

Genetically Modified (GM) foods and the risk to human health and environment

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ABSTRACT

The three major Genetically Modified (GM) foods such as soybeans, canola and corn have been introduced to the global market since 1990. In this article, the potential health impacts of genetically modified foods is reviewed. Contrary to the present biotechnological claims, transgenic products have not proved to be harmless and in many *in vivo* studies have shown harmful effects. Many countries regulate the consumption of Genetically Modified Organisms (GMOs) at a specific percentage of the content and would require labelling the food packages containing GMOs. In some countries, total ban of plantation and consumption and importation of GMOs have been put in place. The acceptance and future use of GMOs by the people in many countries in the world is not guaranteed and discussions around its wide applications is in doubt.

Keywords: Genetically Modified (GM) foods, maize, herbicide, environment

INTRODUCTION

Transgenic crops are often referred to the products being genetically modified through a process known as genetic engineering.

Although transgenic plants bear a close resemblance to their natural counterparts, the way the genetic modifications are introduced does not occur naturally. As a result of genetic modifications, one or more specific

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properties are introduced into the plants. Typical examples of transgenic crops include soy beans, rice, maize, barley, potato, canola, sweet potato, tomato, squash, sugar beet, papaya, apple, mango, banana, pineapple and coconut, so only three of them namely soybeans, canola and corn are currently produced at mass quantity and sold in the global market [1,2]. Although produced at mass quantity, GMOs have not been established to be completely safe, having no ill effects on human health ([3,4]. Many countries regulate the consumption of GMOs at a specific percentage of the content and would require labelling the food packages containing GMOs [5,6,7]. European Union's legislation defines GMOs as "In GMOs (Genetically Modified Organisms), the genetic material has been transformed in such a way that won't ever occur naturally during traditional crop breeding or fertilization [8]. Risk knowledge of GM foods affect consumers attitude positively and negatively [9-11].

Plant genetic engineering methodology ultimately aims to transfer one or a few genes to a certain crop plant and, if conducted satisfactorily, a novel property would be granted to the targeted plant. This recent property is not recognized among the species sharing a common ancestor. Common properties assigned to transgenic plants

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currently in the market include a specific trait as resistance to a certain plant pest or herbicide [12]. One of the methods proposed to help feeding the accelerated growth in the world population is through modern agriculture which includes plant breeding and resistance to diseases, increase in crop yields by genetic engineering and the ability to withstand against environmental adversities such as drought and salt stresses. However, the concept of genetic transformation will itself prompt a huge amount of complications affecting food safety, and has the potential to turn into a real threat to the human health. This can potentially lead to the initiation of certain chronically lethal diseases, which are potentially life threatening for the mankind [13,14].

Transgenic crops are not the same as natural crops

Evidence has shown that transgenic crops contain some distinctive contents compared to a non-transgenic type even though both of them are planted under the same conditions [15]. This confirms the idea that the recent alterations are not due to the environmental circumstances, rather they are induced by some genetic transformation [16,17].

The fact that alterations in the cellular and molecular pathways in the manipulated crop

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plants can lead to a lower nutritional value is discomfoting for two reasons: First, these products that reduce or enhance a certain nutrient bioavailability in the crops has the potential to directly influence the overall health condition of the people or the animals consuming them. Secondly, this could reflect that genetic manipulation has introduced several alterations in the biochemical pathways of the cell which would be permanent in the life of the crop plant [14-17]. Therefore, it may suggest that more unpredictable alterations are made inside the plant cells that are not recognized yet which can lead to production of toxins and potential allergens affecting human and animal health [13-16]. Also using of statistical techniques such as Structural Equation Model (SEM) allows us to evaluate knowledge and fear in consumers behavior toward GM food consumption [18].

Transgenic crops have been reported to have a potential to be a real threat to the human health [19-20]. The rise of certain mutations along the genetic manipulation process has the potential of affecting the bioactivity and cellular structure. These kinds of modifications could result in changes in the cell that could leave their destructive impact on the human health. The current methods widely used by the genetic engineers together with the tissue cultivating procedures are

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believed to be inaccurate and potentially mutagenic. They may basically lead to some unpredictable alterations in the genetic material DNA, proteins and biochemical processing of the transgenic products [21,22]. The unpredictable changes at the cellular level may occur as toxicity, development of allergy, changes in the nutritional values of transgenic products, nutrient reduction, paving the way for chronic diseases and causing harm to the tissues and body organs. Thus due to the induced health hazards to humans imposed by these products, they are not fundamentally recommended [17-20]. However there are many methods to analyze GMO such as Polymerase Chain Reaction (PCR) [23,24,25].

Although GMOs have proved to be unable to solve the global hunger catastrophe in the past 20 years, they have distracted the international food and agriculture organization from making the right decisions to remove the major causes of the world hunger. Some of the primary causes of the world hunger are poverty, lack of food access and small scale agricultural land in the hands of farmers which are considered to be side effects of application of genetic engineering in producing transgenic products [26-32].

GMOs: Herbicides and Insecticides

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One of the main criticisms of GM foods is the fact that they are said to be made resistant to herbicides and insecticides. It has widely been claimed that using GM crops will lead to the lower use of insecticide and herbicide and therefore less potential health and environmental impacts. The majority of these transgenic products have been designed in such a way that their breeding depends on widespread glyphosate (active component of a popular herbicide) use. An estimation of 183,000 tones equal to approximately 7% increase in herbicide and insecticide use has been reported in the USA [33-37].

An article specifically focusing on the impact of GM crops on the herbicides and pesticides application rate within a period of 16 years was published in 2012 [41,48]. This study reported that soybeans resistant to glyphosate, contributes to the 70% development of the herbicide application rate. This is not surprising as the manufacturers of GM crops are exactly those who are involved in the manufacturing of pesticides and herbicides. Clearly, it would be a pure profit for them to produce some types of seeds that are closely dependent to those killers [49,38].

There have been similar reports on the increasing rate of herbicides use coming from several parts of the world including the

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southern part of USA that are widely planting GM plants throughout the region. In countries like Argentina and Brazil, the percentage of increase in herbicides use per hectare has been also reported [50,51] and health impacts considered. Unfortunately, with the growth of super weeds which are resistant to glyphosate, farmers are forced to apply a greater amount of herbicides or switch to some other varieties with higher efficiencies; this will consequently lead to a serious hazard for the human health and contamination of the environment which could potentially affect the human health in a negative manner.

According to some reports from Canada, GM canola seeds have substantially turned into a type of weed spreading throughout the farmlands with soybean and corn planted [52]. In addition to the landmark increase of herbicides use in growing GM crops and the significant threat it potentially imposes on human health and environment, it is of note that the insecticide protein is expressed in every single GM plant cell that will extend a lifelong. This toxicity remains as far as if any part of the plant is consumed by the beneficial insects; it will lead to environmental disasters and leave its unpleasant effects on the human health, ecosystem and bio-diversity.

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Studies have shown that glyphosate accumulates within the plant tissues and later released into the soil through the roots, inducing the growth of certain fungi, named Fusarium, which would infect the plant with some sort of infections. The major concern about this fungus is that it could produce a type of toxin able to penetrate into the human and animal food chain, and impact the reproductive system [53-56].

The possibility of horizontal gene transfer from GMOs

Planting natural products and GM products in parallel will result in gene transfer from GMOs to non-GMO plants. Horizontal gene transfer among unrelated biological types takes place via a mechanism other than reproduction, and the scientists have already warned that modified genes may simply escape from genetically engineered products and transfer to other organisms horizontally. Although horizontal gene transfer between two plants or from a plant to an animal might rarely occur; however, DNA uptake by the bacteria in an environment or through the digestive system is probable. Some reports indicate that DNA uptake by the bacteria existing in the digestive system of GM soybean consumers is likely to take place [57,58,22]. Disturbing the microbiome in the

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digestive tract can potentially lead to many diseases.

Although gene transfer probability to pathogenic bacteria and viruses seems to be low, because of the global abundance and overspread of GM plants, this transfer is expected to take place in the near future. Therefore, the biosafety issue concerning the GM crops, and the transfer of genes to other organisms and the potential hazard to the human health is of concern. Gene flow to the native plant population capable of cross-reacting with the herbicide resistant crops may lead to certain unpleasant molecular changes which could affect human health and/or environment [59-61].

One of the major anxieties of the anti-GMO activism is the claim that GM crops would alter the quality and safety of consumable parts of the plant. This might occur through toxicity of the protein produced by the transferred gene, toxic metabolites derived from the transferred gene coded enzyme and unmodified gene expression alteration by the transferred gene position in the genome [43].

Another matter to worry is the human nutrition and the probability of new allergies outbreak induced by the long term use of GMOs. To identify these probable unknown allergies in humans, long term assessments are needed to be done by the regulatory

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bodies. In many cases, gene transfer and the sites of gene insertion in the host cell genome are not clear because insertion into the host cell's genome occurs randomly which can interrupt the interrelationship between the genes in that specific location. This process may affect negatively on the living organisms due to the cumulative effects and interaction of genes with other genes [62-67].

Toxic Effects in Laboratory animal feeding studies with GMOs

Feeding studies on laboratory animals demonstrate that GM foods are toxic or allergenic. In these studies one group is fed GM diet and a non-GM diet is fed to a control group. In a rat study fed by Monsanto's GM maize NK603, over a long-term two-year period developed damage in kidney, liver, pituitary gland function, hormonal disruption, increased rates of tumours in treatment groups [68,39,42,47].

In another study, rats were fed the GM maize for 45 and 91 days and showed differences in organ and body weights and in blood biochemistry when compared to the rats which were fed the non-GM parent [69,45]. Histopathological investigations from the same researchers found toxic effects in multiple organs [70].

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Mice fed with GM peas engineered to express an insecticidal protein showed a strong immune reaction against the GM protein and developed antibodies against the GM protein and an allergic-type inflammation response. The mice fed with non-GM beans did not show immune or allergic-type inflammation [71].

Mice fed with GM maize for 30 and 90 days showed disturbance in immune system cells and biochemical activities such as an increase in serum cytokines which is associated with allergic and inflammatory responses [72,40]. Mice fed with GM soy demonstrated damage in liver, pancreas and testes functions [73]. Furthermore, Mice fed with GM soy during a 24 month period showed changes in the expression of proteins related to liver functions, stress response, calcium signaling when compared to the control group fed with non-GM soy [74].

CONCLUSION

Contrary to the current claims by the proponents of GMOs, transgenic products are not as safe as it is advertised and holds potential risks to human health and the environment [44]. Horizontal gene transfer from GM foods ingested by humans to the microbiome may lead to disturbance of the balance in the human body and create potential risks to human health in the short

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and long term. Feeding of the GM products in animal studies have shown damages in different organs and induction of immune responses [46]. GM foods are still experimental in nature and should be carefully studied for the long term effects in humans. Any statements supporting the safety of these products in humans are indeed premature and does not have any scientific base.

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