BIOTECHNOLOGICAL INNOVATION IMPROVES CROP QUALITY AND YIELD.

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ABSTRACT:

In the last few decades, technology and modernization have grown at the same rate. For example, improvements in biotechnology have been used to help make more food. In particular, advances in genetic engineering have made it possible to change crops to make them produce more food, which will help feed the world's growing population. Transgenic crops, on the other hand, have not been welcomed by everyone, and there is still a lot of uncertainty about how they might help society and what they might mean for human health. A. Everyone knows that good nutrition is important for human health and growth. Pests and diseases have less of an effect on crop yields than things like drought, flooding, extreme heat, and so on. So, one of the main goals of plant scientists is to find ways for plants to keep producing even when they are under a lot of stress and to make crops that are better for you. Genetically modified (GM) crops can help meet the demand for high-quality food around the world by working well with crops grown in the traditional way. Crops made through genetic engineering can be used not only to increase yields and improve nutrition but also to make them more resistant to both natural and man-made stresses. Even though some people are worried about the biosafety and health risks of GM crops, there is no reason not to eat those that have been carefully made and tested. Food security for both current and future generations can be achieved by combining modern biotechnology with traditional farming methods in a way that is good for the environment.

Keywords: *GM crops, Biotic stress, Abiotic stress, Nutritional quality, Shelf life, Biosafety*

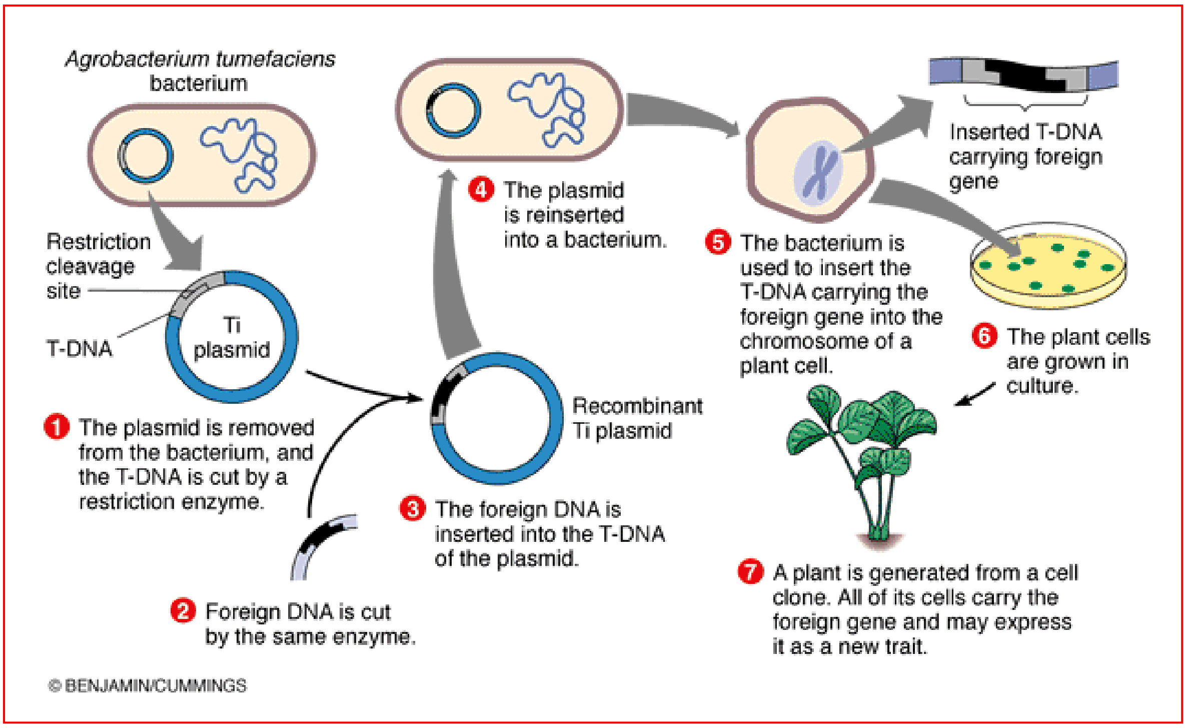
INTRODUCTION:

Many lives are lost every year in underdeveloped nations due to issues related to food insecurity and malnutrition. In addition to getting enough of the right kinds of nutrients every day, a healthy diet also includes foods that do more than just nourish the body. With arable land being lost at an alarming rate and the predominance of adverse environmental circumstances such as drought, salinity, floods, illnesses, and so on, even keeping food production at current levels per capita will become an increasingly difficult task in the future. Despite the expected harsh environmental circumstances, the globe has to produce 50-100 percent more food than it does at today to maintain food production for future generations (Baulco 2010).

During the mid-20th century's green revolution, the use of agrochemicals and high-yielding crop varieties developed through conventional plant breeding practices led to a significant boost in crop productivity in India. However, conventional plant breeding alone can no longer sustain the ever-rising global food demand. It is time to promote sustainable agricultural practices for boosting crop productivity with the utmost conservation of all available natural resources. Agricultural biotechnology is proving to be a powerful complement to conventional methods for meeting worldwide demand for quality food. With the help of modern plant biotechnological tools, today we have access to massive gene pools that can be exploited to impart desirable traits in economically important crops. Geneticallymodified (GM) crops can help us to meet the demand for high-yielding, nutritionally balanced, biotic, and abiotic stress-tolerant crop varieties (Datta 2012, Meli Ghosh *et.al.*,2010, Ghosh *et.al.*, 2011, Chakraborty *et.al.*,2000). While the global area under GM crops continues to expand every year (James 2011), concerns have been expressed regarding unintended and unpredictable pleiotropic effects of these crops on human health and the environment (Dona and Arvanitoyannis 2009) However, novel foods developed either by conventional or genetic engineering approaches are no different in terms of possible unintended harmful effects on human health and the environment (Ronald 2011). In fact, the extent of alteration in genomes, from breeding is much more than that for GM crops.

What are Genetically Modified animals and Plants?

Fig. 1 Genetically modified foods



Genetically modified organisms (GMOs) can be defined as organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination. The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between nonrelated species. Foods produced from or using GM organisms are often referred to as GM foods.

Why are Genetically Modified food Produced?

GM foods are developed – and marketed – because there is some perceived advantage either to the producer or consumer of these foods. This is meant to translate into a product with a lower price, greater benefit (in terms of durability or nutritional value), or both. Initially, GM seed developers wanted their products to be accepted by producers and have concentrated on innovations that bring direct benefit to farmers (and the food industry generally).

One of the objectives for developing plants based on GM organisms is to improve crop protection. The GM crops currently on the market are mainly aimed at an increased level of crop protection through the introduction of resistance against plant diseases caused by insects or viruses or through increased tolerance towards herbicides.

Resistance against insects is achieved by incorporating into the food plant the gene for toxin production from the bacterium Bacillus thuringiensis (Bt). This toxin is currently used as a conventional insecticide in agriculture and is safe for human consumption. GM crops that inherently produce this toxin have been shown to require lower quantities of insecticides in specific situations, e.g. where pest pressure is high. Virus resistance is achieved through the introduction of a gene from certain viruses which cause disease in plants. Virus resistance makes plants less susceptible to diseases caused by such viruses, resulting in higher crop yields.

Herbicide tolerance is achieved through the introduction of a gene from a bacterium conveying resistance to some herbicides. In situations where weed pressure is high, the use of such crops has resulted in a reduction in the number of herbicides used.

Foods derived from GM crops:

At present, there are several GM crops used as food sources. As of now, there are no GM animals approved for use as food, but a GM salmon has been proposed for FDA approval. In some instances, the product is directly consumed as food, but in most of cases, crops that have been genetically modified are sold as commodities, which are further processed into food ingredients.

Fruits and vegetables Papaya has been developed by genetic engineering which is ring spot virus resistant and thus enhancing productivity. This was very much in need as in the early 1990s Hawaii’s papaya industry was facing disaster because of the deadly papaya ring spot virus. Its single-handed savior was a breed engineered to be resistant to the virus. Without it, the state’s papaya industry would have collapsed. Today 80 % of Hawaiian papaya is genetically engineered, and till now no conventional or organic method is available to control the ring spot virus.

The NewLeaf™ potato, a GM food developed using naturally-occurring bacteria found in the soil known as Bacillus thuringiensis(Bt), was made to provide in-plant protection from the yield-robbing Colorado potato beetle. This was brought to market by Monsanto in the late 1990s, developed for the fast-food market. This was forced to withdraw from the market in 2001as the fast-food retailers did not pick it up and thereby the food processors ran into export problems. Reports say that currently no transgenic potatoes are marketed for the purpose of human consumption. However, BASF, one of the leading suppliers of plant biotechnology solutions

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for agriculture requested for approval for cultivation and marketing as a food and feed for its Fortuna potato'. This GM potato was made resistant to late blight by adding two resistance genes, blb1 and blb2, which originated from the Mexican wild potato *Solanum bulbocastanum.* As of 2005, about 13 % of the zucchini grown in the USA is genetically modified to resist three viruses; the zucchini is also grown in Canada (Johnson 2008).

Vegetable oil It is reported that there is no or a significantly small amount of protein or DNA remaining in vegetable oil.

extracted from the original GM crops in the USA. Vegetable oil is sold to consumers as cooking oil, margarine, and shortening, and is used in prepared foods. Vegetable oil is made of triglycerides extracted from plants or seeds and then refined and may be further processed via hydrogenation to turn liquid oils into solids. The refining process removes nearly all nontriglyceride ingredients (Crevel*et al.* 2000). Cooking oil, margarine, and shortening may also be made from several crops. A large percentage of Canola produced in USA is GM and is mainly used to produce vegetable oil. Canola oil is the third most widely consumed vegetable oil in the world. The genetic modifications are made for providing resistance to herbicides viz. glyphosate or glufosinate and also for improving the oil composition. After removing oil from canola seed, which is ∼43 %, the meal has been used as high-quality animal feed. Canola oil is a key ingredient in many foods and is sold directly to consumers as margarine or cooking oil. The oil has many non-food uses, which include making lipsticks.

Maize, also called corn in the USA and cornmeal, which is ground and dried maize constitutes a staple food in many regions of the world. Grown in 1997 in the USA and Canada, 86 % of the USA maize crop was genetically modified in 2010 (Hamer and Scuse 2010) and 32 % of the worldwide maize crop was GM in 2011 (Clive 2011). A good amount of the total maize harvested go for livestock feed including the distiller's grains. The remaining has been used for ethanol and high fructose corn syrup production, export, and also used for other sweeteners, cornstarch, alcohol, human food or drink. Corn oil is sold directly as cooking oil and to make shortening and margarine, in addition, to making vitamin carriers, as a source of lecithin, as an ingredient in prepared foods like mayonnaise, sauces, and soups, and also to fry potato chips and French fries. Cottonseed oil is used as a salad and cooking oil, both domestically and industrially. Nearly 93 % of the cotton crop in the USA is GM.

Sugar The USA imports 10 % of its sugar from other countries, while the remaining 90 % is extracted from domestically grown sugar beet and sugarcane. Out of the domestically grown sugar crops, half of the extracted sugar is derived from sugar beet, and the other half is from sugarcane. After deregulation in 2005, glyphosate-resistant sugar beet was extensively adopted in the USA. In the USA 95 % of sugar beet acres were planted with glyphosate-resistant seed (Clive 2011). Sugar beets that are herbicide-tolerant have been approved in Australia, Canada, Colombia, EU, Japan, Korea, Mexico, New Zealand, Philippines, Russian Federation, Singapore and USA. The food products of sugar beets are refined sugar and molasses. Pulp remaining from the refining process is used as animal feed. The sugar produced from GM sugar beets is highly refined and contains no DNA or protein—it is just sucrose, the same as sugar produced from non-GM sugar beets (Joana et al. 2010).

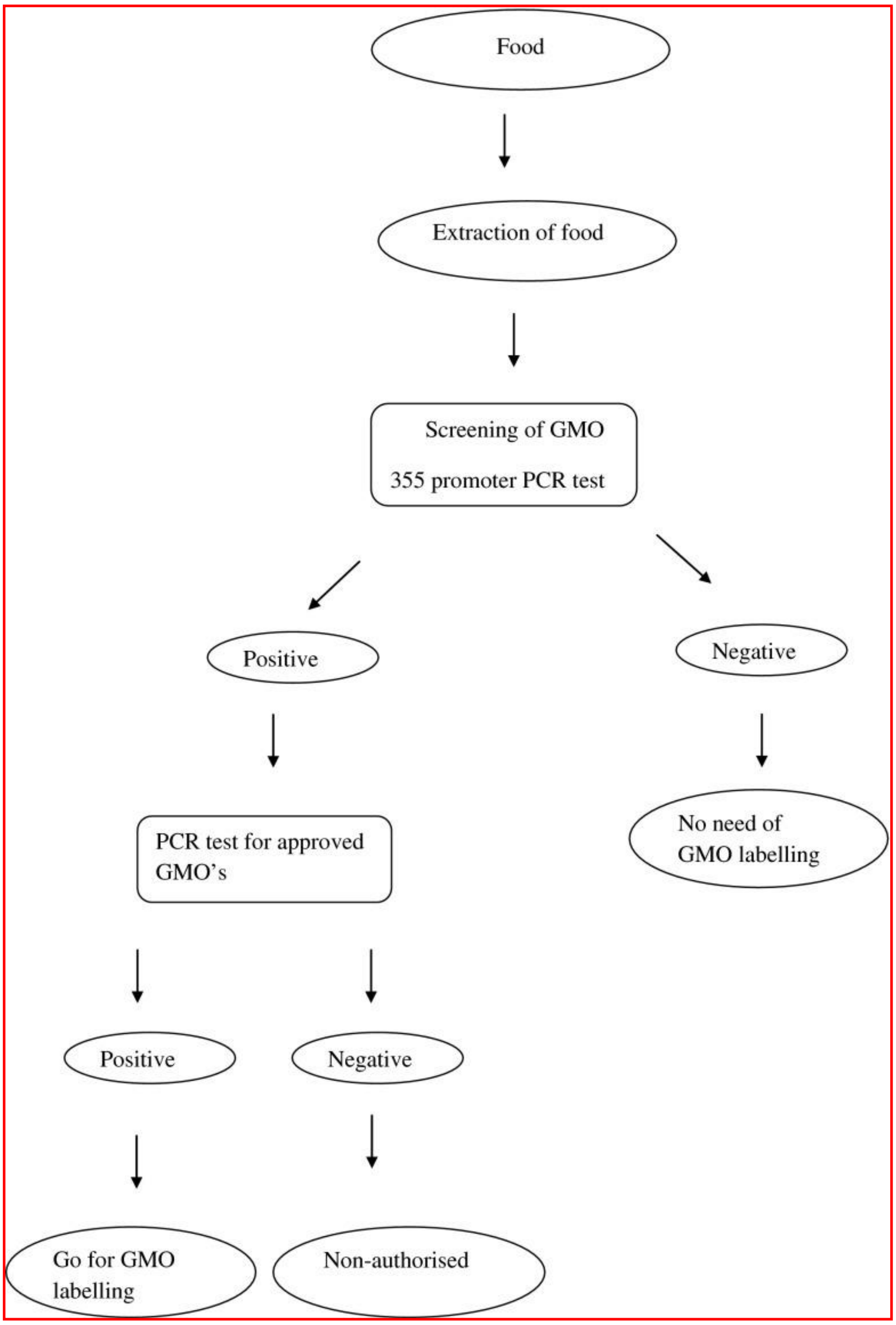

Fig. I1 Protocol for the testing of genetically modified foods

Is the safety of GM foods assessed differently from conventional foods?

Generally, consumers consider that conventional foods (that have an established record of safe consumption over history) are safe. Whenever novel varieties of organisms for food use are developed using the traditional breeding methods that had existed before the introduction of gene technology, some of the characteristics of organisms may be altered, either in a positive or a negative way. National food authorities may be called upon to examine the safety of such conventional foods obtained from novel varieties of organisms, but this is not always the case.

In contrast, most national authorities consider that specific assessment are necessary for GM foods. Specific systems have been set up for the rigorous evaluation of GM organisms and GM foods relative to both human health and the environment. Similar evaluations are generally not performed for conventional foods. Hence there currently exists a significant difference in the evaluation process prior to marketing for these two groups of food.

The WHO Department of Food Safety and Zoonoses aims at assisting national authorities in the identification of foods that should be subject to risk assessment and to recommend appropriate approaches to safety assessment. Should national authorities decide to conduct a safety assessment of GM organisms, WHO recommends the use of Codex Alimentarius guidelines? (See the answer to Question 11 below).

How is a safety assessment of GM food conducted?

The safety assessment of GM foods generally focuses on: (a) direct health effects (toxicity), (b) potential to provoke allergic reaction (allergenicity); (c) specific components thought to have nutritional or toxic properties; (d) the stability of the inserted gene; (e) nutritional effects associated with genetic modification; and (f) any unintended effects which could result from the gene insertion.

Are GM Food safe:

Different GM organisms include different genes inserted in different ways. This means that individual GM foods and their safety should be assessed on a case-by-case basis and that it is not possible to make general statements on the safety of all GM foods.

GM foods currently available on the international market have passed safety assessments and are not likely to present risks for human health. In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved. Continuous application of safety assessments based on the Codex Alimentarius principles and, where appropriate, adequate post-market monitoring, should form the basis for ensuring the safety of GM foods.

WHO has been taking an active role in relation to GM foods, primarily for two reasons:

- on the grounds that public health could benefit from the potential of biotechnology, for example, from an increase in the nutrient content of foods, decreased allergenicity and more efficient and/or sustainable food production; and
- based on the need to examine the potential negative effects on human health of the consumption of food produced through genetic modification in order to protect public health. Modern technologies should be thoroughly evaluated if they are to constitute a true improvement in the way food is produced.

WHO, together with FAO, has convened several expert consultations on the evaluation of GM foods and provided technical advice for the Codex Alimentarius Commission which was fed into the Codex Guidelines on safety assessment of GM foods. WHO will keep paying due attention to the safety of GM foods from the view of public health protection, in close collaboration with FAO and other international bodies.

Main text Genetically Modified Plants (GM) crops versus classically-bred crops

Both conventionally bred and genetically modified (GM) crops result from genetic alterations made using gene transfer technologies developed by the ancient Greeks. Changing DNA sequences and the arrangement of genes is a possibility with both traditional breeding and GM technologies. As opposed to traditional breeding, which may entail hundreds of genes of an organism that have not yet been identified, the number of genetic modifications brought about by GM technology is minimal and clearly defined. Moreover, genetically modified (GM) crops are the result of precise and targeted genome change in which the final products, such as proteins, metabolites, or phenotypic, are fully described. The genomes of both parents are combined and re-assigned at random in conventional breeding. This means that some bad genes may be passed on to the next generation alongside the good ones, while others may be lost. Plant breeders do repeat back-crossing to the preferred parent to fix these issues. Separating a closely connected dangerous gene is a time-consuming process that is not always successful. Potatoes bred the conventional way tend to have high levels of naturally occurring glycoalkaloids, for instance (Hellenas*et.al.,* 1995) Problems with the digestive system, the cardiovascular system, the nervous system, and the skin are all symptoms of alkaloid poisoning, which is caused by these glycoalkaloids. Dianisidine is a toxin that is only found in S. tuberosum x S. provide hybrids and not in either parent species (Laurila*et.al.,* 1996). For example, harvesters of a conventionally produced insect-resistant high psoralens variety of celery reported developing skin rashes (Berkley *et.al.,* 1998). As a result, there may be unforeseen consequences and even dangerous novel products produced by traditional (non-GM) breeding techniques. However, tissue/organ/development/stress-specific expression is feasible using GM technology due to precise control over the time and placement of gene products, which is difficult to achieve through conventional breeding. On top of that, as opposed to traditional breeding, which takes several generations of cross-pollination, GM methods allow for the simultaneous introduction of multiple new features. From a scientific standpoint, there is no difference between the consequences on human health and the environment from foods generated through normal breeding and those developed using GM technology.

CONCLUSION:

There are many issues in agriculture and society that plant biotechnology could help solve. Content-adding procedures including genetic modification (GM) are widely utilized to increase the nutritional value of food crops by adding beneficial compounds such as proteins, vitamins, iron, zinc, carotenoids, anthocyanins, and so on, and to reduce yield losses caused by biotic and abiotic challenges. Efforts to extend the storage life of fruits and vegetables are also undertaken in an effort to drastically cut down on post-harvest crop losses. Vaccines that can be eaten are being developed for use in fruit crops as well, with the goal of stopping the spread of deadly illnesses. Despite the fact that the amount of land dedicated to genetically modified (GM) crops increases every year throughout the world, no negative side effects have been reported despite the fact that these crops have been grown in a broad variety of habitats and consumed by large populations. Better insect and weed control, increased yields, and less reliance on chemical pesticides have all benefited farmers thanks to presently cultivated insect-resistant Bt crops and/or herbicide-tolerant GM crops. Thus, it follows that achieving food security for present and future generations is possible through the sustainable integration of conventional agricultural techniques with contemporary biotechnology. Before being allowed for commercial production, genetically modified crops must undergo extensive bio-safety studies and have their performance monitored over several generations in the field. The great potential of biotechnology must be tapped for the sake of humanity, and GM crops are going to be a vital part of our lives.

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