Genetic Engineering in Food

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GKG 4A 28.4.12

Preface

We had a hard time choosing our topic. We went from genetic engineering in medicine to food quite quickly, but the further specification proved hard to choose. In the end we settled for genetic manipulation in meat, as we though about what we had done in chemistry. We were looking at fast food. So we started to wonder what what actually went into our food and about all the rumors and controversies surrounding it. We divided the workload and set off on writing the pater, however we soon realized that what we had hear from all the rumors and videos was nonexistent. So we had to think fast and decided we would just generalize it a bit, but lay key importance on meat.

Introduction

Genetic engineering is the manipulation of a living cells DNA so that it may produce a certain substances or qualities in a host organism.

It was first tested and trilled in the 1970s when scientists were searching for a more efficient way to produce insulin, which is necessary to regulate the sugar content of our blood and of which sufferers of a certain type of diabetes have a deficiency as their pancreas is failing to produce. However it took until the 1980s to get the cures to market. Shortly after that, genetically modified plants came on to the market, with the aim of making them resistant to herbicides so the farmers had a simpler was to kill off unwanted growths on their fields, and increase the shelf-life of products. This caused far more uproar and debate amongst people, as the products now affected everybody, not just certain people, like with the insulin. There are many misconceptions about genetic engineering, as people do not really now a lot about it. The most common one is the lack of distinction between genetically engineered products and products that have been bred to give the best results, like bigger stronger wheat, that carries more food and favours the needed minerals and proteins. This can be done completely naturally by means of crossbreeding and selective pollination.

As mentioned at the beginning, genetically engineered products are manipulated at the DNA and therefore can only be done in a laboratory. It is most commonly done by method of a secondary bacterium. A gene with the desired trait is cut out of the DNA of a cell and then placed into the desired plants DNA, so that the amino acid sequence is read and the protein responsible for the desired trait or effect is produced. A good example for this is pest control with the bacterium *Bacillus thuringiensis*, which is deadly to insects. It, by means of oral uptake, gets into the gut of the insect, where a protein is released, that dissolves the gut wall and disables the insect to eat. More spores are produced, which then spread into the blood and infect the whole body.

This would be a good way to combat insects, however just spraying it on the plants is very costly and it doesn't last long at that, as a slight rainfall would wash it away.

That is why this protein has been transplanted into the genetic code of maize. That way, the plant is full of the protein, everywhere and as soon as an insect takes the slightest bite out of the plant, no matter where, it will most likely be infected with the protein and die. As it has been integrated into the genetic code, the plant now produces the protein on its own, which not only means you don't have to respray the same plants time and time again, but the code will be maintained from generation to generation, so you never have to do it again! So how do they do it?

As mentioned before, the desired section of the DNA strand must be isolated. Then one must go through a process called splicing. This is where you take out what is called a plasmid ring, which is a DNA ring found in common bacteria. You then take out a section of the plasmid ring (Wildtype DNA) and replace it with the desired strand and replant the modified ring into the bacterium. The next step is to infect a end host cell (cells of desired plant) with the bacterium and they will exchange genetic information. You now regrow the infected plants and sort them out (as there is no 100% success rate) by means of traits, only the modified plants will posses.

That is the basic method of genetic engineering. There are of course others, however, they are most likely more expensive and time consuming and on top of that they work almost the same way. The only real variable is how to implant the new genes into the plants DNA stands.

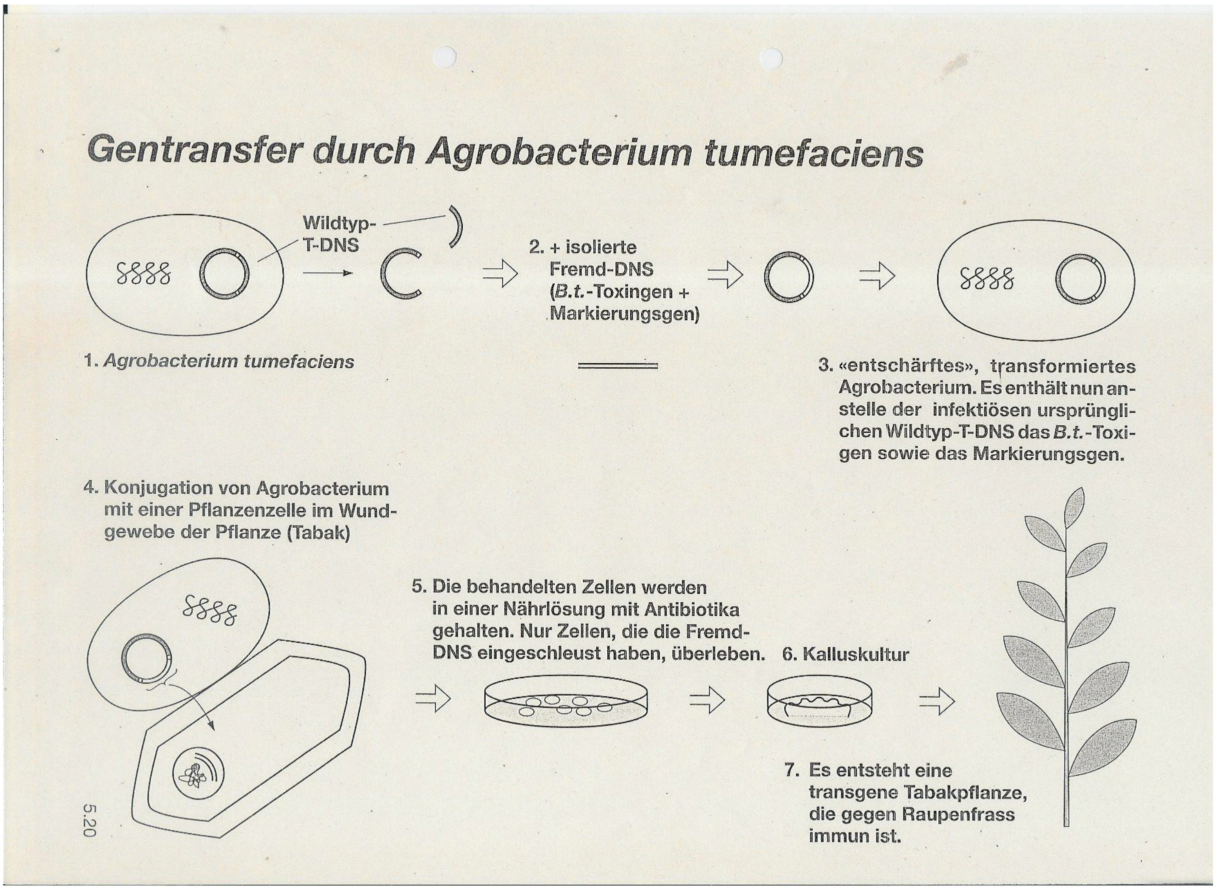

Illustration shows the genetic engineering of a plant by means of another bacterium.

(1) The bacterium with the plasmid ring

(2) The desired gene sequence is isolated from the cell

(3) The sequence is then spliced into the plasmid ring of the carrying bacterium

(4) The end plant is exposed to the now modified bacterium

(5) The new plants are filtered from the unchanged ones

Why doesn't it work on meat?

The rumour mill is nothing short of creative when it comes to the conspiracies concerning our meat produce and its genetic manipulation. Especially the fast-food industry has come under scrutiny concerning how they keep their animals. There have been stories of genetically engineered chickens and cows, that are so beefed up that they can't support the weight of their own body and their bones brittle that they snap as soon as they move. Also body proportions have been speculated to have changed, i.e. head that are so small you can only feed the animal through a tube. But as it happens, these are all just rumours.

It is very possible, that genetically engineered fish will come on to the market in the near future, having been though vigorous testing to acquire approval but it will take a while before we see any meat from genetically engineered live stock on our shelves. This is cause they are mostly engineered not to produce the most for when they are slaughtered, but for while they're still alive. This makes more economic sense, as the required investment just for more meat is higher then what you would eventually get out of it. But there are a few other things that are in the way of genetically engineered meat. One of them is the fact that our technology is simply not capable of performing the procedure flawlessly in that detail, something which is a necessity when you are working with factors like growth. It is of course being tried all the time, but the FDA approvals include the need for the animal to be in perfect order as well as the humans who ends up eating it (kind of weird if you think about it, as the animals is being made to eat, but it's an ethical question). Animals with weird bodily malformation and deformations have been a common result or even animals which were not capable of mating anymore. A more desirable function scientists are trying to figure out is how to clone an animal, instead of risking changes in the perfect animal's offspring every time it mates. This is where it gets complicated. We can synthesize the material of flesh, but to create meat you also need the growing process that creates the stands. This is simply not possible at this point in time. For that you need to synthesize life itself and this is not different from anything natural.

What we do do to change our live stock is to give them genetically engineered food, which promotes favourable traits. This is easier and that is why the field of the manipulation of the meat itself is not very largely occupied.

Genetic engineering of meat at this point in time and in the future

" Transgenic superfish may be the next thing to hit supermarket shelvess

VANCOUVER […] Here, coho salmon swim in a dozen large tubs. But these aren't normal fish, says geneticist Bob Devlin. They're genetically engineered research experiments.

[…]

More dramatic than the salmon's behavior, however, is their growth rate. By inserting an extra gene from a sockeye salmon into these coho, Devlin has created a stock of "superfish" that grow four times faster than ordinary coho. A strain like this could mean huge profits for fish farms, […]

But Devlin's fish aren't for sale. […] What if these superfish fell into the hands of aquaculture companies, and then escaped into the ocean? What if they bred with wild salmon? "The research so far tells me that we should be careful, that we need more information, […] I'm not willing to say there is no risk for the ecosystem."

[…] At least one company has already developed a transgenic superfish, capable of growing up to six times faster than a normal salmon. The company wants to sell it to aquaculture companies, which supply salmon fillets to supermarkets nationwide. […]

"Huge potential" — good and bad

[…]

In order to create fast-growing salmon, geneticists insert an additional gene, taken from a different species, such as an ocean pout, into a newly fertilized egg. […] the foreign gene integrates into a long strand of native DNA […]. Geneticists then breed these modified fish for several generations, until the offspring consistently carry the additional gene.

A/F Protein Inc., a biotechnology firm […] began using this technique to create fast-growing fish over a decade ago, after wild cod and salmon populations plummeted on the East Coast, and rural fishing communities struggled to replace wild fisheries with fish farms.

"Transgenic fish offer huge potential," says Joseph McGonigle, an A/F Protein vice president. Using these fish, industry could produce twice as many fish, he says, while cutting production costs in half.

But critics point out that hundreds of thousands of salmon escape into the oceans from fish farms each year. […] scientists, environmentalists and fishermen worry that escaped transgenic salmon could compete with wild salmon for habitat, pushing endangered runs to collapse.

[…] If these unique creatures [wild salmon] interbreed with transgenic fish, raised in hatcheries and net pens, their progeny may lose the traits necessary for survival.

[…] if 60 transgenic fish escaped and were introduced to a population of 60,000 wild fish, and if they bred with each other, the wild species would become extinct in 40 fish generations.

A/F Protein has pledged to sterilize its transgenic fish, but that's a risky proposition […]. Sterilization is never 100 percent successful. Furthermore, even infertile fish might try to breed with wild fish, wasting eggs and causing a population decrease. "There are huge gaps in the science,"

[…]

So far, no fish-farm companies have expressed interest in genetically modified fish. […]

"Remember, the aquaculture industry is in no way interested in this technology, […] not today." "

High Country News

June 23 2003, Rebecca Clarren

http://www.hcn.org/issues/253/14058

Personal opinion on genetically engineered salmon

First of all, a few questions comes up: Is this morally correct? Will this fix any problems or just make more? Is it ecological?

GE (Genetically engineered) salmon – it’s just not appetizing. The only appealing factor is that they would probably be cheaper in the market. But is the price we pay economically worth it?

We think no. The Idea of having GE fish in our supermarkets is revolting and morally wrong!

The article from High Country News was issued 2003, so it’s not quite up to date.

From an article Issued in 2012:

“GMO Salmon: US Consumer Groups Petition FDA For Tougher Probe Of Engineered Salmon

** Strict FDA review needed for public health-consumer groups*

** Would be first gene-altered animal for U.S. consumption*

** No timeline for Food and Drug Administration decision*

WASHINGTON, Feb 7 […] Three U.S. consumer groups petitioned the Food and Drug Administration on Tuesday to subject a new genetically engineered salmon to a more rigorous review process than is now in place before the fish can be approved as safe to eat.

[…]

AquaBounty is seeking U.S. approval to market its engineered Atlantic salmon, which contains a gene from another fish species, the Chinook salmon, to help it grow twice as fast as normal.

The consumer groups' petition says the way these salmon are created substantially alters their composition and nutritional value, and so they should be treated as a food additive. Under this standard, they said, the company's data would have to overwhelmingly prove AquAdvantage salmon are safe to eat.

[…]

The FDA did not comment specifically on the petition, but confirmed that the company's application for FDA approval for AquAdvantage salmon is under review, and that genetically engineered animals are evaluated under the new animal drug provisions of U.S. law.

AquaBounty has said in the past that it sees these genetically modified salmon as a potential solution to environmental concerns associated with salmon aquaculture, and discounted fears they might accidentally escape into the wild and affect other fish.

[…] company's own study showed that genetically engineered salmon may contain increased levels of a hormone linked to […] cancer.

The petitioners said a proper review would require genetically engineered salmon to go through comprehensive toxicological studies to ensure the fish are safe to consume and properly labeled.

If approved, AquAdvantage would be the first genetically altered animal for human consumption […]"

Huffington Post: The Internet Newspaper

February 07 2012

http://www.huffingtonpost.com/2012/02/08/gmo-salmon_n_1261536.html

According to this article, there aren't yet any genetically altered animals in the food market yet, but we will be seeing this soon. It will start with salmon and soon, many of the meats we buy will be genetically engineered.

Comments on the article from the Huffington Post:

"“are you kidding me? If it tastes good eat it. I don't care if they merge Rainbow Trout with Thresher Shark.”

- *ronnybrume*

"If GM salmon is approved, I will never eat salmon again."

- *cre8f1*

"Cooking destabilizes all proteins......The blending of different Salmon strains is no different than blending cattle breeds.....Test yes, but government is too bent on destroying business innovation.Its not like they are mixing genes from totally unrelated species"

- *rodoner*

"Genetically modified salmon? Bad idea."

- *mikennz* "

http://www.huffingtonpost.com/2012/02/08/gmo-salmon_n_1261536.html

Many more of the comments state that they either are against GE salmon or they don't care about it too much. Some of the comments are completely irrelevant statements, showing how little knowledge people have about these products and their danger to the ecologic system.
So far, there are no animals in the market which are genetically manipulated. We probably will have to deal with this becoming a much bigger deal in the near future because there are always more and more new and easy ways to boost the market with GE animals.

GE vegetables, fruits and plants are found quite often thought nowadays. E.g. golden rice, soy beans, corn, etc.

"Beginning in 1996, genes from bacteria and viruses have been forced into the DNA of soy, corn, cotton, and canola plants, which are used for food."

http://articles.mercola.com/sites/articles/archive/2010/07/08/genetically-engineered-soybeans-may-cause-allergies.aspx

These GE products often lead to problems like allergies and / or health risks, and we shouldn't forget, they are huge risks to our environment, ecological systems and niches.

Pros and Cons of genetic engineering

There exist many arguments for and many arguments against genetic engineering, and in this section, we shall discuss the most important ones, starting off with pros. One of the main arguments for genetic engineering is that the food can be naturally pest-resistant, meaning that there is a reduction in the need for chemicals, pesticides and other additives that could be dangerous for the environment and for our health. Another advantage is that genetically modified foods can grow faster than foods that are grown traditionally. This increase in productivity leads to there being more food for the population and the surplus can also be exported. It is also said that genetically modified crops are a benefit in places where there are frequent droughts or where the soil is incompetent for agriculture, due to which it is difficult to grow normal crops. Genetically modified crops can be grown at places with an unfavorable climate or at the wrong season. Another advantage is that the overall costs of genetic engineering, even though the seeds are very expensive, are lower than those of traditional farming because the genetically modified crops already have a natural resistance towards pests and insects so there is no need to spray pesticides and insecticides. There also is the potential to produce medicines inexpensively from modifying crops. Allergens can also be removed from the plants, thus making them accessible to people who were allergic to them. Last but not least, genetically modified foods are said to be high in nutrients, and contain more minerals and vitamins than those found in traditionally grown foods. Genetically modified foods also are less prone to rotting and it is said that they taste better.

Wherever there are advantages, there must also be disadvantages, and genetic engineering is no exception to this rule. One of the main disadvantages is that genetic engineering can lead to poorer or underdeveloped countries becoming dependant on richer countries because the poor countries have no access to the genetically engineered food other than through the richer countries. This would lead to rich countries controlling the food market which would lead to a broken economy and an even bigger gap between rich and poor countries. Another problem is that genetically engineered food is pretty recent, so the long-term effects on the human body are not yet known to us. Since many modifications include adding chemical properties to the crops, there is a chance that the consumption of such modified crops can be dangerous for the health. It is even believed that the consumption of genetically engineered foods can cause diseases which are immune to antibiotics, and according to experts, these foods can also cause cancer. Also, changing the way things work in nature may cause irreversible changes to the environment, thus possibly negatively affecting other crops or animals. Undesirable genetic mutations can appear which would lead to allergies in the crops. There is also a risk that genetically engineered genes could be introduced into wild plants thus reducing biodiversity and creating super-weeds.

Interview

Genetic Engineering--
What We All Need to Know

An Interview with Dr. John Fagan

NLP News: What exactly is genetic engineering? How does it work?

Dr. Fagan: Genetic engineering is a revolutionary new technology that enables scientists to remove genes from one organism and transfer those genes into any other organism. Genes are the blueprints of life--the biological structures that compose DNA and give rise to the specific characteristics of any living organism. The transfer of genes changes the genetic blueprint of the recipient organism and reprograms its cells to produce different material, which in turn creates new characteristics within the organism. Through this process, researchers can change the traits and characteristics of an organism as they see fit--for instance, they can engineer tomatoes with a longer shelf life or soybeans that are resistant to herbicides.

NLPN: What are the pros and cons of this technology? It seems to have generated intense public debate.

Fagan: Researchers have become very excited about using genetic engineering to produce more abundant crops, to create more nutritious foods, to eradicate certain diseases, and thereby to improve the quality of human life on earth. But in reality, although genes can be cut and spliced accurately in the test tube, the process of splicing them into a living organism is extremely imprecise. These manipulations can cause mutations that damage the functioning of the natural genes of the organism. Inserted genes can also cause unanticipated side effects: genetically engineered foods, for example, may contain toxins and allergens or be reduced in nutritional value--and consumers have, in fact, become sick and even died from such toxins already. Moreover, genetically engineered organisms may multiply and crossbreed with the natural, non-genetically engineered population, creating irreversible biological changes throughout earth's ecosystem.

NLPN: Are there indirect effects of genetically engineered products?

Fagan: Well, genetic engineering will almost certainly lead to increased chemical pollution of our environment. Crops engineered to be resistant to herbicides, for example, will lead to a tripling of agrichemical use by farmers to kill weeds--which will worsen the pollution of America's soil and groundwater. For example, the chemical company Monsanto has already engineered corn, soybeans, and sugar beets to be resistant to Roundup, one of Monsanto's herbicides. Industry officials have repeatedly claimed that Roundup is harmless to living things and is environmentally short-lived. However, preliminary studies in Denmark indicate that Roundup subsists in the soil for up to three years (and can hence be absorbed by subsequent crops), and other scientific evidence indicates that it causes toxic reactions in farm workers, damages reproductive functions in mammals, and harms fish, earthworms, and beneficial insects.

NLPN: You mentioned earlier that in some cases, genetic engineering has actually harmed people. Could you elaborate?

Fagan: Pioneer Hybrid International, the largest seed company in the world, genetically engineered soybeans by introducing a gene from Brazil nuts so that the soybeans would produce complete protein. But the Brazil nut component in the engineered soybeans caused allergic reactions in a significant portion of the population, so Pioneer abandoned the project. And when the Japanese company

Showa Denko genetically engineered natural bacteria to produce the food supplement tryptophan more efficiently, the genetic manipulations caused the bacteria to produce a highly toxic substance in the tryptophan--a substance that was not detected until after the product was put on the market in 1989. As a result, 5000 people became ill, 1500 were permanently disabled, and 37 died.

NLPN: What measures would you suggest to protect consumers?

Fagan: I, along with the Natural Law Party and Mothers for Natural Law, want the implementation of genetic engineering to be guided by science, rather than by economics or politics. Therefore, we stand for the following:

- First, we call for more safety testing--more rigorous, objective, scientific testing of bioengineered organisms, especially foodstuffs.
- Second, at the very least, we call for mandatory labeling of all genetically engineered foods, because consumers have the right to know what they're eating--especially when there's some risk. Even if genetically engineered foods are tested more rigorously, some residual risk will always be present, and consumers should have the right to choose whether or not to take that risk.
- Third, as a remedial measure, we call for a ban on any product currently on the market that has not been adequately tested. We want those products removed from the marketplace until they're proven safe.
- Fourth, in terms of the environment, we call for a ban on any use of genetic engineering in agriculture or in any other area that could result in the introduction of genetically engineered organisms into the ecosystem.

NLPN: How can today's consumers avoid eating genetically engineered foods if these foods aren't labeled?

Fagan: This is a critical question. One way would be to avoid every foodstuff known to have been genetically engineered. But soy is present in 60% of processed foods, corn is equally ubiquitous, and canola oil is quite common--and all have been engineered. So have potatoes, tomatoes. and yellow crooked-neck squash, as well as enzymes and hormones used in treating cows, which therefore end up in milk. The list goes on and on. So avoiding genetic engineering in this way is not really practical.

Thanks to the efforts of the Natural Law Party and other organizations, organic products are still safe at this point--they are free of genetically engineered ingredients, because organic certifiers have required it. But organic foods are expensive. So as a stop-gap measure, a number of food producers are developing lines of products that they will certify as not being genetically engineered. Within the next year, you can expect to see foods on your grocery shelves that have a little sticker saying “not genetically engineered” or “GE free.” But otherwise, it's risky. We really need mandatory labeling of these foods.

NLPN: A recent Novartis poll mentioned in the New York Times found that most Americans want genetically engineered foods to be labeled. But an almost equally large number felt these foods were safe.

Fagan: Novartis said that 93% of Americans wanted genetically engineered foods to be labeled. A recent poll in the U.K. confirmed these findings: 87% of U.K. citizens wanted labeling. And while it's true that most Americans have an open mind about genetically engineered foods, the fact that Americans wanted these foods labeled and that more than half of them had questions about genetic engineering indicates concern in the population about the safety of these foods. And it's a rightful concern. When you alter nature on this deep level of genetic blueprints, you simply cannot predict and control the outcome of those alterations. We need more control to make these outcomes safer.

During this interview Dr. John Fagan speaks very critically of genetic engineering. Although there may be many advantages to it, the process is still to imprecise and so many mistakes can happen, mistakes that can cause a lot of damage to the environment as well as to humans. Because this process is fairly recent, the risks often get overlooked. Dr. Fagan also stresses the fact that it would be very important to label products that have been genetically manipulated because at the moment there is no labelling although a majority of people in the U.S. and the U.K. are favourable of doing this. After reading this interview, it does seem that genetic engineering is not as harmless as it is made to look like. Just one small mistake can cause a lot of problems for the environment and the ecosystem. Dr. Fagan also stresses the importance of not putting any genetically manipulate organisms into a natural ecosystem so as not to disturb it, and he also says that it is very important to test food products thoroughly before bringing them into the market. Dr. Fagan also says that genetic engineering will almost certainly increase pollution. The use of resistant crops will pollute the soil and groundwater.

Reading through this interview, I get the feeling that the process of genetic engineering in food has to be test more thoroughly and that solutions have to be found to the problems stated above by Dr. Fagan before making a big hype about it and bringing too many manipulated products onto the market. It is also important to inform the customer very well so that people know what they are eating and are aware of the dangers.

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