Review Article

International Journal of Bioassays
ISSN: 2278-778X
www.ijbio.com

GM FOODS - A CONTROVERSY BETWEEN TRADITION AND MODERNITY

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Received for publication: January 12, 2013; **Accepted**: March 27, 2013.

Abstract: Genetically engineered plants are developed in a laboratory by altering their genetic makeup and are evaluated in the laboratory for desired qualities. This is accomplished by adding one or few genes to a native or a local genome using genetic engineering techniques. Genetically modified plants are generated by the biolistic particle gun method or by Agrobacterium tumefaciens mediated transformation. When plants of desired quality are produced, sufficient seeds are multiplied and the companies producing them have to apply for regulatory approval for field trials.

Keywords: GM Foods, Gene, Strategy

INTRODUCTION

One must be highly precautious in developing GM food crops wherein genes from other biological sources introduced into them are not under the control of natural regulation that goes on in the native genomes. These include insect and herbicide resistance varieties and fortified GM foods enriched with essential nutrients like vitamins amino acids and proteins.

While doing so there is every possibility that our natural wealth is disturbed to some extent and threat to the existing biodiversity. It also is hazardous to human health in terms of the response of our immune and physiological systems to the de novo substances in GM foods.

Malnutrition is quite common in developing countries where people depend on a sole crop of rice as the main staple food. However, rice lacks sufficient quantities of necessary nutrients to prevent malnutrition. The launching of golden rice variety is one example that could be a solution providing food consumers with high content of beta carotene (vitamin A).similarly vegetables and fruit varieties have been coming in to the super markets labeled as GM foods whose authenticity is to be thoroughly evaluated, properly checked and regulated.

Medicines and vaccines often are expensive to produce and require special storage conditions not readily available in developing countries. A solution to this problem can be available from development of edible vaccines in tomatoes, potatoes and fruits like banana and apple. Such technology also helps protection of environment as it reduces use of chemical fertilizers, insecticides and pesticides which erodes soil and its natural makeup of fertility agents while interfering with wild type genomes an essential component of biodiversity.

One needs to balance between these two aspects keeping in mind the pros and cons while planning such experiments and see that benefits outweigh the ill effects.

The strategies and regulations required for development of GM foods are discussed in this paper. Genetically modified foods are derived from genetically modified organisms (GMOs), such as genetically modified crops or genetically modified fish. GMOs have been developed by genetic manipulations introduced into their DNA by genetic engineering techniques.[1]

Delayed ripening tomato, Flavr Savr was developed and marketed by Calgene in 1994[2]. A variant of the Flavr Savr was used by Zeneca to produce tomato paste which was sold in Europe during the summer of 1996, the first GM food product to occupy the shelves of super markets.

Other genetically modified foods are transgenic plant products: soybean, corn, canola, rice, and cotton seed oil. These are engineered for faster growth, resistance to pathogens, and production of extra nutrients. GM livestock have also been experimentally developed, yet to be marketed. [3]. The major objections are based on the grounds of safety issues,[4] ecological and economic concerns raised by the fact GM plants that are food sources are subject to intellectual property law.

Genetically engineered plants are developed in a laboratory by altering their genetic makeup and are evaluated in the laboratory for desired qualities. This

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is accomplished by adding one or few genes to a native or a local genome using genetic engineering techniques. Genetically modified plants are generated by the biolistic particle gun method or by *Agrobacterium tumefaciens* mediated transformation. When plants of desired quality are produced, sufficient seeds are multiplied and the companies producing them have to apply for regulatory approval for field trials. The company must seek regulatory approval for the crop to be marketed after field trials are successful and the seeds are mass produced for sale to farmers. The farmers produce genetically modified crops containing the inserted gene and its protein product and sell them in food supply markets with permission from authorities.

Golden rice contains beta-carotene, a precursor of vitamin A, and was the first genetically modified crop in which an entire biosynthetic pathway was engineered. Some other transgenic crops received marketing approval are canola with modified oil composition (Calgene), Bacillus thuringiensis (Bt) corn/maize (Ciba-Geigy), Bt potatoes (Monsanto), soybeans resistant to the herbicide glyphosate (Monsanto), virus-resistant squash (Asgrow), and additional delayed ripening tomatoes (DNAP, Zeneca/Peto, and Monsanto).[2] .In 2000 golden rice with nutrient value was produced for the first time was added to the approved list.

In 2011, the U.S. tops the list of countries in the production of GM crops, with 25 GM crops received regulatory approval for commercial cultivation.[5]

Currently, there are several GM crops that are food sources but there were no genetically modified animals approved for use as food, except genetically modified salmon waiting for FDA approval.[6]

In some cases, the product is directly consumed as food. Papaya is one example which has been genetically modified to resist the ring spot virus. Papaya industry was facing disaster because of the deadly papaya ring spot virus which was solved by developing a breed engineered to be resistant to the virus. It is noted that the state's papaya industry would have collapsed if it was not approved. Almost 80% of Hawaiian papaya is genetically engineered, and there is still no conventional or organic method to control ring spot virus."[7] The New Leaf potato, brought to market by Monsanto in the late 1990s, was developed for the fast food market and food processors but was withdrawn from the market in 2001[8] as there was no consumer preference and no export demand.[9]There are currently no transgenic potatoes approved for human consumption of any kind.[9] .

GMOs in food and feed are routinely evaluated using molecular techniques like DNA microarrays or qPCR. These tests can be based on screening genetic elements or plant specific markers. [10]

The qPCR is used to detect specific GMO events by usage of specific primers for screening elements. Controls are necessary to avoid false positive or false negative results. For example, a test for CMV (cauliflower mosaic virus) is used to avoid a false positive in the event of a virus contaminated sample.

The real-time PCR assays using specific probes confirmed all the results and proved that it is possible to detect and quantify genetically modified organisms in the fully refined soybean oil. It represents an important accomplishment regarding the traceability of genetically modified organisms in refined oils.

Available information so far gives the following percentages of gm foods in countries contributing 99% to the total world production

United States (63 %),
Argentina (21 %),
Canada (6 %),
Brazil (4 %),
China (4 %),
South Africa (1 %)

Grocery Manufacturers of America estimate that 75 % of all processed foods in the U.S. contain a GM ingredient. "Genetic engineering is inherently dangerous, because it greatly expands the scope for horizontal gene transfer and recombination, precisely the processes that create new viruses and bacteria that cause disease epidemics, and trigger cancer in cells." - Dr. Mae-Wan Ho

The technology of inserting genes into a species from another species is supposed to be a frontier achievement but sometimes causes a threat to biodiversity and our own health in terms of our immune response and allergic reactions to de novo substances produced by inserted genes and linked markers for identification such as antibiotics and enzymes.

Scientists also feel that it is safer to go for organic farming with natural selection operating on varieties instead of genetic modification unless and until there is urgent need for eradication of an epidemic, increase in yield and fortification of food.

While gene manipulation one must keep in mind the advantage of inserted gene without any health hazard and such GM food crops must be sufficiently separated in space from a conventional variety to prevent cross contamination of wild varieties often thought to be responsible for causing allergies.

GM foods-good and bad

There is a need to solve world hunger problem by producing inexpensive, safe and nutritious foods in sufficient quantities catering to growing population. Genetic modification may provide:

- Tolerant plants to weather extremes
- Fortified foods which are affordable, like carrots with more antioxidants
- Storable foods with a greater shelf life, like tomatoes that taste better and last longer
- Edible vaccines – for example, bananas with bacterial or rotavirus antigens
- Disease and pest resistant crops that requires less chemical application, for example, GM canola.

GM activists argue that genetically modified foods are potentially better for the environment. By using genetically engineered crops that are resistant to attack by pests or disease (insect resistant or IR), farmers and primary producers do not have to apply large amounts of pesticides and chemicals to the surrounding environment. Developing crops that are tolerant to particular herbicides (herbicide tolerant or HT) and pesticides may reduce the amount of pesticides used in food production and the residual pesticide levels in the environment.

The risks of genetically modified crops

Some concerns rose against GM foods by scientists, NGOs (Non-Governmental organizations in the interest of the public are:

- **New allergens** - Allergens may be transferred from traditional wild food varieties into GM foods. For instance, , a gene from the Brazil nut was introduced into soybeans to enrich nutritional value but along with that allergen property was also transferred causing food allergy to people consuming it ,hence the project was withdrawn.

- **Antibiotic resistance** - Scientists sometimes depend on selectable 'marker' gene to help them identify whether a new gene has been successfully introduced to the host DNA. One such marker gene is for resistance to particular antibiotics. If genes coded for such resistance enter the food chain and are taken up by human gut micro flora, the effectiveness of antibiotics could be reduced and human infectious disease risk increased, however found to be insignificant

Cross-breeding - Cross-breeding between GM crops and weed varieties may result in weeds resistant to herbicides requiring greater use of herbicide which could lead to soil and water contamination. The environmental safety aspects of GM crops vary considerably according to the type of modification sometimes leading to reduction in contamination through insect resistant plants where chemical application is reduced.

- **Pesticide resistant insects** - the genetic modification of some crops to permanently produce the natural biopesticide *Bacillus thuringiensis* (Bt) toxin could encourage the evolution of Bt-resistant insects, rendering the spray ineffective.
- **Biodiversity** - growing GM crops on a large scale may also have implications for biodiversity, the balance of wildlife and the environment. This is why environmental agencies closely monitor their use. Since bees are used to pollinate crops, there is also some suggestion that GM crops may affect organic farming.
- **Cross-contamination** - plants genetically engineered to produce pharmaceuticals (such as medicines) may contaminate food crops. Provisions have been introduced in the USA requiring substantial buffer zones, use of separate equipment and a rule that land used for such crops lie fallow for the next year.
- **Health effects** – Not much research has been conducted into the potential acute or chronic health risks of consuming GM foods .Unbiased independent research is the need of the hour minimizing the role of companies producing them for assessment of the long-term effects of GM crops in the field and on human health.

Social and ethical concerns

Concerns about the social and ethical issues surrounding genetic modification include:

- The possible monopolization of the world food market by large multinational companies that control the distribution of GM seeds.
- Using genes from animals in plant foods may pose ethical, philosophical or religious problems. For example, eating traces of genetic material from pork could be a problem for certain religious or cultural groups.
- Animal welfare could be adversely affected. For example, cows given more potent GM growth hormones could suffer from health problems related to growth or metabolism.
- New GM organisms could be patented so that 'life' itself could become commercial property through patenting.

Regulation of GM foods

Regulation and strict monitoring is needed from government agencies to evaluate

- Nutritional content
- Toxicity
- Tendency to provoke any allergic reaction
- Stability of the inserted gene
- Whether there is any nutritional deficit or change in the GM food

- Any other unintended effects of the gene insertion.

The safety of GM foods is still being debated, as it is impossible to predict all of the potential effects on human health and the environment. Some public health experts, however, advocate caution. They believe that we are at the beginning of technology and we are not sure about its end

GM labeling and the law

Labeling procedures are required as mentioned below

Special labeling is not required in case of:

- 'Highly refined' foods where the altered DNA or protein is no longer in the food (for example, oil from modified corn)

- GM food additives or processing aids - unless the new DNA remains in the food to which it is added.
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- GM flavors where less than 0.1 per cent is present in the food.

- Food, food ingredients or processing aids where GM ingredients are 'unintentionally' present in less than 1.0 per cent.

- Food that is prepared at the point of sale (takeaway and restaurant food does not have to be labeled).

Labels may be required where:

- Genetic modification has altered the food so that its composition or nutritional value is 'outside the normal range' of similar non-GM goods; for example, if GM technology is used to add vitamins or omega-3 fatty acids

- Naturally occurring toxins are 'significantly different' to similar non-GM foods

- The food produced using GM technology contains a 'new factor', which can cause allergic reactions in some people

- Genetic modification rises 'significant ethical, cultural and religious concerns' regarding the origin of the genetic material used.

GM food on the shelves

Many foods on supermarket shelves contain imported GM ingredients. A variety of GM foods have also been approved for production in Australia. These foods include corn, soybeans, potatoes and canola. Others are still undergoing field trials approved by the Office of the Gene Technology Regulator (OGTR), although the moratorium by State Governments (lifted in Victoria and NSW in early 2008) stopped some GM field trials. Imported food products are subject to the same regulations as domestically manufactured foods.

There are around 20 GM foods, additives, flavorings, growth hormone (bovine somatotropin) and enzymes (like rennet, used to make cheese) currently approved in Europe. In the USA, there are more than 40 approved GM foods. The main sources of GM foods in Australia include:

- **Imported soya from the United States** - this is one of the main sources of GM ingredients in food sold in Australia since 1996. The soya has been genetically modified to be resistant to a herbicide. It can be found in a wide range of foods, such as chocolates, potato chips, margarine, mayonnaise, biscuits and bread.

- **Cottonseed oil made from GM cotton** - this oil, made from cotton that is resistant to a pesticide, is used in Australia for frying (by the food industry) and in mayonnaise and salad dressings.

- **Imported GM corn** - this is mainly used as cattle feed at present and has not been approved for farming in Australia. However, GM corn may have entered the Australian market through imported foods like breakfast cereal, bread, corn chips and gravy mixes. If so, it is now required to be labeled.

- **Other GM foods available overseas** - these may be ingredients in foods imported to Australia including potatoes, canola oil, sugar beet, yeast, cauliflower and coffee.

- **If you want GM-free food**

Due to consumer demand, some food manufacturers in Australia have taken steps to provide GM-free food. These products may be labeled accordingly; for example, 'contains no genetically modified ingredients'. Although Food Standards Australia New Zealand (FSANZ) does not provide a consumer hotline on GM matters, people can make enquiries to the Office of the Gene Technology Regulator.

A scheme is suggested as follows for the production and proper regulation of GM foods

Laboratory manipulation of food genomes

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Laboratory evaluation of new substances and suspected toxic and allergic substances

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Lab to land transfer for field trials of GM crops for their performance and gene expression studies.

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Testing the food on animal models

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Testing food on human models

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Application for approval from Government/Regulatory authority

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Release as seed to farmers for cultivation if GM passes through all the above criteria/Application for patent

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Involvement of voluntary organizations/NGOs to create an awareness and confidence on the consumption of such proven safety GM food

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Labeling must be made mandatory enabling consumer to exercise an option between conventional and GM foods because consumer is the final entity to identify the difference and make an assessment on the use of such foods on him/herself.

While doing so we should not ignore our conventional varieties which are integral part of our culture and rich heritage. Any culture in the world reflects the importance of nature and consequent biodiversity in the form of their rituals and festivals but understanding it in a proper direction is very important.

Nature prefers Biodiversity
Human prefers Cultural diversity
Cultural diversity preserves Biodiversity

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Source of support: Nil
Conflict of interest: None Declared