Medbiotech Journal

MBTJ, 4(3): 126-133, 2020

Research Paper

Study of Health Aspects of Genetically Modified Foods in Human Life

Mohammad Mohammadi, Eghbal Jafari*

Department of Biology, University of Kabul, Afghanistan

Received: 27 June 2020 Accepted: 09 August 2020 Published: 01 September 2020

Abstract

Throughout the ages, humans have used selective breeding techniques to create plants and animals with desirable genetic traits. One type of technology, however, has given rise to a host of concerns and questions, namely Genetically Modified Organisms (GMOs). GMOs are those organisms that have been modified by the application of recombinant DNA technology or genetic engineering, a technique used for altering a living organism's genetic material. With the rapid advances in biotechnology, a number of genetically modified (GM) foods or transgenic crops carrying novel traits have been developed and released for commercial agriculture production. A number of commercialized, genetically engineered (GE) varieties, most notably canola, cotton, maize and soybean, were created using this technology, and at present the traits introduced are herbicide and pest tolerance. Gene technology enables the increase of production in plants, as well as the rise of resistance to pests, viruses, frost, etc. Gene transfer is used to modify the physical and chemical composition and nutritional value of food. On the other hand, negative effects of gene technology on animals, human, and environment should be considered. The present review article is the compilation of various studies that present both positive and negative impacts of genetically modified food on human health and environment.

Keywords: Genetically Modified Foods; Biotechnology; Human Health; Environment; Desirable Traits.

How to cite the article:
M. Mohammadi, E. Jafari, Study of Health Aspects of Genetically Modified Foods in Human Life, Medbiotech J. 2020; 4(3): 126-133, DOI: 10.22034/mbt.2020.120941.

Introduction

Throughout the ages, humans have used selective breeding techniques to create plants and animals with desirable genetic traits. Genetically Modifies Organisms (GMOs) as modern techniques have widespread applications as they are used in biological and medical research, production of pharmaceutical drugs, experimental medicine, and agriculture. The use of gene technology in food production has become interesting due to increased needs of food as well as its improved quality. Using modern techniques of genetic engineering (or biotechnology), it is possible to introduce specific genetic material derived from any species of plant, animal, or microorganism, or even synthetic material, into different species of plants very rapidly and with great accuracy [1]. Genetically modified (GM), is a term denoting or derived from an organism (i.e. plants, animals or microorganisms) whose DNA has been altered for improvement or correction of defects [2]. Genetically modified foods have been modified in the laboratory to enhance certain traits such as resistance to herbicides, pests, diseases, or viruses, and improved nutritional content and increased drought tolerance, etc. for the purpose of making them more desirable to consumers. The new genetically-modified plant will gain drought tolerance as well. Not only can genes be transferred from one plant to another, but genes from non-plant organisms also can be used. The best

* Corresponding author email: eghbal.j1455@gmail.com

known example of this is the use of *Bacillus thuringiensis* (B.t.) genes in corn and other crops. B.t. is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. B.t. crystal protein genes have been transferred into corn, enabling the corn to produce its own pesticides against insects Since the development of this process, issues such as the concern of the public for possible hazards due to the consumption of a GM food have been discussed, and with their increase in production there has also been great controversy [3, 4].

There are many reasons for producing GM foods. Originally, the intent was increased protection of crops, however there are many additional benefits recognized today. Both consumers and producers who feel that GM foods are advantageous believe that these foods can be cheaper, more durable, and more nutritional. In addition to increased protection from diseases, pests and herbicides, there are other reasons for genetic modification. Many crops are destroyed due to weather conditions. Cold water fish have an antifreeze gene which, when introduced to plants like tobacco and potatoes, can lead to higher tolerance to cold temperatures. A very important quality of food is the nutrition value. Malnutrition is prevalent, especially in third world countries where people tend to rely on only one crop to fulfill their dietary needs. If however, these crops could be genetically modified to contain the amount of vitamins and nutrients necessary to sustain a healthy diet, it would be a great advantage. Vaccination and medicines can be very difficult to produce, and they can also be very costly. Through genetic modification there is hope that the ability to produce foods with edible vaccinations in them will become a possibility. Approximately 15 years have passed after the introduction of genetic modifications in food, and new GM products are currently added to the existing list of foods. However, 10 years ago already have been noticed that there was no sufficient published information concerning safety of GM foods in general, and GM plants, in particular. Specifically, the lack of published toxicological studies on adverse health effects was evident [5, 6]. In 2006, carried out a new review of the scientific literature on the potential adverse health/toxic effects of GM/transgenic plants [5]. The environmental safety of GM crops has been constantly debated, and the interpretation of scientific data differs among stakeholders [7].

However, the general public remains largely unaware of the real notion of GM plants or what advantages and disadvantages the technology has to offer, particularly with regard to the range of applications for which they can be used. From the first generation of GM crops, two main areas of concern have emerged, namely risk to the environment and risk to human health. As GM plants are gradually being introduced into the European Union it is likely that public concern regarding potential health issues will arise [8].

History of GM Foods

An enormous breakthrough in GMO technology came in 1973, when Herbert Boyer and Stanley Cohen worked together to engineer the first successful genetically engineered (GE) organism [9]. The two scientists developed a method to very specifically cut out a gene from one organism and paste it into another. Using this method, they transferred a gene that encodes antibiotic resistance from one strain of bacteria into another, bestowing antibiotic resistance upon the recipient. One year later, Rudolf Jaenisch and Beatrice Mintz utilized a similar procedure in animals, introducing foreign DNA into mouse embryos [10].

In 1982, the United States Food and Drug Administration approved the first human medication produced by a genetically modified organism. Bacteria had been genetically engineered to synthesize human insulin, allowing them to produce enough of the hormone to purify, package, and prescribe it to diabetes patients as the drug Humulin [11].

In 1994, the first GM food the Food and Drug Administration deemed safe enough for human consumption was a tomato called "Flavr Savr", which was made more resistant to rotting by Californian Company [12]. Genetically modified tomatoes were then made into a tomato puree and sold in Europe in the mid-1990s, but later controversy arose over the concept of GM food.

In 1995, *Bacillus thuringiensis* (B.t.) Potato was approved for cultivation, making it the first pesticide producing crop to be approved in the USA [13]. Later in 1998, a doctor from Aberdeen, in Scotland, published results from a research study that GM potatoes, injected with an insecticide gene from the snowdrop plant, were toxic to rats. A year later it was announced that beginning in 1999, there were to be trials of GM crops engineers to be resistant to herbicides. The purpose of the trials was to uncover the effects of this crops on farmland wildlife. However, this was criticized to be potentially dangerous to nearby crops, as well as honey that could be affected by cross-pollination. Sure enough, later that year pollen from GM oilseed rape, a plant that is used to produce canola oil, was found at beehives almost three miles away. Two out of nine samples of honey being sold in supermarkets were contaminated in May 2000. At this point in time, nine out of ten people were against the idea of GM foods [14, 15].

Other genetically modified crops receiving marketing approval in 1995 were: canola with modified oil composition, Bt maize, cotton resistant to the herbicide bromoxynil, Bt cotton, glyphosate-tolerant soybeans, virus-resistant squash, and another delayed ripening tomato [12]. Scientists have also genetically engineered crops to increase nutrition value. For instance, Golden Rice was developed in 2000 with the goal to combat vitamin A deficiency, which is estimated to kill over 500,000 people every year [16]. By 2006 some weed populations had evolved to tolerate some of the same herbicides. Palmer amaranth is a weed that competes with cotton. A native of the southwestern US, it traveled east and was first found resistant to glyphosate in 2006, less than 10 years after GM cotton was introduced. By 2010, 29 countries had planted commercialized biotech crops and a further 31 countries had granted regulatory approval for transgenic crops to be imported. The US was the leading country in the production of GM foods in 2011, with twenty-five GM crops having received regulatory approval. In 2015, 92% of corn, 94% of soybeans, and 94% of cotton produced in the US were genetically modified strains [17]. In other words, any foods that contain field corn, high-fructose corn syrup, soybeans, cottonseed oil, or canola oil all contain GM ingredients. According to a study funded by the United States department of agriculture, only 52% of Americans are aware that genetically modified foods are even sold in grocery stores.

The most frequently transformed plants include soybean, maize and rape. Moreover, potatoes, tomatoes, cotton and tobacco used to be subjected to the process of transgenesis, and among animals, species such as cattle and pigs. Milk can be made from a genetically modified hormone called the recombinant bovine growth hormone. The function of this hormone is to produce more milk by keeping cells to produce milk alive in cows for longer periods of time, however cows injected with the hormone are more prone to disease such as mastitis, and subclinical ketosis may pose a risk to human health. Other Adverse effects in cows consist of decrease in final pregnancy rates, decrease in birth rate, and an increase in embryonic loos and abortion which can in turn have negative effects on the milk [18, 19].

Some Advantages of GM Foods

Due to the remarkable increase in the world population, so ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. GM foods promise to meet this need in a number of ways:

Pest resistance; Farmers typically use many tons of chemical pesticides annually. Consumers do not wish to eat food that has been treated with pesticides because of potential health hazards, and run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the water supply and cause harm to the environment [20, 21].

Herbicide tolerance; Remove weeds in some agricultural products through traditional methods such as plowing or picking is not economical. So farmers to use large amounts of herbicides in this area are due to environmental pollution. The use of crops genetically modified to be resistant to herbicides could prevent environmental damage by reducing the amount of herbicides needed [3, 22].

Disease resistance; Many plant diseases happen by biological agents such as bacteria, fungi and viruses. Plant biologists are working to create plants with genetically-engineered resistance to these diseases [23, 24].

Cold tolerance; Unexpected frost will be destroyed sensitive plants. In this context genes resistant to freezing in cold-water fish extract and has been transferred in to plants such as tobacco and potato, with this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedlings [25].

Drought/salinity tolerance; As the world population is growing and more land is used for housing instead of food production, farmers need to grow crops in places that previously have not been suitable for plant cultivation. Producing plants that can resist long periods of drought and high salt content in soil and groundwater will help people to cultivate crops in formerly unfavorable places [26].

Nutrition; Malnutrition is more common in third world countries where poor peoples rely on a single crop such as rice for the main component of their diet. However, rice does not contain sufficient amounts of all essential nutrients to prevent malnutrition. If rice could be genetically engineered to contain additional vitamins and minerals, nutritional deficiencies could be resolved. For example, in developing countries blindness due to vitamin A deficiency is very common, so the researchers at the Swiss federal institute of technology institute for plant sciences have developed “golden” rice, which contains high levels of vitamin A. The project of enriching rice in dietary products involved the isolation and transfer of genes from *Erwinia uredovora* bacteria and jonquil flowers directly to rice grains. The success of this project was followed by subsequent amendments, achieving parallel augmentation of the level and bioavailability of iron [27, 28]. Using the techniques for the biotechnological improving of plants, other significant changes in transgenic food traits were performed, targeted at the changed content of specific proteins, lipids and carbohydrates. The mentioned food staples, exposing suitability for the genetic transformation process, developing favorable quality traits, with improvement of

nutritive value in individual products of transgenesis.

Pharmaceuticals; drugs and vaccines often are costly to produce and sometimes need special storage conditions not easily accessible in developing and third world countries. Investigators are working to create edible vaccines in tomatoes and potatoes. These vaccines will be much easier to carry, store and administer than traditional injectable vaccines [29].

Phytoremediation; Not all Genetically Modified plants are grown as crops. Soil and groundwater pollution continues to be an issue in worldwide. Plants such as poplar trees have been genetically engineered to cleaning heavy metal contamination from contaminated soil [30, 31].

Table 1. Advantageous features of genetically modified food [32]

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 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 Lower lactose content
Transgenic fishes (carp, salmon, trout)	Faster growth rate

Some Criticisms against GM Foods

Despite the advantages of GM foods, the disadvantages of doing so seem far further the positive aspects of it. The most common criticisms GM foods placed into three major categories: environmental hazards, human health risks, and economic concerns.

Environmental hazards

Unwanted harm to other organisms; Last year a experimental study was published in Nature showed that pollen from B.t. corn caused high morbidity rates in monarch butterfly caterpillars. Monarch caterpillars eat milkweed plants, not corn, but there is fear that if pollen from B.t. corn is blown by the wind on to milkweed plants in neighboring fields, the caterpillars might eat the pollen and perish. Unfortunately, B.t. toxins kill many species of insect larvae purposeless; it is not possible to design a B.t. toxin that would only kill crop harmful pests and remain harmless to all other insects. At present, there is no consensus about the results of these studies, and the potential risk of harm to non-target organisms will need to further evaluation [33, 34].

Reduced impact of pesticides; Only as some populations of mosquitoes developed resistance to DDT that is currently banned pesticide, many people are worried that insects will become resistant to B.t. or other products that have been genetically changed to produce their own pesticides.

Gene transfer to non-target species; Another concern is that crop plants engineered for herbicide tolerance and weeds will cross breed, resulting in the transfer of the herbicide resistance genes from the crops to weeds. These "super weeds" would then be herbicide tolerant also. Other introduced genes may cross over in to non-modified crops planted next to GM crops [35].

Human health risks

Allergenicity; Food allergies are very common among people in Europe and the United States to peanuts and other foods, and in some cases these allergies can be fatal. There is possibility that introducing a gene into a plant may ceate a new allergen or cause an allergic reaction in susceptible individuals. A proposal to incorporate a gene from Brazil nuts into soybeans was abandoned because of the fear of causing unexpected allergic reactions [36]. In Australia, GM peas were found to cause allergic reactions in mice. GM peas also made the mice more sensitive to other food allergies [37]. Extensive testing of GM foods may be required to avoid the possibility of harm to consumers with food allergies.

Effects on human and Animal health; There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. A recent article published in Lancet examined the effects of GM potatoes on the

digestive tract in rats [38]. This study claimed that there were appreciable differences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes that also showed proliferative cell growth in both stomach and intestinal walls. Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals. The scientists who created this variety of potato chose to use the lectin gene simply to test the methodology, and these potatoes were never intended for human or animal consumption [39]. Digestive tract is the first and largest point of contact with foods, can reveal various reactions to toxins and should be the first target of GM food risk assessment.

Another recent study found the effects of GM foods on reproductive tract; Cry1Ab B.t. toxin in the blood of pregnant women and their foetuses showing that it can cross the placental boundary. This raises health concerns, although the implications of this uptake and transference across the placenta are not yet known. Oliveri et al. in their study shown that the testicles of both mice and rats fed roundup ready soybeans showed dramatic changes. In rats, the organs were dark blue instead of pink. In mice, young sperm cells were altered [40, 41].

The results of most of the rather few studies conducted with GM foods indicate that they may cause hepatic, pancreatic, renal, and reproductive effects and may alter hematological, biochemical, and immunologic parameters the significance of which remains unknown. Such changes consist in congestion, cell nucleus border changes, and severe granular degeneration in the liver and tubular degeneration and not statistically significant enlargement in parietal layer of Bowman's capsules in kidney; The liver together with the kidneys are the major reactive organs in case of food chronic intoxication [42, 43]. In one study that a group of rats was studied, fed with various doses of NK603 modified maize, grown with or in absence of exposure to Roundup herbicide, The results of the two-year experiment suggested manifestation of disturbances in the function of liver and kidneys, a higher mortality of animals, and manifestation of palpable tumors in the experimental groups (particularly those exposed to Roundup), compared to the control [44].

GM soybean has also an impact on pancreas, since changes occurred in pancreatic acinar cells of mice and a high synthetic rate of zymogen granules containing low amounts ofα-amylase [45]. DuPont's study in rats fed diets containing GM corn 7051 showed a decrease in red blood cell count and hematocrit of females while GM corn Mon863 affected the development of blood with fewer immature red blood cells and changes in blood chemistry in rats [46, 47]. Subchronic feeding of GNA rice in rats resulted in decrease in glucose, while cholesterol, triglyceride, and HDLD concentration were higher [48].

On the whole, with the exception of possible allergenicity, scientists believe that GM foods do not present a risk to human health.

Table 2. Negative results of consuming genetically modified food [32].

Food	Negative results of Transgenesis Process
Star Link Maize	Risk of food allergy
Soybean enriched in methionine (gene isolated from Brazil nut)	Risk of food allergy
Milk from genetically modified cows	Increase of IGF-1* concentration in serum , positively correlated with breast, lung and colon cancer
Maize MON810	Harmful influence for cells of pancreas, intestines, liver and kidney of rodents
Potato (with lectin)	Immunity handicap Incorrect mitosis of cells and tissues
***IGF – 1: insulin-resembling growth factor-1**	

Economic concerns

From an economic perspective, GM foods is very costly. Many new plant genetic engineering technologies and GM plants have been patented, and patent infringement is a big concern of agribusiness. With new technologies that are continuously surfacing, companies are starting to want to patent their idea, and this rises the concern that with patents will come a raise in price of seeds, making business very difficult for farmers who will not be able to afford them, thus widening the gap between the wealthy and the poor. These plants would be viable for only one growing season and would produce sterile seeds that do not germinate. Farmers would need to buy a fresh of seeds each year. However, this would be financially disastrous for farmers in third world countries who cannot afford to buy seed each year and traditionally set aside a portion of their harvest to plant in the next growing season [49].

Laws of Genetically Modified Foods

Governments around the world are hard at work to establish a regulatory process to monitor the effects and approve new varieties of GM plants. This laws and governmental regulations of GM food varies throughout the world. In japan, as of April 2001, testing of GM foods was made mandatory [50]. India's government has not yet announced a policy on GM foods because no GM crops are grown in India and no products are commercially available in

supermarkets yet. India is, however, very supportive of transgenic plant research [51]. Some states in Brazil have banned GM crops entirely, and the Brazilian Institute for the Defense of Consumers, in collaboration with Greenpeace, has filed suit to prevent the importation of GM crops [52]. In the United States, regulation is achieved by several different governmental agencies, such as the US environmental protection agency (EPA), the US department of agriculture (USDA), and the US food and drug administration (FDA). The EPA is responsible for regulating substances such as pesticides or toxins that may cause harm to the environment. GM crops such as B.t. pesticide-laced corn or herbicide-tolerant crops but not foods modified for their nutritional value fall under the purview of the EPA. The USDA is responsible for GM crops that do not fall under the umbrella of the EPA such as drought-tolerant or diseasetolerant crops, crops grown for animal feeds, or whole fruits ,vegetables and grains for human consumption. The FDA historically has been concerned with pharmaceuticals, cosmetics and food products and additives, not whole foods.

Government of Islamic republic of Iran has declared his obligation to observe biosafety standard through joining the biodiversity convention According to the national biosafety act of Islamic republic of Iran, assessment of GM products safety is issued by the Ministry of Health and Medical Education. Cure and medical instruction and assessment of bioenvironmental risks of GM products are performed by Iran Department of Environment. Ministry of Agriculture is served as the national biosafety act authority [53, 54].

In January 2000, an international trade agreement for labeling GM foods was established, More than 130 countries, including the US, the world's largest producer of GM foods, signed the agreement [55]. The policy states that exporters must be required to label all GM foods and that importing countries have the right to judge for themselves the potential risks and reject GM foods, if they so choose.

Conclusion

Genetically modified food for supplying a significant portion of the world's food needs, reduce environmental risks by eliminating or reducing the use of pesticides are highly regarded and growing. But due to defects in the laws necessary for the health of these materials (especially in the areas of safety testing, regulation, international policy and food labeling), Many still skeptical about the acceptance of these compounds can be seen by people. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. Regulation, food testing, and uncovering more of the possible effects on both human health and the environment are all gear issues involved. The concept of genetic modification is also very controversial. However, regardless of the obstacles and controversy surrounding this phenomenon, it is becoming much more widespread throughout the world. GM foods have both positive and negative effects. These may be either direct effects, on organisms that feed on or interact with the crops, or wider effects on food chains produced by increases or decreases in the numbers of other organisms. To date, no completely negative effects of transgenic food on the human body or its complete harmlessness could have been documented. Increasing amounts of GMO-containing assortments are introduced to the trade market and the consumers themselves must decide whether or not to consume transgenic food, which should be appropriately labelled and supplied with reliable information on the conducted modifications. The advantages of transgenic foods could provide solutions for many problems, but it is first necessary to prove that these foods will not cause other problems. Although numerous advancements can improve the reliability of GM food safety assessment, additional research in other important areas are needed in order to develop new and more effective methods.

References

1) Verma Ch., Nanda S., Singh RK, Singh RB and Mishra S. 2011. A Review on Impacts of Genetically Modified Food on Human Health. *The Open Nutraceuticals Journal* 4: 3-11.

2) www.Dictionary.com

3) Whitman DB. Genetically Modified Foods: Harmful or Helpful? Discovery Guides. 2010.

4) Genetically modified foods and organisms-HGP Ethical, legal, and social issues. Oak ridge national laboratory. Web. 2010.

5) Domingo J.L. Toxicity studies of genetically modified plants: a review of the published literature. 2007. *Critical Reviews in Food Science and Nutrition* 47: 721–33.

6) Domingo-Roig J.L., Gómez-Arnáiz M. 2000, Riesgos sobre la salud de los alimentos modificados geneticamente: una revision bibliográfica. Revista Española de de Salud Pública; 74: 255–61.

7) Sanvido O., Romeis J., Bigler F. 2007. Ecological impacts of genetically modified crops: ten years of field research and commercial cultivation. *Advances in Biochemical Engineering and Biotechnology* 107: 235–278.

8) Key S., Ma J.K., Drake P.M.W. 2008. Genetically modified plants and human health. *Journal of the Royal Society of Medicine* 101: 290–8.

9) Cohen, S. et. al. 1973 Construction of Biologically Functional Bacterial Plasmids In Vitro. *Proceedings of the National Academy of Sciences of the United States of America* 71(4): 1250–1254.
10) Jaenisch, R. and Mintz, B. 1974. Simian Virus 40 DNA Sequences in DNA of Healthy Adult Mice Derived from Preimplantation Blastocysts Injected with Viral DNA. *Proceedings of the National Academy of Sciences of the United States of America* 71(4): 1250–1254.
11) EPA's Regulation of Bacillus thuringiensis (Bt) Crops. U.S. Environmental Protection Agency, 2014.
12) Clive J. Global Review of the Field Testing and Commercialization of Transgenic Plants: 1986 to 1995. The International Service for the Acquisition of Agri-biotech Applications, 1996.
13) Genetically Altered Potato Ok'd For Crops Lawrence Journal-World -1995.
14) Chapman, by james. history of GM food, mail online. Web, 2010.
15) Development and history of GM food-genetically modified foods (UK)."Comphrensive advice on GM foods at GM foods (UK). Web. 2010.
16) Ye X., Al-Babili S., Klöti A., Zhang J., Lucca P., Beyer P., Potrykus I. 2000. Engineering the Provitamin A (β-Carotene) Biosynthetic Pathway into (Carotenoid-Free) Rice Endosperm. *Science* 287 (5451): 303–305.
17) Adoption of Genetically Engineered Crops in the U.S. Economic Research Service. USDA. 2015.
18) Epstein S. 1996 Unlabeled milk from cows treated with biosynthetic growth hormones: a case of regulatory abdication. *International Journal of Health Services* 26: 173–85.
19) Dohoo IR, DesCˆoteaux L, Leslie K, Fredeen A, Shewfelt W, Preston A, and Dowling P. 2003. A metaanalysis review of the effects of recombinant bovine somatotropin 2. Effects on animal health, reproductive performance, and culling. *Canadian Journal of Veterinary Research* 67: 252–264.
20) Baum J.A., Gilmer A.J., Mettus A.L., Inventors; Monsanto Technology LLC (St. Louis, MO), assignee. Lepidopteran-resistant transgenic plants. United States Patent US 6313378, 2001. Moellenbeck DJ, Peters ML, Bing JW, Rouse JR, Higgins LS, Sims L, Nevshemal T, Marshall L, Ellis RT, Bystrak PG, Lang BA, Stewart JL, Kouba K, and Sondag V. Insecticidal proteins from Bacillus thuringiensis protect corn from corn rootworms. *Nature Biotechnology*; 19(7): 668-672, 2001.
21) Ohkawa H., Tsujii H., Ohkawa Y. 1999. The use of cytochrome P450 genes to introduce herbicide tolerance in crops: a review. *Journal of Pesticide Science*; 55(9): 867-74.
22) Lynn S. Dahleen, Patricia A. Okubara, and Ann E. Blechl. 2001. Transgenic Approaches to Combat Fusarium Head Blight in Wheat and Barley; 1: 628–637.
23) Ralph Scorza, Ann Callahan, Laurene Levy, Vern Damsteegt, Kevin Webb, Michel Ravelonandro. Post-transcriptional gene silencing in plum pox virus resistant transgenic European plum containing the plum pox potyvirus coat protein gene. 2001; 10(3): 201-209.
24) Kenward K.D., Brandle J., McPherson J., Davies PL. 1999. Type II fish antifreeze protein accumulation in transgenic tobacco does not confer frost resistance. *Transgenic Research* 8(2): 105-17, 1999.
25) Zhang H.X., Blumwald E. 2001. Transgenic salt-tolerant tomato plants accumulate salt in foliage but not in fruit. *Nat Biotechnol.* 19(8):765-8.
26) Rice biotechnology: Rockefeller to End Network After 15 Years of Success. Science; 286(5444): 1468-1469, 1999.
27) Rockefeller Foundation. New rices may help address vitamin A- and iron deficiency, major causes of death in the developing world. Rockefeller Foundation press release. New York: Rockefeller Foundation, 1999.
28) Daniell H., Streatfield S.J. and Wycoff K. 2001. Medical molecular farming: production of antibodies, biopharmaceuticals and edible vaccines in plants. *TRENDS in Plant Science* 6(5): 219-226.
29) Bizily S.P., Rugh C.L., Meagher R.B. Phytodetoxification of hazardous organomercurials by genetically engineered plants. *Nature Biotechnology* 18(2): 213-217, 2000.
30) Ahmed M, Focht DD. 2000. Phytodetoxification of hazardous organomercurials by genetically engineered plants. *Nat Biotechnol* 18(2): 213-17.
31) Kramkowska M., Grzelak T., Czyżewska K. 2013. Benefits and risks associated with genetically modified food products. *Annals of Agricultural and Environmental Medicine* 20(3): 413–419, 2013.
32) Niiler E.1999 GM corn poses little threat to monarch. *Nature Biotechnology*; 17: 1154.
33) Losey J.E., Rayor L.S., Carter M.E. 1999. Transgenic pollen harms monarch larvae. Nature; 20: 399.
34) Jibrin, by janis. Genetically modified foods (biotech foods) pros and cons. Mebmd-better information. Better health. Web. 2010.
35) Nordlee J.A., Taylor S.L., Townsend J.A., Thomas L.A., Bush R.K. 1996. Identification of a Brazil-nut allergen in transgenic soybeans. *The New England Journal of Medicine*; 334(11): 688-92.
36) Prescott V.E., Campbell P.M., Moore A., Mattes J., Rothenberg M.E., Foster P.S., Higgins T.J.V. & Hogan S.P. 2005. Transgenic expression of bean alpha-amylase inhibitor in peas results in altered structure and immunogenicity. *Journal of Agricultural & Food Chemistry* 53: 9023- 9030.
37) Ewen S.W., Pusztai A. 1999. Effect of diets containing genetically modified potatoes expressing Galanthus nivalis lectin on rat small intestine. *Lancet* 354(9187):1353-4.

38) Enserink M. The Lancet Scolded Over Pusztai Paper. *Science* 286(5440): 656, 1999:
39) Aris A. & Leblanc S. Maternal and fetal exposure to pesticides associated to genetically modified foods in Eastern Townships of Quebec, Canada: Reproductive Toxicology in press. Available online; 2011.
40) Oliveri et al. 2006. Temporary Dpression of Transcription in mouse Preimplantation Embryos from mice fed on Genetically Modified Soybean, 48th Symposium of the Society for histochemistry: Lake Magggiore (Italy).
41) Kilic A., Akay M.T. 2008. A three generation study with genetically modified Bt corn in rats: biochemical and histopathological investigation. *Food and Chemical Toxicology*; 46: 1164-1170.
42) Séralini G.E., Mesnage R., Clair E., Gress S., de Vendômois J.S., Cellier D. 2011. Genetically modified crops safety assessments: present limits and possible improvements. Séraliniet al. Environmental Sciences Europe; 23: 10.
43) Séralini G.E., Clair E., Mesnage R., Gress S., Defarge N., Malatesta M., et al. 2012. Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. *Food and Chemical Toxicology*; 50: 4221–4231.
44) Malatesta M., Caporaloni C., Rossi L., Battistelli S., Rocchi M., and Tonucci F. 2003. Ultrastructural analysis of pancreatic acinar cells from mice fed on genetically modified soybean. *Journal of Anatomy* 201: 409–415.
45) MacKenzie S.A., Lamb I., Schmidt J., Deege L., Morrisey M.J., Harper M., Layton R.J., Prochaska L.M., Sanders C., Locke M., Mattsson J.L., Fuentes A., and Delaney B. 2007. Thirteen week feeding study with transgenic maize grain containing event DAS-Ø15Ø7-1 in Sprague–Dawley rats. *Food and Chemical Toxicology* 45: 551–562.
46) Seralini G.E., Cellier D., and de Venomois J.S. 2007. New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicityArchives of Environmental Contamination and Toxicology.
47) Poulsen M., Kroghsbo S., Schrøder M., Wilcks A., Jacobsen H., Miller A., Frenzel T., Danier J., Rychlik M., Shu Q., Emami K., Sudhakar D., Gatehouse A., Engel K.H., and Knudsen I. 2007. A 90-day safety study in Wistar rats fed genetically modified rice expressing snowdrop lectin Galanthus nivalis (GNA). *Food and Chemical Toxicology*; 45: 350–363.
48) Mogilna N., Magufwa A. Genetic Modified Foods: Advantages and Disadvantages. Sumy State University, Sumy, Ukraine.
49) Uozum Y. Japan to bring in mandatory tests for GM foods. Nature; 402: 846, 1999.
50) Jayaraman K.S. 1999. India intends to reap the full commercial benefits. *Nature*; 402(6760): 342-3.
51) Bonalume N.R. 1999. Smugglers aim to circumvent GM court ban in Brazil. *Nature* 402(6760): 344-5.
52) Hasheminya S.M. Management mechanisms in food biotechnology (in Persian). 2nd National & 1st International MBA-Biotechnology Congress, Tehran University of Medical Sciences, Tehran, Iran, 2012.
53) Hasheminya S.M., Dehghannya J. 2013. An overview of genetically modified food products: Benefits, risks, health safety and related regulations. *International Research Journal of Applied and BasicSciences*; 4 (3): 724-727.
54) Macilwain C. 2000. Rules agreed over GM food exports. *Nature*; 403: 473-474.