Journal of Genetic Syndromes & Gene Therapy

Arun Kumar, et al. J Genet Syndr Gene Ther 2011, 2:3
DOI: 10.4172/2157-7412.1000110

Review Article Open Access

A Comprehensive Assessment and Perception of Genetically Modified Foods

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Abstract

Generally by the use of genetically modified (GM) foods we believe that labels should be placed on all GM products so that we can also understand the risks involved, but believe the benefits far outweigh the costs. Starvation is much more dangerous to more people than any threat presented by GM foods. Droughts and famine are increasing throughout the world, particularly on the continent of Africa. Although some traditional environmental groups insist that they are simply providing facts about potential health and environmental effects of GM foods, others oppose it.

Keywords: Gm Foods; Genes; Threats; Environment; Gene Transfer; Bt Cotton; Human Health; Risks; Gm Products; Gene Transfer; Resistant

Abbreviations: GM: Genetically Modified; PG: polygalacturonase; PRSV: Papaya ringspot virus

Introduction

Genetically modified (GM) foods [1,2] are derived from genetically modified organisms based on genetic engineering techniques, which involves altering or manipulating an organism's genome to create a new and useful result [3]. The Genetic modification involves the insertion or deletion of genes [4,5]. Genetically modified (GM) foods are accurately called as Genetically Engineered Foods from Genetically modified organisms [6,7] have specific changes introduced into their DNA [8-10] by genetic engineering techniques [11,12]. The techniques are much more precise than mutagenesis [13,14] and the other techniques by which humans modify food organisms include selective breeding and somaclonal variation. Genetically modified foods are obtained from both the transgenic plants as well as from transgenic animals. Transgenic plant products include soybean, corn, canola, rice, and cotton seed oil. Animal products include omega-3 fatty acids [15] and genetically-modified breed of pigs that are able to absorb plant phosphorus [16].

Methods for genetic modification

Genetic modification is considered as a relatively new technology employing a number of methods in order to modify an organism [17,18] genetic make-up in order to produce ideal and better characteristics. Genes in every organism contain the code that controls how an organism look like, how an organism behave as well as all the resulting characteristics of every living thing. The method to introduce new genes particularly into plants requires several important factors such as specific promoter, codon [19,20] usage of the gene and how to deactivate the gene. Traditional processes used by farmers to create better breeds had limited scope to develop better plants. Farmers do it by cross breeding plants [21] displaying the best characteristics in the hopes that the next generation is able to produce plants that have the ideal characteristics being looked for. But such traditional practices are limited only to cross breeding plants belonging to the same species. In the new methods of genetic modification being employed today, it is now possible to transfer genes from one plant of a different species to another. Different gene transfer [22] process involves cisgenesis, transgenesis and horizontal gene transfer. In the process cisgenesis, genes [23] are artificially transferred between organisms [24] that could be conventionally bred. In the process of transgenesis, genes from a different species are inserted, which is a form of horizontal gene transfer. The transgenic genes should be denatured in heat in order for human consumption. In nature this can occur when exogenous DNA [25,26,27] penetrates the cell membrane[28].

Development of genetically modified food crops

The first commercially grown genetically modified whole food crop [29,30] was the tomato also called as Flavr Savr which was made more resistant to rotting by Californian Company Calgene. The tomatoes were released into the market in 1994 without any special labelling. In 2003, countries that grew 99 % of the global transgenic crops were the United States (63 %), Argentina (21 %), Canada (6 %), Brazil (4 %), China (4 %), and South Africa (1%) and today the Grocery Manufacturers of America estimate that 75 % of all processed foods in the U.S. contain a GM ingredient .Some other foods genetically modified are Soybeans that are resistant to glyphosate or glufosinate herbicides, Corn field (Maize) Resistant to glyphosate or glufosinate herbicides, Cotton is genetically modified in order to produce Pest-resistant cotton. Hawaiian papaya Variety is resistant to the papaya ringspot virus. Canola is Resistant to herbicides such as glyphosate or glufosinate. Sugar cane is Resistant to certain pesticides and also modified to increase high sucrose content. Sugar beet is Resistant to glyphosate, glufosinate herbicides. Golden Rice a genetically modified rice variety contains beta-carotene a source of vitamin A, Squash is Resistant to watermelon, cucumber and zucchini yellow mosaic viruses, Sweet Peppers are Resistance to virus. Several concerns surround GM crops, including the transfer of food allergens across crop species [31,32], gene flow of GM crops, and

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Received November 15, 2011; **Accepted** November 18, 2011; **Published** November 20, 2011

Citation: Arun Kumar R, Sathish Kumar D, Gayatri V, Nishanth T (2011) A Comprehensive Assessment and Perception of Genetically Modified Foods. J Genet Syndr Gene Ther 2:110. doi:10.4172/2157-7412.1000110

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contamination of organic and other non-GM crops, the development of weed and pest resistance, and toxicity to animals that may feed on or near the crops [33].

Genetically Modified Tomato

Tomatoes contain small amounts of flavonoids, most of which are located in the peel of the fruit. It has been shown that flavonoid accumulation in tomato flesh because of their potential health benefits and hence an overall increase in flavonoid levels in tomato fruit can be achieved by means of simultaneous overexpression of the maize transcription factors *LC* and *C1*. The total flavonoid glycoside content of ripe transgenic tomatoes is more than the naturally grown tomatoes [34]. In Flavr savr tomato fruit enzyme polygalacturonase (PG), because of its ability to dissolve cell-wall pectin, was key to fruit softening. Researchers at Calgene, Inc., in Davis, proposed to suppress PG accumulation in ripening tomatoes by introducing a reverse-orientation copy of the gene, an "antisense" copy designed to prevent or drastically reduce the formation of PG. The expectation was that ripe fruit would remain firm longer, perhaps even allowing it to be transported to market after vine-ripening [35].

Genetically modified soyabean

The growing clinical interest in and use of soybean-based food [36,37] products or extracts to increase dietary phytoestrogen intake makes the precise composition of the key biologically active ingredients of soybeans, notably genistin and daidzin, of substantial medical interest. Conventional soybeans are increasingly being replaced by genetically modified varieties. Genetically modified soybeans may be less potent sources of clinically relevant phytoestrogen than their conventional precursors. Genetically modified soybeans were processed into finished, refined, bleached, and deodorized oils [38].

Genetically modified corn

Genetically modified corn has been approved as an animal feed in several countries, but information about the fate of genetically modified DNA [39,40] and protein in vivo is insufficient. Genetically modified corn Bt11 is developed by inserting a recombinant DNA [41,42] sequence encoding insecticidal Cry1Ab protein from *Bacillus thuringiensis*. The Genetic modification involves the insertion or deletion of genes [43]. Five genetically modified corn Bt11-fed and five nongenetically modified corn-fed pigs. BT corn (genetically modified to resist damage from the ECB and Southwestern corn borer), outweigh the potential risks. It is found that BT corn growers, consumers, and industry all benefit from Bt corn adoption, though the purported health and environmental benefits of reducing chemical pesticide usage through Bt corn are negligible [44,45].

Genetically modified cotton

Genetically modified cotton is also called as BT cotton.BT cotton adoption reduced pesticide use. Assessment of a health-production function showed that predicted pesticide use had a positive impact on poisoning incidence. Taken together, these results indicate that the adoption of BT cotton can substantially reduce the risk and the incidence of poisoning. One component of the current technology for growing crops in developing countries is heavy use of chemical pesticides, which kill and sicken many farmers and farm laborers each year and cause debilitating sicknesses for years after exposure. So, this BT cotton was introduced. It was clear that BT cotton provided benefits in terms of higher yield and gross margin relative to farmers growing conventional (non-Bt) cotton, and the benefits were particularly apparent for the smallest producers. Bt growers also used significantly less insecticide than growers of non-Bt cotton. BT cotton has had a significant positive impact on yields and on the economic performance of cotton growers [46]. This difference remains even after controlling for different soil and insecticide inputs in the production of BT cotton. There is also significant spatial and temporal variation in this 'benefit', and much depends upon where production is taking place and on the season [47].

Genetically Modified Papaya

Papaya is a tropical-subtropical crop that is grown in back yards as well as in large-scale farms, it produces year round, many people in lesser-developed countries eat it, and it is arguably one of the most nutritious fruit crops i.e., making food [48,49] rich in vitamins A and C. Papaya ringspot virus (PRSV) is often a limiting factor in the production of papaya worldwide. Efforts to develop transgenic papaya to control PRSV began shortly after news spread that transgenic tobacco expressing the coat protein gene of tobacco mosaic virus was resistant or showed delay in symptoms following inoculation with tobacco mosaic virus. Hawaiian papaya Variety is resistant to the papaya ringspot virus. Canola is Resistant to herbicides such as glyphosate or glufosinate [50].

Genetically Modified Rice

The first generation of genetically modified (GM) crop varieties sought to increase farmer profitability through cost reductions or higher yields. Golden rice which has been genetically engineered to contain a higher level of vitamin A and thereby boost the health of poor people in developing countries. Protein could be harvested for the GM rice to help people suffering from blood loss without needing a human donor and without having to screen the blood protein from diseases [51].

Genetically Modified Sugar Beet

Herbicide tolerant crops generally lower average yields. Genetically modified herbicide-resistant sugar beet had an adverse effect on growth of the weed *Chenopodium album* and on the skylark, which feeds on the seeds of this weed [52]. The transgenic plants of sugar beet sorts Ramonskaya single seed 47, L'govskaya single seed 52 and RMS 73, and LBO 17 and LBO 19 lines expressing the gene of phosphinothricin acetyl transferase bar have been obtained [53].

Benefits of Genetically Modified Foods

New, genetically modified (GM) foods [54,55] can contribute to enhance human health and development. But also various issues suggests that the need for continued safety assessments on GM foods [56,57] before they are marketed, to prevent risks to both human health and the environment.

a. Saves the use of toxic chemicals. For some crops, it is not cost-effective to remove weeds by physical means such as tilling, so farmers will often spray large quantities of different herbicides (weed-killer) to destroy harmful organisms [58] or weeds, a time-consuming and expensive process that requires care so that the herbicide doesn't harm the crop plant or the environment. Crop plants genetically-engineered to be resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed.GM crops can be made resistant to pests, so pesticides do not need to be sprayed on them. So, food [59,60] from GM crops is free from hazardous chemicals. This is also better for the environment safety.

b. Prevents wasted crops. Crop losses from insect pests can be staggering, resulting in devastating financial loss for farmers and starvation in developing countries.If pests cannot eat the crops, nothing goes to waste. Therefore, farmers make more money. There are many viruses, fungi and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically-engineered resistance to these diseases.

c. Unexpected frost can destroy sensitive seedlings. An antifreeze gene from cold water fish has been introduced into plants such as tobacco and potato. With this antifreeze gene, these plants are able to tolerate cold temperatures that normally would kill unmodified seedling.

d. It could potentially solve hunger. Many people agree that there is not enough food [61,62] in the world to feed everybody. Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. As genetically modified foods [63,64] increase the yields of crops, more food [65,66] is produced by farmers.

e. Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

f. Genetic modified plants helps in Phytoremediation.GM plants are grown as crops. Soil and groundwater pollution continues to be a problem in all parts of the world. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil

g. We can begin to grow foods [67,68] in different conditions. For instance, strawberries can be genetically engineered to grow in frosts. Other foods that grow in cold climates could be engineered to grow in hot climates such as Africa where much of the continent does not have enough food [69,70].

h. Some foods can be genetically modified to contain higher amounts of important vitamins and minerals. Vitamin A deficiencies cause blindness. For an example In Africa, 500,000 go blind each year. If rice can be modified to contain more vitamin A, the amount of people going blind will decrease [71].

Disadvantages for Genetically Modified Foods

Human health risks

a. Unknown effects on human health there is a growing concern that introducing foreign genes [72-74] into food [75,76] plants may have an unexpected and negative impact on human health. In recent studies it was found the adverse effects of GM potatoes on the digestive tract in rats i.e., there were appreciable differences in the intestines of rats fed GM potatoes and rats fed unmodified potatoes. This shows this paper, like the monarch butterfly data, is flawed and does not hold up to scientific scrutiny. Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals. These potatoes were never intended for human or animal consumption.

b. Allergenicity is seen in many children who had developed life-threatening allergies to peanuts and other foods [77,78]. There is a possibility that introducing a gene into a plant may create 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. Extensive testing of GM foods may be required to avoid the possibility of harm to consumers with food allergies [79,80].

Environmental hazards

a. Unintended harm to other organisms is a publication showed that pollen from BT. corn caused high mortality rates in monarch butterfly caterpillars [81]. Monarch caterpillars consume milkweed plants, not corn, but the fear is that if pollen from BT. corn is blown by the wind onto milkweed plants in neighbouring fields, the caterpillars could eat the pollen and perish. Although the Nature study was not conducted under natural field conditions, the results seemed to support this viewpoint. Unfortunately, BT. toxins kill many species of insect larvae indiscriminately; it is not possible to design a BT. toxin that would only kill crop-damaging pests and remain harmless to all other insects.

b. Reduced effectiveness of pesticides such as some populations of mosquitoes developed resistance to the now-banned pesticide DDT; many people are concerned that insects will become resistant to BT or other crops that have been genetically-modified to produce their own pesticides.

c. Gene transfer to non-target species crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbicide resistance genes [82,83] from the crops into the weeds. These "superweeds" would then be herbicide tolerant as well. Other introduced genes may cross over into non-modified crops planted next to GM crops. The possibility of interbreeding is shown by the defence of farmers against lawsuits filed by Monsanto. The company has filed patent infringement lawsuits against farmers who may have harvested GM crops. Monsanto claims that the farmers obtained Monsanto-licensed GM seeds from an unknown source and did not pay royalties to Monsanto. The farmers claim that their unmodified crops were cross-pollinated from someone else's GM crops planted a field or two away. More investigation is needed to resolve this issue.

There are several possible solutions to the three problems mentioned above. Genes [84] are exchanged between plants via pollen. Two ways to ensure that non-target species will not receive introduced genes from GM plants are to create GM plants that are male sterile (do not produce pollen) or to modify the GM plant so that the pollen does not contain the introduced gene [85]. Cross-pollination would not occur, and if harmless insects such as monarch caterpillars were to eat pollen from GM plants, the caterpillars would survive. Another possible solution is to create buffer zones around fields of GM crops. For example, non-GM corn would be planted to surround a field of BT. GM corn, and the non-GM corn would not be harvested. Beneficial or harmless insects would have a refuge in the non-GM corn, and insect pests could be allowed to destroy the non-GM corn and would not develop resistance to BT. pesticides. Gene transfer to weeds and other crops would not occur because the wind-blown pollen would not travel beyond the buffer zone.

Ban for Genetically Modified Foods

Regulations in France, Italy, Greece, Denmark and Luxembourg have imposed de facto moratoriums on GMOs while other countries in the European Union have limited GMO field testing, imports and marketing. Citizen activists around the world are raising concerns about the safety of genetically altered plant products for human consumption.

British newspapers have called GMOs as Frankenstein Foods [86,87]. The long term effects of GMOs on humans and ecosystems are still unknown despite the industry`s rapid progress to develop new altered strains of plants and animals. Many U.S. companies that incorporate GMOs into their products are now prohibited from exporting products to India, Sri Lanka and many other countries. The Irish Government plan to ban GM crops and foods to provide a voluntary GM-free label for qualifying animal produce makes obvious business sense for our agri-food and eco-tourism sectors [88,89].

Conclusion

Genetically modified technology will not eliminate hunger and malnutrition because dysfunctional governments and economies create problems with production, access and distribution of food. Flawed policies, greed and incompetence will always keep some people in ignorance and poverty. However, GM foods can improve survivability and increase productivity of plants in adverse conditions. GM foods can also reduce the need to use large quantities of herbicides and pesticides.

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