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Assessment of the safety of genetically modified foods

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Abstract. In recent years, with the rapid development of modern science and technology, as people utilize various scientific and technological means to alter the characteristics of organisms, potential hazards to the ecological environment and human health may arise. Due to the extensive application of modern biotechnology, genetically modified (GM) technology has been employed in agricultural production, resulting in genetically modified foods. People are highly concerned about the safety of GM foods. This article uses a literature review to assess the safety of GM foods from the perspectives of the current status of GM animals and plants and potential risks. The results suggest potential toxicity to humans, food allergies, certain environmental hazards, and the possible reduction of biodiversity and gene flow.

Keywords: Genetic Modification Technology, Genetically Modified Food, Food Safety, Ecological Environment

1. Introduction

Entering the 21st century, with the rapid increase in global population, human demands on natural resources have intensified. Earth's resources are finite, so from the perspective of increasing food production, people have used biology and genetic engineering to cultivate genetically modified animals and plants. Successful development of various GM animals and plants has enhanced the resistance of crops to various biotic and abiotic stresses, making a significant contribution to solving global food shortages. Genetic modification technology improves and cultivates new varieties, promotes rapid food growth, improves yield and quality, reduces costs, enhances taste and texture, and brings enormous socio-economic benefits and social effects to humanity. However, with the proliferation of GM foods, traditional varieties are inevitably impacted. This has led to some people's rejection and skepticism of GM foods, even going as far as to maliciously smear and spread anxiety about them. This article aims to organize literature research, sort out the pros and cons of GM foods, discuss their safety, and uphold a scientific and impartial attitude without demonizing GM foods.

Genetically modified foods refer to foods and food additives produced by animals, plants, and microbes with genetically engineered alterations to their genome compositions. This includes:products from GM animals, plants, and microbes, direct processed products of GM animals, plants, and microbes; and foods and food additives derived from GM animals, plants, their processed products[1]. This article evaluates from the perspective of the development status of GM animals and plants and potential risks. It speculates that the impact of GM foods on the human body mainly lies in potential

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allergies and antibiotic resistance, but the environmental impact is of even greater concern. The use of GM might lead to the emergence of super weeds and pesticide-resistant pests.

2. Development and Achievements of Genetically Modified Animals and Plants

2.1. Genetically Modified Animals

Research on genetically modified animals began in the 1980s when Palmiter and others [2] successfully introduced the growth hormone gene of rats into the mouse genome using microinjection. This was recognized as the world's first genuine genetically modified animal. The most famous genetically modified animal was created in 1997 when Wilmut and others [3] produced the world's first genetically modified cloned sheep, "Dolly," using somatic cell nuclear transfer technology. This marked the first time that human beings had transplanted mammalian somatic cell nuclei.

Today, genetically modified animals are widely used by humans. They, especially mice, are often used as human disease models to study disease mechanisms and drug treatment strategies. In honor of the mice who sacrificed their lives for science, a sculpture of experimental mice weaving a DNA chain was erected in front of the Novosibirsk Institute of Cytology and Genetics.

Moreover, genetically modified animals play a significant role in the biopharmaceutical industry. The world's first genetically engineered protein drug—recombinant human antithrombin III (trade name: ATryn) produced using a genetically modified animal mammary bioreactor—received marketing authorization from the European Medicines Agency (EMA) in 2006 and the U.S. Food and Drug Administration (FDA) in 2009. This signaled that drug production through genetically modified animals had entered the industrial phase.

Furthermore, genetically modified animals have found applications in agriculture. In November 2015, the world's first genetically modified salmon with foreign genes that accelerate its growth rate was approved for market sales by the FDA. This marked the beginning of human consumption of genetically modified animals, another significant contribution of genetic engineering technology.

2.2. Genetically Modified Plants

The exploration of genetically modified plants saw breakthroughs starting from the 1980s. In 1983, scientists successfully expressed a foreign gene in plants for the first time. Then, in 1994, the world's first genetically modified food—a tomato named FlavrSavr that had an extended shelf life—was launched in the United States.

Through years of experimentation and research, a myriad of commercial genetically modified plants have been developed. Common examples include glyphosate-tolerant crops like genetically modified soybeans, which, through genetic engineering, have been made resistant to specific herbicides like glyphosate. There are also cotton and maize plants that have been genetically modified to produce insecticidal proteins to fend off certain pests, thereby reducing the use of insecticides. Another advantage of genetically modified plants is that, unlike mammalian cell-derived drugs, plant-derived antibodies, vaccines, and other pharmacologically relevant proteins are particularly beneficial because they do not contain mammalian virus vectors and/or human pathogens. Advantages provided by plants include low cultivation costs, high biomass production, relatively quick "gene-to-protein" times, low investment costs, good scalability, eukaryotic post-translational modifications, and high protein yields [4]. Genetically modified plants have vast developmental prospects. New plant breeding technologies (NPBT), including genetically modified organisms (GMO) and gene-edited crops, might bring significant changes [5]. They may help increase crop yields, reduce the use of fertilizers and pesticides, enhance crops' resistance to climate stresses, minimize post-harvest losses, and provide more nutritious food [6]. However, NPBTs have not yet been widely used and accepted. GMOs, in particular, are often viewed very critically. Despite 30 years of research and commercial application, studies show that GMOs are no riskier than conventionally bred crops [7].

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3. Risks Associated with Genetically Modified (GM) Foods

Health and Safety Risks of GM Foods to Humans People demand food that is both safe and nutritious. Although there has been no direct evidence of harm from GM products to date, there isn't sufficient scientific justification to prove they are entirely safe either. The potential and suspected harms of GM products primarily relate to toxicity, food allergies, and inducing drug resistance in humans. There are two primary reasons for potential toxicity:

The organism providing the gene might be a toxic one, which, when consumed as food, could produce toxic substances. The introduction of new genes could disrupt the original genetic "management system" of the organism, activating previously dormant genes that produce toxins. From 1988 to 1989, a Japanese company introduced a product containing L-tryptophan into the U.S. market using genetically recombined microorganisms. This resulted in 37 deaths and left 1,500 people with permanent disabilities due to the toxic dimeric products containing L-tryptophan. Thus, although no decisive studies have shown toxicity in GM foods, the "unforeseen impacts" and potential toxicity issues mean there might be hidden health risks in the foods produced.

Food Allergies: Genetic modification might introduce new genes into plants. These genes could code for new proteins, which, if allergenic, could cause food allergies. There's also the potential for protein cross-reactions—new proteins might share structural similarities with known allergens, triggering what's termed a "cross-reaction". This means a consumer might develop an allergic reaction to a GM food, even if they have never been allergic to it, due to its protein similarity with another allergen. Inducing Drug Resistance in Humans: Introducing foreign genes into plants or animals might cause these genes to link with other genes. When humans consume such modified foods, the antibiotic-resistant genes might be transferred to pathogenic bacteria in the human body, leading to drug resistance.

Ecological and Environmental Safety Risks GM plants also have substantial negative impacts on the environment. Resistant pests and "superweeds": Similar to antibiotic-resistant bacteria, harmful pests or weeds might develop resistance to the traits expressed by GM crops, leading to newer or more challenging pests and weeds. Gene flow: Genes, carriers of biological genetic information, naturally drift and flow. They might hybridize into another population, altering the genetic composition of the latter. Reduced biodiversity: GM crops, having advantages over natural organisms, can be favored by many farmers. This can change inter-species competition, disrupt ecological balance, harm agricultural ecology, and potentially create detrimental ecological cycles. Maintaining biodiversity is essential to reduce the vulnerability of organisms to diseases and pests.

To harness the benefits of genetic modification technology while sidestepping the risks of resistant pests and "superweeds", the following approaches are suggested: educate farmers on the correct use of GM crops and pesticides, and rotate different herbicides to reduce the chances of weed resistance. Continuously refine GM techniques to develop crops with multiple resistance mechanisms against various pests. Implement crop rotation to break the life cycle and reproductive patterns of weeds, minimizing their spread.

4. Conclusion

This study found that GM organisms have rapid development with significant potential. From a cautious perspective, GM foods pose minimal harm to humans, but potential environmental harms persist. There should be a focus on the rational use of GM technology, preventing misuse which might lead to significant accidents. A limitation of this study is its reliance on literature reviews without direct experimental data. Future research could include animal tests or crop trials to evaluate the impact of extensive GM food consumption on offspring and the possibility of gene flow.

Suggestions for GM food development include ongoing long-term safety research, improving crop drought and salt tolerance to adapt to changing climatic conditions, and enhancing public awareness to foster trust in GM products.

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