A Review of Possible Health Consequences of Genetically Modified Foods

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Abstract

Many countries are considering the option of importing genetically modified (GM) foods to reduce food shortage. However, its planned introduction in Nigeria has been trailed with controversy due to its possible health consequences. This article reviewed the possible health effects of GM foods to clear the controversy surrounding its introduction. The Google search engine was used to retrieve information on the subject from reliable sources on the internet such as PubMed, Google Scholar, among others. Studies funded by various governments reported no safety issue with GM foods, while independent researchers say GM foods can cause allergies, cancer, antibiotic resistance and toxicity. Some scientific studies implicating GM foods in serious health consequences have appeared in reputable journals in the past, but were later withdrawn, allegedly due to pressure from governments and companies. Policy makers in Nigeria are therefore advised to carry out short and long term studies of possible health effects of GM foods and put in place palliative measures before introducing them.

Keywords: GM foods, Allergies, Toxicity, Cancer, Antibiotics

1.0 Introduction

Genetic engineering (GE) is a process by which genes from the DNA of one organism are inserted into the genes of an unrelated organism. The organisms whose DNA has been modified with foreign genes are called genetically modified organisms (GMOs). The foreign genes may come from bacteria, viruses, insects, animals or even humans. GMOs are also known as "transgenic" organisms because the process involves the transfer of genes [1].

Humans have been altering the genetics of organisms through selective breeding for over 30,000 years [2]. However, a major breakthrough in GE occurred in 1973 with the creation of the first genetically modified mouse by Rudolf Jaenisch, a Professor of Biology at Massachusetts Institute of Technology. Immediately following the announcement of the first genetically modified mouse; the media, government officials and scientists began to worry about the potential effects of GE on human health and the environment. At the Asilomar Conference of 1975, scientists, lawyers, and government officials debated the safety of GM foods and concluded that the GE projects should be allowed to continue [3]. Since then the world has been flooded with genetically modified foods, particularly when it was found they have some benefits.

GE incorporates desirable traits from nature into crops, resulting in plants with superior characters. GE enable farmers to be better stewards of the environment, allowing farmers to grow more crops on less land while using fewer pesticides and less water. In the United States, the adoption of GM crops resulted in reduced pesticide use by 46.4 million pounds in 2003 [4]. Between 1996 and 2011, GM crops have reduced pesticide spraying globally by 9% or 975 million pounds. As a result of reduction in pesticides, land and water use, GE has helped keep food production costs down resulting in lower prices for consumers. GM foods have helped feed more than 300 million Americans and a global population of 7 billion, some of whom are suffering from hunger and malnutrition. By 2050, the global population is expected to rise to 9 billion and experts predict that 70% more agricultural production will be needed to keep pace [4]. Utilizing GE that increase productivity while reducing land, water and pesticide use will be critical to this achievement [4].

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Presently the world is facing serious food scarcity and Nigeria in particular is considering the option of importing GM foods to lower food costs and support conventional crops. However, the masses and even government fear the health consequences of GM foods. More so, this is coming at a time when the acceptability of GM foods is declining worldwide due to their health effects. As at the time of writing this review, nineteen (19) European countries have shut their borders against GM foods, citing health consequences. It is therefore necessary to review the benefits and health consequences of GM foods for the awareness of the masses and to guide policy makers in taking decisions.

2.0 Search Methods

The Google search engine was used to search for literature on the benefits and health consequences of GM foods. Information was obtained from reliable sources such as PubMed, Google Scholar, Medline, Agencies, Blogs, among others.

3.0 Health Hazards of GM Foods

Generally, the truth about the health and environmental safety of GE has been politicized. While studies conducted by government agencies found no safety issue with GM foods, studies carried out by independent researchers reported serious health risks with GM foods. The types of potential hazards posed by GM foods depend on the type of organism being modified and its intended application. Most of the concerns surrounding GM foods relate to their potential for negative effects on human health and environment. Health effects of primary concern to safety assessors are production of new allergens, increased toxicity, decreased nutrition, infertility and antibiotic resistance [5, 6].

3.1 Food Allergy

Food allergy affects approximately 8% of children and 4% of adults in the U.S., making it a significant public health threat in the country [7]. Food allergic reactions in humans occur when a normally harmless protein enters the body and stimulates an immune response [8]. Allergic reactions to a GM food can occur if the novel protein in the food comes from a source that is known to cause allergies in humans. It can also occur if the protein comes from a source that has never been consumed as human food [9].

In 1996, a team of scientists from the University of Nebraska identified a possible allergic reaction to GM soybeans [10]. The researchers found that a Brazil nut protein introduced to improve the nutritional quality of GM soybeans was able to provoke an allergic reaction in some people. However, this problem can likely be prevented with proper safety testing. Unfortunately, GE companies are not compelled by governments to do thorough safety testing before releasing GM foods into the market [11]. The US Food and Drug Administration (FDA), for example, does not require a single safety study, and does not mandate labeling of GM foods [12]. The agency also allow companies to put their GM foods in the market without prior notification based on the claim that it had no information showing that GM foods were substantially different. However, secret memos from the agency made public by a lawsuit showed that the overwhelming consensus even among the FDA's own scientists was that GM foods can create unpredictable, hard-to-detect side effects [13]. The scientists recommended long-term safety studies before introducing GM foods, but the White House had instructed the FDA to promote GM foods. To carry out the directive of the White House, the agency appointed Michael Taylor, Monsanto's former attorney, as the officer in charge of policy. Mr. Michael was later promoted to the position of vice president and now the president of the agency [14].

In 2011, Sherbrooke Hospital in Canada carried out a test on blood samples obtained from some pregnant women. It was found that 93% of the pregnant women and 82% of the fetuses tested had a certain protein called pesticide protein in their blood. This protein is formed when a foreign pesticide resistant gene is introduced into the genome of a target crop. Pesticide protein is recognized in its many forms as mildly to severely allergenic [15]. Long term feeding studies in mice and rats have shown that pesticide protein could produce serious allergies leading to breast cancer, kidney and liver damage [16].

3.2 Increased Toxicity

Most plants produce toxins, however, edible plants produce toxins at levels low enough that they do not produce any adverse health effects [17]. There is concern that inserting an exotic gene into a plant could cause it to produce toxins at higher levels that could be dangerous to humans. If other genes in the plant become damaged during the insertion process, it could cause the plant to alter its production of toxins. Alternatively, the new gene could interfere with a metabolic pathway causing a stressed plant to produce more toxins in response. Although these effects have not been observed in GM plants, they have been observed in conventional breeding methods creating a safety concern for GM plants. For example, potatoes conventionally bred for increased disease resistance have produced higher levels of glycoalkaloids [17].

According to researchers at Suez Canal University in Egypt, GM corn diet resulted in increased or decreased organs or body weight in experimental rats. The researchers also discovered that GM corn caused changes in blood biochemistry that indicated possible toxicity [18]. Another study also revealed that Monsanto's Bt corn is toxic to humans, even at small exposure [18]. A 91-day study, which compared histopathology of rats fed with GM maize and rats fed non-GM maize found clear signs of multi-organs damage in the GM-fed group. The testes revealed necrosis (death) and desquamation (shedding) of the spermatogonial cells, which are the foundation of sperm cells and thus male fertility [19].

3.3 Reduction in Nutritional Value

A GM plant could theoretically have lower nutritional quality than its traditional counterpart by making nutrients unavailable or indigestible to humans. For example, phytate is a compound common in seeds and grains that binds with minerals and makes them unavailable to humans. An inserted gene could cause plants to produce higher levels of phytate decreasing the nutritional value of such plants. Compared with conventional crops, GM crops may also produce lower levels of phytoestrogens, which are believed to protect against heart disease and cancer [20, 21].

In 1999, a group of scientists conducted a study on the nutritional qualities of some conventional and GM soybeans. In the study, Roundup-Ready soybeans (a GM crop) had reduced levels of isoflavones, notably genistin and daidzin [22]. Considering the potential health benefits of these two compounds, this may have significant implications on human health. However, the American Soybean Association published a response to this study indicating the difference in phytoestrogen levels was within the limits of variability for conventional soybean varieties. The association argued further that not all comparisons in the study of the two compounds in conventional versus transgenic varieties showed reduced levels; some showed significant increases [22].

In 2012, a self-defined "coalition of unstoppable America moms," published a report on their blog which also gave rise to heated debate about GM foods. The study was outsourced to an independent major food company that compared the nutrient contents of GM corns with non-GM corns. According to the analysis, the GM corns contain a similar amount of nutrients, including a number of elements which are absent from traditional corns, such as chlorides, formaldehyde and glyphosate in harmful quantities [23].

3.4 Antibiotic Resistance

In recent years, health professionals have become alarmed by the increasing number of bacterial strains that are showing resistance to antibiotics [21]. Bacteria develop resistance to antibiotics by creating antibiotic resistance genes through mutation. Biotechnologists use antibiotic resistance genes as selectable markers to know whether the plant has incorporated the new genes into its genome or not. By attaching the desired gene to an antibiotic resistance gene, the new GM plant can be tested by growing it in a solution containing the corresponding antibiotic. If the plant survives, scientists know that it has taken up the antibiotic resistance gene along with the desired gene. However, there is concern that bacteria living in the guts of humans and animals could pick up an antibiotic resistance gene from a GM food before the DNA becomes completely digested [22].

A British study conducted at the University of Newcastle found traces of the modified genes in the small intestines of volunteers who ate GM soya [24]. Three of the seven volunteers fed with GM soya in the study had evidence of DNA gene transfer in the bacteria that occurs naturally in their digestive systems. Scientists fear that GM foods, which are often modified to be resistant to antibiotics, will leave Britons vulnerable to intractable illnesses. The research contradicts repeated claims by GM companies that gene transfer from foods to humans is extremely unlikely. It also raises the possibility that millions of people may already have GM bacteria from foods they have eaten [24].

3.5 Contamination of Gene Pool

GM plants cross pollinate and the resulting seeds can travel, hence it is impossible to fully clean up contaminated gene pool. The potential impact of GE pollution is huge; it will outlast the effects of global warming and nuclear wastes. Contamination of GM plants has also caused economic losses for organic and conventional farmers who often struggle to keep their crops pure [25]. In a recent article, researchers emphasized that there is sufficient evidence that meal-derived DNA fragments carry complete genes that can enter into the human circulatory system through an unknown mechanism [26]. This finding was based on the analysis of over 1000 human blood samples from four independent studies. In one of the blood samples, the relative concentration of plant DNA is higher than the human DNA, confirming what many have been suspected for years [26].

3.6 Disorders Associated with Herbicide Use

Most GM crops are engineered to be "herbicide tolerant", for example, Roundup-Ready crops are designed to survive applications of Roundup herbicide. Theoretically, this should have led to less herbicide use on farms; but in practice, more and more herbicides are being used annually. For instance, between 1996 and 2008, US farmers sprayed an extra 383 million pounds of Roundup on GM crops. The increasing volume of pesticide needed annually could have been caused by the creation of ''super weeds'' which are resistant to the herbicide. Thus prompting farmers to use even more toxic herbicides every year. Herbicides harm the ecosystems and GM foods containing them have been linked with sterility, hormone disruption, birth defects and cancer [25].

A research from Canada found Monsanto's Bt toxin and pesticides associated with genetically modified foods in maternal, fetal and non-pregnant women's blood. The study pointed out that the fetuses were highly susceptible to the adverse effects of the xenobiotics found in the blood. Xenobiotics are foreign chemical substances found within an organism that is not naturally produced. The study concluded that better understanding of GE is crucial, because environmental agents could disrupt biological events that are required to ensure normal growth and development [27].

In 2012, Seralini *et al*. [28] reported the first and only long term study under controlled conditions, examining the possible effects of GM corns treated with Monsanto roundup herbicide. The paper established a link between GM crops and tumors; however, this paper has since been retracted perhaps due to pressure from government or the biotech company. The retraction of this article is suspicious considering the outlet and rigorous review process it must have gone through. It is also important to note that hundreds of scientists from around the world have condemned the retraction of the study as it was done by experts and their findings cannot be denied.

3.7 Reduction in Crop Yields

On average, genetic modification of crops does not increase yields based on findings by a group of scientists known as the Union of Concerned Scientists (UCS) in 2009 [29]. It is the only definitive study to date on GM crops and yields. The paper reviewed 24 academic studies of corn and soybeans, the two primary genetically engineered food and feed crops grown in the United States. Based on those studies, the UCS report concluded that genetically engineering herbicide-tolerant soybeans and herbicide-tolerant corn has not increased yields. Insect-resistant corn, meanwhile, has improved yields only marginally. The increase in yields for both crops in 13 years was largely due to traditional breeding or improvements in agricultural practices [29]. This claim is also supported by a paper presented by the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). The report, authored by more than 400 scientists and backed by 58 governments, stated that GM crop yields were highly variable and in some cases, yields declined. The scientists concluded that GE can neither reduce hunger and poverty, nor improve nutritional quality and waste management. On the contrary, it diverts money and resources that would otherwise be spent on safe, reliable, and appropriate technologies [25].

3.8 Infertility and Organ Damage

Medical doctors and medical associations have warned that GM foods can cause infertility and multi-organ damage [30]. In fact, the American Academy of Environmental Medicine (AAEM) urges doctors to prescribe non-GMO diets for all patients. They cited animal studies showing organ damage, gastrointestinal and immune system disorders, accelerated aging and infertility. The group also cited human studies showing how GM foods can leave behind material, possibly causing long-term problems. In one of the studies cited, a toxic insecticide produced by GM corns was found in the blood of pregnant women and their unborn fetuses [30]. The American Public Health Association and American Nurses Association also condemn the use of GM bovine growth hormone. They found that milk from treated cows has more of the hormone IGF-1 (insulin-like growth factor 1), which is linked to cancer and infertility [25].

Many doctors reported an increase in numerous health problems after GM foods were introduced in 1996. In America, the percentage of patients with three or more chronic illnesses jumped from 7% to 13% in just 9 years. Worldwide, food allergies, autism, reproductive, digestive and other disorders skyrocketed. Medical groups such as the AAEM concluded that we should start protecting ourselves, and especially our children who are most at risk [25]. Eyewitness reports from around the world describe several situations where animals, when given a choice, avoid GM foods. These include cows, pigs, geese, elk, deer, raccoons, mice, rats, squirrels, chicken, and buffalo [25].

4.0 Conclusion

Though GM foods have some benefits, studies have established that such foods may cause health consequences which outweigh the benefits in the long run. Policy makers in the country are therefore advised to carry out short and long term studies on possible health consequences of GM foods and palliative measures before introducing them.

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