Nutrition and Biodynamics:
Evidence for the Nutritional Superiority of Organic Crops
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Also see:

Is Organically Grown Food More Nutritious?
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While it is generally acknowledged that pesticide residues in food and drinking water may be a bad thing, the conventional wisdom still holds that organic food is no more nutritious than conventionally grown food. A stunning lack of interest on the part of government and university researchers is in large part to blame for this situation. What is behind claims about the nutritiousness of organic food and how does biodynamic food stack up against the rest of the pack? Let's take a look at the evidence.

There have not been a huge number of researchers that have even considered the influence that agriculture methods might have on human or animal nutrition. Nevertheless, there have been at least thirty-five studies comparing the nutrient levels of organic and conventional crops. Few of these studies are directly comparable. Some look at only fertilizers and others at farming systems such as biodynamics; some examine freshly picked produce at the farm gate while others look at crops that have been in storage or have been shipped to market. Moreover, taken individually, few of the studies show conclusive evidence one way or the other. As a consequence, it is easy to walk away thinking that there is no significant difference. However, when the nutritional comparisons are piled up together and we ask the right questions, a different picture emerges which suggests that organically grown crops are more nutritious. In the following sections, we will ask a few of these questions with regard to the body of published comparisons, and along the way see how well biodynamic crops compare both to conventional and to other organic crops.

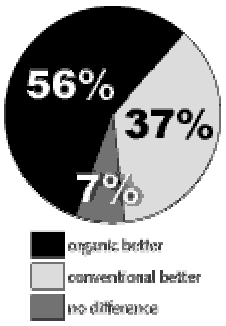
How often is organic better?

This first question deals with how much of the time organic crops have a better nutrient content than similar conventional crops. This is an important questions because it tells how likely a consumer would be to come across an organic food item with higher nutrient levels or lower levels of toxic substances. A rough answer to this question can be obtained by looking at the numbers in the published studies, and sorting the comparisons by outcome - organic with a higher nutrient content (or lower for toxics), conventional higher, or both exactly the same. Figure 1 shows the results of this process: the organic crop has the higher nutrient level or lower toxic level in 56 percent of the comparisons while the conventional crop was better only 37 percent of the time. For biodynamic crops, the numbers are similar with the biodynamic crop having a better nutrient content 59 percent of the time and the conventional crop 27 percent of the time. These results are significant since the organic crop has the better nutrient content the majority of the time. Overall this pattern suggests that any nutritional benefits that organic food might offer would occur often enough to be useful to a consumer and that biodynamics has a slight edge in that regard.

How much better is organic?

The second question asks how much more of each nutrient is there on average for organic crops versus conventional crops. The average percent more or less for some nutrients is shown in Table 1 below. Over a number of nutrients in the crops that have been studied, the average organic crop has approximately 10-20 percent higher nutrient levels than a comparable conventional crop. For toxic substances, there are not many studies except for nitrates, but it appears that, on average, the organic crop has at least 10-20 percent less toxics.

Figure 1. Organic versus conventional
Percent of 1230 published comparisons where nutrient levels are better, worse or the same



How do biodynamic crops compare to other organic crops in terms of nutrient levels? There are too few biodynamic studies to answer this question in any meaningful way for most nutrients. Nonetheless, we can do a preliminary evaluation. Table 1 shows the average difference in nutrient levels for both biodynamic and other organic crops. Of the nutrients shown in Table 1, only vitamin C has been studied to any extent in biodynamic crops, and vitamin C levels appear to be higher in biodynamic crops compared to other organic crops. Otherwise, from the small quantity of existing data, biodynamic crops appear to be reasonably similar to other organic crops.

We have seen now from this analysis that organic crops have higher levels of nutrients the majority of the time. Still, it is easy to dismiss all of this as insignificant since the absolute quantities of nutrients are small. For example, if there is 47 percent more vitamin C, for most foods that amounts to no more than a few milligrams. Are these small differences of any consequence? A few years ago it would have been easy to brush them aside, but it is now known that there are many nutrient interactions and that small differences do matter.

For example, an increase in vitamin C increases the effect of vitamin E, folic acid and iron. The increase in vitamin E then increases the effect of selenium and vitamin A. Vitamin A further increases the effect of iron, and so on. Because of these interactions, small increases (or equally decreases of toxic substances), over the many nutrients in a food, can have a much bigger effect than would be expected from looking at the individual nutrient levels. Nutritionally speaking, the whole is greater than the sum of the parts. And small differences in nutrient levels can matter a lot.

Table 1. Average difference in nutrient levels
***Biodynamic, non-biodynamic and all organic crops compared to similar conventional crops**

	Biodynamic	Other organic	All organic
Nutrient	**% difference**	**% difference**	**% difference**
vitamin C	+47.6%	+11.9%	+22.7%
Iron	+33.9%	+15.6%	+17.2%
calcium	+07.4%	+38.4%	+30.8%
Phosphorus	+06.6%	+14.3%	+12.5%
sodium	+20.3%	+19.3%	+19.6%
Potassium	+07.9%	+16.2%	+14.1%
Magnesium	+13.2%	+28.3%	+24.4%
beta-carotene	+14.0%	-09.2%	-00.3%

Nitrates	-49.8%	-30.9%	-33.9%

*All nutrients that have been measured in biodynamic crops are included.

Does organic food make you healthier?

This brings us to the most relevant question: what happens to the health of animals and humans eating organic foods? There are no human studies to look at, but there are reports of positive health effects from consumption of organic foods. One published report tells of the improved health of students at a boarding school that began serving organically fertilized fruits and vegetables. Other reports come from doctors, administering alternative cancer treatments, who have observed that a completely organic diet is essential for a successful outcome.

As for formal investigations, there are fourteen animal studies comparing organic with conventional feed. Biodynamic studies are shown in Table 2 and other organic studies in Table 3. What is striking about the studies as a whole is that there are eight studies where the organically fed animals performed significantly better and no studies where the conventionally fed animals performed much better. In addition, the three studies showing no difference had methodological problems that made them unlikely to find one. In these studies, animals were either supplemented with vitamin A or fed high vitamin A feed and then judged on outcomes which would be affected by this vitamin.

The positive studies showed that organically fed animals had less illness, better recovery from illness, better testes condition and greater sperm motility in males, greater egg production in females, better fertility, fewer stillbirths and perinatal deaths, and better survival of young. These outcomes, reproduction and incidence and recovery from illness, are sensitive indicators of health status, and should be given appropriate weight. Taking all of this into account, the available data is very strong with regard to the health benefits of organic feed.

Of the strongly positive studies, the majority used biodynamic feed, and all of the biodynamically fed animals performed excellently compared to conventionally fed animals. All of the biodynamic studies were clearly positive. Non-biodynamic studies, on the other hand, showed more mixed results, with some studies being extremely positive and others showing a less clear cut benefit. Altogether, these results suggest that while a number of organic systems may be capable of producing positive results, biodynamics at the very least provides a model for a healthy agricultural system.

Table 2. Animal studies comparing biodynamic with conventional feed

Study	Outcome
Pfeiffer, 1938 cited in Linder, 1973	earlier (166 vs 181 days of age) & greater egg production (192 vs 150 eggs per hen) in chickens fed biodynamic versus conventionally fertilized grain. Spoilage of eggs after 6 months was 27% for biodynamic eggs versus 60% for conventional eggs lower mortality (9% vs 17%) in weanlings fed biodynamic wheat versus conventionally grown wheat
Aehnelt & Hahn, 1973	greater number of eggs (8.6 vs 1.8 & 0) and higher fertilization rate (93.1% vs 0% & 0%) in rabbits fed biodynamic versus conventionally fertilized feed
Staiger, 1986 cited in Vogtmann, 1988	fertility rate of rabbits remained constant over 3 generations with biodynamic feed and declined with conventionally grown feed

Plochberger, 1989 better weight gain after coccidial illness & fewer incidents of illness in chickens fed biodynamic feed; significantly higher egg weight and yolk weight in chickens fed biodynamic feed compared to birds fed chemically fertilized feed

Velimirov et al, 1992 fewer stillbirths and perinatal deaths in first litters and better weight maintenance in lactating female rats fed biodynamic feed versus conventional feed

Table 3. Animal studies comparing non-biodynamic organic with conventional feed

Study	Outcome
McCarrison, 1926	less weight loss (22.4% vs. 37.4%) & longer survival (50 vs 33 days) in birds with polyneuritis fed a manure fertilized millet supplement versus birds fed a chemically fertilized millet supplement higher weight gain (77.7% vs 51.4%) in young rats fed manure- versus chemically-fertilized wheat
Rowlands & Wilkinson, 1930	greater weight gain in vitamin B deficient rats fed a manure fertilized seed supplement versus rats fed a chemically fertilized seed supplement
Harris, 1934	duration of cure for bradycardia in rats was 6, 5 and 4 days when fed grain fertilized with ammonium sulphate, manure, and complete chemical fertilizer
Leong, 1939	duration of cure for bradycardia was similar or longer for rats fed wheat (5.0 vs 5.4, 5.2, 5.1 days) or barley (8.1 vs 5.3, 4.8, 4.7 days) from fields treated with manure versus complete chemical fertilizer, ammonium sulphate or both
Swanson, 1940	no difference in growth in vitamin A depleted rats supplemented with sweet potatoes fertilized with manure, muriate of potash, nitrate of soda or superphosphate
Miller & Dema, 1958	no difference in reproduction in rats
Scott et al, 1960	less testes degeneration & similar reproductive performance in mice fed manure-fertilized wheat versus conventional feed
Aehnelt & Hahn, 1973	reduced sperm motility in bulls transferred from organic to conventional fodder; motility restored when organic fodder resumed
Gottschewski, 1975 cited in Vogtmann, 1988	mortality of newborn rabbits was 27% for animals fed organic feed versus 51% for those fed conventional feed and 50% for those fed commercial pellets

McSheehy, 1977 no difference in reproduction in mice

Is there any more evidence?

A final point is that there are known mechanisms and scientific explanations for the observed differences in nutrient levels. A portion of the difference is due to effects of fertilizer. The soil dynamics and plant physiology that would produce some of the observed nutritional differences are known. For example, the excessive quantities of nitrogen presented to the plant by chemical conventional fertilizers cause the plant to produce more nitrates, less vitamin C and a poorer quality protein. Similarly, conventional potassium fertilizers make soil magnesium less available to plants so that levels of this nutrient are lower in potassium fertilized plants.

In addition, pesticides are known to affect plant composition, and there are a few studies showing nutritional effects. Herbicides are particularly nasty in that they kill plants by altering their production of key compounds such as beta-carotene, tocopherols and amino acids, all of which have nutritional significance. Although food crops are not killed by herbicides, the nutritional composition of these crops may still be altered. For example, the few studies that examined the effects of herbicides on protein, all showed a decline in protein quality with herbicide usage.

A complete exposition of the science behind the nutritional effects of agricultural chemicals is well beyond the scope of this article, but nonetheless, the fact that these chemicals are known to affect the nutrient composition of plants should not be forgotten.

Conclusion

Where does this leave us? We have seen a pattern of better nutrient composition in organic crops, better health in animals consuming organic food and the existence of known mechanisms explaining observed differences between organic and conventional crops. Biodynamic crops performed extremely well on the most important measure, the health of consumers. Whatever problems there may be with the quantity or quality of existing studies, the body of evidence, at a minimum, provides strong indications that organic crops are more nutritious.

Appendix: analytical methods

This analysis used all studies, available to the author, comparing crops produced with organic fertilizer or by organic farming systems to conventional fertilizers or systems (see sections 1and 2 of the references). Studies of research plots, pot studies, farm gate produce, stored produce and produce purchased at markets were all included. The reason for this is that there are insufficient data of any one type to draw meaningful conclusions. Consequently, all the data was considered. Fertilizer studies were used because differences in fertility management are historically the most fundamental difference between organic and conventional agriculture. In addition, fertilizer effects are often ignored in the furor over the toxic effects of pesticides.

For purposes of this analysis, a single comparison consisted of a single nutrient in a single organic vegetable crop grown in one growing season compared to the same nutrient in the same conventionally grown crop grown in the same season. A few studies reported pooled comparisons that included more than one year or more than one crop. These comparisons were included in the analysis when single comparisons were not available.

To produce Figure 1, all available published comparisons (n=1230) were sorted by outcome. The three outcome categories are:

1. organic with a higher nutrient level or a lower level of a toxic substance
2. conventional with a higher nutrient level or a lower level of a toxic substance
3. both the same.

This sorting was done by the numerical values or by the stated outcome for studies where no numbers were published. Statistical significance of differences was not considered.

The percentages in Table 1 use the conventional crops as the standard or 100% so that a difference of +10 means that organic crops have on average 110% of the conventional level for the same nutrient. Only studies that contained numerical values were used for this part of the analysis. The percentages were calculated by first calculating a percentage difference for each nutrient within a study. For each nutrient, the percentage differences by study were averaged. In a few cases, a study included both biodynamic and other organic comparisons. Separated averages were calculated for these groupings.

The number of studies and comparisons for each nutrient used in Table 1 is shown in Table A-1 below:

Table A-1. Number of studies and comparisons for nutritional factors classified by biodynamic or non-biodynamic status

	Non-biodynamic		Biodynamic	
	No.	No.	No.	No.
Nutrient	of studies	of comparisons	of studies	of comparisons
nitrates	16	144	3	27
beta-carotene	9	24	3	15
vitamin C	17	92	5	39
iron	14	77	1	7
magnesium	14	73	2	24
phosphorus	14	75	2	22
calcium	14	72	2	22
sodium	9	41	2	19
potassium	13	70	2	22

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