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Stacking the odds against finding horizontal gene transfer

UK's Food Standards Agency dismissed its new research findings that GM DNA in food has transferred to bacteria in the human gut. Dr. Mae-Wan Ho reveals how the experiment was designed to bias against positive findings, so the actual transfer of GM DNA could be much more extensive. There should now be a comprehensive ban on all GM crops, she says.

That GM DNA should transfer to bacteria in the human gut is not at all unexpected. We already know that DNA persists in the gut, and that bacteria can readily take up foreign DNA. Why did our regulators wait so long to do the experiment? And an experiment that's designed *against* making positive findings?

The research in question is the final part [1] of the Food Standards Agency (FSA) project on evaluating the risks of GMOs in human foods [2], commissioned by the former Ministry of Agriculture, Fisheries and Food (MAFF).

A *single* meal containing GM soya was fed to human subjects. It consisted of commercial soya meal - 150g El Corte Ingles, batch number and GM content unspecified - mixed in the burgers and soya protein supplement - 100g Holland and Barrett, batch number and GM content again unspecified - mixed in 'milk' shakes. No data were presented on how much DNA was present in the commercial samples, and whether the DNA was broken down and to what degree. Needless to say, the GM DNA inserts were not characterised at all.

The method of detecting GM DNA is highly flawed. It depends on amplifying a small part - 180bp - of the entire GM DNA insert that was at least ten or twenty times as long. So, any other fragment of the insert would not be detected, nor would a fragment that did not overlap the whole 180bp amplified, or that had been rearranged. The chance of obtaining a positive result is 5% at best, and likely to be much, much less. *Thus, a negative finding with this detection method most probably does not indicate the absence of GM DNA.*

More revealing still, the researchers checked for GM DNA *only* in the gut contents, but failed to check if the DNA has passed through the gut into the blood stream and blood cells. This omission is inexcusable, as a series of experiments in mice [3] dating back to 1997 had already documented that GM DNA can pass through the gut wall into the bloodstream, to be taken up by cells in the blood, liver and spleen. When fed to pregnant mice, the GM DNA also passed through the placenta to be taken up by the cells of the foetus and the newborn.

In the first trial, the GM meal was fed to seven subjects that had part of their lower bowel removed from a previous operation and wearing a colostomy bag. The digested food from the colostomy bag was analysed, and GM DNA was detected in all seven subjects. As much as 3.7% of the GM DNA was recovered in one subject. Bearing in mind the limitation of the method used for detecting GM DNA, all the values are probably gross underestimates.

In the second trial, the meal was fed to 12 human volunteers with intact bowels. No GM DNA was detected in the faeces, which the researchers claimed, indicated that the nucleic acid did not survive passage through the complete intestine. *But this claim is most likely to be false*, due to the limitation of the GM DNA detection method.

Microbes in the digested food that had passed through the small intestine were cultured through 6 passages in broth containing glyphosate. Bacteria grew to a density of 10^8 /ml in each sub-culturing. In each sub-culture derived from samples taken from 3 subjects at 180, 240 and 300 min after eating, the transgene was found. This is yet another gross underestimate. This method depends on the bacteria having taken up an intact gene

coding for glyphosate tolerance, and would not have detected bacteria that have taken up fragments of that gene, or other parts of the GM DNA containing other genes or gene fragments.

Although GM DNA was not detected in samples taken from these 3 subjects prior to GM soya consumption, when the microbes in this material were cultured in broth containing glyphosate, the transgene was detected in a sample collected before the GM meal, though at very low concentrations. This suggests that the subject may already have GM DNA in the gut prior to the experiment, possibly from consuming GM soya. The bacteria harbouring the transgene could not be isolated, so the researchers concluded that, “although present, the bacterium represented a very small proportion of the indigenous intestinal microflora”. *But as bacteria are capable of multiplying, even rare gene transfer events cannot be ignored.*

The researchers were disingenuous when they expressed surprise at the relatively large proportion of GM soya DNA that has survived passage through the small bowel. But in earlier research already published, the same group had found that DNA in food or mixed up with food was much slower to degrade than naked DNA [4].

Despite the severe limitations placed on detecting GM DNA, and an experimental design both biased towards *negative* results, irrefutable positive evidence was nevertheless obtained. That means the transfer of GM DNA in the human gut could be much more extensive than the data indicate. This makes it all the more astonishing for the FSA to have reportedly claimed that “the findings had been assessed by several Government experts who had ruled that humans were not at risk”. ***Those experts should now be named and made to defend their ruling.***

In a statement on its website, the FSA said that the study had concluded it is “extremely unlikely” that GM genes can end up in the gut of people who eat them [5]. This statement is highly misleading and very likely to be false.

Our government’s scientific advisers have been guilty of persistent denial in the face of mounting evidence that horizontal gene transfer can happen and has happened. They are guilty of bad scientific research that misleads the public, of downplaying positive evidence, and of taking the absence of evidence as evidence of absence.

I first pointed out the dangers of horizontal gene transfer to MAFF in a series of correspondence in 1996. Their scientific advisers said there was no evidence it could happen. When it became clear that horizontal transfer of GM DNA from GM plants to bacteria can readily happen in the laboratory, the scientific advisors said “just because it happens in the laboratory does not mean it will happen in the field” [6]. When positive findings turned up in the only field monitoring experiment in the world that has ever been performed [7], the scientific advisors dismissed that too, and explained it away by a ‘cautious’ interpretation of the evidence [8].

This latest finding is the last piece of damning evidence that horizontal transfer of GM DNA can indeed happen, has already been happening, and cannot be controlled if GM crops continue to be released to the environment. GM DNA, as opposed to natural DNA, is in many respects optimised for horizontal gene transfer [9]. Horizontal transfer of GM DNA can create new viruses and bacteria that cause diseases, spread drug and antibiotic resistance among pathogens, and trigger cancer by jumping into genomes of mammalian cells. New ‘pharm’ crops are being developed that poison our water and soil, affecting all organisms in our food web [10-12]. The ecological impacts are unthinkable. What more do we need for an immediate comprehensive ban on GM crops?

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2. Technical report on the Food Standards Agency project G010008 "Evaluating the risks associated with using GMOs in human foods"- University of Newcastle.
3. Hohlweg U. and Doerfler W. On the fate of plant or other foreign genes upon the uptake in food or after intramuscular injection in mice. *Mol Genet Genomics* 2001, 265, 225-33, and references therein; see also "Denial continues over horizontal gene transfer" by Mae-Wan Ho, ISIS Report, 7 June 2002 www.i-sis.org.uk
4. Martin-Orue SM, O'Donnell AG, Arino J, Netherwood T, Gilbert HJ and Mathers JC. Degradation of transgenic DNA from genetically modified soya and maize in human intestinal simulations. *British Journal of Nutrition* 2002, 87, 533-542.
5. "Can GM food make your body immune to antibiotics?" by Sean Poulter, *Daily Mail*, July 17, 2002.
6. Ho MW. Special Safety Concerns of Transgenic Special Safety Concerns of Transgenic Agriculture and Related Issues, Briefing Paper for Minister of State for the Environment, The Rt Hon Michael Meacher, April 1999; published in Seminario Internacional sobre Direcito da Biodiversidade, Revista cej: Centro de estudos Judiciarios do Conselho da Justica Federal, pp.120-6.
7. Gebbard, F. and Smalla, K. (1999). Monitoring field releases of genetically modified sugar beets for persistence of transgenic plant DNA and horizontal gene transfer. *FEMS Microbiology Ecology* 28, 261-72; see also "Horizontal gene transfer happens. A practical exercise in applying the precautionary principle" by Mae Wan Ho in *Horizontal Gene Transfer*, ISIS Reprints, ISIS Publications, London, March 2002.
8. Oral Submission to Public Hearing for the proposed addition of CHARDON LL to the UK National List, presented 10 June 2002, Dr. Mae-Wan Ho www.i-sis.org.uk
9. "The best kept secret of GM crops" Written statement to public hearing on Chardon LL GM maize by UK Advisory Committee on Releases to the Environment, 20 February, 2002 www.i-sis.org.uk
10. "Poison pharm crops near you" by Joe Cummins, *Science in Society* 15, Summer 2002, p.16.
11. Veljkovic V and Ho MW. Aids vaccines or slow bioweapons? *AIDScience* 25 April 2002 www.aids-science.com
12. "New US report sounds alarm about crops genetically engineered with drugs and chemicals" Friends of the Earth International Press Release 13 July 2002 www.gefoodalert.org