Nutritional Quality:

Organic Food Versus Conventional

by Mary-Howell R. Martens

Is organic food more nutritious or better tasting than conventionally produced food? This is a question that many people are asking, but unfortunately, there is no simple answer. So much more is involved in the nutritional quality of food than simply comparing organic versus chemical agronomic practices. There is certainly quite a bit of incorrect information, confusion, and wishful thinking on both sides concerning this subject, and probably there is as much variation in food quality produced on different organic farms as there is in the quality of food produced on different conventional farms.

Many people do believe that they can taste a difference between organic and non-organic food. I usually think I can, but that might be because organic food is often fresher and more likely to be locally produced. Margaret Wittenberg, of Whole Foods Inc., says that in their stores, when customers ask whether organic foods are more nutritious, the company policy is to say that there is no evidence to say that this is true. However, she says that many customers remain unphased with this answer due to their own experiences and perceptions.

Some animals apparently can detect a difference in organic crops by taste. Floyd Hoover, in Penn Yan, New York, grows organic corn. One night he left several ears of conventional and organic corn side by side in his barn. The next morning, the organic corn had been nibbled by mice while the conventional corn had been ignored. Floyd then rearranged the order of the cobs, but still the mice avoided the conventional corn. Finally, he hid the organic corn, but the mice refused to touch the conventional corn. Within a few nights, the mice found the hidden organic corn and had a feast. Anecdotal evidence such as this indicate that for many people and apparently animals too, detectable quality differences do exist. Scientifically, however, it is difficult to draw definitive comparisons about the nutritional quality of conventional and organic food. Many environmental factors influence the nutritional quality and flavor of any type of farm product, including soil type, soil moisture, soil microbial activity, weather and other climatic conditions. Cultural practices, such as crop variety, seed source, length of growing season, irrigation, fertilization, cultivation, and postharvest handling, will also affect food quality.

There have been few studies that directly contrast the chemistry of conventional food to organic food. Research reported in the *Journal of Applied Nutrition* showed that on a per-weight basis over a two-year period, average levels of essential minerals were much higher in the organically grown apples, pears, potatoes and corn as compared to conventionally produced products. The organically grown food averaged higher in calcium, chromium, iron, magnesium, molybdenum, phosphorus, potassium and zinc, and lower in mercury and aluminum. A more recent study out of Australia showed a similar difference between calcium and magnesium levels in organic and non-organic food.

Simply knowing the absolute quantity of chemical elements in a food sample may not be particularly revealing if we don't know what molecules those elements are incorporated into in the food product. The same simple chemical elements may be organized into nutritious and flavorful molecules or may be organized into toxic, unpleasant-tasting molecules, or even into molecules that render plants more susceptible to insects and diseases. Certain amino acids such as proline have been linked to increased insect feeding and egg laying behavior. A plant slightly deficient in potassium may lack enzymes necessary to convert free amino acids into complex proteins. Another plant with adequate potassium might not show detectable differences in overall nitrogen level, but would contain more protein, might be much different in food flavor and quality, and might be much more resistant to insect attack.

It is possible to identify the specific chemical molecules that cause the typical characteristics we call "flavor" or "quality." These generally are large, complex molecules, such as sugars, proteins, enzymes, esters, and organic acids. In a preliminary study, Dr. Franco Weibel at the Research Institute of Organic Agriculture in Ackerstrasse, Switzerland, compared a variety of parameters in apples grown under organic and conventional conditions, such as mineral elements, sugars, phenols, malic acid, selenium, dietary fiber, and vitamins C and E. Organic fruit also had significantly firmer flesh and better sensory taste evaluations. Weibel found interesting correlations between the microbial activity in the soil, a condition closely associated with organic management, and the nutritional status of the apples, especially the phosphorus level. The actual chemical soil phosphorus level had little impact on fruit nutritional status. This research also found that organic fruit was considerably higher in phenols. Plants naturally synthesize phenols for defense against pests and diseases. Possibly, the unsprayed organic plants were stimulated to make higher levels of these critical molecules in response to pest attack. These phenolic compounds that protect the plant also have been shown to be disease protectants in humans. This corroborates work done by Elaine Ingham at Oregon State University, who has shown that corn and grape plants grown in association with mycorrhizal fungi produce fruit with higher protein levels.

Research conducted at Ohio State University by Dr. Larry Phelan has shown that European corn borer insects given a choice between organic and conventional corn plants avoid the organic plants. His research is continuing to test two hypotheses for these observations. He feels that the organic soils, with a rich microbial population, may release

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plant nutrients more evenly over the season, resulting in slower, sturdier plant growth that is more resistant to insect attack. He also believes that the mineral balance of the soil and the plant plays a key role in insect resistance. In either case, the levels of complex molecules and water content in the plant tissue probably determines how tasty the plant is to an insect.

Animal nutritionists have noted a drop in nutritional quality of animal feed, especially corn and forages, over the past 25 years. Dave Mattocks of the Fertrell Company in Bainbridge, Pennsylvania, has been formulating animal rations for many years. He reports that he has had to continually increase quantity of protein sources in animal rations in order to maintain a constant level of protein. He feels that this reflects that the average protein level in grain has been dropping. When plants are induced to produce more quantity (higher yield), it is usually at the expense of something else, in this case, certain key molecules that affect quality and nutrition. Confirmation of this observation would probably be available if one took the time to sort through and analyze the reams of data that forage analysis labs have collected over the past 25 years.

Indirectly related to observations about declining feed quality, an article in the March 25, 2000 issue of *Science News* described research that showed that plants growing with increased air CO_2 levels (as is possible in the future with the greenhouse gas effect) do indeed grow faster and produce more carbohydrates, but the protein levels are lower. Insects feeding on these plants eat excessively but grow poorly. Sheep eating such plants eat less, grow poorly, and digest their food more slowly, probably because the essential bacteria in the ruminant gut are themselves protein deficient and malnourished. This is important research that needs to be considered for several critical reasons. First, of course, because the Earth's atmosphere is changing and we need to anticipate how this may effect vegetation and the organisms that feed on the vegetation. Secondly, this research can offer valuable insight into the critical factor of genotype-x environment interaction, a factor which is largely being overlooked in the biotech and Green Revolution discussions.

Regardless of all the other issues involved with genetically engineered crops, it seems logical that unless we pay attention to the soil and other environmental factors *first*, efforts to improve yield, nutrient content, or pest resistance of crops through genetics alone will be far less successful than they might be. Results obtained on well-managed research farms may not be repeatable on poorer soils that are not being as intensively managed. Most crops have far more genetic potential than they are able to express already. Producing high yields on poor soils without maintaining fertility levels will only postpone famine until the soil becomes exhausted. We should not see genetics alone as the solution to management problems, as a way that allows farmers to continue poor production practices on their farms. Many American farmers face a corn borer problem because they don't rotate properly and use other practices, such as no-till, that allow large pest populations to build. Bt corn makes it easier to continue poor management practices, at least until pest populations develop resistance. Obviously, new traits could then be engineered into corn to control the resistant pests, but the underlying problem is still not being addressed by this approach.

Often, when discussions of the relative nutritional merits of organic versus conventional food come up, someone will invariably quote a 1948 study by Dr. Firman Bear at Rutgers University. Unfortunately, using this research to support any such claims is quite incorrect, because this study did not compare organic and conventional food. Instead, it compared crops grown in mineral versus organic (muck) soils, it had nothing to do with use of chemicals. However, perhaps Dr. Bear did get it right on one point. The research showed that the composition of the soil has a major and readily detectable influence on the mineral content and the nutritional quality of food. By better understanding the role that a healthy, microbially active soil can make on nutritional quality of plants, perhaps then we then can design agricultural systems that will maximize this. On an organic farm, careful attention is placed on improving soil quality, increasing soil organic matter, and enhancing soil microbial life, crops are carefully rotated and soil is specifically amended to balance all aspects of soil fertility. It makes logical sense to conclude that plants produced under such a system could indeed be more flavorful and nutritious.

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