Human health

Human health and GM potato

Since the first genetically engineered crop was released commercially in 1992, food and non-food crops have been genetically engineered with new traits and safety to human health and GM food assessment has been public concerns from the very beginning.

Genetically engineered potatoes have been on the market for about 6 years and the only one case of putative risk involving a transgenic potato was the unsafe lectin potato of Dr Pusztai. However, Audit report and scientists community asked for higher scientific rigor and revalidation of results. To date over 90 million hectares of transgenic crops are grown in 21 countries and no human health problems associated specifically with the ingestion of transgenic crop or their products have been identified. Two kinds of safety concerns have been raised about GM foods: specific health concerns like transferring allergens across foods and unknown long-run health concerns.

Potato have been mainly engineered by introducing the cry3A gene isolated from the common soil bacterium Bacillus thuringiensis subspecies tenebrionis (Btt) for insect resistance, the coat protein (CP) gene from PVY-O for PVY resistance and the ORF-1 and ORF-2 regions from PLRV for PLRV resistance. Transfers into potato genome have been done using Agrobacterium tumefaciens. Food and environmental assessments have been done for three potato lines containing those transgenes. Three main issues are raised for human health and GM potato food safety assessment:

- Allergenicity and toxicity of transgens
- GM potato nutritional constituents and composition and substantial equivalence
- Transfer of antibiotic resistance gene used in Agrobacterium tumefaciens mediated gene transfer

Allergenicity and toxicity of transgenes

Genes introduced in potato by genetic engineering originate from a variety of organisms or combination of these. Like Bt gene, some of them are either not part of our normal diet or at a much higher level of expression than in the conventional counterpart. These situations may favor new allergenicity to be present in food derived from potato.

Before a GE crop can be found suitable for human consumption, it have to go through a range of strict and exhaustive tests, executed by the developer and later by independently acting experts in nutrition, allergenicity, toxicology and others. These tests are done according to the guidelines formulated by national regulatory agencies. Some of the many questions in these tests that have to be answered are:

- Does the food have a traditional counterpart that has a history of safe use?
- What is known about the donor organism, concerning toxicities, allergenicities and concerning the introduced gene(s)?
- What is known about the host plant?s composition of nutrients, anti-nutrients, toxicants and allergenic potential?
- Does the novel food have any allergic property?
- Do any of the novel substances in the food have a toxic or allergic effect?
- Is there any change in the food?s concentration of nutrients or naturally occurring toxicants?
- Has the food?s digestibility changed because of the introduction of the gene?
Has the food been produced using accepted, established procedures?

The Cry3A protein expressed in these transgenic potato cultivars is identical to that found in nature. Cry3A is insecticide only when eaten by the larvae of coleopteran insects such as Colorado potato beetle and its specificity of action is directly attributable to the presence of specific binding sites in the target insects. No binding sites for delta-endotoxins of *B. thuringiensis* are on the surface of mammalian intestinal cells therefore, livestock animals and humans are not susceptible to these proteins.

Food and nutrition scientists have obtained very detailed insights about the triggering of allergenic reactions in humans. Allergens are almost always proteins and they are usually not broken down in the human stomach. More than 90 percent of all known food-related allergenic reactions are caused by 8 common food allergens. These are: Milk, eggs, fish, soy, shellfish (Crustacea and mollusks), wheat, peanuts and tree nuts. Cry3A, PLRV replicase proteins or PVY CP don’t shares amino acid sequence homology with any known protein toxins or known protein allergens.

Studies on toxicity of Cry3A protein have established that this protein does not result in any adverse effects when fed to laboratory mice at doses up to 5220 mg/kg body weight. Toxicity testing is not required for the PLRV replicase and PVY CP because human have been exposed to those proteins through the consumption of infected potatoes. Additionally, the Cry3A protein has a history of safe use in agriculture and forestry for more than 30 years with no evidence of adverse effectsA study was carried out on the ileum of mice fed with potatoes harboring the Cry1 gene (Fares and El-Sayed, 1998).

It was shown the delta- endotoxin and to a lesser extends the Bt potato caused villus epithetical cell hypertrophy and multinuclearisation. Disrupted microvilli caused mitochondrial degeneration, increased number of lysosomes and autophagic vacuoles and increased activation of crypt Paneth cells. However some flaws in the experimental design can be observed. Gene expression level in GM potato was not given and it was not clear if the potato in the diet were cooked or raw. Although, the assumption that the ileum is the most absorptive part of the rodent small intestine can be argued against because 90% of all nutrients absorption in fact occur in the jejunum.

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However, science may never be blind to the concerns of the public. A well understandable factor of fear is that one of the genetic engineering products will be unsafe to eat for humans, even though it has passed all available safety assessments. References: EPA: BtPlant-Incorporated Protectants October 15, 2001 Biopesticides Registration Action Document : human health assessment

References:

- Safety Assessment of NewLeaf Y Potatoes Protected Against Colorado Potato Beetle and Infection by Potato Virus Y Causing Rugose Mosaic
Safety Assessment of NewLeaf Plus Potatoes Protected Against Colorado Potato Beetle and infection by Potato Leafroll Virus


Document database on Bt gene technology

Document database on allergen risk in other crops

GM potato nutritional constituents and composition

For marketed GM potato, nutritional constituents, proximate composition, internal quality characteristics were analyzed and compared with those of non-transgenic tubers. The analysis of nutrients did not reveal any significant differences in levels of crude protein, ash, or starch. Similarly, the levels of micronutrients and trace elements (including thiamine, niacin, riboflavin, vitamin C, calcium, iron and zinc) were comparable to those of unmodified counterpart potatoes. Analyses of total glycoalkaloide levels demonstrated that in each case the levels were within the standards previously established for potatoes.

Compositional study on GM potatoes expressing the soybean glycinin gene demonstrated that total protein content appear to be less than in the control potato plants and substantial difference in some vitamins and an increase level of solanine and chaconine have been shown (Hashimoto et al, 1999). However, glycoalkaloids, solanine and chaconine, are naturally occurring toxicants found in potato tubers, particularly green tubers that have been exposed to sunlight and concentrations were not higher than potato safety standards.

Antibiotic resistance

The third point of great public concern about the release of GMO? is the possible movement of antibiotic resistance genes from the GM crop to microorganisms that naturally come in contact with humans. In this view, this kind of event could possibly lead to situations of humans getting infected with bacteria that have resistance against antibiotics.

Image of Enterococcus cells, bacteria now known to cause resistance problems in infections
Antibiotic resistance genes are used in genetic engineering technology to be able to identify the cells that have been successfully transformed with the new genetic material (marker genes). Some of the GM crops on the field contain this kind of genes.

In case such a rare event would happen, the impact of this event on human health would be negligible because the group of antibiotics (among them the most widely used kanamycin) to which the markers used in plant genetic engineering provide resistance are hardly ever used for medical purposes. Moreover, this antibiotics resistance gene can quite commonly be found in bacteria that live in the soil. (European Commission, 1996; U.S. Food and Drug Administration, 1994; FDA, 1998)

Internationally recognized scientific bodies that have reviewed the use of antibiotic resistance markers include the OECD, WHO and the FAO, as well as regulatory agencies in various countries (Argentina, Canada, Japan, United States, and Europe) have consistently concluded that these genes have never been shown to be transferred from crops derived through biotechnology to bacteria in nature.

Because public concern is taken seriously, at this moment other types of marker systems are being evaluated and developed that can be used in genetic engineering and that are not based on antibiotic resistance.

1. A system in which the antibiotic resistance (or any other) gene can be spliced out completely.
2. A system that uses a marker gene that is not based on antibiotic resistance.

References:

Guidance for Industry: Use of Antibiotic Resistance Marker Genes in Transgenic Plants

European Food Safety Authority ?EFSA- : Opinion of the Scientific Panel on Genetically Modified Organisms on the use of antibiotic resistance genes as marker genes in genetically modified plants


