HEALTH HAZARDS OF GM FOODS

Myth: GM foods are safe to eat
Truth: Studies show that GM foods can be toxic or allergenic

"Most studies with GM foods indicate that they may cause hepatic, pancreatic, renal, and reproductive effects and may alter haematological [blood], biochemical, and immunologic parameters, the significance of which remains to be solved with chronic toxicity studies." – Dona A, Arvanitoyannis IS. Health risks of genetically modified foods. Crit Rev Food Sci Nutr. 2009; 49: 164–175[1]

Feeding studies on laboratory and farm animals show that GM foods can be toxic or allergenic:

- Rats fed GM tomatoes developed stomach lesions (sores or ulcers).[2] [3] This tomato, Calgene's Flavr Savr, was the first commercialized GM food.
- Mice fed GM peas (not subsequently commercialized) engineered with an insecticidal protein from beans showed a strong, sustained immune reaction against the GM protein. Mice developed antibodies against the GM protein and an allergic-type inflammation response. Also, the mice fed on GM peas developed an immune reaction to chicken egg white protein. The findings showed that the GM insecticidal protein acted as a sensitizer, making the mice susceptible to developing immune reactions and allergies to normally non-allergenic foods. This is called immunological cross-priming.[4]
- Mice fed GM soy showed disturbed liver, pancreas and testes function. The researchers found abnormally formed cell nuclei and nucleoli in liver cells, which indicates increased metabolism and potentially altered patterns of gene expression.[5] [6] [7]
- Mice fed GM soy over their lifetime (24 months) showed more acute signs of ageing in the liver than the control group fed non-GM soy.[8]
- Rabbits fed GM soy showed enzyme function disturbances in kidney and heart.[9]
- Female rats fed GM soy showed changes in uterus and ovaries compared with controls fed organic non-GM soy or a non-soy diet. Certain ill effects were found with organic soy as well as GM soy, showing a need for investigation into the effects of soy-based diets (GM and non-GM) on health.[10]
- A review of 19 studies (including industry's own studies submitted to regulators in support of applications to commercialise GM crops) on mammals fed with commercialised GM soy and maize that are already in our food and feed chain found consistent toxic effects on the liver and kidneys. Such effects may be markers of the onset of chronic disease, but long-term studies, in contrast to these reported short- and medium-term studies, would be required to assess this more thoroughly. Such long-term feeding trials on GMOs are not required by regulators anywhere in the world.[11]
- Rats fed insecticide-producing MON863 Bt maize grew more slowly and showed higher levels of certain fats (triglycerides) in their blood than rats fed the control diet. They also suffered problems with liver and kidney function. The authors stated that it could not be concluded that MON863 maize is safe and that long-term studies were needed to investigate the consequences of these effects.[12]
- Rats fed GM Bt maize over three generations suffered damage to liver and kidneys and alterations in blood biochemistry.[13]
- A re-analysis of Monsanto's own rat feeding trial data, submitted to obtain approval in Europe for three commercialised GM Bt maize varieties, MON863, MON810, and NK603, concluded that the maize varieties had toxic effects on liver and kidneys. The authors of the re-analysis stated that while the findings may have been due to the pesticides specific to each variety, genetic engineering could not be excluded as the cause.[14]

- Old and young mice fed GM Bt maize showed a disturbance in immune system cells and in biochemical activity.[15]
- Female sheep fed Bt GM maize over three generations showed disturbances in the functioning of the digestive system, while their lambs showed cellular changes in liver and pancreas.[16]
- GM Bt maize DNA was found to survive processing and was detected in the digestive tract of sheep. This raises the possibility that the antibiotic resistance gene in the maize could move into gut bacteria, an example of horizontal gene transfer.[17] In this case, horizontal gene transfer could produce antibiotic-resistant disease-causing bacteria ("superbugs") in the gut.
- Rats fed GM oilseed rape developed enlarged livers, often a sign of toxicity.[18]
- Rats fed GM potatoes showed excessive growth of the lining of the gut similar to a pre-cancerous condition and toxic reactions in multiple organ systems.[19] [20]
- Mice fed a diet of GM Bt potatoes or non-GM potatoes spiked with natural Bt toxin protein isolated from bacteria showed abnormalities in the cells and structures of the small intestine, compared with a control group of mice fed non-GM potatoes. The abnormalities were more marked in the Bt toxin-fed group. This study shows not only that the GM Bt potatoes caused mild damage to the intestines but also that Bt toxin protein is not harmlessly broken down in digestion, as GM proponents claim, but survives in a functionally active form in the small intestine and can cause damage to that organ.[21]
- Rats fed GM rice for 90 days had a higher water intake as compared with the control group fed the non-GM isogenic (from same genetic background but without the genetic modification) rice. The GM-fed rats showed differences in blood biochemistry, immune response, and gut bacteria. Organ weights of female rats fed GM rice were different from those fed non-GM rice. The authors claimed that none of the differences were "adverse", but they did not define "adverse". Even if they had defined it, the only way to know if such changes are adverse is to extend the length of the study, which was not done.[22]
- Rats fed GM Bt rice developed significant differences as compared with rats fed the non-GM isogenic line of rice. These included differences in the populations of gut bacteria – the GM-fed group had 23% higher levels of coliform bacteria. There were differences in organ weights between the two groups. The authors concluded that the findings were likely to be due to "unintended changes introduced in the GM rice and not from toxicity of Bt toxin" in its natural, non-GM form.[23]
- A study on rats fed GM Bt rice found a Bt-specific immune response in the non-GM-fed control group as well as the GM-fed groups. The researchers concluded that the immune response in the control animals was due to their inhaling particles of the powdered Bt toxin-containing feed consumed by the GM-fed group. The researchers recommended that for future tests involving Bt crops, GM-fed and control groups should be kept separate.[24] This indicates that animals can be sensitive to very small amounts of GM proteins, so even low levels of contamination of non-GM crops with GMOs could be harmful to health.

In these studies, a GM food was fed to one group of animals and its non-GM counterpart was fed to a control group. The studies found that the GM foods were more toxic or allergenic than their non-GM counterparts.

Study findings such as those described above have made it increasingly difficult for GM proponents to claim that there are no differences between the effects of GM foods and their non-GM counterparts – clearly, there are.

To sidestep this problem, GM proponents often claim that statistically significant effects, such as those found in the above studies, are not "biologically relevant".

But this is not scientifically justified. In order to determine whether changes seen in these short- to medium-term studies are biologically relevant, the researchers would have to:

- Define in advance what "biological relevance" means in the context of the particular crop and test animal
- Extend the current study design from a medium-term to a long-term period to see how changes seen in the short-term experiments develop – whether they disappear or develop into disease or premature death.[11]

This is not generally done.

Myth: EU research shows GM foods are safe
Truth: EU research shows evidence of harm from GM foods

A report published in 2010 by the European Commission called *A Decade of EU-Funded GMO Research (2001–2010)*[25] is often claimed to show that GM foods are safe. But this is untrue: some of studies included in the project, summarised below, show risks.

- A feeding trial on rats fed GM rice found significant differences in the GM-fed group as compared with the control group fed the non-GM parent line of rice. These included a higher water intake by the GM-fed group, as well as differences in blood biochemistry, immune response, and gut bacteria. Organ weights of female rats fed GM rice were different from those fed non-GM rice. Commenting on the differences, the authors said, "None of them were considered to be adverse". But they added that this 90-day study "did not enable us to conclude on the safety of the GM food."[22] In reality, a 90-day study is too short to show whether any changes found are "adverse" (giving rise to identifiable illness).

- A study on rats fed GM Bt rice found significant differences in the GM-fed group of rats as compared with the group fed the non-GM isogenic (of a genetically similar background but without the genetic modification) line of rice. These included differences in the distribution of gut bacterial species – the GM-fed group had 23% higher levels of coliform bacteria. There were also differences in organ weights between the two groups, namely in the adrenals, testis and uterus. The authors concluded that the "possible toxicological findings" in their study "most likely will derive from unintended changes introduced in the GM rice and not from toxicity of Bt toxin" in its natural, non-GM form.[23]

- A study on rats fed GM Bt rice found a Bt-specific immune response in the non-GM-fed control group as well as the GM-fed groups. This unexpected finding led the researchers to conclude that the immune response in the control animals must have been due to their inhaling particles of the powdered Bt toxin-containing feed consumed by the GM-fed group. The researchers recommended that for future tests on Bt crops, GM-fed and control groups should be kept in separate rooms or with separate air handling systems.[24]

Myth: GM foods have been proven safe for human consumption
Truth: The few studies that have been conducted on humans show problems

GM foods are not properly tested for human safety before they are released for sale.[26] [19] The only published studies that have directly tested the safety of GM foods for human consumption found potential problems but were not followed up:

- In a study on human volunteers fed a single GM soybean meal, GM DNA survived processing and was detected in the digestive tract. There was evidence of horizontal gene transfer to gut bacteria.[27] [28] Horizontal gene transfer is a process by which DNA is transferred from one organism to another through mechanisms other than reproductive mechanisms.

- In a study on humans, one of the experimental subjects showed an immune response to GM soy but not to non-GM soy. GM soy was found to contain a protein that was different from the protein in non-GM soy. This suggests that GM foods could cause new allergies.[29]

- A GM soy variety modified with a gene from Brazil nuts was found to react with antibodies present in blood serum taken from people known to be allergic to Brazil nuts. This indicates that this soy variety would produce an allergic reaction in people allergic to Brazil nuts.[30]

- A study conducted in Canada detected significant levels of the insecticidal protein, Cry1Ab, which is present in GM Bt crops, circulating in the blood of pregnant women and in the blood supply of their foetuses, as well as in the blood of non-pregnant women.[31] How the Bt toxin protein got into the blood is unclear and the detection method used has been disputed. Nevertheless, this study raises questions as to why GM Bt crops are being commercialised when research raises serious concerns about their safety and no systematic effort is under way to replicate and assess the validity of that research.

These studies should be followed up with controlled long-term studies and GM foods and crops should not be commercialised in the absence of such testing.

Myth: No one has ever been made ill by a GM food
Truth: There is no scientific evidence to support this claim

GM proponents claim that people have been eating GM foods in the United States for 16 years without ill effects. But this is an anecdotal, scientifically untenable assertion, as no epidemiological studies to look at GM food effects on the general population have ever been conducted.

Furthermore, there are signs that all is not well with the US food supply. Reports show that food-related illnesses increased two- to ten-fold in the years between 1994 (just before GM food was commercialized) and 1999.[32] [33] No one knows if there is a link with GM foods because they are not labelled in the US and consumers are not monitored for health effects.

References

All references are to peer-reviewed studies with the exception of nos. 2, 18 (FDA documents); 3 (scientist's testimony to New Zealand government); 25 (EU Commission report).

1. Dona A, Arvanitoyannis IS. Health risks of genetically modified foods. Crit Rev Food Sci Nutr. 2009; 49(2): 164–175.

2. Hines FA. Memorandum to Linda Kahl on the Flavr Savr tomato (Pathology Review PR–152; FDA Number FMF–000526): Pathology Branch's evaluation of rats with stomach lesions from three four-week oral (gavage) toxicity studies (IRDC Study Nos. 677–002, 677–004, and 677–005) and an Expert Panel's report. US Department of Health & Human Services. 16 June 1993. http://www.biointegrity.org/FDAdocs/17/view1.html

3. Pusztai A. Witness Brief – Flavr Savr tomato study in Final Report (IIT Research Institute, Chicago, IL 60616 USA) cited by Dr Arpad Pusztai before the New Zealand Royal Commission on Genetic Modification: New Zealand Royal Commission on Genetic Modification; 2000.

4. Prescott VE, Campbell PM, Moore A, et al. Transgenic expression of bean alpha-amylase inhibitor in peas results in altered structure and immunogenicity. J Agric Food Chem. 16 Nov 2005; 53(23): 9023–9030.

5. Malatesta M, Biggiogera M, Manuali E, Rocchi MBL, Baldelli B, Gazzanelli G. Fine structural analyses of pancreatic acinar cell nuclei from mice fed on genetically modified soybean. European Journal of Histochemistry. Oct-Dec 2003; 47: 385–388.

6. Malatesta M, Caporaloni C, Gavaudan S, et al. Ultrastructural morphometrical and immunocytochemical analyses of hepatocyte nuclei from mice fed on genetically modified soybean. Cell Struct Funct. Aug 2002; 27(4): 173–180.

7. Vecchio L, Cisterna B, Malatesta M, Martin TE, Biggiogera M. Ultrastructural analysis of testes from mice fed on genetically modified soybean. Eur J Histochem. Oct-Dec 2004; 48(4): 448-454.

8. Malatesta M, et al. A long-term study on female mice fed on a genetically modified soybean: effects on liver ageing. Histochem Cell Biol. 2008; 130: 967–977.

9. Tudisco R, Lombardi P, Bovera F, et al. Genetically modified soya bean in rabbit feeding: Detection of DNA fragments and evaluation of metabolic effects by enzymatic analysis. Animal Science. 2006; 82: 193–199.

10. Brasil FB, Soares LL, Faria TS, Boaventura GT, Sampaio FJ, Ramos CF. The impact of dietary organic and transgenic soy on the reproductive system of female adult rat. Anat Rec (Hoboken). Apr 2009; 292(4): 587–594.

11. Séralini GE, Mesnage R, Clair E, Gress S, de Vendômois JS, Cellier D. Genetically modified crops safety assessments: Present limits and possible improvements. Environmental Sciences Europe. 2011; 23(10).

12. Séralini GE, Cellier D, Spiroux de Vendomois J. New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity. Archives of Environmental Contamination and Toxicology. May 2007; 52(4): 596–602.

13. Kilic A, Akay MT. A three generation study with genetically modified Bt corn in rats: Biochemical and histopathological investigation. Food Chem Toxicol. Mar 2008; 46(3): 1164–1170.

14. de Vendomois JS, Roullier F, Cellier D, Séralini GE. A comparison of the effects of three GM corn varieties on mammalian health. Int J Biol Sci. 2009; 5(7): 706–726.

15. Finamore A, Roselli M, Britti S, et al. Intestinal and peripheral immune response to MON810 maize ingestion in weaning and old mice. J Agric Food Chem. Dec 10 2008; 56: 11533–11539.

16. Trabalza-Marinucci M, Brandi G, Rondini C, et al. A three-year longitudinal study on the effects of a diet containing genetically modified Bt176 maize on the health status and performance of sheep. Livestock Science. 2008; 113(2): 178–190.

17. Duggan PS, Chambers PA, Heritage J, Michael Forbes J. Fate of genetically modified maize DNA in the oral cavity and rumen of sheep. Br J Nutr. Feb 2003; 89(2): 159–166.

18. US Food and Drug Administration. Biotechnology consultation note to the file BNF No 00077. Office of Food Additive Safety, Center for Food Safety and Applied Nutrition. 4 September 2002. http://www.fda.gov/Food/Biotechnology/Submissions/ucm155759.htm

19. Pusztai A, Bardocz S. GMO in animal nutrition: Potential benefits and risks. In: Mosenthin R, Zentek J, Zebrowska T, eds. Biology of Nutrition in Growing Animals. Vol 4: Elsevier Limited; 2006:513–540.

20. Ewen SW, Pusztai A. Effect of diets containing genetically modified potatoes expressing Galanthus nivalis lectin on rat small intestine. Lancet. Oct 16 1999; 354(9187): 1353-1354.

21. Fares NH, El-Sayed AK. Fine structural changes in the ileum of mice fed on delta-endotoxin-treated potatoes and transgenic potatoes. Nat Toxins. 1998; 6(6): 219-233.

22. Poulsen M, Kroghsbo S, Schroder M, et al. A 90-day safety study in Wistar rats fed genetically modified rice expressing snowdrop lectin Galanthus nivalis (GNA). Food Chem Toxicol. Mar 2007; 45(3): 350-363.

23. Schrøder M, Poulsen M, Wilcks A, et al. A 90-day safety study of genetically modified rice expressing Cry1Ab protein (Bacillus thuringiensis toxin) in Wistar rats. Food Chem Toxicol. Mar 2007; 45(3): 339-349.

24. Kroghsbo S, Madsen C, Poulsen M, et al. Immunotoxicological studies of genetically modified rice expressing PHA-E lectin or Bt toxin in Wistar rats. Toxicology. Mar 12 2008; 245(1-2): 24-34.

25. European Commission. A decade of EU-funded GMO research (2001–2010). 2010.

26. Freese W, Schubert D. Safety testing and regulation of genetically engineered foods. Biotechnol Genet Eng Rev. 2004: 299-324.

27. Netherwood T, Martin-Orue SM, O'Donnell AG, et al. Assessing the survival of transgenic plant DNA in the human gastrointestinal tract. Nat Biotechnol. Feb 2004; 22(2): 204–209.

28. Heritage J. The fate of transgenes in the human gut. Nat Biotechnol. Feb 2004; 22(2): 170-172.

29. Yum HY, Lee SY, Lee KE, Sohn MH, Kim KE. Genetically modified and wild soybeans: an immunologic comparison. Allergy Asthma Proc. May-Jun 2005; 26(3): 210-216.

30. Nordlee JA, Taylor SL, Townsend JA, Thomas LA, Bush RK. Identification of a Brazil-nut allergen in transgenic soybeans. N Engl J Med. Mar 14 1996; 334(11): 688-692.

31. Aris A, Leblanc S. Maternal and fetal exposure to pesticides associated to genetically modified foods in EasternTownships of Quebec, Canada. ReproductiveToxicology. 2011; 31(4).

32. Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. Emerg Infect Dis. Sep-Oct 1999; 5(5): 607-625.

33. Foegeding PM, Roberts T, Bennet J, et al. Foodborne pathogens: Risks and consequences. Ames, Iowa. Council for Agricultural Science and Technology. 1994.