Genetic Modification-A Good Deed or a Bad One

Ayesha-Masood, Faiza-Unbreen

Abstract— GM is quite a hot topic and has attracted quite a large media attention in the past years and even in the present too. They have become a controversy as they are beneficial for the producers and for the consumers but they are also glued to many biomedical and environmental risk factors. Despite all this, the public is still unaware regarding the pros and cons of GM technology and complex studies are being carried out around the world to evaluate this. Various controversies and public concerns regarding GMO (crops and foods mainly) generally highlight environmental conservation, labelling, ethics, consumer choice, food security, poverty reduction and intellectual property rights.

Index Terms— Genetic Modification, Genetically Modified Organism, Biomedical, Food Security, Controversies, Labelling, Consumer choice

1 INTRODUCTION

Presently, there are some GM crops such as Papaya (80% of Hawaiian Papaya is genetically engineered), NewLeafTM potato, Vegetable oil, Maize, Cottonseed oil (93% of the cotton crop in the USA is GM), Sugar (from the GM Sugar beets), Bt. Brinjal, Alfalfa, Squash, GM Salmon are used as food sources. For now, there are no GM animals that are approved by FDA for use as food sources. In some cases, the product is directly consumed as a food source and in some cases indirectly as the derived product from any GMO.

Genetically Modified Organisms are made by the insertion of a gene from any virus, bacteria, plants, and animals into unrelated species. By the aid of Biotechnology, we can exchange genetic materials among all the living organisms. Genetically Modified Food (GMF) can be defined as foods that are derived from a genetically modified organism.

A common claim put forth by the Biotech-companies is that genetically modified plants increase the productivity and are economical to grow as they are cheaper. This is because it will encourage the Farmers to buy their products more and more that will in return boost up the economic status of the company but will cause the increase in expenses for farmers. The best example for this is illustrated by Richard Manning's article "Super Organics," which highlights that for the Flavr Savr Tomato approximately $200 million were invested in the genetic modification of the tomato but as it was introduced to global markets it didn't meet consumer choices and thus the invested two million dollars went to trash.

Although GM products like Roundup Ready Soy increase the production but each year, but farmer has to again purchase new GM seed from the agricultural companies a to make sure that the crops will have the same genetically modified strain. By this repeat business of the companies, they increase their economic growth.

- *Ayesha Masood is currently pursuing bachelor's degree program in Bioinformatics & Biotechnology from Government College University, Faisalabad,Pakistan PH-+923206565382 E-mail: ayeshamasood903@gmail.com*
- *Faiza Unbreen is currently pursuing bachelor's degree program in Bioinformatics & Biotechnology from Government College University, Faisalabad,Pakistan PH-+03105590152. E-mail: kungfuchambeli200@gmail.com*

Most of the Biotech-crops globally available are manipulated to express; resistance against insects and viruses and to tolerate certain herbicide and insecticides and enhanced nutritional value. Presently, throughout the world, nearly 149 million hectares of the cultivated land is for Biotech-crops. The major producers of GM crops are Argentina, Canada, USA, China. The rate of adoption of Biotech-crops is higher in Developing countries than in Developed countries. The reason is the hunger and pov

erty issues in Developing Countries.

An important aspect in this is public opinion that is in most cases not in favour of GMO due to some incidents and because of Monopoly of some Biotech-companies. The event that highlights "population not accepting the genetically modified foods" was seen in 2004 when Monsanto announced that GM Wheat would not enter global markets as in BBC News article which was titled as "Monsanto drops plans for GM wheat" in that it was clearly stated that due to customers not accepting GM Wheat Monsanto would wind up the project to grow Roundup Ready wheat. But they marketed other Roundup Ready products which created more problems for customers. This revealed that Monsanto knew that the consumers didn't want GMF but still the modified products were pushed to the global markets just for monetary interests. This attitude and lack of customers respect and to give them the right to opt what they want to have has made the public against GMF. One of the most crucial factors in this is letting customer know about the pros and cons of GMF as they might be affected by the effects of GMO and so that they can make a well-informed choice with full informed consent.

The claim that food biotechnology is quite a promising solution to food shortage by the development of nutrient-fortified staple food is not supported by the evidence of global markets where GMF has been introduced. This is because the consumers are worried about the long-term effects of Biotech-crops on health. Moreover, many affiliated scientists and Biotechnologists believe GM food as the environmentally un-friendly crop. Environmentalists believe that genetically engineered organisms can transform the global ecosystem and can have long-term consequences on Biodiversity.

No doubt GMO has been a controversy since the primary

commercial production of Genetic Modified Food. The GMF opponents are of the view that Genetic Engineering has no resemblance to that of natural breeding as it forcibly combines genes from unrelated species and is of the view that Genetic Engineered Products are not the replacement of Traditional breeding. No doubt most of the seed industries are claiming the benefits of GMF. However independent scientists and Biotechnologists have warned the public that GMF is more nutritious and safe food is not based on the expected health standards.

So, with the genetic manipulation techniques, it's more like "tampering with nature". This article will examine GMO impact on human health both directly and indirectly, safety and environmental and ecological risks, hypothesis about the solution of this problem.

2 PROS AND CONS OF GMO'S

2.1 Pros

There are countless **environmental, economic and health benefits** of Genetically Modified Organisms. Some crops can be modified to supply whole nutritional profile. By adjusting genetic profiles of these crops a variety of minerals and vitamins can be fixed in them, making it feasible for the people to obtain what they require with **fewer foods and lesser cost** e.g Golden rice, rich in vitamin A, have been produced by genetic engineering to cope with the problem of childhood blindness. A large variety of crops have been modified that are able to produce their own highly specific pesticides and herbicides and are resistant to insects, pests and weeds allowing farmers to apply less pesticides and herbicides to their crops and **save more money**. This exhibits GMO's more economical and health beneficial. In addition to crops, animals have also been genetically modified for the production of improved dietary nutrients for humans. Novel proteins, vaccines and drugs have been produces by GM animals to **cure human diseases** e.g insulin that is used by diabetic patients is produced from genetically GM bacteria. For better industrial production, silkworms have been genetically modified to **improve silk strength**. To reduce environmental pollution genetically modified 'Enviropigs' have been developed that are capable of digesting phosphorus in feedstuff and help to **eliminate phosphorus pollution** from the environment

2.2 Cons

Despite of all these benefits there are some **health concerns** related to GMO's. Sometimes, these genetic modifications cause unpredictable and **unintentional mutations** in organism with resultant medical and legal events. GMO's can induce allergic reactions e.g some pesticide residue from GM crops when present in alimentary canal may cause gut bacteria provoking **allergic reactions**. Consuming GM foods like soybean, corn, cottonseed and canola cause **antibiotic resistance** as well as allergic reactions in humans because these foods contain foreign gene from those viruses and bacteria that have never been in the human food supply. The most popular GM crop i.e Bt crops causes **sterility** and even **death** as reported by the farmers of US that bt corn varieties caused sterility in cows and pigs. Thousands of goat, buffalo and sheep died after grazing on bt cotton varieties. GM crops can also function as mediator in transferring genes to the wild type crops that can **generate more weeds**. GM plants also have negative effects on country's agriculture because GM plants can leave undesirable residues that remain in the soil for extended period of time after they are removed, **changing agriculture regulators**. Moreover, **lack of labelling of GMO** products obstructs their post-marketing inspection for safety.

3 SAFETY TESTS:

3.1 Determine sequence homology, structural similarity, and serological identity

Determine whether protein of interest has similarity with the proteins that cause allergies. For this purpose, consider three different approaches. First is to determine the structural similarity of novel protein with the known allergens. Second is using the databases to find similarity of novel protein with already reported allergens. It may consider over all amino acid homology or the similarity that indicates the presence of common epitopes. Third approach is to determine whether the specific IgE antibodies drawn from sensitized subjects can recognize the protein of interest.

3.2 Assessment of Proteolytic ability

Proteins that have allergenic potential and resist proteolytic digestion facilitate the induction of allergic responses. Therefore, digest the protein by pepsin or in simulated gastric fluid in order to characterize the susceptibility. However, use of this approach alone may not enough to identify proteins having potential to induce allergic responses in individual's sensitive to food or-latex allergy.

3.3 Equivalence of Nutritional value

Nutritional value, including vitamins and minerals in GM food must be same as that of non-GM food. Determine that composition of micro and macronutrients is same in GM crops and non- GM crops while performing the Compositional equivalence tests.

3.4 Toxicological assessment

To perform toxicological assessment main focuses on the product of gene and the modified crop. This generally tests the toxic effects of single high dose of the protein in animals.

3.5 Molecular characterization

Characterize the site of insertion and unknown flanking regions using PCR; determine the insertion copy number by the use of DNA based method, use of next generation sequencing to characterize the unknown flanking region and site of insertion comprehensively.

4 Hypothesis for what can be done to solve the problems of GMO

4.1 Risk Assessment and Management

The basic reason for the risk assessment is the quantification of risks and to analyse the probability of the possible outcomes, based upon the scientific data. The important fact is the improvement in quality, whether it is the quality of products or the quality of life. The basic step is the identification of the risks that include:

- Characteristics of the donor organism, vector or inserted DNA. The individual components that are employed to produce Genetically Modified Organisms.
- The Analyses Methodologies involved in statistics.
- The new traits that are acquired by a GMO and the characteristics of the environment in which that GMO is present.
- The information produced by Research institutes by public and private surveys must considerate.

4.2 Enlighten Public

Most of the people have no idea about the origin of the food they are consuming. So, the populations need to be properly guided about the food they are eating and this would allow them to have a proper control of what they are eating. We can get the citizens to donate surplus land so that crops or even the hydroponic gardens or starting farms can be planted. We can also make other communities interested in donating by taking help of social media.

4.3 Labelling

This is a genuine issue as the public must be aware of what they are consuming. All the GM products in the markets should be properly labelled so it will be on the will be on the will of customer to buy them or not. If the GMO are not labelled than it is against the laws of food safety standards and general consumer protection laws.

4.4 Purchase Organic-GM Free Diet

The best thing about the organic foods is that it is free of any genetically modified organisms and synthetic pesticides. For this one must be a conscientious consumer if he must boycott GM products. There are some of the ingredients that may be from GM crops: Baking Powder, Cellulose, Cobalamin, Caramel colour, Aspartame etc.

Following list throws light on the list of approved GM crops which is based upon GM approval database (http://www.isaaa.org/gmapprovaldatabase/cropslist/default.asp)

- Alfalfa (*Medicago sativa*)
- Apple (*Malus x Domestica*)
- Argentine Canola (*Brassica napus*)
- Bean (*Phaseolus vulgaris*)
- Carnation (*Dianthus caryophyllus*)
- Chicory (*Cichorium intybus*)
- Cotton (*Gossypium hirsutum L.*)
- Creeping Bentgrass (*Agrostis stolonifera*)
- Eggplant (*Solanum melongena*)
- Eucalyptus (*Eucalyptus sp.*)
- Flax (*Linum usitatissimum L.*)
- Maize (*Zea mays L.*)
- Melon (*Cucumis melo*)
- Papaya (*Carica papaya*)
- Petunia (*Petunia hybrida*)
- Plum (*Prunus domestica*)
- Polish canola (*Brassica rapa*)
- Poplar (*Populus sp.*)
- Potato (*Solanum tuberosum L.*)
- Rice (*Oryza sativa L.*)
- Rose (*Rosa hybrida*)
- Soybean (*Glycine max L.*)
- Squash (*Cucurbita pepo*)
- Sugar Beet (*Beta vulgaris*)
- Sugarcane (*Saccharum sp*)
- Sweet pepper (*Capsicum annuum*)
- Tobacco (*Nicotiana tabacum L.*)
- Tomato (*Lycopersicon esculentum*)
- Wheat (*Triticum aestivum*)

5 Conclusion

Increasing population with greater demand for better quality food made the scientist to look for other sources than natural. Genetically modified food grabs huge attention in recent years. Somehow including massive benefits, GMOs have some disadvantages as well. We cannot end this debate whether human should consume GMOs or not. The arguments should be made on the basis of pros and cons of GMOs. In current situation if we look at the GMOs we find them more advantageous but unintended risk should be kept in mind. Officially we cannot find any document regarding real adverse health effects of these GMO except some common side effects that are being reported by reporting system. There is need to address all issues and apply regulatory strategy to avoid any unwanted situation.

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