies and Genetically Engineered Foods

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One of the greatest fears about biotechnology is that common foods might inadvertently harbor new allergens, becoming an unexpected food hazard to unknowing consumers. There is no evidence to support this fear, in spite of years of consumption of a range of biotech foods by hundreds of millions of people.

Biotechnology is instead being used to overcome the hazards of common food allergies, exploiting a great advantage of this technology. Instead of creating new allergenic threats, biotechnology is being used to reduce or even remove allergens from common foods.

Question: How do food proteins cause allergy?

Answer: In humans and other mammals, the normal immunological response is to protect against the presence of unusual, potentially harmful proteins or other associated metabolites. But in an allergic person, the immune system overreacts upon encountering the triggering substance. During an allergic reaction, immunoglobulin (IgE) antibodies respond to the presence of certain allergens. The IgE antibodies dock with mast cells, causing a release of histamine normally contained within the mast cells. The released histamine, in turn, causes the inflammation we observe as red wheals and rashes, and may constrict airways and dilate blood vessels.

Depending on the severity of the reaction, the victim may suffer from mild discomfort or irritation to, in extreme cases, potentially fatal anaphylaxis. In this extreme case, death may result from one or a combination of airway constriction, severely reduced blood pressure, pulmonary edema, heart arrhythmias and other unpleasant effects.

Although food allergies are common, more than 90 percent of food allergies in the U.S. can be traced to just eight food groups (wheat, soybeans, peanuts, tree nuts, milk, eggs, fish, and shellfish). The allergenic proteins in these foods provide a relatively small number of targets for research to remove or reduce the allergenic properties. Because of the small number of targets, even partial success at removing or reducing allergenicity in these foods would help a large number of people.

Q: What is genetic engineering doing to solve the allergenic protein problem?

A: Genetic engineering of foods is now being used to alleviate the dangers of allergens, through at least three different approaches:

1) One approach is simply to remove the offending protein from the food. This strategy depends on identifying the specific allergenic protein, then engineering the plant or animal not to produce that protein. This is not as simple as it sounds, because foods contain as many as 10,000 different proteins. Even the common Brazil nut's allergenic protein was not identified until recently (and that was with the help of biotechnological methods).

Also, the allergenic factor may be not one protein, but several. Peanuts, another common allergenic food, contain at least three classes of allergenic proteins; removing just one allergen will not necessarily help if the other allergens remain.

Another complication: Sometimes the allergenic protein is a major component of the food, so removing it will alter the characteristic nature of the food. Or, the allergenic protein may play a crucial role in the growth or development of the plant or animal producing it; removing the critical protein may kill the plant or animal before it can be harvested. So, while using biotechnology to remove a protein seems simple, it is not always feasible.

2) A second strategy is to alter the protein so it still functions normally in the crop or animal, but is not recognized by the allergic person's body as the trigger for an allergic response. We may be able to use genetic engineering to change the structure of the protein at the IgE recognition portion without affecting the normal function of the protein.

This approach is being undertaken in peanuts, where researchers are altering the three major allergens to make them less recognizable by IgE antibodies.

3) A third method is to provide the body with a means to lessen the allergic response. A feature common to many allergenic proteins is that they are very stable and slow to digest in the stomach. Instead of being quickly destroyed by digestion as most proteins are, allergenic proteins remain intact longer, giving them time to prompt the allergic response.

In this approach, researchers have identified a common mechanism that causes digestive stability in the allergens, and have sought to overcome that mechanism. Scientists have shown the potential for this approach by treating milk, one of the common allergenic foods, with a common, non-allergenic protein called Thioredoxin H, which breaks the chemical bonds in the allergenic proteins. Milk so treated was 300 times less allergenic when fed to sensitive dogs.

The researchers are now using genetic engineering to add additional Thioredoxin H to wheat, soy, and other allergenic foods in the hope that the additional enzyme (Thioredoxin is already present in small amounts) will help break down the allergens.

All of these strategies are in early stages of research so reduced allergen foods are not ready for market. However, preliminary results from all studies are encouraging and show real potential for providing relief to millions of humans suffering allergic reactions to common foods. Clearly, here is a use of genetic engineering with real and important benefit to consumers.

References and further reading

- Buchanan, B., Frick, O.L., Lemaux, P.G., and McHughen, A., “Mitigation of food allergies via crop biotechnology,” Symposium on Advances in Clinical Nutrition, American College of Nutrition, San Antonio, Texas, October 5, 2002.
- Burks W., Lehrer, S.B., and Bannon, G.A., “New approaches for treatment of peanut allergy,” *Clinical Reviews in Allergy & Immunology* 27 (3): 191–196, December 2004.
- Konan K.N., Viquez, O.M., and Dodo, H.W., “Silencing the three major allergens for the production of hypoallergenic peanut,” *Journal of Allergy and Clinical Immunology* 111 (4): L6, April 2003.
- <http://www.ars.usda.gov/is/AR/archive/sep02/soy0902.htm>, Researchers Develop First Hypoallergenic Soybeans, originally published in *Agricultural Research*, September 2002.