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Extension FactSheet

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The Impact of Genetically Modified Organisms on Human Health

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What are genetically modified organisms?

A genetically modified organism (GMO) is an organism whose genetic structure has been altered by incorporating a gene that will express a desirable trait, often termed gene splicing. Most often the transferred gene allows the organism to express a trait that will add to its desirability to producers or consumers of the end product. For example, the first food produced from gene splicing and evaluated by the FDA was the *Flavr Savr Tomato*. Tomatoes generally get softer as they ripen because of a protein in the tomato that breaks down the cell walls of the tomato, which makes it difficult to transport a quality ripe tomato across the country. The *Flavr Savr Tomato* had a gene spliced into its DNA to prevent the breakdown of the tomatoes' cell walls. The result of the incorporation of the new gene is a firm ripe tomato for consumers on store shelves (1).

What are the impacts of genetically modified organisms?

While not all impacts have been fully researched, specific aspects have been documented. Genetically modified organisms are theorized to reduce production costs due to reduced chemical and mechanical needs in planting, maintenance, and harvest. Conceivably, this savings could in turn be passed on to the consumer. The most obvious benefits to consumers are the nutrition implications. The biotechnology of gene splicing allows for the opportunity of creating plants that will produce food that is more nutrient dense. This is the case with a product termed "Golden Rice," which contains beta carotene, a source of vitamin A and iron. Rice is a dietary staple in most developing countries. These are the same countries that suffer from high rates of childhood blindness and maternal anemia. Iron and vitamin A have been identified to prevent or treat maternal anemia and blindness, respectively. Research efforts are underway 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 (2).

What are the nutritional concerns of consuming genetically modified organisms?

The most obvious nutrition concern with genetically modified organisms is the risk of allergic reactions. More than 90% of food allergies occur in response to specific proteins in milk, eggs, wheat, fish, tree nuts, peanuts, soybeans, and shellfish (3). The risk for allergic reaction stems from a protein from one of these foods incorporated into a food that does not cause a known allergic reaction. For example, if an individual who has a known allergy to peanuts unsuspectingly consumed a genetically modified organism that contained the allergenic protein from the peanut, conceivably the individual would experience an allergic reaction. This concern has been addressed with FDA measures put into place to prevent such a scenario. The FDA requires that each presenter of a genetically modified organism show 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 the consumer of its possible allergic reaction (4).

Why would the FDA approve genetically modified organisms 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 that protein. Once we have ingested the protein, the genetically modified organism digests in the same way every other protein we consume. When it reaches the stomach, the stomach acid straightens and unwinds the protein. Concurrently, the stomach acid activates pepsin, which is an enzyme that breaks the protein apart into smaller amino acid sequences. The partially broken down protein then enters the small intestines where it is broken down to smaller peptides by the enzymes, trypsin, chymotrypsin, and carboxypeptidases A & B. Finally, the peptides are cleaved into individual amino acids by aminopeptidases when they come in contact with the cells that line the intestines. The body then takes up the amino acids. The body, in effect, breaks down all bonds and subsequently uses the amino acids. The human body cells cannot discern what is a gene from a "natural" or genetically modified organism because they are completely unbound from the original plant.

At this point, traditional clinical trials to investigate impact would be difficult. Clinical trials would be difficult to perform because 60-70% of food products in groceries are already genetically modified. It would be extremely difficult to get a large enough control group (people who consume no GMOs) to conduct a valid study (3). Therefore, the FDA has taken precautions to make sure that GMOs do not affect human health. When a new product is introduced, the presenter must provide information as to what gene was incorporated and where the gene was incorporated in order to receive approval. The FDA must determine if the newly incorporated protein is similar to that of other proteins found in our foods. If it is not, then the newly incorporated protein must be treated as a food additive and will require pre-market approval by the FDA (1).

Investigation questions to be addressed concerning GMOs

There are many questions to be answered before genetically modified organisms can be labeled "a good idea" or "a bad idea." At this time, some questions are being investigated from multiple discipline perspectives. Some general investigation areas include:

- Genetically modified organisms 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 into 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 augment certain properties of foods through genetic manipulation.

  Can we understand interactions with other systems of the body, 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 an answer. Before any policy decisions are made, more conclusive research must be completed.

References

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