The Impact on Human Health of Genetically Modified Organisms (GMOs) in Foods

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What are genetically modified organisms?

A genetically modified organism (GMO) is an organism whose genetic structure has been altered by adding a gene that will express a desirable trait. This is often referred to as “gene splicing.” This new trait might improve a crop’s nutritional qualities, make a crop resistant to herbicides or protect a crop from pests. The overall goal is to make the crop more desirable for producers or consumers of the end product. Foods that contain GMOs are often called genetically engineered foods or biotech foods. Launched in 1994, the Flavr Savr Tomato was the first U.S. Food and Drug Administration (FDA)-approved genetically modified food available on the market. This tomato had a new gene that prevented the breakdown of the tomato’s cell walls, extending the shelf life of the tomato. While there was no scientific concern over its safety, the tomato was removed from the market in 1998 due to consumer concerns (Bruening and Lons, 2000). Today, cotton, corn and soybeans are the most common genetically engineered products in the U.S. About 90 percent of these crops are genetically engineered varieties (U.S. Food and Drug Administration, 2013, FDA’s Role). These crops have been altered to have increased insect resistance or tolerance to herbicides. There are currently no crops on the market that have been genetically modified to improve their nutritional quality.

Developers of GMO crops must apply for a permit, which requires addressing the potential risks. Developers must also address the possibility of the organism spreading into the environment.

The EPA regulates any GMO that contains a pesticide as part of its genetic makeup. The EPA defines safe levels of the pesticide and requires manufacturers of the organisms to address short- and long-term consequences of the pesticides on humans, livestock and the environment. The EPA only regulates the genetic material incorporated into the plant, not the plant itself.

When it comes to human health, the FDA plays the biggest role. It is the job of this organization to regulate the safety of all genetically modified crops that are consumed by people or animals. To accomplish this, the FDA established a policy in 1992, which defines most genetically modified crops as “substantially equivalent” to non-modified crops under the Federal Food, Drug and Cosmetic Act. In doing so, the agency defined all GMOs as “generally recognized as safe.” The FDA uses this same term for all food additives that it feels have been shown to be safe under conditions of their intended use. Under this policy, GMO crops do not require approval before being marketed. Instead, the developers of GMO food products are given the voluntary option to consult with the FDA to discuss nutrition and food safety issues. The consultation begins with a safety assessment, conducted by the product manufacturer. This assessment compares the levels of nutrients in the genetically modified plant to conventionally grown plants. It also addresses whether products made from the genetically modified plant are potentially allergenic or toxic when consumed. Lastly, unique qualities of new genetic traits are identified. FDA researchers then assess the safety evaluation, along with a review of their own records, scientific literature and other publicly available data (U.S. Food and Drug Administration, 2013, FDA’s Role).
What are the consumer benefits of GMOs?

While not all benefits have been fully researched, specific impacts have been documented. GMOs are theorized to reduce production costs due to reduced chemical and mechanical needs in planting, maintenance and harvest. It is possible that this savings could be passed on to the consumer. Additional benefits to consumers are the potential nutrition implications. GMO technology allows the creation of plants that are more nutrient dense. However, there is only one product the FDA has reviewed that focuses on nutrition and health: soybean oil that is high in omega-3 fatty acids rather than omega-6 fatty acids. This product is not yet available on the market (U.S. Food and Drug Administration, 2013, *Completed Consultations*). Another product termed “golden rice” contains beta-carotene (a source of vitamin A) and iron. Golden rice is directed toward developing countries with deficiencies in these nutrients. These deficiencies can cause childhood blindness and maternal anemia. While rice is a dietary staple in most developing countries, currently no nation is planning to grow golden rice (Enserink, 2008). Research is under way to identify other ways to increase efficiency and productivity of our food sources, thus allowing us to prevent diseases and feed the growing population as well (Osteen, Gottlieb, and Vasavada, 2012).

What are the health concerns of consuming GMOs?

The most common concern with GMOs is the risk of allergic reactions. More than 90 percent of food allergies occur in response to specific proteins in milk, eggs, wheat, fish, tree nuts, peanuts, soybeans and shellfish (U.S. Food and Drug Administration, 2013, *Food Allergies*). The risk for allergic reaction stems from a protein from one of these foods being unknowingly incorporated into another food that is not known to cause an allergic reaction. For example, if an individual who has a known allergy to peanuts unsuspectingly consumed a genetically modified food that contained the allergenic protein from the peanut, it is possible that the individual would experience an allergic reaction. This concern has been addressed with the FDA's consultation process to prevent such a scenario. The FDA requires that each presenter of a GMO shows scientific evidence that they have not incorporated an allergenic substance into their product. If the presenter cannot produce this evidence, the FDA requires a label on the product to alert consumers of its possible allergic reaction (U.S. Food and Drug Administration, 1992, *Statement of Policy*).

Why would the FDA approve GMOs without clinical trials?

Genes code for the production of specific proteins. All proteins consist of amino acids. Proteins differ from one another based on the sequence of the amino acids. When humans consume a GMO that has had a gene spliced into its genetic structure, we are then consuming the protein for which it codes. Once we have consumed the protein, the protein from the GMO is digested in the same way as every other protein we consume. During digestion, the body breaks down all bonds in the ingested protein, reducing the protein to individual amino acids that can be used in the body. The cells in the human body cannot detect if a gene or protein is “natural” or from a GMO because it is completely unbound from the original plant.

Clinical trials to investigate the impact of genetically modified foods on human health are difficult (World Health Organization and Food and Agriculture Organization of the United Nations, 2001). It is generally thought that 60–70 percent of processed foods in the U.S. contain a genetically modified ingredient, making a non-GMO control diet difficult to achieve. Because some conventional foods can also have unfavorable health effects, it is difficult to measure the effect of the GMO food versus unfavorable conventional foods such as those containing high levels of saturated fat or simple sugars. Additionally, the clinical trial would have to take place over a very long period of time to reflect a lifetime of consumption of GMO foods. Therefore, the FDA encourages creators of new GMO crops to consult with the agency before marketing their products to assure safety. GMO foods assessed by the FDA through the consultation process are prohibited from being marketed until all of the FDA's questions regarding the safety of such products have been answered (U.S. Food and Drug Administration, 2013, *FDA's Role*).

Are GMOs Labeled?

The FDA only requires labeling of GMOs if a food contains a known toxicant that exceeds tolerable limits, if the nutritional properties of the food have been significantly altered or if an allergen is present that consumers would not expect based on the name of the product (for example, a peanut protein in a corn product).

Mandatory labeling of all genetically modified foods has been proposed in the U.S. at the national, state and local levels, but to date, no regulation has been put in place. The FDA does support voluntary labeling by manufacturers, and it issued guidance to manufacturers for such labeling in 2001. Those in favor of GMO labeling emphasize using labeling as a risk management tool for any future unexpected adverse health effects, consumers' right to know what is in their food and the fact that some type of mandatory labeling has been established in at least 21 other countries and the European Union. Opponents of labeling point out the logistical challenges and expense of labeling, and the fact that no significant differences have been detected between conventional foods and GMO foods. Bills requiring mandatory labeling have been introduced in several states but have only passed in Maine and Connecticut. Neither regulation will go into effect until at least one neighboring state passes a similar bill (U.S. Food and Drug Administration, 2013, *FDA's Role*).

Currently, the only food label that ensures the absence of GMOs in the product is the “USDA Certified Organic” label. GMOs are prohibited in organic products. This means organic livestock cannot eat GMO feed, an organic farmer cannot plant GMO seeds and an organic food producer is not permitted to use any GMO ingredients. To meet USDA organic regulations, farmers and manufacturers must prove
they are not using GMOs and that they are shielding their products from contact with GMO materials. If it is determined that a certified organic operation is using GMOs, they may face financial penalties and loss of certification, which would require removal of the organic label from food products containing GMOs (U.S. Department of Agriculture, 2013).

What are the investigation questions to be addressed concerning GMOs?

There are many questions to be answered before GMOs can be labeled “good” or “bad.” At this time, some questions are being investigated from multiple discipline perspectives. Some general investigation areas include the following:

- GMOs have potential to help prevent diseases. Can these food items be used effectively to prevent disease in at-risk populations?
- GMOs have potential to create less expensive foods that contain the appropriate amount of nutrients. Can this translate to appropriate food supplies for people with limited economic resources?
- GMOs could produce more food from the same amount or less cropland. What is the economic impact to U.S. and world agricultural economies?
- GMOs could be developed that can survive droughts or floods on lands that are currently unable to sustain crops. What are the environmental impacts of bringing this land into production?
- GMOs have potential to reduce the amount of pesticides used on crops. Does this significantly reduce the environmental damage of pesticide use, thus easing the adverse health effects to farmers?
- GMOs can augment certain properties of foods. Can we understand interactions with body function, other foods, pharmaceuticals or allergic reactions?

Before any hard and fast conclusions can be made about positive or negative impacts on human health, multidisciplinary research efforts must address a multitude of questions that probably don’t have a brief or immediate answer. Before any policy decisions are made, more conclusive research must be completed.

Additional Information

List of genetically engineered foods that have completed the consultation process through the FDA: accessdata.fda.gov/scripts/fcn/fcnNavigation.cfm?rpt=bioListing

OSU Extension Agronomics Crops Team, Corn Cropping Systems: agcrops.osu.edu/specialists/corn/general-information/gmos

References


U.S. Food and Drug Administration. 2013. FDA’s Role in Regulating Safety of GE Foods. Washington, D.C. Available at fda.gov/ForConsumers/ConsumerUpdates/ucm352067.htm

