Antibiotic Resistance in Genetically Engineered Plants

Many of the genetically engineered (GE) crops which are already being grown on a commercial scale contain genes which are resistant to antibiotics used for the treatment of diseases in both humans and animals. These genes are unnecessary to the development of the GE plants themselves and could severely undermine the effective treatment of diseases if the antibiotic resistance is transferred to bacteria which are harmful to human and animal health.

Why are they used?

Because the techniques used to introduce a foreign gene into an organism have a low success rate, scientists need to test whether the genetic engineering has worked. This is often achieved by transferring genes which confer resistance to particular antibiotics at the same time as the genes for the desired trait (e.g. insect resistance). The modified cells are then grown in a medium containing the relevant antibiotic(s). The only cells able to survive are those which contain the antibiotic resistance gene. As this 'marker gene' is closely linked to the gene with the desired characteristic, it can be concluded that these cells have been successfully genetically engineered and they are then grown to maturity.

Antibiotic marker genes have been used in the development of many of the GE crops which are now being grown on a commercial scale. These include Novartis' herbicide and insect resistant maize, which contains ampicillin resistance genes, Monsanto's beetle resistant potato and Plant Genetic Systems' herbicide resistant oilseed rape, which contain genes resistant to kanamycin and neomycin antibiotics.

Although the antibiotic resistance genes serve no further function in the development and growth of the crops after the initial selection process, they remain in the plants' tissues throughout their lives. This has led to serious concerns over the consequences for human and animal health.

Human and animal health threats

Antibiotics have been used extensively for the treatment of infectious diseases since 1944 and have been routinely included in animal feeds to prevent disease and promote growth. The overuse of antibiotics has resulted in antibiotic resistant bacteria which have already caused major medical and veterinary problems throughout the world. By 1990, almost every species of disease causing bacteria had developed at least partial resistance to antibiotics and in some cases (e.g. *Staphylococcus* infection), antibiotics

have become almost totally ineffective[1].

Marker genes are often resistant to antibiotics which are commonly used in both human and veterinary medicine. Eating foods derived from GE crops therefore poses a risk that the antibiotic resistance genes could be transferred to bacteria living in the guts of humans and animals and render them immune to antibiotic drug treatments. Antibiotic resistance can also be transferred to soil bacteria from decomposing parts of the plants.

Proponents of genetic engineering claim that there is little likelihood that such gene transfer would actually occur, but scientists and regulatory authorities have expressed the view that even the slightest risk would be unacceptable. A survey of chemotherapists, for instance, revealed that 57% of respondents felt that Novartis' GE maize should be banned until the ampicillin resistance gene is removed[2]. Similarly, the United Kingdom's Advisory Committee on Novel Foods and Processes (ACNFP) advised the British Government to vote against the authorisation to market Novartis' maize in Europe because of the risk of antibiotic resistance developing [3].

An unacceptable risk

Producers of GE plants containing antibiotic resistance genes argue that, even if these genes were transferred to human or animal gut bacteria, this would make little difference to the already high levels of antibiotic resistance[4]. Such an attitude is irresponsible, since any increase in antibiotic resistance could be disastrous for human and veterinary medicine. Novartis' maize, for instance, confers resistance to ampicillin, which belongs to the penicillin group of antibiotics. These are the antibiotics most commonly used for the treatment of several serious diseases. Ampicillin itself is frequently used for the treatment of pneumonia, bronchitis and diphtheria. Similarly, several GE crops contain genes resistant to kanamycin, which is of concern as single mutation in this gene could give resistance against the Amikacin antibiotics.[5] Amikacin is regarded as a 'reserve' or 'emergency' antibiotic in human medicine, i.e. at present it is used as little as possible in order that no resistances are produced among bacteria.

The risks associated with antibiotic resistance genes in GE crops are clearly unacceptable. Alternative marker systems have been available for several years and the United Kingdom's Advisory Committee on Releases to the Environment (ACRE) has observed that "*it is good practice not to insert into plants unnecessary genes which have no purpose in the GM plant*"[6]. Others have described the practice of including antibiotic resistance genes as "*sloppy genetic engineering*"[7].

Calls for precaution and a ban

Because of the unnecessary presence of antibiotic resistance genes and the serious implications for human and animal health, many biosafety committees and governments have opposed the introduction of these crops. Norway banned them altogether. Austria and Luxembourg have banned Novartis' maize, Switzerland did not allow a planting experiment with a GE potato because the potato contained a kanamycin resistance gene. From the British Medical Association[8] to the European Parliament a variety of

institutions have demanded a ban of antibiotic resistance genes in GMOs.

Precaution clearly demands that any use of antibiotic resistance genes be prohibited. There is no reason to risk any further health threats from antibiotic resistance to serve short term industry interests. Novartis, the worlds leading pharmaceutical manufacturer, should be ashamed of such a policy.

References

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2 Pechère, J-C. (1998) Concerns about the presence of a ß-lactamase gene in a transgenic maize. Newsletter of the International Society of Chemotherapy, December 1998, p16.

3 AgBiotech: News and Information 8 (9): 159N

4 See for example, Ciba Seeds (1996) Documentation on Bt-maize from Ciba Seeds.

5 Patrice Courvalin, Plantes transgéniques et antibiotiques, La Recherche No. 308, Mai 1998

6 ACRE Annual Report No 4: 1996/97. Department of the Environment, Transport and the Regions: London.

7 The Times, 4th May 1998.

8 British Medical Association, Board of Science and Education, The Impact of Genetic Modification on Agriculture, Food and Health, An Interim Statement, May 1999, ISBN: 07279 1431 6