

**Daniel Ramón**

Correspondence to:  
Departamento de Biotecnología. Instituto de  
Agroquímica y Tecnología de Alimentos (CSIC).  
46071 Valencia. Spain  
Tel.: +34-963900022  
Fax: +34-963636301  
E-mail: dramon@iata.csic.es

## Genetically modified foods: a case of information or misinformation?

Some twelve thousand years ago, agriculture, as we know it, began in a region of the Fertile Crescent (present Iraq, Syria, south of Turkey, Jordan). Since then, humans have selected better varieties of plants and hence performed plant biotechnology. Likewise, stockmen have been selecting improved animal lines by genetic crossing. Humans have thus long applied genetics in an empirical way to select better varieties of plants, animals and industrial starters for food production. During the last fifteen years, it has become possible to apply molecular genetic engineering techniques in food technology. The application of these techniques has given rise to the so-called genetically modified foods (called “transgenic foods” in Spanish speaking countries) whose commercialization has brought about much discussion, particularly in Europe.

The difference between genetically modified food and conventional food lies in the type of genetic technique used, and can be summarized as follows: (i) reduction in the random nature of the classical genetic approach, (ii) shortening of the development time of the product, and (iii) the possibility of crossing the species barrier. This last point has both ethical and social implications which scientists working in this field should not overlook.

About sixty different genetically modified kinds of food have been marketed world-wide. In the European Union (EU), although only two genetically modified foods have been authorized for commercialization, there is an intense social debate concerning the risks associated to the production of such foods. Two poles of opinion exist: on the one hand, the production companies; on the other, lobbies—mainly environmentalist groups—, which view genetically modified foods as a risk to both health and the environment, and are against their commercialization. Three premises must be taken into account to clarify this discussion. Firstly, it is obvious that zero risk does not exist neither in what we eat nor in any other facet of life. Secondly, more than 300 genetically modified foods have been developed, each of them with different properties. Thirdly, there are at least three distinct areas of putative risk: health, environmental and financial. Bearing this in mind, it would be desirable to evaluate foods on a case by case basis; and each case, risk by risk.

One strategy for the safety evaluation of genetically modified foods is to compare their risks with those of conventional foods. The concept of “substantial equivalence”, generally well accepted by the scientific community, involves the comparison of a genetically modified food to its traditional counterpart. If substantial equivalence can be established between them, the novel food can be treated like the conventional food with respect to safety. The studies made by scientists, combined with debates held by

organizations such as FAO, OECD and WHO, confirm that genetically modified foods commercialized to date are at least as safe, with regard to the health of the consumer, as conventional foods. They have all passed strict tests to check their nutritional composition and their lack of allergenicity and toxicity.

Detractors of these products express their concerns about a potential increase in the allergenicity of genetically modified foods, and the transfer of marker genes encoding antibiotic resistance from the novel food to the intestinal microbiota. Of all genetically modified foods tested to date, there is only one reported case of genetic transfer of allergenicity to a transgenic soybean expressing a Brazil nut gene. The problem was detected during the safety evaluation, and this food was never commercialized. With respect to antibiotic resistance, at present there is general agreement to avoid the presence of these genes in the final genetically modified organisms. As recognized by WHO, the presence of these genes *per se* in foods would not constitute a safety concern. Nevertheless, given the technical feasibility of avoiding their presence in the final product, antibiotic marker genes should be eliminated from food products obtained by genetic engineering.

On August 10, 1998, Arpad Pustzai, a scientist working at the Rowett Research Institute in Aberdeen (Scotland), appeared in a TV documentary, “World in Action”. Pustzai described how five rats fed with genetically modified potatoes expressing a lectin exhibited slightly stunted growth, and their lymphocytes demonstrated a suppressed response *in vitro* to mitogenic stimuli. Two days later an official letter from his institute indicated that the feeding trials had been prepared but not completed. By then, however, public opinion in the UK was totally against genetically modified foods. More than one year later, and after three revisions and the criticisms of six different reviewers, the results of Pustzai’s work were published in *The Lancet* [3]. The opinion of the experts is that the data presented are incomplete, too few animals were included per diet group, and there were insufficient controls. Consequently, the results are difficult to interpret and do not allow us to conclude that the consumption of genetically modified potatoes has adverse effects on animals. Nevertheless, the alarmist climate against genetically modified foods in the UK has not dissipated.

The release of transgenic organisms into the environment has potential ecological risks and, in contrast to safety evaluation, there is little previous experience / expertise in environmental risk assessment. In the case of genetically modified foods, transgenic organisms to be released are primarily plants. Thus the possible spread of a transgene from its transgenic host to wild relatives is

a potential risk. Gene transfer between sexually compatible varieties is a constant in nature and in this regard transgenic plants are not different from their non-transgenic (conventional) counterparts. In fact, crop-weed hybridization between a transgenic oil-seed rape *Brassica napus* resistant to a herbicide and its wild relative *Brassica campestris* has been reported. Is this new variety an ecological risk? Crawley and co-workers have assessed the demographic variables of oilseed rape (transgenic and conventional) growing in a variety of habitats and under a range of climatic conditions, and concluded that there was no indication that genetic engineering for herbicide tolerance increased the invasive potential of oilseed rape [1]. In any case, the risk of gene transfer is not exclusive of transgenic plants; varieties obtained by classical genetic methods could also suffer this phenomenon. So, more effort in gene transfer evaluation would be desirable not only for transgenic plants but also for conventional ones.

A second environmental risk is the potential decrease in biodiversity associated to the cultivation of transgenic crops. Unfortunately, biodiversity decrease is directly associated with food consumption. By way of an example, twenty different apple varieties were cultivated in Lleida, Spain, two hundred years ago. Nowadays only two are produced, neither of which are old varieties. The responsibility for this lies with the consumer and his/her preferences. Transgenic crops might increase this tendency; hence, it is of great importance to defend microbial culture collections and germplasm banks. Another possible environmental risk is the occurrence of harmful effects of transgenic crops on non-target species. World-wide controversy arose some months ago after the release of a report on the effects of transgenic pollen from maize plants that expressed the *Bacillus thuringiensis* toxin effective against the European corn borer. According to that report, besides its initial target, the transgenic pollen also killed the larvae of the Monarch butterfly. Experts in the field criticized that work immediately; they stated that the results were premature, incomplete and unconvincing. Mass media world-wide commented on the results of the study, but they did not make later comments on the critical opinion it had deserved. As a result, public anxiety concerning genetically modified foods increased.

Some scientists have stated that genetically modified foods are the solution to the problem of world hunger. Unfortunately, hunger is mainly a political problem. Nevertheless, by using genetic engineering techniques it is possible to increase the productivity or the nutritional value of some crop varieties of interest in developing countries. For example, a transgenic rice variety combating vitamin A and iron deficiencies has been obtained by the group of Ingo Potrykus at the Swiss Federal Institute of Technology [2]. This result and others such as the production of transgenic potatoes useful as oral vaccines, and the construction of transgenic papaya which grow in acidic soils, highlights the need to transfer this technology to developing countries.

About legal and social repercussions, how is the commercialization of genetically modified foods controlled? Several EU Directives and Regulations cover the commercialization and labeling of genetically modified foods. Some arose due to public pressure and have been subject to criticisms, mainly EU regulation 1139/98 concerning the labeling of foods containing transgenic soya or maize or their derivatives [4]. In fact, the labeling of genetically modified foods is another matter for discussion. The food industry rejects the labeling of such products claiming that they are equivalent to foods produced by conventional techniques. However, consumers have the right to be informed about what they eat, and genetically modified foods should be labeled as such. Unfortunately, in the current critical atmosphere, labeling a food as "genetically modified" creates a negative impression in the consumer. That this is so highlights the need to inform consumers about the reality of genetically modified foods.

Consumer opinions about genetically modified foods depend largely on the consumer's country of origin. Nevertheless, there exist some common ideas: (i) consumers are more favorable towards genetically modified foods of plant or fermentation origin, but largely reject those of animal origin; (ii) acceptance is greater if the development made favors the consumers; (iii) consumers want all genetically modified foods to be labeled.

In the 21st century we will have to produce more and better foods. More in developing countries, where the efficiency of the agricultural system is still low and population growth and hunger occur; and better in developed countries, where consumers are concerned about novel organoleptic sophistication or nutrition that can be added to their daily diet. This will only be possible through the application of molecular genetic technology. Food technologists wait eagerly for data from the Human Genome Project. When these data are available we will be able to better define our dietary requirements. We are at the start of a new branch of science: molecular nutrition. Without a doubt, the forthcoming years will be very exciting.

---

## References

1. Crawley MJ, Hails RS, Rees M, Khon D, Buxton J (1993) Ecology of transgenic oilseed rape in natural habitats. *Nature* 363:620–623
2. Editorial (1999) A golden bowl of rice. *Nature Biotech* 17:831
3. Ewen SWB, Pustzai A (1999) Effect of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine. *Lancet* 354:1353–1354
4. Ramón D, Calvo MD, Peris J (1998) The new regulation for labelling of genetically modified foods: a solution or a problem? *Nature Biotech* 16:889

---

## Daniel Ramón

The author is a researcher at the Institute of Agrochemistry and Food Technology (CSIC) in Valencia (Spain). In 1997 he was awarded the 7th Biennial Prize of the Spanish Society for Microbiology (SEM). [See Ramón, D. (1997) Trends in wine microbiology. *Microbiología SEM* 13:405–412.]

---