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GMO'S: APPLICATIONS, USES AND FUTURE PROSPECTS

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ABSTRACT

Genetically modified organisms (GMOs) are organisms in which the genetic material has been altered using recombinant DNA technology. Genetic manipulation involves a wide variety of modifications to produce nutritionally valued GM crops. In some cases, genetic modifications represent more faster and efficient mechanisms for achieving desired resulting traits. Production of GM food crops provides new ways to fulfill future food requirments but risk associated factors cannot be neglected. To overcome these problems and to cope with the continuous increase in the number and variety of GMOs, new approaches are needed. Different strategies can be used to identify, detect and quantify GM crops for increasing production levels with high effieciency. In this review, we have discussed various factors involved in production of GM crops, their uses and risk factors to adopt preventions and to overcome the related problems.

KEYWORDS: Genetic manipulation involves a wide variety of modifications to produce nutritionally valued GM crops.

INTRODUCTION

Genetically modified organisms (GMOs) are the organisms whose genetic material has been modified through unnatural means. This technology has been used to transfer selected genes from one organism to another organism. This technique is also referred as recombinant DNA technology and has been used around many countries of the world for creating GM crops. The new gene will contain desirable traits such as pest resistance, herbicide tolerance, drought resistance and enhanced nutritional values. These kind of desired genes are called novel genes. There has been a substantial increase in the area for GM crops throughout many countries of the world, especially after the first GM crop was commercialized in 1996. Similarly, there has been an increasing trend amongst the farmers to grow GM crops and according to the figures of 2007, the number of farmers who are planting GM crops across the world are about 12 million across 23 various countries.[1] The desirable characteristics arose from naturally occurring variations in the genetic make up of individual plants and animals. Hence, this type of natural genetic modification is the basis of evolution and breeding. The term genetically modified can only be applied to products that have been genetically engineered. Application of genetic modification does not inherently increase or decrease the risk associated with the organism. Biotechnology has contributed to the well being of the hungry is through higher incomes from production of GM cotton.[2] Only small set of countries have extend GM crops and most of them in a relatively minor way. Genetically modified (GM) plants manifest new traits via the expression of novel proteins encoded by inserted transgenes. For example, cotton modified to contain a Bt (*Bacillus thuringiensis*) gene and expressing Bt insecticidal protein in its leaves and buds will be protected from caterpillar attack. Both the transgene and the novel protein in such plants could be considered as genetically modified.

Genetically modified (GM) crops are the predominant GMOs introduced into the environment for food and feed production and to a lesser degree for industrial applications, and are controversial for this reason.[3] GM plants used in agriculture are the largest class of GMOs intentionally introduced into the environment. GM crops are grown in varying amounts in select countries, the largest producers being the United States, Canada, Brazil, Argentina and India. The main traits introduced are herbicide tolerance and insecticide tolerance.[4,5,6]

Genetically Modified Food Crops

The GM products include vaccines, food ingredients, medicines, feeds and fibres. The use of recombinant chymosin in cheese production represents one of the first application of genetic engineering in the food industry. The Flavr Savr tomato was considered to be one of the first genetically modified crop. Since 1980s, 42 more genetically engineered crops have been approved. Similarly, some genetically modified food crops derived from Agrobacterium tumefacians is the most frequently used as a terminator in transgenic crops. Researchers are now trying to improve crops for production of nutrionally improved traits to gain health benefits. The have tried to develop GM crop resistance to certain pesticides and herbicide e.g seed and soyabeans. Crop development is known for introducing novel traits and transgenic technology is currently being used for conventional breeding. A number of genetically modified crops are used to produce food ingredients like soya and maize. Soyabeans can be processed to yield many different food ingredients from soya protein and flour to oil lecithin used as emulsifiers. Similarly, maize can be processed to yield a variety of ingredients from starch and sugars to oil and flour. Such advantages of GM crops would mitigate public hesitation about GM technology.[7]

With the rapid advances in biotechnology, a number of transgenic crops carrying novel traits have been developed and released for commercial agriculture production. These include pest resistant cotton, maize, canola, herbicide glyphosate resistant soybean, cotton and viral disease resistant potatoes, papaya and squash. In addition, various transgenic crops are under development and not yet commercially released with traits for biofortification, phytoremediation and production of pharmaceuticals, such as rice with high level of carotenoid for production of Vitamin A like golden rice and bananas with vaccines. Tolerance of crops to herbicides has been achieved either by introducing a gene coding for a target enzyme insensitive to the herbicide or by introducing a gene encoding an enzyme metabolizing and detoxifying the herbicide.[8-9] Major benefits exhibited by Bt-resistant plants comprise improved crop yields, reduced use of chemical insecticides, reduced levels of fungal toxins and preservation or enhancement of populations of beneficial insects.[10-11] Protection against viral diseases has been achieved by expressing viral coat proteins or by introducing viral replicase genes.[12] Resistance to fungi is conferred by GM-induced biosynthesis of phytoalexins, by expression of ribosomal inhibitor proteins specific to fungal ribosomes.[13]

Methods used for analysis GM Food

Polymerase chain reaction (PCR) can be used for analysis, detection and quantification of transgene DNA, a short sequence of DNA i.e primer is added to a sample of the food to be tested. If primer match with any DNA in the sample was observed, PCR will cause this DNA to be amplified. The amplified DNA can then be stained and visualised to check the presence of transgene. Quantitative PCR can also be used to check the concentration of transgene in the sample. In general practice, its sensitivity will depend on the nature of the food being tested and the transgene DNA sequence that is being sought. For example, a study of GM soyabeans and maize showed that PCR using a CaMV 35S primer had a detection limit of 0.1% w:w of GM soyabeans, but with a nopaline synthase primer the test had a limit of 1%.[14]

Sequence Mismatch and Substitutions

Different varieties of the same GM crop are available on the market. For example, there are a few hundred different varieties of the insect-resistant GM maize (event MON810) worldwide. All of these varieties include the same event specific target, which is unique and match only one GMO. However, mismatches in inserted sequences that have arisen during crossing have already been reported.[15] A mismatch between a primer and the DNA template can cause partial to complete failure of the amplification of the initial DNA template, which will depend on the type and location of the nucleotide mismatch. The maize genome is highly diverse. Mutations like single base-pair substitutions, small insertions or deletions of bases are very frequent and these can lead to the inaccurate determination of the GMO content.[16-17]

RISK Factors and Preventions

Horizontal gene transfer of pesticide, herbicide, or antibiotic resistance to other organisms would not only put humans at risk, but it would also cause many ecological imbalances allowing some plants to grow uncontrolled leading to spread of disease among both plants and animals. Horizontal gene transfer occurs naturally at a very low rate and cannot be simulated in an optimized laboratory environment. In contrast, the alarming consequences of vertical gene transfer between GMOs and their wild-type counterparts have been highlighted by studying transgenic fish released into wild populations of the same species. According to some studies, GM food crops have not yet been commercially grown in developing countries. This is due to the reason that government authorities in most developing countries have not given farmers official permission to plant any GM crops because of safety concerns.[18] Nearly 70% of poor and food-insecure people live in rural areas in developing countries. Low production in agriculture is a major cause of poverty, food insecurity and poor nutrition. Genetic engineering can help to facilitate agricultural and rural growth through high-yielding varieties resistant to biotic and abiotic stresses, to reduce pest-associated losses and to enable precision agriculture, i.e. use of right inputs at the right time. Recombinant DNA techniques should be increasingly used to improve the nutritional status of crops essential for the population in developing countries.

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