

Labeling Genetically Modified Food

The Philosophical and Legal Debate
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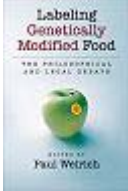


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A scientific perspective on labeling genetically modified food

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What is “food?”

We should begin by defining the word “food.” On one level this may seem obvious to the point of being trivial. For example, one might say the term “food” refers to articles used for food or drink by man or other animals. In other words if humans or animals think that something is a food, then by definition that something is a food. While this may seem rhetorical, the sort of definition that seeks to explain everything while in fact explaining nothing, it does, nonetheless, have important utility. It is also how the U.S. federal government defines food (Federal Food, Drug, and Cosmetic Act, 21 U.S.C. 301) (1). (For completeness the government also includes in its definition synthetic and naturally-occurring ingredients that are intentionally added to food, as well as chewing gum, perhaps mentioned specifically not only because we ingest the ingredients in gum but also because anxious students have been known to swallow their gum rather than admit to breaking the rule against chewing in class.) For the purposes of our discussion we shall refer to this as the *legal* definition of food.

Another definition of “food” flows from taking a reductionist approach: Food is defined as a complex mixture of chemicals that humans and animals consume to nourish and sustain life. This, which we’ll refer to as the *reductionist* definition, is clearly unappetizing but nonetheless does a good job of capturing the material nature of food without the transcendental associations of culture and tradition. Nutritionists and toxicologists will quickly add that the complex chemical mixtures that typically comprise any given food may consist of chemicals that under some circumstances may be beneficial, benign, or possibly even harmful (2) (another good reason to follow Mother’s advice to eat a variety of foods.)

Then there is what one might call the *biologist's* definition of food. In this case food is defined as the products of other living organisms, each of which has its own unique evolution, and none of which has evolved simply to provide humans with nourishment. However, because of human intervention, our most common foods are in fact derived from plants and animals with which we have developed highly dependent synergistic relationships. In many cases we truly need each other-- they provide us with food, we ensure their survival.

We should also consider the meaning of adjectives that are often applied to food, for example *novel*, *biotechnology-derived* and *genetically-modified*. Throughout human history there have been examples of foods that were novel in one region or locale, while simultaneously being dietary staples in another part of the world. In the years following the voyages of Columbus a large number of foods were introduced to Europe, including corn, potatoes, tomatoes, squash, and cacao (chocolate) (3). These were well-known foods to Native Americans but novel for Europeans, and Europeans often reacted with an understandable degree of caution. For example, many Europeans were initially concerned about toxicity from tomatoes because the tomato plant resembles the deadly European nightshade plant; fortunately for the evolution of Italian cuisine this concern has been put to rest. Over time these “novel” foods have been modified by agricultural practices that include very traditional techniques (e.g. plant breeding, cross breeding, selection) as well as very modern genetic modification technologies that have only become available in recent years (e.g. recombinant DNA) (4). Food processing technologies have also substantially changed these foods, for example the invention of milk chocolate. Accordingly, it is appropriate to consider the terms novel, biotechnology,

and genetically-modified in the context of a continuum of agricultural and food production evolution that began thousands of years ago.

Food and food labels

The focus of this book, Labeling genetically modified food: The philosophical and legal debate, should be considered in the context of the forgoing. The *legal* definition is found in the statute that authorizes the Food and Drug Administration (FDA) to regulate food and food ingredients in the United States (1). As such this definition is broad and easily interpreted: food is whatever consumers think it is; FDA is thereby given sweeping authority to regulate the safety and quality of whatever it is that consumers may eat or drink. But while this definition tells FDA what to regulate, it does not give guidance on how to regulate. That is where the *reductionist* and *biologist's* definitions of food come into play, because without a scientifically-based understanding the nature of food it would not be possible to develop a rational regulatory framework (4).

The *reductionist* definition tells us that whatever else, food is in the end a complex mixture of chemical substances (2,4). Most consumers are aware of food labels, but these only describe the added ingredients. The ingredients may be defined substances, for example ordinary table salt which is a single chemical (sodium chloride); defined mixtures of substances, for example high fructose corn syrup which consists of the natural sugars glucose and fructose; or whole foods, for example milk, which contains many naturally-occurring chemicals that are produced within the body of a cow or passed through from the food the cow ate. The ingredient list might also include natural cheese,

which contains all the naturally-occurring chemicals in milk plus the bacteria used to manufacture the cheese as well as metabolites naturally produced by those bacteria during the manufacturing process. And if the cheese is cooked, for example on a pizza, then an entirely new mixture of chemicals will be produced as a result of heat-catalyzed reactions between various naturally-occurring chemical components of the cheese. In other words the food label lists only a very tiny fraction of the actual food constituents (2,4).

FDA's position is that the information on a food label should be useful to the consumer with regard to nutrition and health decisions. Hence, added salt is listed because some consumers should control their salt intake; added sugar is listed because some consumers need to control their sugar intake and sugar can also contribute to dental carries; total fat is listed because many consumers want to control their fat intake; *trans*-fat is now listed because it can contribute to elevated blood cholesterol; peanuts and other potential food allergens are listed to warn consumers with severe food allergies to these ingredients; etc. However, the innumerable minor naturally-occurring or heat-derived chemical constituents that are found in virtually all foods are not listed because the information would be of no practical use to a typical consumer, and of course because there is insufficient room on a typical label for such an array of declarations. If, however, qualified experts were to conclude that a particular naturally-occurring or heat-generated substance might indeed pose a health risk for a segment of the population, then FDA might indeed mandate that the substance be identified on the label.

The *biologist's* definition reminds us that humans are part of a larger order. Virtually all of the food on Earth comes as a result of the sun providing energy to green

plants, which in turn use that energy to split water and carbon dioxide to produce glucose and molecular oxygen through a process called *photosynthesis*. The resulting glucose is then metabolized in highly controlled and efficient fashion via the action of specific enzymes to ultimately produce proteins, lipids, nucleic acids, complex carbohydrates, and so forth. Animals eat the plants (as well as other animals that have eaten plants) to acquire needed nutrients, so in a very real sense our existence is very nearly totally dependent on sunlight and green plants.

But what sorts of green plants do we eat? The answer is, very few (4). From a human perspective the vast majority of green plant species are inedible for a myriad reasons including unacceptable taste, palatability, nutritional quality, and/or toxicity. The properties that make them unacceptable for our tables are precisely the same qualities that make it possible for plants to survive in hostile natural environments where they are in constant danger of being eaten by animals that can range in size from elephants to mites, as well as a legion of ubiquitous microbial pathogens and parasites including viruses, bacteria, molds, higher fungi, protozoa, etc. To protect themselves from predators and pests, successful plant species have evolved numerous defense mechanisms that include synthesizing naturally-occurring pesticidal chemicals (5), and it is largely these defense mechanisms that make the plants unappetizing (which of course, from the plant's "perspective," is entirely the point.). One can easily visualize the success of this defensive strategy by taking a summer stroll in a woods: green plants dominate the scene even in the presence of insects (that one can see) and microbes (that are invisible to the naked eye).

So, again, what sorts of green plants do we eat? In fact we eat only a very few plant varieties that have been selected, cultivated, and genetically altered with a range of traditional and modern agricultural practices and technologies to match the qualities of taste, palatability, nutritional properties and lack of toxicity that humans value. In fact the wild relatives of the plants one typically finds in a supermarket would be largely unrecognizable (4). Most of the plant species that we regularly eat are substantially weakened genetically, and they survive only because of constant human intervention and protection. In a remarkable example of symbiosis driven by human imagination, we protect and nurture our crop plants, and they provide us with food.

It should come as no surprise that the organoleptic qualities in a crop plant that we prize are also prized by other species. Accordingly our success in crop improvement creates a dilemma: how do we protect the plants we've selected from being devoured by pests and pathogens? Natural armaments, the naturally-occurring pesticides and physical attributes that protect plants in a natural environment, are no longer effective for many food crops because these protective mechanisms are typically linked within common biochemical pathways that were inevitably reduced as we selected the traits we desired (4). Accordingly we need alternative strategies and the principal strategies in current use include synthetic pesticides, crop and integrated pest management programs, and biotechnology-based solutions.

Assuring the safety of genetically-modified foods

The philosophical and legal debate surrounding genetically-modified crops includes two issues that are amenable to scientific inquiry: concern for the environment,

and concern for human health (the creation of genetically-modified animals triggers an additional concern regarding animal welfare, which is beyond the scope of this discussion).

Environmental concerns associated with genetically-modified crops have been addressed in recent reports (6,7). Experts in agricultural science generally agree that there is no one best way to protect all crops from all pests and diseases. Each approach, for example the use of synthetic pesticides, crop and integrated pest management systems, and biotechnology-based solutions, has limitations. Rather than using a single approach, the consensus recommendation is to utilize all available technologies in a manner that is consistent with safety and sound land management. From an ecological standpoint it may even be counter-productive to favor any one approach at the expense of others, unless the basis for doing so is scientifically sound. For example, a report by the National Research Council of the United States National Academy of Sciences (7) contained the following observation: *“The committee recognizes that in any attempt to mitigate environmental risk there is a need to be mindful of the fact that avoiding one risk can sometimes inadvertently cause another greater risk. For example, a regulation that discouraged research on pest-specific, plant-produced compounds could in some cases lead to continued use of environmentally disruptive synthetic pesticide.”*

Human health concerns have also been addressed and a framework for evaluating the safety of genetically-modified has been established (4,8). In essence, the novel food is compared with its traditional counterpart via series of carefully crafted questions, including the requirement that the intake of any new constituents be shown to present no safety concerns. This framework, based on established scientific principals, is accepted

by FDA and has been successfully used in the U.S. for more than a decade to evaluate the safety of genetically-modified foods.

The philosophical and legal debate and the limits of science

As discussed above, FDA's position is that the information on a food label should be useful to the consumer with regard to nutrition and health decisions. This position does not recognize a consumer's "right to know" simply for the sake "knowing," nor does it recognize a manufacturer's "right to inform" simply for the sake of "informing." Rather, FDA's position appears to be aimed at protecting the integrity of the food label against being used to advocate for or against whatever food controversies happen to be fashionable at a given time.

This policy is at the heart of the philosophical and legal debate that is the basis for this book. Science can help sort out the environmental and human health safety issues, but it cannot settle philosophical and legal disputes that deal with matters beyond what can be tested using the scientific method. In this regard it is worth recounting the experience regarding the introduction of a genetically-modified tomato product in the U.K. by J. Sainsbury and Safeway stores, as documented by the National Centre for Biotechnology Education at the University of Reading on its web site ([://www.ncbe.reading.ac.uk/NCBE/GMFOOD/menu.html](http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/menu.html)) and quoted in part here as follows:

"In February 1996, J. Sainsbury and Safeway Stores in the United Kingdom introduced Europe's first genetically-modified food product. The modified tomatoes were grown in America, but they had been developed in the UK at Nottingham University and at Zeneca Seeds, based in Bracknell. The two retailers

did everything you might expect of responsible firms: they labelled the tins very clearly, even though there was no legal obligation at that time for them to do so; they made sure that an alternative non-GM product was always available alongside the modified one; and additional information was available in leaflets in the stores and a telephone help line. Rather than avoiding publicity they encouraged it, in newspaper and magazine articles and in radio interviews. The Consumers' Association applauded this approach and sales of the product were brisk. If there can be said to be a 'right' way of introducing such a product, this came pretty close.

Three years later, almost to the day, everything changed. Friends of the Earth held a press conference at the House of Commons, highlighting the preliminary findings of a small-scale study in which rats had been fed GM potatoes. Arpad Pusztai's research had not at the time been published, and the [presented by his supporters](#) was principally concerned with securing Pusztai's right to publish his findings, and highlighting the apparently heavy-handed way in which he had been treated by his employers.

Pusztai's work had been reported by a 'Panorama' television programme the previous summer but had gained little attention. Now, however, the opponents of GM food swung into action with a carefully-orchestrated campaign whose effectiveness shocked even its organisers. For several weeks in February 1999, each day almost all UK newspapers carried many pages of GM-related articles. TV reports showed maize being dumped at the gates to Downing Street, protesters dressed as animals, scientists munching on tomatoes and the Prime Minister

depicted as Frankenstein's monster. This media circus was fuelled by press releases, publicity stunts, claims and counter claims from both sides of an increasingly-polarised debate. The most recent (2002) [survey](#) conducted by the European Commission noted that 1999 was indeed the turning point in Europeans' attitudes to GM food.

*[Pusztai's rat-feeding study](#) was eventually published in *The Lancet*. A Royal Society report in May 1999 criticised the design and conduct of the study and its statistical analysis. Even Pusztai's original supporters had noted the study's apparent shortcomings [their memorandum](#), and had urged that more research was needed (although they admitted that they had not actually seen Pusztai's work and when, subsequently, it was published and subjected to public scrutiny, several of them distanced themselves from it). To be fair to Pusztai, the study was only preliminary and was never intended to be published. Pusztai, however, has staunchly defended his original work against those who thought it flawed. Others have suggested that Pusztai was the victim of a wide-ranging pro-GM conspiracy.*

Whatever the truth of these particular claims, today there is hardly any GM food in European shops, largely because of the success of the anti-GM campaign, triggered (in the UK at least) by the Pusztai work... .

... Reiss and Straughan, in their study of the science and ethics of genetic engineering, point out that arguments against GM generally fall into two categories: those that regard the technology as fundamentally wrong in principle (i.e., intrinsically wrong); and those that focus on the potential consequences of

its application (i.e., its extrinsic properties). Note that similar sorts of reasoning also apply to some who speak in favour of the technology.

With those who object to (or support) GM on principle (e.g., by arguing that the process is morally objectionable (or desirable) there is no debate to be had. Their moral views should be respected and that is that.

For those whose arguments are based on extrinsic concerns, however, the choice is less easy. Essentially they are making a prediction about what might happen if a particular technology is used. The evidence, scientific and non-scientific, is difficult to assess, even for those with a knowledge and understanding of the subject. After considering all the arguments, assuming a person does not decide to reject the technology entirely, what sort of GM crops might they accept, and which ones might be rejected? What regulations and safeguards should be put in place, and how should these be policed? How, if at all, can it be ensured that farmers of all types both here and overseas are not disadvantaged, and that vulnerable ecosystems are protected?” (quoted from [://www.ncbe.reading.ac.uk/NCBE/GMFOOD/menu.html](http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/menu.html))

Rarely has the essence of a societal debate been captured with more clarity. There is indeed a raging philosophical and legal debate. Both sides attempt to use science but the scientific method is as delicate as it is sharp, and it is easily misused and manipulated. Scientists must guard against that. However, it is also incumbent upon philosophical and legal scholars to guard against the misuse of their disciplines in this crucially important debate.

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