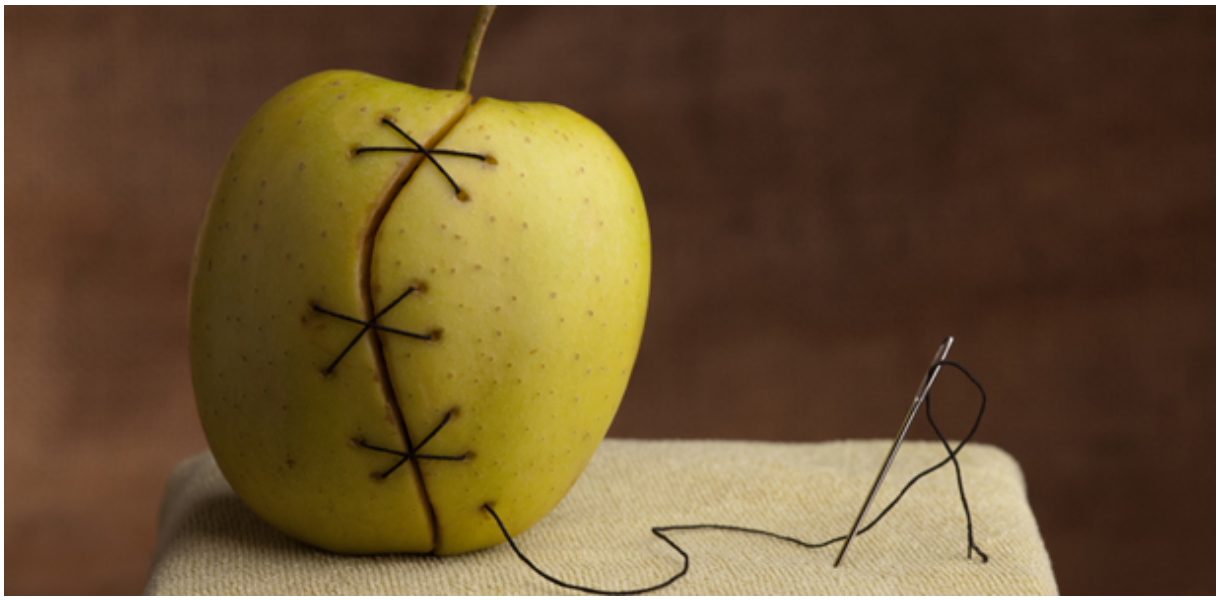
The Very Real Danger of Genetically Modified Foods

By Ari LeVaux

New research shows that when we eat we're consuming more than just vitamins and protein. Our bodies are absorbing information, or microRNA.



***Update 1/12**: Thanks to science and biology bloggers, Christie Wilcox and Emily Willingham at the Scientific American blog network and The Biology Files, respectively, we've learned of the scientific inconsistencies made in Ari LeVaux's most recent Flash in the Pan column, which is syndicated by a number of newspapers and magazine websites. This column has been expanded and updated for AlterNet, with LeVaux discussing specific improvements in the comments.*

Chinese researchers have found small pieces of rice ribonucleic acid (RNA) in the blood and organs of humans who eat rice. The Nanjing University-based team showed that this genetic material will bind to receptors in human liver cells and influence the uptake of cholesterol from the blood.

The type of RNA in question is called microRNA (abbreviated to miRNA) due to its small size. MiRNAs have been studied extensively since their discovery ten years ago, and have been implicated as players

in several human diseases including cancer, Alzheimer's, and diabetes. They usually function by turning down or shutting down certain genes. The Chinese research provides the first *in vivo* example of ingested plant miRNA surviving digestion and influencing human cell function in this way.

Should the research survive scientific scrutiny -- a serious hurdle -- it could prove a game changer in many fields. It would mean that we're eating not just vitamins, protein, and fuel, but gene regulators as well.

That knowledge could deepen our understanding of many fields, including cross-species communication, co-evolution, and predator-prey relationships. It could illuminate new mechanisms for some metabolic disorders and perhaps explain how some herbal and modern medicines function.

This study had nothing to do with genetically modified (GM) food, but it could have implications on that front. The work shows a pathway by which new food products, such as GM foods, could influence human health in previously unanticipated ways.

Monsanto's website states, "There is no need for, or value in testing the safety of GM foods in humans." This viewpoint, while good for business, is built on an understanding of genetics circa 1960. It follows what's called the "Central Dogma" of genetics, which postulates a one-way chain of command between DNA and the cells DNA governs.

The Central Dogma resembles the process of ordering a pizza. The DNA codes for the kind of pizza it wants, and orders it. The RNA is the order slip, which communicates the specifics of that pizza to the cook. The finished and delivered pizza is analogous to the protein that DNA codes for.

We've known for decades that the Central Dogma, though basically correct, is overly simplistic. For example: MiRNAs that don't code for anything, pizza or otherwise, travel within cells silencing genes that are being expressed. So while one piece of DNA is ordering a pizza, it could also be bombarding the pizzeria with RNA signals that can cancel the delivery of other pizzas ordered by other bits of DNA.

Researchers have been using this phenomena to their advantage in the form of small, engineered RNA strands that are virtually identical to miRNA. In a technique called RNA interference, or RNA knockdown, these small bits of RNA are used to turn off, or "knock down," certain genes.

RNA knockdown was first used commercially in 1994 to create the Flavor Savr, a tomato with increased shelf life. In 2007, several research teams began reporting success at engineering plant RNA to kill insect predators, by knocking down certain genes. As reported in MIT's *Technology Review* on November 5, 2007, researchers in China used RNA knockdown to make:

> ...cotton plants that silence a gene that allows cotton bollworms to process the toxin gossypol, which occurs naturally in cotton. Bollworms that eat the genetically engineered cotton can't make their toxin-processing proteins, and they die.

And:

> Researchers at Monsanto and Devgen, a Belgian company, made corn plants that silence a gene essential for energy production in corn rootworms; ingestion wipes out the worms within 12 days.

Humans and insects have a lot in common, genetically. If miRNA can in fact survive the gut then it's entirely possible that miRNA intended to influence insect gene regulation could also affect humans.

Monsanto's claim that human toxicology tests are unwarranted is based on the doctrine of "substantial equivalence." According to substantial equivalence, comparisons between GM and non-GM crops need only investigate the end products of DNA expression. New DNA is not considered a threat in any other way.

"So long as the introduced protein is determined to be safe, food from GM crops determined to be substantially equivalent is not expected to pose any health risks," reads Monsanto's website.

In other words, as long as the final product -- the pizza, as it were -- is non-toxic, the introduced DNA isn't any different and doesn't pose a problem. For what it's worth, if that principle were applied to intellectual property law, many of Monsanto's patents would probably be null and void.

Chen-Yu Zhang, the lead researcher on the Chinese RNA study, has made no comment regarding the implications of his work for the debate over the safety of GM food. Nonetheless, these discoveries help give shape to concerns about substantial equivalence that have been raised for years from within the scientific community.

In 1999, a group of scientists wrote a letter titled "Beyond Substantial Equivalence" to the prestigious journal *Nature*. In the letter, Erik Millstone *et. al.* called substantial equivalence "a pseudo-scientific concept" that is "inherently anti-scientific because it was created primarily to provide an excuse for not requiring biochemical or toxicological tests."

To these charges, Monsanto responded: "The concept of substantial equivalence was elaborated by international scientific and regulatory experts convened by the Organization for Economic Co-operation and Development (OECD) in 1991, well before any biotechnology products were ready for market."

This response is less a rebuttal than a testimonial to Monsanto's prowess at handling regulatory affairs. Of course the term was established before any products were ready for the market. Doing so was a prerequisite to the global commercialization of GM crops. It created a legal framework for selling GM foods anywhere in the world that substantial equivalence was accepted. By the time substantial equivalence was adopted, Monsanto had already developed numerous GM crops and was actively grooming them for market.

The OECD's 34 member nations could be described as largely rich, white, developed, and sympathetic to big business. The group's current mission is to spread economic development to the rest of the

world. And while the mission has yet to be accomplished, OECD has helped Monsanto spread substantial equivalence globally.

Many GM fans will point out that if we do toxicity tests on GM foods, we should also have to do toxicity testing on every other kind of food in the world.

But we've already done the testing on the existing plants. We tested them the hard way, by eating strange things and dying, or almost dying, over thousands of years. That's how we've figured out which plants are poisonous. And over the course of each of our lifetimes we've learned which foods we're allergic to.

All of the non-GM breeds and hybrid species that we eat have been shaped by the genetic variability offered by parents whose genes were similar enough that they could mate, graft, or test tube baby their way to an offspring that resembled them.

A tomato with fish genes? Not so much. That, to me, is a new plant and it should be tested. We shouldn't have to figure out if it's poisonous or allergenic the old fashioned way, especially in light of how new-fangled the science is.

It's time to re-write the rules to acknowledge how much more complicated genetic systems are than the legal regulations -- and the corporations that have written them -- give credit.

Monsanto isn't doing itself any PR favors by claiming "no need for, or value in testing the safety of GM foods in humans." Admittedly, such testing can be difficult to construct -- who really wants to volunteer to eat a bunch of GM corn just to see what happens? At the same time, if companies like Monsanto want to use processes like RNA interference to make plants that can kill insects via genetic pathways that might resemble our own, some kind of testing has to happen.

A good place to start would be the testing of introduced DNA for other effects -- miRNA-mediated or otherwise -- beyond the specific proteins they code for. But the status quo, according to Monsanto's website, is:

> There is no need to test the safety of DNA introduced into GM crops. DNA (and resulting RNA) is present in almost all foods. DNA is non-toxic and the presence of DNA, in and of itself, presents no hazard.

Given what we know, that stance is arrogant. Time will tell if it's reckless.

There are computational methods of investigating whether unintended RNAs are likely to be knocking down any human genes. But thanks to this position, the best we can do is hope they're using them. Given it's opposition to the labeling of GM foods as well, it seems clear that Monsanto wants you to close your eyes, open your mouth, and swallow.

It's time for Monsanto to acknowledge that there's more to DNA than the proteins it codes for -- even if

it's for no other reason than the fact that RNA alone is a lot more complicated that Watson and Crick could ever have imagined.

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