Genetically modified food: good news but bad press.

Pamela Greenwell
Sanjiv Rughooputh
School of Biosciences

This is an electronic version of an article published in The Biomedical Scientist, 48(8), pp. 845-846, August 2004.

ARTICLE

As a concept, the genetic manipulation of plants and animal is far from new, but it is only since the introduction of recombinant technology that concerns have been expressed. In this overview, Pamela Greenwell and Sanjiv Rughooputh look at the wide-ranging effects of DNA transfer between species.

Genetically modified food

Good news but bad press

The negative aspects of genetically modified (GM) foods are often presented in the media. Reports of 'supercrops', 'superweeds', allergic reactions, health hazards and environmental damage have appeared. So, are GM foods really bad news or is the public simply being misled about the good and bad aspects of this technology?

Since man started to modify plants some 10,000 years ago, farmers have been searching for new crops and varieties that are more productive. With the discovery of fundamental genetics, organisms have been selected to express a range of required traits. Hence, new animal strains, plant varieties and hybrids have been produced. Now, with the introduction of recombinant DNA techniques, the transfer of DNA between species is possible.

First-generation GM foods were designed to provide growers with alternative crop management solutions. Here, selected genes were identified from plants and other sources and then transferred to the crop plant. Subsequent modifications provided traits such as enhanced nutrition or health promoting characteristics; however, GM food remains a controversial subject because of public misconception of the risks.

With changing climatic conditions and pest infestations, growing food crops is becoming a real challenge to farmers both locally and internationally, a situation compounded by the increase in population. With a predicted global increase of 10 billion by the middle of the century, it is imperative that food crops are found that are more productive and are resistant to the changing weather conditions and to more pests.

Against this background, many biotechnology companies are making use of recombinant gene technology to produce GM crops that would, in theory, be able to meet these conditions. For example, different genes have been studied that would make plants more resistant to pests or allow them to grow in adverse weather conditions.

> 'Genetically modified food remains a controversy subject because of public misconception of the risks'

Natural insecticides and edible vaccines

One gene currently under investigation is from *Bacillus thuringiensis*. The so-called *Bt* gene produces proteins such as Cry1Ab and Cry9c, which are toxic to certain insects. The rationale for the introduction of this gene into crops under culture is that it will produce plants that are resistant to certain insects, thus reducing or eliminating the need to use pesticides. The quality of food thus produced will be both better and cheaper.

The *Bt* gene is currently used in corn (eg Starlink corn developed by Aventis CropScience) and soybeans. Trials in rice are underway in China, while scientists in Kenya have been trying to develop a 'golden maize'. However, there are fears that farmers growing crops containing the *Bt* gene will use other insecticides more liberally as the plants will be resistant to certain insects. Also, transfer of the *Bt* gene from the food crop to other plants could result in the production of a 'superweed' that might prove difficult to eliminate.

Interest has also been shown in the gene that allows sorghum to grow in extremely dry conditions. Researchers in Texas have been studying this plant for the past 15 years and they are now confident that genetic manipulation will allow it to grow in arid conditions.

Other concepts that have surfaced recently include the delivery of 'edible vaccines', made possible when a gene with vaccine potential (eg a viral surface antigen) is introduced into tomato or potato plants. The aim is to deliver low-cost vaccines to remote, inaccessible places in, for example, rural Africa.

Is GM food safe?

Thus far, GM food has not been proven to be harmful, although there have been some fears that it may produce allergies, which are immunological responses to the presence of foreign proteins in the body. Recently, Sten *et al.*[1] investigated patients who were 'soybean sensitised' to determine the allergenicity of different soybeans. Both GM and non-GM soybean were tested by measuring the levels of IgE and histamine release; however, they were unable to establish any allergenic potency in the GM soybean.

Similarly, Raybourne and colleagues[2] investigated the insecticidal protein Cry9c, which is suspected of causing allergic reaction. On testing the sera of 18 people they concluded that there was no link

> 'Although a single gene may not have an adverse effect, its interaction with other genes may have an impact on the phenotype of recipient cells'

between allergic conditions and Cry9c. However, although the protein could not be incriminated, they suggested that glycosylated epitopes of Cry9c expressed in the plant could be responsible for the allergy. To date, this problem has not been investigated on a large scale.

The International Food Biotechnology Council (IFBC)[3] published on the issue of GM food in 1990 and subsequently specific guidelines have been produced by the Food and Agriculture Organisation (FAO), the International Life Sciences Institute (ILSI) and the Organisation for Economic Cooperation and Development (OECD). The EU has also produced legislative policies related to transgenic products (EU Directive 2001/18/Ce).

Other causes for concern include the safety of any new proteins synthesised, and their potential side effects, not only on the individual but also on the bacteria that may be exposed to the new protein, either in the intestinal tract or in the soil. Although a single gene may not have an adverse effect, the interaction with other genes may affect the enzymatic and metabolic pathways and thus have an impact on the phenotype of recipient cells.

From the time of Mendel, plant biologists have crossbred species to produce more resistant and productive traits. This type of crossbreeding transfers uncontrolled and randomly assorted groups of genes. In contrast, recombinant DNA technology allows precise identification, characterisation, enhancement and transfer of selected genes.

There are well-founded fears about conferring resistance during the process of selection of hybrid plants. Indeed, antibiotics such as kanamycin, ampicillin or chloramphenicol are used as selectable markers to identify organisms that have taken up the gene of interest. However, new concepts have been developed that do not require the use of antibiotics as a selectable marker for gene uptake.

Alternative methods of selection

The simple sugar mannose can be used for selection. Plants convert mannose to mannose-6-phosphate, using a hexokinase. Susceptible plants that cannot metabolise mannose-6-phosphate accumulate it and this inhibits growth. Thus, the plants are transformed with the gene of interest, together with the gene for phosphomannose isomerase (PMI). The latter converts mannose-6-phosphate to fructose-6-phosphate, which is easily metabolised. The plants are then grown on mannose. Only those that have taken up the gene of interest and PMI will grow, while those that have not been transformed will not. The plants are then screened for the uptake of the gene of interest.

Health and recombinant drugs

Recombinant DNA technology has been used for decades in the health sector. Scientists at Genentech first cloned human insulin in 1978 and recombinant insulin was marketed in 1982. Furthermore, recombinant hepatitis B vaccine is offered to all health service workers to prevent HBV infection. The US Food and Drug Administration (FDA) tested these products stringently before they were made available for use.

Antibiotic resistance

The public remains sceptical about GM products. But what is the underlying fear? Is it antibiotic resistance in the food chain?

The veterinary industry is a heavy user (or abuser) of antibiotics as these are given to animals prophylactically to enhance growth. The animals are then slaughtered for human consumption and the antibiotics find their way into humans through the food chain. As there is considerable pressure on farmers to produce ever larger quantities of cheap meat, it is unlikely that the practice of using prophylactic antibiotics in animal husbandry will cease.

> 'Genetically modified foods undergo considerably greater scrutiny of their nutritional and toxicological content than do traditional crops'

Under scrutiny

Fear that GM plants may produce harmful proteins remains a concern. Genetic modification is carried in a controlled manner. Production of any unusual protein can be detected and accounted for using techniques such as the polymerase chain reaction (PCR).

As Malarkey[4] pointed out, GM foods undergo considerably greater scrutiny of their nutritional and toxicological content than do traditional crops, and this makes them safer. Some 1700 GM foods have been analysed in the EU and around 7800 in the USA. In the EU only five GM crops have been approved, and the amount of GM food produced accounts for just 0.03% of world production. In the USA, 50 GM crops have been approved.

Global perspective

Objective assessment might suggest that GM food is safe; however, people should be comfortable with what they eat, and it is imperative that the public be made aware of which products are genetically modified so that an informed choice can be made. Clearly, as the farming industry is under pressure to produce more food at a competitive price, it is almost inevitable that GM foods will find their way into markets and supermarkets.

However, the value of GM crops to the Third World should not be underestimated. Famine and poverty are responsible for millions of deaths each year, and thus crops designed to be resistant to pests, grow in unfavourable conditions and produce products with a higher calorific value could save lives.

Importantly, liaison with biotechnology companies is essential to ensure that crops which undergo genetic modification are fully tested and that their effects are well scrutinised to prevent the uncontrolled spread of the introduced genes. ■

REFERENCES

1 Sten E, Skov PS, Andersen SB *et al*. A comparative study of the allergenic potency of wild-type and glyphosate-tolerant gene-modified soybean cultivars. *APMIS* 2004; **112**(1): 21–8.
2 Raybourne RB, Williams KM, Vogt R, Reissman DB, Winterton BS, Rubin C. Development and use of an ELISA test to detect IgE antibody to Cry9c following possible exposure to bioengineered corn. *Int Arch Allergy Immunol* 2003; **132**(4): 322–8.
3 International Food Biotechnology Council. Biotechnologies and food: assuring the safety of foods produced by genetic modification. *Regul Toxicol Pharmacol* 1990; **12**: S1–S196.
4 Malarkey T. Human health concerns with GM crops. *Mutat Res* 2003; **544** (2–3): 217–21.

Dr Pamela Greenwell and Dr Sanjiv Rughooputh are members of the Molecular and Medical Microbiology Research Group at the School of Biosciences, University of Westminster, London.