

## Genetically modified food : friend or foe ?

There is an increasing interest worldwide in genetically modified (GM) food, also known as genetically modified organisms or living modified organisms. Genetic modification implies the introduction of genes from plants or animals into other organisms to change their behaviour and development. Genetic manipulation can endow such organisms with the ability to increase yield, resist disease, defy attack by pests, and expand tolerance to herbicides, pesticides and toxins. It has also produced foods that have better keeping qualities, increased shelf life and commercial value. The expected end result is the availability of more food for the people. Specialised genetic manipulation has even produced newer varieties of rice such as “Golden Rice” which is rich in  $\beta$ -carotene [1], and is consequently expected to reduce the prevalence of vitamin A deficiency in the developing world, and “high iron rice” which could do likewise with iron deficiency anaemia [2].

Food is essential for the survival of the human race. The quantum of food available globally is threatened by many factors including natural and man made disasters. Geographic and seasonal variations in the availability of food, their keeping qualities and nutritional value are of abiding importance to the entire world. There is little doubt that GM foods have several benefits to offer the human race and many countries have taken to the production of GM foods on a huge scale. The biggest producer of such foods, the USA, is estimated to have over 80 million acres planted with genetically modified flora.

Yet, GM foods have become a contentious issue in recent times. Concerns have been expressed as to their safety for human health as well as the environment. Some of these apprehensions are based on documented evidence but a significant proportion is the product of conjecture. It is claimed that genetic modification uses material from organisms that have never been a part of the human food supply to change the fundamental nature of what we eat, and that without long term testing, their safety is doubtful. Many authorities are apprehensive also about the imprecise technology of gene modification with random insertion of the genes, and possible effects of mutations [3].

Many Americans have died of [4] and large numbers have been afflicted by [5] the eosinophilia-myalgia syndrome attributed to genetically modified L-tryptophan ingestion. In fact, the Japanese chemical company responsible for its production paid two billion US dollars to the victims as compensation. Near deaths have been reported from allergic reactions to consumption of GM soybeans into which Brazil nut genes had been spliced

[6]. Certainly, the products of agricultural biotechnology should be subjected to comprehensive safety assessments before marketing [7].

In a comparative study of rats fed on non-GM and GM potatoes, there was a significant increase in the mucosal thickness of the stomach and crypt length of the intestine in those fed on GM potatoes [8]. These effects were due to the insertion of a gene which had been preselected as a non-mitotic lectin, unable to induce hyperplastic intestinal growth and epithelial T lymphocyte infiltration. Such unexpected effects may have implications for proliferative human gut lesions.

There are several other hypotheses that may be relevant to human health. The genetically modified recombinant bovine growth hormone (rBGH) used in dairy cows may have implications for human cancer and degenerative diseases. It increases insulin-like growth factor 1 (IGF-1), which raises the risk of human breast, prostate and colon cancer by 400% to 500%. rBGH is secreted in cow milk and only about 20% of it is destroyed even after boiling for 30 minutes. Genetically modified foods are at least partially incriminated in the increased cancer rates of the 20th century. GM foods have also been considered to be one of the causes for the production of gene mixing in viruses leading to the so-called “super viruses”. One such example is the cauliflower mosaic virus (CaMV), the most common virus used in genetic engineering, which is a “pararetrovirus”. It is similar to the Hepatitis B virus and HIV, and the implications of infections caused by a modified “super” CaMV are quite disturbing.

Some GM foods involve antibiotics. Milk cows injected with rBGH have increased udder infections requiring dosing with antibiotics, leaving unacceptable levels of antibiotic residue in milk, with the possible hazard of promoting antibiotic resistance. Much of genetic implantation uses marker genes to track the progress of the implanted genes. The GM maize plant uses an ampicillin-resistant marker gene. Propagation of this gene may threaten the usefulness of a vital antibiotic.

It has been suggested that there is no way of predicting the effects of GM foods on human evolution. Increases in birth defects and shorter life spans are two of the hypothetical disasters that have been predicted. GM foods have also been accused of developing interior toxins, the so-called “pesticidal foods” with the potential to cause long term health sequelae. Some GM foods are known to have lower levels of vital nutrients, particularly phytoestrogen compounds that protect us from heart disease and cancer. Other GM foods seem to have compounds that are probably best avoided in the human

diet. One example is of the GM line of glyphosate-resistant soya that contains about 30% more of the Kunitz-trypsin inhibitor, a known anti-nutrient and an allergen.

Many effects of GM food on the environment too have been postulated. Some of them have been documented while others are only hypotheses [6, 9]. The need to use increased amounts of herbicides and pesticides for GM plants, effects on the ecology, impact on soil, extinction of certain varieties of seeds, emergence of “super-weeds”, and possible effects on insects and larger animals are just a few of these. Widespread crop failures and genetic pollution from cross-pollination are also causing concern. It has been shown that more than 50% of wild strawberries growing within 50 m of a GM strawberry field had acquired GM gene markers [6]. In the event of a catastrophe, once genes are released into the environment, their elimination may be impossible.

A major problem with rational assessment of any form of GM food is the dearth of data on their long term safety for human beings. In fact there are no peer reviewed publications of clinical studies on the human health effects of GM food. Even animal studies are few [10]. The preferred approach of the industry has been to use compositional comparisons between GM and non-GM crops. When they are not significantly different the two are regarded as “substantially equivalent”, and the GM food crop is regarded as safe as its conventional counterpart [10]. This ensures that GM crops can be patented without animal testing. But substantial equivalence is an unscientific concept that has never been properly defined, and there are no legally binding rules on how to establish it [11]. Nevertheless, an independent review of over 600 scientific papers in the UK [12], while acknowledging that there are gaps in scientific knowledge, concludes that existing genetically modified crops and foods pose a “very low” risk to human health, and are “very unlikely” to rampage through the British countryside. The report also stresses that existing uncertainties should not be allowed to hold back scientific advances. The Food Standards Agency of the UK, the institution responsible for evaluating GM foods under the European Union Food Regulation, is confident that all GM foods in the region are subjected to rigorous safety assessments before being permitted. The procedure can involve up to 60 independent scientists, and the agency is satisfied that the current safety assessment procedures for GM foods are sufficiently robust to ensure that approved GM foods are as safe as their non-GM counterparts [13]. However, accusations have been levelled against the governments of both the UK and USA for suppressing evidence that some GM foods, specifically GM potatoes and GM tomatoes, had adverse effects in experimental studies [14].

It may be thought that GM foods are not a serious threat, as they are not distributed worldwide. However, it is a sobering thought that between 1997 and 1999, gene-modified components appeared in two-thirds of all the

processed foods in the USA [6]. During that time, as much as one quarter of all American agricultural land was quickly used to raise GM crops. Given the propensity and speed with which many ingredients of the currently available foods are processed from a variety of sources, it is likely that gene-modified constituents are present in a significant proportion of our food. This is perhaps unavoidable, as things stand in the world today. What is certainly not in dispute is that the people should be given the opportunity of making informed choices on the food they eat. It is essential that globally, laws should be modified to make it a mandatory requirement for complete labelling of GM foods. It has been claimed that there is widespread dumping of such foods on the unsuspecting people of the developing world. It is high time that, at least in our little island, strict laws are imposed to make complete labelling of GM foods an obligatory requirement.

One has to agree with the article in *Science* [15] that there are many opinions but only scarce data on the potential health risks of GM food crops. Present databases are woefully inadequate and the scientific quality of what has been published is, in most instances, of poor standard. Small differences between GM and non-GM crops may have little biological significance, but it is clear that most GM crops fall short even of the definition of “substantial equivalence.” Besides, this poorly defined and unscientific concept, has long outlived its putative usefulness. If we are to put this technology on a scientific basis and allay people’s fears, we need novel methods and concepts to assess compositional, nutritional, toxicological and metabolic differences between GM and conventional crops, and the safety of genetic techniques used. We need more science, certainly not less. It would be wise to hold off until we know more about the health, ecological and economic effects of genetically modified food [16].

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## **The evidence based reformer can face isolation, ostracism and cost**

It is easier to engage in one controversy at a time; I am not sure I could have coped at the same time with the onslaught from the British glass industry that followed publication of our research finding that pub glasses were often used as weapons in assault and that toughened glasses were safer than non-toughened glasses (*BMJ* 1994; **308**: 932). Before the UK glass industry switched to toughened pint glasses in 1997 I vividly remember picking up the office phone to hear the director of a glass company protesting that my research would put 500 of his employees out of work.

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