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Benefits and Risks of Genetically Modified Food (GMO) Products: A Review

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ABSTRACT

Biotechnology has a number of possible advantages as well as drawbacks. It has increased food production by reducing plant susceptibility to drought, frost, insects, and viruses, as well as allowing plants to compete more successfully for soil nutrients against weeds. Changing the content of meals has increased their quality and nutrition in a few circumstances. However, concerns about biotechnology's potential hazards to the environment and people have emerged because of its use. In several ways, genetic engineering differs from traditional breeding in terms of how genes are introduced into plants. This method has resulted in a large number of commercialized genetically engineered (GE) cultivars, most commonly canola, cotton, maize, and soybean, with herbicide and/or insect resistance as the main features. Gene technology allows plants to produce more and develop tolerance to pests, viruses, frost, and other environmental stresses. Gene transfer is a technique for altering the physical and chemical composition of foods as well as their nutritional worth. Negative repercussions of gene technology on animals, people, and the environment, on the other hand, should be taken into account.

KEYWORDS

Biodiversity; Biosafety; Biotechnology; Genetic engineering; Genetic material; Genetically modified organisms; Recombinant DNA; Transgenic organisms

INTRODUCTION

GMOs are organisms with genetic material that has been altered in a way that does not occur naturally through mating and/or natural recombination. GMOs offer a wide range of uses in biological and medical research, pharmaceutical medication development, experimental medicine, and agriculture [1].

Foods that have been genetically modified (GM) are those that come from organisms whose genetic material (DNA) has been altered in a way that does not occur normally.

Genetically Engineered Food (GE), Transgenic or Biotechnological Food, and Genetically Modified Organism (GMO) are some of the terms used to describe GM foods [2]. The 1970s saw the beginnings of plant and animal modification. Stanley Cohen and Herbert Boyer obtained recombined DNA for the first time in 1973, kicking off the genetic engineering era. Plants, as well as a considerably smaller number of animals and bacteria, are used to collect genetically modified food. The most often changed plants are soybean, maize, and rape. Transgenesis was also utilized on potatoes, tomatoes, cotton, and tobacco,

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as well as livestock and pigs. The goal of genetic modification is to improve utilizable and technological features, nutritional enrichment of the resulting products, and the potential for medicinal chemical synthesis using transgenic organisms [3].

One of the most concerning aspects of genetically modified foods is their ability to trigger sensitivity in people. Some of the features used in GM development could come from a meal that causes allergies in some people. Incorporating that trait into other living things could cause the host organic entity to express the allergy as a characteristic. Another disadvantage of GM technology is that it may cause harm to various organic entities in the biological system, resulting in a reduction in biodiversity [4]. The main objective of this review is to look at the risks and advantages of GMO foods.

LITERATURE REVIEW

GMOs in the World

Since the mid-1990s, the United States has produced and consumed commercial genetically modified crops. The most prevalent GM crops now on the market are soybean, corn, cotton, canola, and sugar beet [5]. In comparison to global producers of transgenic food (such as the United States, Argentina, Brazil, India, Canada, or China), the United European countries have a slower increase in the variety of food derived from genetic modifications, reflecting the principle of limited confidence in genetic engineering products. Consequently, certain EU member states are working to phase out genetically modified organisms. The majority of GM crop output has occurred in industrialized countries (mainly the US and Canada). Although industry-based data shows a trend of GM crop output transferring to developing countries (GMO Compass), the United States still has the majority of worldwide GM crop production (45%) [3].

Cotton is a major cash crop in India. Despite this, India falls 48 percent short of the world's average cotton production, equivalent to 280 kg/ha^2, due to significant pest infestations, particularly cotton bollworms. Cotton bollworm infestations cause farmers in India to lose up to half of their harvest. The cyclic infection of bollworm has been controlled in India since Bt. cotton was commercialized in 2002. In 2016, India overtook China as the world's leading producer of cotton [2].

GMO in Ethiopia

Since 2009, Ethiopia has ratified Proclamation No.655/2009 and its directions (Directives No.1 to 6/2009), which are highly preventive biosafety laws. GM crops production may motivate Ethiopia to successfully develop its varied objectives and boost competitiveness in the agricultural and industrial sectors of the economy via the use of foreign assets and native inventions. In order to boost agricultural production and safety, Ethiopia has approved the commercial cultivation of genetically modified (GM) cotton and field research on GM maize in 2018 [6].

Benefits of Genetic Modification of Food Products

Enhance nutrition

One of the major potential benefits of GM crops, according to proponents of the technology, is the ability to increase the nutritional composition of food. "Golden Rice," or rice with increased beta-carotene levels, is one of plant biotechnology's most celebrated yet divisive laboratory breakthroughs. The International Rice Research Institute (IRRI) in the Philippines is working to develop golden rice varieties that are adapted to local tastes and growing conditions around the world, in the hopes that it will thrive in tropical areas like Southeast Asia, where 70 percent of children under the age of five are vitamin A deficient [7].

Improvement in technological and utility trends

Plant cell genetic transformation is used to change the chemical composition and nutritional value of transgenic crops, as well as functional features that are useful in technological and processing processes. Varieties where the introduced modification has a practical significance draw the most attention. The Flavr Savr tomato is one of the first

molecular triumphs in food perfection, with its genetic material changed in terms of polygalacturonase activity [3].

Food	Benefits From Genetic Modifications
Rice	Higher content of β-carotene, Higher iron bioavailability
Tomato	Higher content of dry matter, Delayed ripening process, Aroma intensification, and Virus resistance
Potato	Higher amylopectin content, Cyclodextrin production, Resistance to viruses and potato beetle, Lower alkaloids content
Milk (cow, goat, sheep)	Increased tolerance for high temperature, Modified casein content, and Lower lactose content
Transgenic fishes (carp, salmon, trout)	Faster growth rate

Table 1: Advantageous technological and utilitarian features of genetically modified food [8].

Pharmaceutical

The utility of genetic alteration incorporating plant raw materials is expected to provide medicinal compounds, bringing up the completely new pharmacy and medicine perspectives. Transgenic potato, salad, tomato, and spinach types can produce oral vaccines or compounds that stimulate the human immune system in response to specific infections. Humans have successfully transferred the genes responsible for the production of viral or bacterial antigens directly to plant cell nuclei or chloroplasts using genetic engineering techniques. The antigens trigger a whole-body reaction that leads to the development of antibodies, resulting in long-term immunity against pathogenic microflora. A lyophilizate (a freeze-dried form) of the resistance-stimulating plants is advised for commercial use, as it has a lower risk of contamination and can be stored in more suitable conditions [1].

Risks of Genetic Modification of Food Products

Risk of food allergy

By genetic alteration of genetic modification plants, allergy portions of donor genes can be passed to recipient plants or animals. Furthermore, donor microorganisms with unknown allergenic potential can be used in many genetically engineered foods. The most prevalent allergens are believed to be alimentary proteins, which can cause skin reactions, respiratory system changes, and circulatory system alterations in that order when consumed. Genes and novel gene combinations derived from non-food sources might trigger allergic reactions or exacerbate existing ones. The manufacturing of soybean enriched in methionine, an amino acid derived by synthesis as a product of the gene isolated from a Brazil nut, is another example of the danger of food allergy development involved. An allergy caused by genetically modified foods is most commonly linked to types with new expression genes derived from organisms with a specific allergizing potential [8].

Synthesis of toxic compounds

The potential for anti-alimentary, poisonous compounds or materials that raise the risk of activating neoplastic processes to be synthesized in consumers' cells and tissues is the biggest problem associated with GMOs' effects on health and life. Eosinophilia-myalgia syndrome was caused by L-tryptophan, which was utilized as a food supplement to treat a variety of ailments including insomnia and depression (EMS). The intoxication is thought to be linked, first, to changes in production technology and compound purification that occurred in 1989 [9].

Risks to biodiversity

The introduction of genetically modified plants into the environment may have devastating effects on biodiversity. Birds, insects, and other animals that are dependent on certain crops for survival may find themselves unable to eat the genetically engineered crops due to the introduced gene or modification [10]. They may be allergic to the new traits or find them poisonous. Therefore, these animals would have to find other sources of food or face starvation. This would affect the entire food chain and the predator-prey relationships. The introduction of a modified organism into the environment may cause the displacement of indigenous fauna and flora. If the new strain is superior to the parent strain, it may take over the habitat or eliminate the wild

strain. Also, any change in animal behavior could affect the entire food chain as well as predator-prey relationships [11].

Application of GMO in Human Nutrition

Genetically modified foods are divided into three groups [1] based on their application and legal requirements:

- Genetically engineered foods are now available (potato, tomato, soya, maize, sunflowers, rice, pumpkins, melons, rape, etc.).
- Genetically engineered plants are present in food (starch, oil, sugar, amino acids, vitamins, etc.).
- GMOs are found in food (yogurt contains transgenic microorganisms).

The most common type of GMOs purposefully released into the environment is GM plants used in agriculture. Select countries grow GM crops in varying amounts, with the United States, Canada, Brazil, Argentina, and India being the main producers. Maize, soybeans, cotton, and rapeseed are the most important.

GM plants for agricultural and industrial activities. Herbicide resistance (mostly glyphosate and glufosinate tolerance) and insecticide tolerance are the most important characteristics introduced (mainly Bt or *Bacillus thuringensis*). In recent years, double- and triple-stacked qualities have also been introduced [12].

Risk Management and Ethical and Legal Assessment of GM Food Products

Even though biotechnology has proven to be effective in food production, numerous problems remain about the ethics, legality, biosafety, health care, commercial, social, and cultural implications of GM food use. Biotechnology has resulted in significant advancements in science and the ability to generate plants with novel genetic features. The lack of knowledge regarding the repercussions of the changes made to GM products, on the other hand, is a serious concern [13]. As a result, a definition of ethics and adherence to ethical bounds when employing this technology appears to be required in order to define legal limits and avoid unfavorable effects. Ethics in GM technology is defined as a set of ethical criteria that assess the permissible limitations of genetic experimentation on living beings. In other words, GM technology ethics is a realistic technique for improving benefits and lowering hazards in genomic technologies [14].

Special conferences on GM products have been held by legal organizations such as the WHO, FAO, and the Codex Alimentarius Commission to discuss the importance of GM-related developments as well as genetic engineering in all aspects and potential risks resulting from ignorance of biosafety principles. Since 1962, the FAO's Codex Alimentarius Commission has been in charge of enforcing FAO and WHO food standards. The potential dangers of genetically modified organisms were first addressed at the Asilomar Conference in 1975, followed by the approval of the first legal regulation of GM products in the 1990 decade. In addition, the international biodiversity convention was signed in Rio de Janeiro in 1992 and implemented in 1993. The Cartagena Protocol, which is considered an attachment to the biodiversity treaty, is a driving force for ratification of this treaty. The Cartagena Protocol is an important international mechanism for limiting the movement of genetically modified foods that can be implemented anywhere in the world. The ratification of this agreement is a crucial step toward establishing a consistent framework for regulating risk management requirements in relation to the need to expand universal trade for GM technology [13].

CONCLUSION

Biotechnology's most recent advancements, such as molecular biology, genetic engineering, and transgenic technology, have a wide range of potential uses in food production, including microorganisms, plants, and animals. Transgenesis in farm animals is significantly more difficult than it is in plants or microbes. Some crops' yields have risen because of genetic engineering. Nonetheless, there are

too few difficulties in too few crops for the technology to be effective. Although genetic modification is not good in and of itself, it is a method for balancing public and private science. High yield, salinity/drought tolerance, insect resistance, cold resistance, pest resistance, and other advantages of genetically modified crops are only a few of the benefits.GM foods have a lot of health effects (allergic, toxicity, etc.) on living things. Genetically modified foods have a variety of negative health impacts on living creatures (allergies, toxicity, etc.). The benefits and drawbacks of genetically modified foods were discussed. These could be direct effects on species that eat or interact with the crops, or broader effects on food chains caused by changes in the number of other organisms. Labeling and traceability are vital in the worldwide context of biosafety.

The extent of an appropriate safety assessment of GMO products should be determined prior to commercialization. It should be based on the presence of novel compounds or substantial changes in the levels of naturally occurring substances, such as nutrients that are above or below the normal range for that species.

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