

Research Article

Safety Assessment and Countermeasures of Genetically Modified Food

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Abstract: With the rapid development of science-biotechnology, the safety of genetically modified organisms has become some of the most controversial issues in our society. This study aims to review the safety assessment and countermeasures of Genetically Modified (GM) foods. Firstly, the research status and the main contents of GM foods safety assessment are discussed. What's more, the countermeasures of GM foods safety assessment are proposed. This study tries to summarize and discuss the safety assessment of GM foods.

Keywords: Assessment, countermeasures, genetically modified food, security

INTRODUCTION

Since the mid-1990's, Genetic Modification (GM) is a rapidly growing and controversial method that can boost agricultural productivity, but the technology is not fully understood by the consumers (Bennett *et al.*, 2005). Use of biotechnology in food production is one of the most controversial subjects in modern agriculture (Jayson *et al.*, 2005). GM foods are the product of one of the most progressive fields of science-biotechnology. There are major concerns about GM foods in the public (Celec *et al.*, 2005). GM foods are foods derived from Genetically Modified Organisms (GMO). Along with introducing of GMO into daily life, the GMO give rise to safety concerns. GMO have had specific changes introduced into their DNA by genetic engineering techniques. This group of organisms includes microorganisms, plants and animals. Although there is no direct evidence that GMO have any harmful effect on human's health many people are skeptical about. Critics have objected to GM foods on several grounds, including possible safety issues (NRC, 2004), ecological concerns and economic concerns raised by the fact that these organisms are subject to intellectual property law.

The introduction of GM foods into our food supply has stimulated much discussion about the nature of these foods, their safety and their place in global food production. The issue of GMO crops, foods derived from GMO crops and genetic manipulations generally are very controversial. Nevertheless, GMO bring many benefits, on other hand many concerns and risks related to GMO impact on human's health in relationship with allergy, toxicity and nutrition value are associated with

GMO. There are concerns that transgene protein may provoke allergic reaction in sensitive individuals. Many studies show that GMO crops nutrition value is comparable with their traditional counterparts. Much discussed is the potential risk of GMO related to environment such as extension of antibiotics resistance genes, Horizontal Gene Transfer (HGT), spontaneous formation of super weed or GMO adverse effect on biodiversity. It is necessary to improve and develop new techniques for GMO safety assessment related to human health and environment.

Agriculture is an important economic sector of China, developing of laws and regulations on bio-safety, strengthening the safety management of agricultural GM foods and regulating the development of related industries are of great practical significance for the maintenance of global biodiversity and protect the ecological environment and human health.

THE RESEARCH STATUS OF GM FOODS SAFETY ASSESSMENT

The research status of GM foods safety assessment in China: GM foods were first put on the market in the early 1990s. Typically, GM foods are transgenic plant products: soybean, corn, canola and cotton seed oil. After entering WTO, facing international competition, Chinese government and consumers have concerned the food-safety and potential damage of GMO. The use of modern biotechnology to create GMO allows agricultural crops as our main food to be an alternative that was not believed even by specialists who took part in the green revolution decades ago. Even though agricultural biotechnology has been improved rapidly,

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their deployment and impact have been under controversy. In addition, the potential out crossing from GMO plants to other organisms is also concerned by China's government. In 2001 and 2002, the China's government ratified the GMO regulation and its three measures. Although the temporary measure announced in 2002 could resolve the issue to some extent, it could not provide a long-term and steady guarantee for traders. The impact of this GMO regulation and its measures is still difficult to assess (Shi *et al.*, 2005).

Agricultural GMO in China engaged in research, testing, production, processing, management and import and export activities, must comply with the regulations and methods.

The research status of GM foods safety assessment in abroad: Within the United States of America there is not much public resistance towards the use of GMO in food. However, in other areas of the world, for instance Oceania and Europe, the production of novel foods using GMO is subject to strong debate (Wilbert *et al.*, 2006).

Fermentation-based bioprocesses rely extensively on strain improvement for commercialization. Until now, strain improvement was mainly based on the selection of new natural strains but, as detailed in the previous sections, numerous improvements can be obtained by using gene technology. However, at least in Europe, no modified Lactic Acid Bacteria (LAB) is commercialized as yet and some aspects underlying this issue will be discussed here. Community legislation on GMOs has been in place since the early 1990s, but this regulatory framework has been further extended and refined. It was designed to protect the health of European Union citizens and the environment at the same time as the creation of a unified market (Pierre, 2002).

Social acceptance of GM foods or ingredients is not uniform in developed countries, which over the past few years have established mechanisms for adjudicating on the safety of novel foods before they are marketed (Ahmed, 2002). In 1998, the EU introduced a de facto moratorium on the import and production of GM foods and in March 2003, the European Commission upheld the moratorium and is standing firm on its decision that any food containing 0.9% of a GM product should be labeled (Hellemans, 2003).

Current analyses are based on the international principles of food safety FAO/WHO 1995 and 1997. There are three basic approaches determining the toxicity, which include:

- The testing of interaction between structure and function to assess the potential toxicity and allergenicity
- In vitro assays using enzymes, receptor proteins or cultured cell lines
- In vivo animal experiments (Koniget *et al.*, 2004)

The safety assessment of a GM food is conducted within the established risk assessment framework used by Food Standards Australia New Zealand (FSANZ). In the case of GM foods, the primary purpose is:

- To identify new or altered hazards associated with the food as a result of the genetic modification
- To assess whether there is any risk associated with these hazards under the intended conditions of use
- To determine if any new conditions of use are needed to enable safe use of the food

THE MAIN CONTENTS OF GM FOODS SAFETY ASSESSMENT

The biological safety assessment of GM foods:

The safety assessment of gene operation: The gene operation safety includes gene source, functions, carrier characteristics, GM method, gene pleiotropy and secondary reaction, the agronomic traits expression of GM crops, sites effect, genetic stability and insertion mutation. Biological characteristics of GM plants include the differences between genotype and phenotype of transgenic plants and the receptor, the stability and expression of foreign genes in transgenic plants and the toxicity and allergy of GM products and so on. According to the impact of gene operation to receptor biological safety, the type and extent of gene operation were determined (Wu *et al.*, 2010).

The safety assessment of genetic engineering body and its products: Genetic engineering is the direct human manipulation of an organism's genetic material in a way that does not occur under natural conditions. According to the safety level of receptor and the impact type and influence of gene operation to receptor safety, the safety level of genetic engineering body and its products, the possibility of gene flow.

The edible safety assessment of GM foods:

Toxicity evaluation: The principle of GM foods toxicity evaluation was GM foods should not be the same species than any other edible food contains more toxins. Theoretically, any gene transfer methods may lead to GMO unpredictable and unexpected changes. The existing equivalence was firstly determined between GM foods and real food for genetically modified food. Then the key nutrients, toxins and other components were compared. If the receptor has potential toxicity, the toxin composition whether change should be detected, the inserted genes was whether causing the changes in toxin content or a new toxin produced. The chemical composition comparison of new food and existing food can better estimate the potential effect. At the same time, to do the further safety assessment was carried out, for instance, using animal feeding tests and other toxicity tests. Animal

feeding tests must be designed based on the evaluation purpose (even in clinical trials) for meeting the new GM food safety evaluation needs. The evaluation of the toxicity of GMO should also consider the environmental and ecological effects.

Allergy evaluation: A food allergy is an adverse immune response to a food protein. They are distinct from other adverse responses to food, such as food intolerance, pharmacological reactions and toxin-mediated reactions. Before the consumption of GM foods, whether the donor of the gene contains allergens was firstly investigated. The allergies caused by GM crops may be due to the product of GM itself and may be due to the changes caused by GM crops for the target's natural nutrients expression levels. The current prevention means can be used including if the foreign gene from a species in the history of allergic reactions. In addition, using management means and establishing effective mark, tracking system and recovery system could ensure that any GM allergens can be recovered from the market through these systems if identified by any consumer.

Antibiotics resistant marker genes evaluation: An antibacterial is a substance that kills bacteria or inhibits their growth. The use and misuse of antibiotics in medicine and animal husbandry are the main causes of increased antibiotic resistance. Society must decide if the relative risks require existing GM varieties to be directly replaced, with substantial costs to industry and loss of benefits, or gradually replaced as new varieties are introduced.

The transfer of genetic material occurs naturally in the environment within bacterial populations and could potentially occur between microbial species or between plants and microbes. Modified ARG are optimized for expression in plants rather than bacteria and would function weakly, if at all, on transfer back to bacteria. There is no evidence to date of gene transfer from GMO to naturally occurring soil bacteria under field conditions, but there are examples under optimal laboratory conditions. There is already widespread resistance to kanamycin and ampicillin, the antibiotics most commonly used in production of GM crops and they are being used less often. Therefore, the replacement of ARG with alternative selectable markers and the development of "clean gene" technology is the future of GM varieties.

The environment safety assessment of GM foods:

The risk of gene flow: Gene flow, also called gene migration, the introduction of genetic material from one population of a species to another, thereby changing the composition of the gene pool of the receiving population. The introduction of new alleles through gene flow increases variability within the population

and makes possible new combinations of traits. In human beings gene flow usually comes about through the actual migration of human populations, either voluntary or forced. There are a number of factors that affect the rate of gene flow between different populations. One of the most significant factors is mobility, as greater mobility of an individual tends to give it greater migratory potential. Animals tend to be more mobile than plants, although pollen and seeds may be carried great distances by animals or wind. Maintained gene flow between two populations can also lead to a combination of the two gene pools, reducing the genetic variation between the two groups. It is for this reason that gene flow strongly acts against speciation, by recombining the gene pools of the groups and thus, repairing the developing differences in genetic variation that would have led to full speciation and creation of daughter species. GMOs could destroy the genetic diversity of wild relatives through gene flow. Gene flow non-purpose plants may form super weed and cause incalculable damage to the ecological environment (He *et al.*, 2007).

The effect on biodiversity: Biodiversity is the degree of variation of life forms within a given ecosystem, biome, or an entire planet. Biodiversity is one measure of the health of ecosystems. Life on earth today consists of many millions of distinct biological species. After GMOs were released into the environment, GMOs may become dominant population, destroy the ecological balance of the original and result in some populations decline or disappear and influence genetic diversity of biological. If the diversity of germplasm resources were damaged, the genetics and breeding, industrial and agricultural production and ecological environment will have a great loss. The reduction or extinction in the number of biological species directly affect on the survival of natural enemies, biodiversity, even the entire food chain.

The effect on soil micro-ecology: The stubble and roots exudates of *Bacillus thuringiensis* (Bt) GM crops contain Bt toxin. Bt toxin which is not easily biodegradable can be maintained insecticidal activity for a long time in the soil environment and kill soil biology. This not only reduces the biodiversity of soil, but impacts on soil micro-ecological cycle.

The pollution of the environment: At present, the planting area of herbicide-resistant GM crops increase, followed by a continued growth in herbicide usage. An herbicide, commonly known as a weed killer, is a type of pesticide used to kill unwanted plants. Selective herbicides kill specific targets while leaving the desired crop relatively unharmed. Herbicides transfer to other places with the rain, soil erosion, caused continuous soil, water and environmental pollution.

Simultaneously, the usage of herbicide reduces farmland biodiversity. In some insect-resistant cotton growing area, farmers must use pesticides to control the bollworm because of bollworm had a resistance of Bt cotton. Thereby with the increasing amount of pesticides, the different levels of environmental pollution were caused.

THE COUNTERMEASURES OF GM FOODS SAFETY ASSESSMENT

Establish GM foods detecting technology and safety evaluation standards system: Although the promotion of GM foods can bring considerable economic benefits and social benefits, potential risks cannot be ignored. From the perspective of sustainable development, its long-term impact may have full consideration. Currently, the safety technological means of transgenic technology is still weak in China. The testing work on GM foods should be strengthened and the pace of GM foods safety research and evaluation technology should be speeded up. The detection of GM foods is rapid, accurate and economic and the safety evaluation is open and transparent (Zhang and Lu, 2010).

Reasonable application of biotechnology: Biotechnology is a field of applied biology that involves the use of living organisms and bioprocesses in engineering, technology, medicine and other fields requiring bio-products. With the rapid development of GM foods and promotion rate, its management is a bit behind. It is necessary to develop appropriate principle for the development of transgenic biotechnology such as demand principle. That is to say, before carrying out the production of GM foods, there must have evidence that there is a need for their output. This controls the unnecessary production from the source or causes the possibility of long-term risks for GM foods. The strict and non-limited management should be carried out for the safety of GM foods. Aspects of GM legislation should accord to the international practice. The legislation will cover all aspects of GMOs safety, provide protection for the healthy development of GMOs and accurately grasp the scale of the implementation of the provisions. It is necessary to ensure the safety of GM foods; however, the development of transgenic technology is not limited. The safety of biotechnology transgene legal system was improved and the sustainable development of transgenic technology was achieved.

Improve the labeling system of GM foods: GM foods identity management is a common practice in most countries and international organizations. It is primary to protect the consumers' right to know and to choose. At present, consumers' concern for specific food safety includes allergens and to inhibit the use of antibiotic

marker genes, because genes with allergic characteristics may be led into other foods by transgene. This is an uncertainty, using the standard risk analysis method response and judge these concerns is difficult. International practice is to identify the GMO products. Letting consumers choose and providing consumers with true and accurate information on GMO products. Consumers have the right to ask the performance, valid and manufacturer, etc., from operators, when they buy GM foods. Operators also have an obligation and responsibility to explain the circumstances to consumers. Currently, many GM products are not labeled as GM labeling. The labeling system of GM foods is to be improved and strengthening the regulation is the key to ensure the right to know (Quiet *al.*, 2006).

Strengthen publicity and education on GM foods: GM foods should be not strange for consumers. However, consumers' awareness of GM foods remains in the initial stage. After all, the rise of GM foods will not be long. Ordinary people are not very understanding of the concept on GM foods. Therefore, it is essential to publicize and teach to the public by multi-channel and multi-level means. Finally, people have the capacity to choose and accept safe GM foods. Moreover, the authoritative advisory agencies were set up to provide effective guidance for consumers.

CONCLUSION

New technical and legal approaches are needed to gain consumer acceptance of bioengineered food products (Kamil and Yakup, 2011). Knowledge of the genetics and molecular biology has advanced rapidly during the last decade. The risks but also the possible benefits of GM foods should be assessed and evaluated individually for every GM organism. Risk assessment and expected benefits will determine the future use of modified bacteria in the domains of food technology and health. This study provides an overview of the research status and the main contents of GM food safety assessment. In addition, the countermeasures of GM food were proposed. The countermeasures included that establishing GM food detecting technology and safety evaluation standards system, reasonable application of biotechnology, improving the labeling system of GM foods and strengthening publicity and education on GM foods.

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