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Review

# An overview of genetically modified foods: agreement, challenges and assessment of safety

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ABSTRACT

The technology of genetically modified (GM) food can overwhelm agricultural and nutritional difficulties in the food industry, food safety and security by increasing resistance to pests and herbicides, drought tolerance, rapid ripening and ultimately increasing yield and food quality. However, in the last few decades, significant dangers of GM foods to humans, animals, and the environment have been identified. Nevertheless, there is insufficient scientific evidence to prove the harmful effects of these foods on human and animal health. In this article, several advantages and disadvantages of this technology are reviewed. Therefore, it is necessary to perform all the requested risk assessments before releasing any GM product and next post-release checking to track probable gene flow and limit any possible contamination of the food chain catastrophe. Therefore, the safe use of this technology, in compliance with all protocols of environmental health and safety assessment at the national and international levels is demanded.

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## 1. Introduction

Biotechnology is that change alive organisms or sections of organisms to creation or modification of crops are called agricultural biotechnology (1,2). Nowadays, modern biotechnology includes the genetic engineering tools. Genetic engineering (GE) is a new type of technology that facilitates the transfer of selected genes from one organism to other organisms. Genetically Modified Organisms (GMO) in plants, animals, or microorganisms are organisms whose genetics have changed in a way that did not exist naturally. Also, gene function can be affected by both environment and field performance.

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Environmental factors affecting the process of methylation or chromatin synthesis cause gene silencing and different results are seen (3). The revolutionary benefits of GMOs over the past decades as well as the potential human, animal and environmental hazards to GMOs or foods have been explored in this study. In this review, prior findings, available data, varieties of evaluations, and rules related to GM products have been reviewed to reduce ambiguities caused by this technology. The object of present review was investigating the beneficial and harmful results of GM foods on food safety.

**1.Food Security**

The use of GE can help farmers meet the challenges of agri-food fabrication and food security (4). GM technology may be useful for controlling some agricultural difficulties (5). Using this technology, crops can be grown in a short time that are resistant to various factors such as insect damage, weeds, plant diseases, as well as soils contaminated with mineral salts, poor soils with acid or alkali (6).

1.1. Virus and bacteria-resistant products

Ugandans eat about a pound of bananas a day. Bananas can be exposed to bacterial wilt malady and cause the banana sap to leak, leaves to wither, fruit to rot, and the crop to destroy. None of the pesticides or chemicals were as effective in controlling the disease as inserting the green pepper genome into the banana structure. The novel gene initiates a procedure that removes infected cells and saves the product from disease (4).

Cassava fruit is also fortified with iron, zinc, protein and vitamin A precursors, engineered beta-carotene or reduced yanogenic content, disease and pest-resistant species, delayed post-harvest physiological lesions in storage roots, and improved overall quality. Cassava is another genetic engineering material. For example, cassava species that have a longer shelf life after harvest in the field are more acceptable than species that are more susceptible to brown spot disease (6). Also in another example, insect-resistant rice produced in China is a good example of genetic engineering. In this product, the use of various artificial insecticides repeatedly to control rice insect pests cause huge economic and environmental losses. GM plants with insecticidal gene(s) from *Bacillus thuringiensis* Laboratory and field tests confirm these rice lines can provide effective and economic control (4). In citrus, there is a disease called citrus greening that causes the greens to turn green, shrink and become bitter. The disease is caused by small insects and has been a serious threat to the citrus industry. Because it destroys citrus crops, it can destroy the citrus industry. In modified citrus species, the genome has been modified to include a gene from the spinach plant, which produces a protein that makes citrus trees unacceptable against the bacteria that cause citrus greens (7).

1.2. Longer shelf life products

Foods can be GE to be less vulnerable and have longer shelf lives (8). An apple called GE Arctic Apple is resistant to enzymatic browning.

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In fact, preventing browning is done by inserting additional copies of the genes that the apple already had, and all related genes are turned off. In this way, it stops the production of the enzyme and prevents the browning reaction (9). Innate potatoes, which have 40% less bruising due to impact and pressure during harvesting, have also been approved by the USDA. Innate reduces annual potato waste and also has low levels of asparagine. Therefore, due to the fact that asparagine is caused acrylamide during frying. Therefore, Innate potatoes have 80 to 90% less acrylamide (10).

1.3. Healthier food products

Nutritionists emphasize health and good nutrition. In genetically engineered products there is a type of high oleic acid soybean oil with improved fatty acid profiles including trans-zero fat, low linoleic acid and higher oleic acid levels (11). Therefore, consuming more of this type of oil than non-engineered species of long-chain fatty acids such as omega-3 can be considered in terms of health (12). Soy is also fortified with steroidic acid, which the body converts to eicosapentaenoic acid (EPA) and one of the three omega-3 fatty acids used by the body and healthy for the heart (13, 14).

**2. GMOs in Food**

The US Food and Drug Administration (FDA) first published the commercialized transgenic food feature in 1994, which was the longer-lasting Flower Savor tomato.

Although most transgenic crops are in the animal feed basin, processed foods such as oils and high fructose corn syrup are also included in this category (15). There are currently 9 commercially available transgenic products, including corn (field and sweet) and one approved animal product. GMO crops available commercially are apples, potatoes, corn, alfalfa, soybean, papaya, cotton, sugar beets, sweet corn, zucchini, yellow summer squash and salmon (16, 17).

The development of herbicide-resistant and pest-resistant products was the first major commercial success in applying GE approaches to food. In the early 1990s, attention to the ability of a bacterium to naturally insert its DNA into another organism, and at the same time to scientists' attention to plant genome sequencing and finding sequences that encoded certain proteins or traits led to the development of these products (18). Thus, the combination of these two findings led to the production of specific plants that were able to survive glyphosate or RoundUp. This was made possible by introducing the trait of resistance in corn or soybeans. As a result, weeds are killed by RoundUp spraying when the crop comes out of the ground, leaving the product with a competitive advantage over healthy weeds. In this category, due to less chemical spraying operations and higher yield, it was quickly accepted by farmers, and this category includes corn, soybeans and cotton (16). Using the same approach, the scientists inserted a gene into the crop genome that acts as an insect toxin and represents a protein produced by a common soil bacterium. *Bacillus thuringiensis* (Bt) toxin acts as a natural insecticide. Herbicidal tolerance or resistance to pests depends on the specific mechanism of action of the species on insects, depending on the specific protein (19, 20).

**3. Processed foods**

About 70-80% of all processed foods contain GMOs because most processed foods contain substances obtained from corn, soybeans, canola and sugar, or foods (meat, milk, dairy products) from animals that have consumed GMOs. Humans use these products to produce a wide range of foods. For example, corn alone produces ascorbic acid (vitamin C), citric acid, baking powder, cellulose, caramel dye, sugar alcohols and etc. (20, 21). The important point here is that compounds obtained from a GE or non-GE product will eventually be chemically and nutritionally the same. For example, corn is processed into three main components: lipids (which produce oil), carbohydrates (which produce starch and sweeteners), and protein (which is primarily for fiber and animal feed). What is certain is that lipid and carbohydrate compounds do not contain any of the proteins or DNA because they do not contain a genetic origin and therefore the products of these parts will be chemically/nutritionally identical. In addition, feeding genetically engineered cereals to animals has no effect on the composition of meat, milk or eggs. This is because when proteins or DNA are consumed by humans or animals, they are broken down into their elemental components during the digestive process and are not absorbed by the body. This is true of all natural genetic traits that are permitted to enter food sources, and it must be exposed that DNA or natural proteins in foods are degraded and have no side effects (22).

**4. GMO labeling**

Given the global acceptance of transgenic farmers, the FDA has stated that there are no novel safety or health concerns for GE or animals. Voluntary food labeling for GE has been approved by the FDA. Lately, there have been groups which have emphasized the compulsive GE food labeling, that has met with strong resistance from the food industry (34). Finally, after several years of debating whether to make GMO labeling mandatory in 2016, a bill was signed. The bill essential food companies to obtain information on GMOs in food through one of them. Three ways - a sticker on the package, a symbol to be produced with the USDA, or by accessing a website or phone number (24).

**5. Concerns about GMOs**

Despite the advantages of GM crops, environmental and health concerns about these products were raised, some scientists concern around its serious threats to biodiversity, the development of resistant pests, and side effects impacting humans and animals as well as the environment (35).

About Bt products, in the study of liver and kidney of rabbits treated with Bt seeds and leaves and non-Bt cotton, no adverse histopathological changes were observed. They also showed no significant difference in weight gain (38). In the case of Bt corn, studies have shown that no allergies have been observed after 30 years of commercial use.

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Also, like other transgenic foods, no harmful, toxic, or allergenic effects have been reported for GM rice. In addition, a greater expression of glutamic acid (23.40% vs. 19.38%) was seen in GM rice, that is interestingly within the previously reported reference range (39). All aspects of DNA recombination should be examined to determine the final product and not have unexpected adverse effects on humans and ecosystems (39, 40). About human immunity, it related to the development of toxicity, allergic and other possible risks due to inserted genes, expressed proteins, possible polytropic effects due to metabolites other than the target protein and non-target changes in gene integrity owing to Manipulation is a major concern. But there are differences in biosafety amongst animals and plants. For example, animals with a history of safe utilization of GM in dietary designs do not have genes encoding adverse metabolites (44). In new protein risk assessment approaches, a secondary effect and the expression of proteins as targets may lead to the agglomeration of secondary metabolites (44). Modifications in the genome can also cause novel enzymes involved in other metabolic pathways to participate in the production of new metabolites (24). GE rice included changes in the decrease in gluten levels with an increase in prolamin. Dietary quality and allergenicity are a kind of gluten protein and are accountable for allergies in coeliac disease, especially when it is present in the main dishes of rice. Similar findings were saw in the creation of golden rice, which has high levels of beta-carotene in rice as a precursor to vitamin A. This alteration was unpredictably associated with greater xanthophyll creation (45). One of the most controversial concerns in GM technology is the inclusion of antibiotic resistance genes as natural markers. Plants containing novel genes are resistant to antibiotics though other plants are unable to grow.

The *bla* gene in soybean is accountable for expressing the enzyme lactamase, that breaks down lactam antibiotics such as penicillin and ampicillin, and in soybeans through two plasmids containing the *bla* gene (40). Although they are rarely transmitted (48), some GM critics are concerned about the transmission and expression of antibiotic-resistant genes to bacteria in the gastrointestinal tract. Aside from the complexity of the process, there is no health concern around bacterial resistance to lactam antibiotics such as ampicillin because the bacteria in the gastrointestinal tract are already resistant to ampicillin (40). Transgenic products cause an allergic reaction of the body due to the identification of foreign factors, reduced biodiversity in the ecosystem due to changes in the structure of these products, reduced effectiveness of antibiotics, different and unusual taste due to changes in the structure of these products, nutritional inadequacy for humans and the environment and the possibility of creating new diseases in humans and other animal species, the creation of new and unidentified toxins and carcinogens (41). Some studies have reported adverse effects of transgenic food consumption and its potential risks to human health, such as increased susceptibility to allergies and fatty liver syndrome, or adverse environmental effects (42, 43).

Environmental disasters are another concern about GM products. In some studies, have suggested that the utilization of herbicides and pesticides increases afterward the development of GM-resistant plants.

The compatibility of weeds and insects with chemicals on farms forces farmers to apply higher contents of chemicals or other effective options that may have many harmful effects on humans, animals, and the environment. Comparative researches show which the utilization of glyphosate has enhanced sharply since 2005 (49). Also, the glyphosate used to protect GM plants is eventually released in the soil and stimulates the development of the *Fusarium* (50). Glyphosate affects soil living organisms inversely relevant on the quantity, frequency, and biochemical conditions of the soil. But one of the concerns is that soil organisms are exposed to Bt toxins afterward crop dying. These organisms play critical roles including nitrogen fixation, growth enhancement, and nutrient dissolution. The results show which there is no any concern around its adverse effect on the soil ecosystem. Also, in experiments and field studies, no adverse effects were observed on vital soil organisms such as mites, columbus, and earthworms (36). However, in snails, reduced growth of snails exposed to Bt maize has been observed (37). In the case of ecosystems, it is also required to explore the potential effects on water, soil, air, and animals due to possible damage to GM products. Some other drawbacks to GM technology include the introduction of resistance genes in products that are likely to cause pest resistance.

An introduced example in recent decades is the development of insects resistant to Bt products comprising the gene encoding cry- proteins. The severity of resistance depends on the type of pest.

Next strategy is gene pyramiding in that multitude Bt genes are conveyed to the genome of products to decrease the pest persistence. In this regard, insects are exposed to various toxins (46).

Contradictory views have also been reported in gene exchange. The gene transfer horizontally is the procedure by that DNA is transferred amongst organisms (plants, animals, and microorganisms) instead of each other.

Several researches report which gene exchange happens infrequently, though other researchers suggest which genes can be consumed with the digestive bacteria environment of consumers. It is claimed that the acidic state of the gastrointestinal tract and the thermal procedure can destroy the external genome of transgenic foods eaten (47). However, there is no proven reason for the hypotheses, but given the widespread use and diversity of transgenic in the world, it may be possible shortly (35). It should be noted which transfer of gene from one organism to another is a twisted procedure and requires a series of step-by-step events.

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**6.Conclusion**

GM products are broadly produced and consumed around the world. Their interests are undeniable. Despite all the worries and uncertainties about GM foods, international agencies have agreed to use some of the products. In addition to the current potential promises and challenges, it should be noted that nowadays there is an acme of water scarcity, and food shortages or malnutrition also draw attention to food security challenges. The crops of high-yield products and desirable metabolites or products enriched with certain vitamins and minerals are promising foods of GE technology in food safety. Therefore, further studies on the safety of GM food products are necessary to determine the probability of any adversative effects in the future.

**Conflict of interest**

The authors declare that there is no conflict of interest.

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