From Wonder Bread to GM Lettuce

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When I was a young boy we used to drive on the highway to Denver and I remember the lovely scent of baking bread wafting into the car. After a number of trips I discovered the source: a large Wonder Bread factory. I didn't really connect this sensual experience with my daily consumption of Wonder Bread. I consumed Wonder Bread in two ways. One was as the covering for my peanut butter and jelly sandwiches. The other was in advertisements: "Wonder Bread Helps Build Strong Bodies in 12 Ways!" I didn't know what this meant, but I sure loved squishing two or three slices into a little ball and popping it into my mouth. Only later did I learn that Wonder Bread had everything nutritious in wheat flour processed out of it, only to receive the wondrous 12-fold enrichment conceived by nutrition scientists and industry marketeers.

Like most other Americans, I grew up with the subliminal message: food is composed of individual nutrients and each one does something different for you; just take in enough of the right kind and you'll be fine. When, in the early seventies, I turned my back on processed food (as part of an overall protest against our materialistic culture) and started eating whole foods, I didn't really know why and what I was doing. I just did it, and with time my relation to food changed. Not only did Wonder Bread, Puffed Rice and their companions feel more and more like poisons when I occasionally ate them, but I also realized that food and nutrition are all about activity—sensing, mixing, and taking apart the food we eat. In digesting we analyze—break down—the food we eat and then actively build up our own individual bodily substances. But the All-American processed food industry would have us believe that eating is a passive endeavor. Not only does it need minimal preparation, but enriched food has everything we need already in it. Just swallow and it will do the rest.

Moreover, we have very little awareness of how our food is produced. It's not only the increasing number of children who don't know milk comes from cows; most of us have no idea about the agricultural production of our fruits and vegetables, where they come from, how they are grown, and how they get to the supermarket. This alienation from food is increased by single-nutrient thinking. We don't eat eggs; we eat a combination of proteins and cholesterol. So for most of us food has become isolated from the context of its production and turned into a simple, cause-and-effect abstraction. (Cheerios lower your cholesterol levels.)

This Wonder Bread ad is from the 1950s. Only in the 1960s were four new ingredients added so that Wonder Bread could help build strong bodies in twelve, rather than eight, ways.

What's on the Way

With the advent of genetic engineering, food processing takes on a new dimension. Instead of adding new ingredients into foods in the factory, we put them into the plants themselves. Food processing no longer begins in the factory but in the living organism. The idea is to provide plants, animals and food with characteristics they wouldn't otherwise have by adding genes from other organisms.

The first generation of genetically modified (GM) crops has been designed to make pesticides or to be resistant to certain herbicides. Since 1996, transgenic plants with these characteristics—soybeans, corn, canola, cotton—have been commercially cultivated. In 2003, 140 million acres of these crops were planted world wide (that's four times the acreage of New York state), eighty percent in the United States. Since this application of genetic engineering serves solely the desires of the producers, the changed characteristics are called producer-oriented input traits. We will likely see a greater variety of such modified crops in the coming decade—for example salt-resistant plants that can grow in salt-rich desert soils.

A next generation of GM crops is currently under development in university and industry labs around the globe. Scientists are working to genetically alter plants to produce characteristics and substances that are useful and enticing to a market broader than farmers. Genetic engineers also hope that these new “consumer-oriented output traits” will redeem the bad name that GM crops have acquired over the past decade.

To date there are three different categories of next-generation GM crops—industrial, pharmaceutical, and nutritionally enhanced transgenic plants. Prototypes of these have been produced in the laboratory, but none is presently on the market. Industrial transgenic plants would produce silk proteins, bioplastics or industrial enzymes. Such crops are not meant to produce food, and they all would be farmed solely for the valuable substances they produce for other industries.

The second, pharmaceutical class of next-generation GM crops would produce therapeutic substances for human or animal consumption. Some would be grown on a large scale so that a specific hormone or therapeutic enzyme could be isolated from the harvested crop, purified, and sold as a medication. Other GM crops are being modified with the goal of having, say, edible vaccines. A child could eat a banana and receive flu vaccine along with it. Or corn grown for animal feed could produce vaccines for swine, cattle or chickens. The hope is that, in the long run, we could produce these transgenic plant vaccines cheaply and also save on costs needed for doctors and vets to inject the vaccines. And what child wouldn’t rather eat a banana than get a tetanus shot!

The third category encompasses traits that would improve (according to proponents) the quality of food. Examples of such nutrient-enriched plants that have been produced in the lab are rice that stores beta-carotene (“golden rice”) or iron in the otherwise nutrient-poor white rice kernel, tomatoes that produce large amounts of an antioxidant (flavonol), and lettuce with vitamin C (ascorbic acid). It’s these nutrient-enriched biotech food plants that I want to focus on here.

The idea of fortified white rice is conceived with the Asian third world in mind, since vitamin A deficiency (our body makes vitamin A out of beta-carotene) and iron deficiency are two main proximate effects of malnutrition. This approach to alleviating world hunger is simplistic and naïve—and the subject of a whole other article (see Holdrege and Talbott, 2000). Suffice it to mention here: seventy-eight percent of countries with significant child malnutrition and hunger *export* food; beta-carotene needs proteins and fat in order to be digested and assimilated by the body, so providing single nutrients does next to nothing to alleviate the problem; and if white rice, which is cherished in Asia for its pure whiteness, were suddenly golden through beta-carotene, would the people eat it?

But what about high-flavonol tomatoes or vitamin C-enriched lettuce? Wouldn’t they catch on in our single-nutrient-conscious America? Here the GM industry would profit from the market built up over the past few decades by the processed food industry. (The industry has had the help of nutrition science and government policies.) “Health-bestowing, enriched” GM foods, if intelligently marketed, would certainly find eager consumers in the U.S.

The Illusion of Single-Target Effects

One of the illusions associated with improving plants through genetic technologies is that you can alter one specific trait in the plant without changing anything else. Examples abound in the literature; let’s look at a few:

* Bioengineers had the idea of enriching animal feed plants with the amino acid lysine, which is an essential amino acid for animals but is not contained in large amounts in corn or soybeans. So they genetically modified these two species and the plants doubled the amount of lysine in the seeds. But they also found that lysine was being broken down in the seeds and very different amounts of these break-down (catabolic) products arose in the two different species (Mazur et al. 1999). Attempting the same experiment in tobacco, they found that lysine accumulated in the leaves but not in the seeds; they discovered a new metabolic pathway through which tobacco seeds actively break down lysine. So each species reacts differently and unforeseeably to the manipulation.

* Tomato plants were genetically modified to produce more carotene. To their surprise, the researchers found that the more extra carotene a plant produced the smaller it became (Fray et al. 1995). In some unknown way the extra production of carotene was linked with decreased production of a particular hormone related to growth.

* Different lines (genetic varieties) of transgenic potatoes were created that break down sucrose in different ways. This entails a small genetic change that is associated with the production of a new enzyme in each of the transgenic lines. The scientists wanted to know if other changes were being

effected, so they carried out a so-called metabolic profile. They investigated the amounts of eighty-eight different substances (starch, different sugars, different amino acids, and so on) being produced in the tubers. Surprisingly, the changes observed were not restricted to substances in the specific breakdown pathway affected by the genetic manipulation. Rather, most of the eighty-eight substances showed changes in their amounts. The transgenic lines differed from each other and from the non-manipulated potatoes. For example, the transgenic potatoes often produced more amino acids than the non-manipulated potatoes. Moreover, nine substances were found in the transgenic potatoes that could not be detected in the non-manipulated potatoes.

Genetic engineering has been advertised as a method to introduce well-defined, single-target effects. It's startling, therefore, to discover that a seemingly small genetic alteration in the metabolism of *one* sugar is associated with global changes in substance production within the potato tuber. And the scientists investigated only eighty-eight of the thousands of substances produced within a potato. (The mustard plant *Arabidopsis*—the workhorse of plant geneticists—is known to make more than five thousand different compounds.)

So we can be sure that any genetic manipulation is likely to have myriad unnoticed effects on the physiology of the plant. A gene does not function in isolation from the rest of the organism. The substances associated with it are involved in numerous metabolic pathways and, ironically, genetic engineers often discover new metabolic pathways through unintended effects within their experiments. The life of the plant is much more complicated and dynamic than the scheme in the mind of the engineer. What we're doing is influencing plants to take on functions we desire and yet we have little or no knowledge of the larger consequences of these intrusions.

If our concept of nutritional value is based solely on a desired array of different nutrients, and we put blinders on in relation to anything else that might be occurring, we may have no problem with this approach. In fact the dream crop will be, as Dartmouth biologist Mary Lou Guerinot imagines, the one that contains as many as possible of the 13 essential vitamins and 14 minerals required in our diet (Guerinot, 2000). It's Wonder Bread all over again, except that the living organism itself will be the vehicle to transport all those "valuable" nutrients into our bodies. I can already imagine: "Enjoy your movie and enhance your health by eating our vitamin- and mineral-enriched popcorn!"

In this view there is no interest in the "small" fact that individual plant species have evolved very different qualities and substances that make them unique. Maybe it's *not* desirable to have bananas and lettuce that are fortified in the same ways. And the "sameness" would be only in connection with the desired trait; we'd be overlooking all the other subtle changes taking place.

CSA (Community Supported Agriculture) pick-up day at Hawthorne Valley Farm in Ghent, New York. [Photo: courtesy of Hawthorne Valley Farm]

We have next to no idea how the particular constellation of substances in a specific plant enhances or modifies the effects of each particular substance and how such effects bear on the whole organism. We just naively assume that substances isolated and purified in the lab and then combined in a new mixture will have essentially the same effects on the human organism as the much more complex composition in the whole food. And now we take this isolating and mixing paradigm and transfer it into the plant. Can we truly believe we know what we're doing?

Health is in the Whole

I believe that what I've just described will have little effect on traditional food scientists, government bureaucrats, or GM proponents. The faith in simple solutions to complex problems is rock-solid despite myriad examples of its failings. And, unfortunately, many American consumers are in a deep sleep regarding these issues. Faith in experts and reliance upon the media and Madison Avenue are like sedatives, robbing us of independent and critical judgment. When Americans start eating flu-vaccine containing vitamin C-enriched lettuce because the food industry and the government are telling us it's good and wholesome, we'll know how bad the situation has become.

But, thankfully, many people are unsatisfied with the status quo and are engaged in the organic food and sustainable agriculture movement—as farmers, food processors, distributors, retailers, and consumers. As consumers we have a significant role to play in assuring that this deep sleep does not overtake the whole of society and that a heightened and new awareness for agriculture, food, and health enlightens our culture. I'd like to focus on only one aspect of this task.

If we view organic food only as a commodity characterized by the fact that it lacks certain "bad things," such as pesticide and herbicide residues, and that it is healthier for *me* (and my family), then we're operating within the same mindset that dominates the GM-food industry. It is a substance-based, egocentric view of food and health. Organics can only provide a real and significant choice if it supports the awakening of a new ecological and process-based view of food and health. Let me explain.

Most of us have grown up with an egocentric notion of health. A food or substance is good or bad for me. I form a bubble around the food and myself and ignore the larger context. In this larger context, food is connected with transportation and distribution, processing, marketing, and a specific kind of agriculture being carried out at a specific place on the planet by a specific farmer. The farming takes place within complex ecological, social, political and economic environments. So when I buy a carrot I am, in fact, supporting everything that contributed to the production of this carrot—including, for example, any fertilizer runoff that pollutes a stream.

Realizing that with each meal I'm connected with, and a supporting member of, a whole world of processes, I begin to see the carrot as much more than an isolated food product lying on the table. It begins to matter where the carrot came from and how it was farmed. By connecting myself consciously with the carrot writ large, my concept of health also shifts. It's not just a matter of *my* health but of the health of the whole system. Or, rather, my health expands beyond vitamins and minerals and beyond the carrot and becomes part of the health of the whole. I cannot separate myself out of the whole anymore. A future culture based on this principle will assess quality in terms of sustainable and thriving processes and not only in terms of nutrients.

Of course it's no simple matter to gain such a concrete process-relation to all the food we eat. I joined a CSA (Community Supported Agriculture) so that I can have a pretty good sense of the process involved from seed to harvest of the vegetables I eat from a local biodynamic farm during the growing season. But I also buy in stores—coffee, bananas, and, yes, organic cornflakes. In these cases the staff of the retail store and food labels are my main window into the processes that brought forth the product. The organic food industry has a significant task here—to give consumers as vivid a picture as possible of the product's story. Product labels, store posters, and store staff can help draw the consumer into the larger picture and to conscious participation in it.

But labels need to be truthful and transparent. I believe that when consumers buy organic milk, they will naturally assume that the cows have access to pasture and grazing during the months of the year where this is possible and that the farmers are practicing sustainable, organic agriculture. They will *not* assume that it is possible to label milk as organic if the cows are basically factory-farmed but fed organic hay and grains, having never stepped on a pasture in their lives. But this is possible under the definition of "organic milk" in the federal organic standards. Consumers Union provides a valuable service in its "eco-labels" program, which investigates and describes the regulatory definitions and the sometimes misleading nature of "natural" and "organic" food labels (www.eco-labels.org).

If organic agriculture is truly to provide an alternative to the industrial, technologically enhanced model of food, and if it is to serve consumers who long for responsible human efforts within nature, then it must be concerned about viewing food as part of a whole process. Then it will provide a real counterbalance and alternative to a coming generation of "enhanced" GM food that the biotech industry would like us all to embrace.

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