Do Genetically Modified Organisms (GMOs) Cause Cancer?

Are GMOs unsafe and harmful to health? A look into the evidence.

October 14, 2018 By Danielle Penick

There is no doubt about it, GMOs are a highly controversial topic for much of the public. And I can tell you, I've personally been on both sides of the debate and understand many criticisms and accolades for this technology.

As a registered dietitian I hear statements from my patients ranging from "GMOs are poison" to "they cause cancer" and "are unsafe," while some report their safety and benefits. Because of the back and forth public debate, many feel confused and conflicted.

We are also surrounded with marketing such as the non-GMO verified label, which has become increasingly popular. If you weren't worried about your food before, you might be now. Grocery shopping and meal planning can be hard enough, let alone the anxiety that's added with a cancer diagnosis. These labels make you question if genetically modified organisms are in everything at the store—but many people are surprised to learn there are actually only 11 commercial GMOs in the US.

So what exactly is a genetically modified organism (GMO) anyway?

A GMO is defined as any organism whose genetic material has been altered using genetic engineering techniques. It typically involves insertion or deletion of one or more genes to get a desired effect or remove an undesirable trait. For example: a crop could be modified to be more likely to survive during a time of drought.

It's important to note that 'GMO' is a bit of a generic term as it could be applied to any food since most things have been genetically modified in some form along the way. But we eventually agreed on the common term GMO. It's supposed to refer to an organism created through genetic engineering, though if taken literarily it means any organism with modified genes—like any domesticated plant or animal. But what most people are referring to is known as transgenesis (as described below). This is a technology that helps farmers become more efficient with their jobs, just like other technologies we use everyday. For example I'm using a computer to type this post instead of paper and pen. Many of you drive in cars or fly to get to your destination quicker. But I get it, food is much more personal since it is something that goes into our bodies.

Graphic by Biology Fortified, Inc. (CC BY-NC-ND 4.0)

How did the idea of GMOs arise?

Did you know that cross-breading plants and using selective breeding or artificial selection has been in practice for centuries, ever since the start of agriculture? Plant breeding is a method we've been using on almost every crop. Since 12,000 BC, we have been picking desirable traits from food, plants, and animals by mating them over and over again to mold the species that we like in order to meet our dietary needs. For example, corn used to be a tropical grass called teosinte that was small and nearly inedible. Ancient farmers were altering corn genomes by manipulating their DNA and this has resulted in 5 changes to its genome—it gave us the desired corn that we eat today.

Molecular biologists identified a large, wild grass called Balsas teosinte as the ancestor of maize, or modern corn.Nicolle Rager Fuller, National Science Foundation (CC0)

Also bananas are another type of crop that is vastly different from what it was. We probably wouldn't even recognize them—they were hard to eat due to extremely thick skins that were difficult to open, had large seeds that you had to constantly spit out, and some were even bitter. Over generations of breeding bananas that were best suited for consumption is it possible that we have the banana we know and see at the store.

Scientists began to look into technologies to develop to modify plants in order to get the traits we wanted with more efficiency. The difference from altering plants genomes from thousands of years ago (selective breeding) to today is that they can be altered with much more speed and precision. Instead of trying to selectively breed the traits we want, we can now go directly to the gene that we want to modify. Technology has just made it easier without the risk of accidentally altering other genes in the process. All breeding "modifies" the genetics of a crop.

By XiaoZhi Lim for the Genetic Literacy Project

To me what's fascinating, is humans did not invent the exchange of DNA from one organism to another. Viruses and bacteria insert their DNA into other organisms and so in a real sense we are also genetically modified, not by humans but by viruses and bacteria. We often hear that GMOs aren't natural since scientists are taking genes from one species and adding it to another, but this does occur naturally. For example, Biofortified writes about how this occurred when a bacteria inserted genes into the sweet potato here. GMOs on the market now add fewer genes than what is naturally introduced to plans and animals from other organisms.

What a GMO isn't…

Photo by Arturs Budkevics on Pixabay

This iconic photograph is found all over the internet and instills fear, but GMOs are not created with a syringe and there's also no such thing as a commercialized GMO tomato. This technology is not an ingredient, but instead a production method.

You may also come across another popular photo of the fish tomato or see someone protesting that they don't want "fish genes in their tomato". But there is no commercialized GMO with fish DNA either.

Photo by elizaIO on Flickr (CC BY-SA 2.0)

To be fair, though, the first GMO on the market was in fact a tomato called the Flavr Savr. It was made by a small biotech company called Calgene and the tomato was engineered to have a longer shelf life by slowing down the ripening process, preventing it from softening, while allowing the tomato to retain it's natural color and flavor. However, due to low harvests and costly shipping methods, it was only commercialized for 3 years before going off the market.

As time went on researchers looked at inserting a fish gene from the Arctic flounder to make tomatoes more resistant to freezing. This flounder lives in cold water and has a gene that prevents it from freezing—called the "antifreeze protein". It was studied because tomato farmers live under regular threats of a single freeze destroying their crop. But preliminary data revealed plants with this gene were not effective in preventing ice crystal formation and the project never came to the market.

It can sound horrifying to think about eating tomatoes with fish DNA. But interestingly tomatoes and fish already share 60% of their DNA and fish genes are not to be confused with actual an fish. It's a misunderstanding of what a gene actually is. All living things share the same genetic tool box and humans share many genes (which are made up of DNA) with other plants, animals, and even bacteria.

We all come with an instruction manual or a blue print that tells us how to grow and operate. This instruction manual is called a genome and the instructions are made up of DNA. DNA orchestrates what a living organism is—and plant and animal cells contain the same DNA shape, have similar DNA sequences, and are made from the same chemical building blocks. Genes are just sequences of these chemical bases and what matters is what the DNA does, not where it came from. All living things are composed of rearrangements of building blocks of DNA and we share many of the same genes, which is why we can study flies and bacteria to see what these genes might do in humans.

What causes a negative public view of this technology?

For starters to many it just feels like a big science experiment, which affects us emotionally—if it feels bad, then it must be bad. Some have dubbed it as "Frankenfood" and others feel tampering with Mother Nature is not natural and must therefore be harmful and there are other reasons people may have as well. These feelings are understandable and the Scimom's have a wonderful write-up on this here.

Other negative perceptions stemmed from a few earlier studies indicating possible safety concerns. This received a lot of attention, but back to this later.

Both sides of the debate

During my undergraduate speech class we could pick any topic we wanted to present on. Enthusiastically, I choose to speak about GMOs. At the time I was working at a local food co-op and heard many awful things about GMOs from customers. I was a novice in my studies and assumed if

so many people were upset by them that they must be dangerous. I preached about eating only organic, avoiding GMOs completely, and how terrible this technology was. This was before I got further into my career and started to understand science more. It has also helped to have a husband who is a research scientist to talk with. We regularly challenge each other's pre-held thoughts and beliefs. He also helps me to understand the complex research that's out there. I learned, there is scientific consensus regarding GMO safety for existing GMO technology in food production.

Where the public fear of GMOs got started in the scientific literature

Now back to those studies I mentioned earlier…in 1998, a study was published by a plant biochemist named Arpad Pusztai. He studied rats that were fed GMO potatoes at the Rowett Institute of Scotland and found that these rats were suffering from stunted growth and weakened immune systems. Since this study was published reviewers have dismantled it as they found that the genetically modified (GM) potato he was using was not meant for human consumption and was actually designed to be toxic for research purposes. After this discovery, the Rowett Institute refuted the findings of this study and found the experiment to be so flawed that Pusztai was charged with misconduct.

Perhaps the most famous study on the topic and was led by Gilles-Eric Seralini et al. This study was also conducted on rats and GM foods, but this time the rats were eating GM corn. Seralini's research team at the University of Caen Lower Normandy in France found that these rats were contracting cancer at alarming rates. After review, the European Food Safety Authority and several other European agencies dismissed the study's findings. It was found that he relied on a type of rat that too easily develops tumors, did not include proper control groups, and failed to report many details of the experiment—including how the analysis was performed. Rats are also not always good models for how humans will respond to similar protocols. Many studies start in animals or human cells on a petri dish, but most don't have the same outcomes in humans.

These studies are currently still commonly cited to say GMOs are unsafe. Despite the papers being retracted it's hard to prevent the misinformation and cease the myth that continues to get perpetuated. A big problem with retracted scientific papers is they aren't removed from journals. The journals only publish a statement of a papers retraction. This leaves people to continue citing these articles thinking they are credible resources.

An analysis of the current literature

In 2017, a 400-page scientific consensus report was published at NC State University. They concluded there is no evidence to support claims that GMOs are dangerous for either the environment or human health. The thousands of scientific research articles that have studied GMOs also all overwhelmingly find there is no evidence that the current genetically engineered (GE) foods pose any risk to humans. These studies have been conducted by almost every university in the country, the National Institute of Health, USDA, the European Commission, and many others. The American Institute of Cancer Research also reports there is no evidence that

GMOs increase the risk of cancer. With all of this research being done showing safety, it's not to say that no GMO could ever cause harm, but each one needs to be taken on a case-by-case basis and continue to be rigorously tested.

GMO use can reduce the amount of pesticides and fertilizers that we need and prevent excess use that would normally leech into the surrounding land and water to have a more environmentally friendly and sustainable practice. GMOs can make plants flood tolerant so that occasional intentional flooding could replace herbicide use as a means of killing weeds. They also allow plants to be modified to grow in environments that would normally be inhospitable, thus increasing crop production. Plants could even be virus resistant to preserve vast amounts of crops that would have otherwise died. GMOs aren't a panacea however, there are pros and cons to every production method. But if you take GMOs away then agriculture becomes less sustainable, not more (this is not to say that I don't think organic has its benefits, because it does).

GMOs aren't a black-and-white issue or meant to vilify any farming methods. They can be a viable option for the majority of the world. Facts don't always change minds though and the debate mostly stems from how people feel about how the world should operate. It's important to remember farmers and their families are the first to eat the foods they produce. It's in their best interest to produce safe crops. Many conventional farms also produce organic foods as well and use similar farming practices.

Personally I eat a mixture of organic, local, and conventional foods depending on what's available, what's on sale, and what looks best. If you would like to read more on biotechnology, I recommend

checking out Biofortified blog or GMO Answers for information from experts in the field.

Ideally, I think that the future will merge conventional and organic techniques while at the same time using GMOs and other new technologies to decrease pesticide use, improve nutritional quality and biodiversity in agricultural lands, while increasing the bioavailability of soil, and crop yields. Ultimately you should choose the food that's best for you and your family. But make sure you eat plenty of plant foods regardless of production method. Fearing food does have major negative impacts by decreasing the intake of cancer preventing foods, increasing anxiety, and increasing added stress. The silver lining is that GMOs are not unsafe and you can have peace of mind simply focusing on a balanced diet.

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