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Genetically Modified Food[1]

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What are GM Foods?

A genetically modified (GM) food is a result of recombinant DNA biotechnological procedures that allow the genetic makeup of an organism to be modified. This can be accomplished by incorporating genes from other organisms or by rearranging genes already present. These changes can result in the expression of attributes not found in the original organism. Examples of products that have been engineered include delayed-ripening tomatoes; pest-resistant crops, such as virus-resistant squash and Colorado potato beetle-resistant potato; herbicide-tolerant crops, such asbromoxynil-tolerant cotton and lyphosate-tolerant soybean; and many others. In fact, since 1987, seed producers have submitted nearly 11,600 applications to USDA APHIS (United States Department of Agriculture Animal and Plant Health Inspection Service) for field testing.

Genetic modification can be used to assist food manufacturers and to improve on the storage capacity or nutritional value of foods. The first commercial food product developed from gene splicing (a term for a type of genetic modification) was the Flavr Savr™ Tomato. The Flavr Savr™ Tomato had a gene added to prevent the breakdown of cell walls as the fruit ripened. The genetic modifications allow these tomatoes to remain firm even after extended shipping and storage times.

Hard cheeses provide another example of the use of genetically modified organisms in food production. Chymosin, the primary component of rennet, is the milk-clotting enzyme used to make cheese and other dairy products. Traditionally, this substance was derived from the stomachs of calves. It is now commercially produced by genetically modified microorganisms (most commonly, fungi). The FDA gave chymosin (from both traditional and GM sources) "generally recognized as safe" (GRAS) status, which makes it exempt from the usual premarket approval requirements. Approximately 90% of hard cheeses are now made using this enzyme, which is obtained from a genetically modified source.

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Types of GM Foods

A **genetically modified** (GM) organism is one that has had its genetic material altered through any method. (Although traditional breeding and hybridization are technically genetic modifications, these techniques pre-date recombinant techniques and will therefore not be considered GM in this discussion.) A **genetically engineered** (GE) organism is one that is modified using techniques that permit the direct transfer or removal of genes in that organism. Such techniques are also called recombinant DNA or rDNA techniques. Lastly, **transgenic** organisms have a gene from another organism moved into them.

For example, the plant product known as "Bt corn" is a transgenic plant, because it contains a gene from the bacterium *Bacillus thuringiensis.* Initially, the term "transgenic" was used when DNA had been transferred from an organism of one genus to an organism of another genus. More recently, the term has been used to describe the practice of taking DNA from an animal or bacterial source and cloning it into plants. For instance, genes from an animal, such as a fish, may be inserted into the genomes of foods such as strawberries or tomatoes.

This practice has raised ethical issues as well as concerns about possible health implications. Groups opposed to the genetic manipulation of food have termed this practice and its subsequent products "Frankenfood." Though more research is needed, the FDA feels that there are no serious food safety issues associated with these products, although they are always alert for possible food allergens.

GM foods are classified into one of three generations. First-generation crops have enhanced input traits, such as herbicide tolerance, better insect resistance, and better tolerance to environmental stress. Second-generation crops include those with added-value output traits, such as nutrient enhancement for animal feed. Third-generation crops include those that produce pharmaceuticals, improve the processing of bio-based fuels, or produce products beyond food and fiber.

As previously mentioned, since 1987, seed producers have submitted nearly 11,600 applications for field testing. More than 92% of these have been approved. Applications peaked in 2002, with 1,190 approvals. Most involve major crops, with more than 5,000 approvals for corn, the most commonly improved crop (followed by soybeans, potatoes, and cotton). More than 6,600 of the approved applications include GE varieties with herbicide tolerance or insect resistance.

How Could GM Foods Help Consumers?

Industry has argued that we need GM foods because they will reduce production costs by reducing the need for additional chemicals (pesticides and fertilizers) and mechanical inputs. Theoretically, the savings could, in turn, be passed on to the consumer. The nutrition implications are also often cited as an obvious benefit for consumers, since the bioengineering could create plants that could produce more nutritious food. An example of one such product is "Golden Rice." This strain of rice contains beta-carotene, a source of vitamin A and iron. Developing countries that rely on rice as their major food source are often are the same countries to suffer from high rates of childhood blindness and maternal anemia. Iron and vitamin A have been shown to aid in the prevention and treatment of maternal anemia and blindness, so "Golden Rice" might help to reduce the rates of these problems.

Are There Health Concerns About GM Foods?

The potential for GM foods to cause allergic reactions is the most obvious health concern associated with these products. Specific proteins in milk, eggs, wheat, fish, tree nuts, peanuts, soybeans, and shellfish cause over 90% of food allergies. If a protein from one of these food types were to be incorporated into a food that normally would not have this protein, people who are allergic to these proteins could unknowingly consume such a food and suffer allergic reactions. The FDA has put measures into place to prevent such a scenario by requiring that each producer of a GM food product present scientific evidence that they have not incorporated any allergenic substance into their product. If this

evidence cannot be produced, the FDA requires a label to be put on the product to alert consumers.

What Kinds of GM Foods Are Sold in the U.S.?

It has been estimated that 60 to 70% of food products in retail stores already contain genetically modified ingredients. In 1998, U.S. farms cultivated over 45 million acres of GM commodities. This is a 250% increase from 1997 plantings. Commonly planted GM Foods include many major agricultural commodities, with genetically modified plants accounting for 25% of the corn acreage, 38% of the soybean acreage, and 45% of the cotton acreage grown today. Worldwide, over 69 million acres of GM crops were cultivated in 1998, with 15% of the acreage in developing countries.

In 2000, the media carried many stories about GM salmon. These fish are twice the size of normal salmon and can grow up to ten times faster, while being fed 10 to 25% less food. The company that engineered the GM fish claims the salmon are sterile and would therefore be unable to breed if they were to escape into the environment.

The Flavr Savr™ Tomato

The first genetically modified crop approved for commercial sale was the Flavr-Savr tomato. The product, developed by a company called Calgene, was approved by the FDA in 1993. It went on sale one year later, but in 1997, due to increasing public concerns and the need for specialized transportation equipment, production ceased. Calgene (which was subsequently bought by Monsanto) wanted to create a tomato with a vine-ripened taste that could withstand the rigors of shipping. What they created was a controversy that is still being debated a decade later.

Bt *(Bacillus thuringiensis)* Corn

Bt corn is a hybrid plant bioengineered to produce an insecticide. This induced insecticide provides effective, consistent control of pests such as the European corn borer and offers some protection against the fall armyworm and corn earworm. It does so at a lower cost than insecticides, and with better results. In August of 1995, both the EPA and the USDA approved Bt corn for commercial use as a human food product. The use of Bt corn has increased dramatically, from 1.4% in 1996 to about 30% of total corn acreage (26 million acres) in 1999.

The StarLink Corn Incident

StarLink (Aventis Crop Science) is the trademark for a variety of corn that was genetically modified to produce its own pesticidal protein, Cry9C. This protein, like other GM insecticides, was effective in controlling certain insects and thus could substitute for chemical insecticidal sprays. When questions about the potential human allergenicity of the Cry9C protein arose, investigations showed the EPA had approved StarLink in 1998 for use only in animal feed and other industrial, nonfood uses.

In September 2000, StarLink corn was found in the human food supply--first in corn tortillas, but later in other processed foods. This event triggered extensive publicity and increased public awareness of the presence of GM-derived foods in the American food supply. The U.S. registration for StarLink corn was voluntarily withdrawn by Aventis Crop Science. This means that StarLink corn is no longer available for sale and should not be planted. Seed companies have destroyed their stocks of StarLink corn seed. The use of previously stockpiled StarLink corn in livestock feed and for industrial, non-food uses remains fully approved by the Environmental Protection Agency (EPA).

L-Tryptophan

Concerns have also been raised about contaminated L-Tryptophan, a food supplement that was implicated in cases of Eosinophilia Myalgia Syndrome (EMS). L-Tryptophan was linked to 37 deaths in the late 1980s in the U.S. The supplement was produced by fermentation using a GM bacterium, but the FDA believes this problem was almost certainly due to the omission of an important purification stage from the process, not to the use of GM organisms in production. Although the product involved GM-produced ingredients, the adverse effects were not attributable to the GM character of the product or process. This tragic case illustrates the importance of strict quality control monitoring for all food products, regardless of their source.

How the FDA and the EPA Ensure Food Safety

There is no one statute or federal agency devoted to the regulation of GM foods. The public relies on the FDA for assurance that the foods we buy are safe and wholesome. Under the Food, Drug, and Cosmetics Act, the FDA has the authority to ensure the safety of most domestic and imported foods in the U.S. market (except meat and poultry, which are regulated by the USDA).

The pesticides used in or on foods are regulated primarily by the Environmental Protection Agency (EPA), which reviews safety and sets tolerances (or establishes exemptions from tolerance) for pesticides. The FDA monitors foods to enforce the tolerances for pesticides set by EPA. Finally, it is USDA-APHIS that controls the field trials of any GM crop that falls under permitting requirements.

The Future

With all the controversy surrounding GM foods, especially in Europe, researchers have been searching for new methods to enhance crop production. The newest technique is called marker-assisted selection (MAS). This product combines traditional genetics and molecular biology. MAS allows for the selection of genes that control traits of interest, such as color, meat quality, or disease resistance. It has the promise of becoming a valuable tool in selecting organisms for these traits of interest. Because this process uses existing DNA, not transgenic DNA, to choose desired traits, MAS stands to be less controversial then other GM techniques.

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