

Genetically Modified Food: Transgenic Engineering, Ethical and Societal Implications

Genetic engineering of foods can simply extend what has been done in selective breeding. However there is a new capability which is added, not previously available in the science of plant breeding. With gene sequencing it is now possible to trans-genetically splice a foreign species DNA into a type of crop or plant. The two most popular ways to do this are micro-projectile bombardment, the agro-bacterium method and the cauliflower mosaic virus method.

The micro-projectile method uses metallic particles, coated with the gene which researchers desire to add to the plant DNA. As the name implies the metallic particles are then shot into the host cells. This is typically done using a compressed air gun. If the particle makes into the nucleus, the gene has a chance of integrating into the chromosome. How it integrates depends on what new event is created. The gene may integrate into different: chromosomes and locations within the chromosomes. Gene expression is dependent on both of these factors, therefore the reliability and predictability of this method is not as high as others are.

Agrobacterium gene splicing is much more proactive. In this technique *Agrobacterium tumefaciens*' unique ability to infect plant DNA with their own DNA material is harnessed. The bacteria take advantage of the plant to insure that the bacterial population flourishes. It is the ti-plasmid within the bacteria that is responsible for this process. Genetic engineers integrate desired genes with the ti-plasmid, the ti-plasmid then assists in transferring the T-DNA into the plant DNA.

The cauliflower virus mosaic (CaMV) is transmitted to crops through aphids. An interesting feature of the virus is its ability to pass through wounds in a plant and interject its DNA within a plant cell. It is similar in function to the HIV and Hepatitis B. The similarity is in that the virus uses the internal machinery of host cells to reproduce itself. CaMV is used in a comparable way to *Agrobacterium* gene splicing, the new

gene is introduced into the plant cell, and the plant cell itself then produces more copies of the gene as well as integrating the gene within its own DNA. The main difference between the ti-plasmid and CaMV is the aggressive nature of CaMV that causes for the foreign genome to be inserted at multiple locations within the host genome as well as being replicated thousands of times. The advantage of this method is the increased rate at which the gene is introduced, leading to a potentially higher degree of success.

The following web-site was very helpful in providing a good deal of information on the topic of genetic modification in crops and plants for agricultural use:

<http://www.colostate.edu/programs/lifesciences/TransgenicCrops/>

One of the biggest concerns is that the science behind transgenetically modified crops is not well founded and tested. Although gene splicing has allowed for much more efficient outcomes in what is an old art of cross breeding, transgenic engineering is different. Dr. Linda Kahl, a compliance officer from the US Food and Drug Administration is quoted as saying this "The process of genetic engineering and traditional breeding are different, and according to technical experts within the agency they lead to different risks."

One study may show transgenetically modified foods are harmful, mice have suffered from intestinal harm due to large amounts of GM potatoes that they ingested (Ewen, S.W.B. and A. Pusztai. 1999. Effects of diets containing genetically modified potatoes containing Galanthus nivalis lectin on rat small intestines. Lancet 354:9187). However, many have deemed that this study was limiting and inconclusive.

Much of the scare surrounding genetically modified food is speculative, and it is not based on long term studies that have been conducted. Although the fear of transgenetically engineered foods is not backed solidly by science, the technology is new and may benefit from more testing and research. Transgenic splicing may be harmful; potentially both at the microbiological level and at the biological system level. There are many legitimate concerns that have been brought up by the scientific community.

At the microbiological level, some gene vectors that are being used may be harmful to other plants as well as animals. Gene vectors facilitate splicing of genetic material into the chromosome to be modified. In particular some are concerned about the use of CaMV. The CaMV virus is used due to its aggressive nature. The concern due to the aggressive nature of the virus and its tendency to recombine and mutate. Some have said that the virus may form stronger versions of itself.

"Probably the greatest threat from genetically altered crops is the insertion of modified virus and insect virus genes into crops. It has been shown in the laboratory that genetic recombination will create highly virulent new viruses from such constructions. Certainly the widely used cauliflower mosaic virus (CaMV) is a potentially dangerous gene," Dr. Joseph Cummins, Professor Emeritus in genetics from the University of West-Ontario.

More extreme opinions go as far as saying that the virus may infect vertebrates and invertebrates as well. This could be potentially dangerous and arguments have been made on both sides as to whether the risk of this type of infection is feasible.

"The available scientific information does not support the contention that the application of the CaMV...promoter in the genetic engineering of plants would pose an increased risk of horizontal gene transfer or any additional risk to human health," Dr. Douglas Powell Dept. of Plant Agriculture, University of Guelph, Guelph, Ontario.

Some also argue that cross-pollination between wild and GM species of plants will reduce the biodiversity as well as introduce genetically engineered characteristics into the wild plant population. This may be harmful in the case where pesticides are engineered into a plant. If the pesticide spreads beyond the crop into the wild it may speed up the resistance insects take up to a specific class of pesticides. In terms of biodiversity, losing wild strains of plants translates into a diluted gene pool. A diluted gene pool may eventually threaten a species. In all fairness this problem exists in developing nations, and can not be attributed to genetic engineering. However, genetic engineering will only exacerbate the problem.

As crops are modified to be resistant to certain herbicides there are concerns that super-weeds will be created. This is deemed to be a valid concern, and it could happen in several ways. Weeds growing beside crops could actually cross-pollinate and attain the genetic characteristics of the GM crop. Alternatively the ability of GM crops to sustain high levels of herbicide exposure could spur the survival of resistant weed varieties.

The same could be said of pesticides. This is very well documented and has happened historically. Pesticide proteins, which are engineered into crops, could create resistant insects. There is a proposed remedy for this that the FDA has mandated. It entails setting up an area of the crop that is not GM. The hope is to maintain a population of less pesticide resistant insects in this area of the field. If any pests survive from the GM crop, it is hoped that they breed with the less resistant insects and in this way the resulting offspring do not increase in their resistance to the pesticide proteins. However, there are several unknowns. The resistance traits may be dominant in which case the number of resistant insects will increase more quickly. Additionally, the mating cycles of the insects in each field must match.

I believe that in a lot of ways genetic science can be compared to the discovery of nuclear physics. The rapid growth and discovery of genetic engineering and its applications are powerful. When Feinman finalized his calculations on the atomic bomb he stated that there was a one in three chance that the nuclear reaction would not stop at the 'fissionable' material, potentially destroying the whole universe. This statement seems ridiculous. However, few would argue that Feinman was not one of the best qualified to answer such a question.

I believe the same to be true in genetically modified food. There is not yet enough science done in this field of industry to truly understand what the consequences are. Corporations and individuals in this industry need to realize that it is not just about profits. There are some serious potential risks. Some of risks that have been brought up may seem outlandish others have track records. I believe it is the ethical responsibility of the technicians, researchers, scientists, engineers and CEOs involved in this industry to address the potential risks.