



GM Food: Scientific Evidence of Health Risks

1. Introduction

The Soil Association believes that genetically modified (GM) foods should be completely prohibited. This is because their use goes against the Association's principles for safe and sustainable food production, including:

- the use of natural biological processes
- production only to the natural capacity of the crop, livestock and environment
- a systems approach to food production (recognising that interactions occur between different aspects of the system, so individual aspects cannot be considered in isolation)
- a precautionary approach to safety issues

Although this opposition has sometimes been referred to as 'anti-science', it is supported by the scientific evidence. The evidence that has emerged on GMOs over the last few years indicates that there are several risks to human health and the environment.

2. What Do Scientists Really Know About the Risks?

Contrary to the statements by the biotechnology companies that genetic engineering is a precise technique and just an extension of traditional breeding methods, the process is significantly different. According to many scientists, the outcome is inherently random, introducing many new risks. GMOs have now been marketed for several years, but scientific knowledge of the processes involved are still at an early stage. Not only is the process probably unsafe, but key information and experimental data which would be needed for safety assessments are lacking.

- **Random location of the inserted genes:** when genetic engineers create GM crops, they do not insert the gene in a particular position. The gene ends up in a random location in the genetic material, disrupting the existing genes at that place. Also, genes do not work in isolation but interact with each other. Unintended side-effects therefore occur and most GM plants are deformed. As the side effects are often not obvious, they may not all be identified and eliminated before the GMO is marketed. There are many examples of unexpected effects being found in GM plants in the US only after approval (eg. GM cotton with deformed cotton bolls; increased lignin in GM soya).

- **Lack of normal control over the genes:** all genes are present in every cell of an organism. But in nature they do not function the whole time or in every cell: genes are controlled so that they only operate in the relevant part of the plant and at the necessary time (eg. gene for flower opening would only operate in the flower bud in spring). This control is believed to be from a mixture of the other genetic material (only a small part of the genetic material of an organism comprises functional genes) and the gene's local chemical environment in the organism. However, little is known about this, so most GMOs have no equivalent control to natural organisms. The genes usually operates the whole time in every cell, including the part destined for consumption.

- **Most genes have several functions:** Genetic engineering is based on a false assumption, that each genes has only a single function. The discovery that humans have only c.30,000 genes producing the c. 250,000 proteins in the body showed that most genes actually have several effects. It is not yet known how these different functions are controlled. In other words, it is not known how to artificially determine only a *single* function of a gene, without other undesired effects.

The random position and lack of control of the gene's functions and how it interacts with other genes, means side effects are generally inevitable. These could affect any character of the plant and are unpredictable in advance. These changes may be evident immediately, in which case they can often be eliminated, or only in response to environmental stresses (eg. the increased lignin in GM soya was only evident in hot weather when the stems started splitting).

- **Horizontal gene transfer:** Genetic engineers introduce the foreign gene into plant cells along with other genetic material of bacterial and viral origin. The other parts insert the gene ('vectors'), activate it

('promoters'), and indicate the successful transfers ('markers'). Together these form a 'construct'. The constructs are specifically designed by genetic engineers to 'cross the species barrier' so that genes can be introduced artificially, including from other species. Some scientists are concerned that this also means that artificial genetic constructs are much more liable to "horizontal gene transfer" than non-GM organisms - the inserted genes may move out of the GMO and enter other micro-organisms, or possibly even mammalian cells. This could result in GM characteristics being taken up from GM food by our gut bacteria, or taken up by micro-organisms and result in new viral diseases. Worryingly, the first human trial of GM food, by the University of Newcastle in 2002, found that transgenes indeed do transfer out of GM soya and into the human gut bacteria.

Therefore even if a gene is 'safe' in the original organism, it may not be 'safe' in a GMO. The problems with the process of genetic engineering calls into question the whole technology, not just individual GMOs. Neither the public information nor the testing procedures of the biotechnology companies fully address these problems.

- **Novel allergens:** genetic engineering causes new proteins to be present which could cause allergic reactions. The companies are required to exclude this risk by screening GM plants, but the science of identifying and testing for allergens is not well developed. A study found that one GM soya contains 27% more of an allergen trypsin inhibitor (Padgett *et al*, 1996). The accidental contamination of many US foods with GM StarLink maize in 2000 is believed have caused allergic reactions in over 50 people, some serious.

- **Herbicide resistant plants: toxicity of the herbicide:** the creation of herbicide resistant plants allows the use of herbicides on the growing plant that would not normally be possible. This means people could be exposed to new residues in their food. The consequences have not been properly considered. For example, the GM forage maize, Chardon LL, was approved for commercialisation by the Government, despite a risk to human health from this aspect. The herbicide that would be used on the plant is glufosinate, a neurotoxin and a teratogen (damaging to embryos). Apparently, there is a reversion rate of up to 10% of the degraded herbicide back to the original toxic form in the gut.

- **Increase in agrochemicals:** contrary to the industry claims that herbicide use is reduced by herbicide tolerant (HT) GM crops, recent data shows farmers in North America and Argentina have substantially increased their use of herbicides.

- **Effect of processing GMOs:** it is often stated by the biotechnology companies and Government, that processing denatures DNA. However, a study (October 2000) by the Advisory Committee on Animal Feeding Stuffs revealed that "DNA fragments large enough to contain potentially functioning genes" survived the processing of GM food for animal feed. This increases the concerns over horizontal gene transfer.

- **Nutritional differences:** There can be significant nutritional differences in GMOs due to the side effects of the gene and the insertion process. The companies are required to screen GM crops to ensure that changes are no greater than variations resulting from other breeding methods or different environmental conditions. However, the science of nutrition is far from complete and only a limited number of nutrients are screened; moreover negative findings have often been ignored. Despite claims that Chardon LL maize had no nutritional differences, a peer review of the company data revealed significant differences in fat, protein and fibre content. Milk from GM soya-fed cattle was also found to have a higher fat content.

- **Contamination of surrounding areas:** Any risks from GM crops will apply to a large area around the crop. A review of the scientific literature by the National Pollen Research Unit concluded that separation distances of 1-6km are needed to protect non-GM food from contamination by GM pollen. However, the Government is still using industry backed distances, which are a fraction of those recommended.

3. Tests for the Effects on Health

(i) Safety trials of GM foods are not required

Despite all this uncertainty and the claims that GMOs have been "rigorously tested", routine trialling for unexpected health effects is not required before GMOs can be sold as food or grown in the open countryside. New medical drugs and pesticides, in contrast, undergo lengthy animal trials for side effects to be discovered. However, with GMOs the testing for side-effects is mainly limited to establishing whether the levels of known nutrients, allergens and toxins are similar to the non-GM plant. This approach is called the 'principle' of "substantial equivalence". It is condemned by many scientists since the concerns are not just about the impacts on known important compounds but about the *unpredictable* effects of the process. The Government and companies argue that there are difficulties in designing suitable animal feeding trials.

(ii) Shortage of independent and peer reviewed research

There is a major shortage of independent and peer reviewed research on the health effects. The Government

relies mainly on company data to assess the safety of GMOs, most of which are not peer reviewed or published. Many animal feeding trials have been done to test the commercial value of GM animal feed, but only a handful have been carried out on the safety aspects. Moreover, unexpected negative effects that have emerged in the small body of independent, peer reviewed research have been ignored. Dr Pusztai's research on GM potatoes was the only UK Government sponsored animal safety trial of GMOs and it found unexplained effects. The paper was peer reviewed and published - in the Lancet, a prestigious medical journal. Both the Lancet and the Royal Society said the results should be investigated. However, after heavy attacks by the biotechnology companies, it and similar findings have been ignored.

(iii) Studies on the health effects

Some of the independent studies have found problems. Most of the published company studies concluded there were no significant effects, but in some cases when other researchers looked at the data more closely, they found negative effects. At least four studies have found negative effects:

- Flavr Savr tomato: resulted in lesions in the rats. On a scale of 1-4, the effects were 2-3, but described by the company as "mild". Seven of the 40 rats also died within a fortnight. Despite concerns by US scientists, it was approved in the US and the UK.
- GM potatoes: Dr Arpad Pusztai's experiments at the Rowett Institute found gut lesions in rats following consumption of GM potatoes with the gene for lectin production. The rats were unaffected by non-GM potatoes or lectin alone.
- GM forage maize (Chardon LL): in the company study, twice as many chickens died as those fed non-GM feed (10 vs. 5). The UK Government approved the maize.
- Newcastle University research on gene transfer: this study, commissioned by the Food Standards Agency, found that eating food containing GM soya results in the inserted genes moving out and entering the gut bacteria.

4 Evidence of Effects in the General Population

It is often claimed that there have been no ill effects from several years of GMO consumption in the US. However, there is no scientific evidence to support this statement. Indeed, one GM food product is known to have caused severe problems and health trends indicate that unidentified negative effects could be occurring:

- L-tryptophan: this GM food supplement caused many deaths and disabilities in the US, because of unidentified toxins. The company paid £2 billion to over 2000 victims.
- UK: soya allergies rose by 50% over the previous year in 1999 when imports of GM soya started, according to the York Nutritional Laboratory which monitors allergies.
- Ireland: doctors report a rise in soya allergies in children since the start of GM soya imports. (Dr Elizabeth Cullen, co-chair of the Irish Doctors', The Irish Times 13.3.2001)
- US: coinciding with the introduction of GMOs in food, food derived illnesses are believed to have doubled over the last seven years. (New York Times, 18.3.2001)

From the above, the claimed safety of GMOs is based on many assumptions about the effects and not fully supported by the limited available scientific evidence.

5 Conclusion

Genetic engineering introduces many random hazards, and the limited level of scientific knowledge means that risk assessment and control measures cannot be reliably designed. Currently, it seems that decisions on the safety of GMOs and the necessary control measures are often not being made on the basis of science, but on assumptions and industry opinion. Some scientists are concerned that GM crops could therefore cause unpredictable and possibly serious impacts on health and the environment. The way in which genetic engineering is being introduced into food production is unnecessary and unsound. We believe all research on GMOs should take place in contained conditions. There are many good solutions to the problems of agriculture which involve far less risk and uncertainty, and offer clear and substantial benefits. Investment should be preferentially directed at these solutions.

Further Reading

"Seeds of Deception", Jeffrey Smith. Available from sales@greenbooks.co.uk, 01803 863 260

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