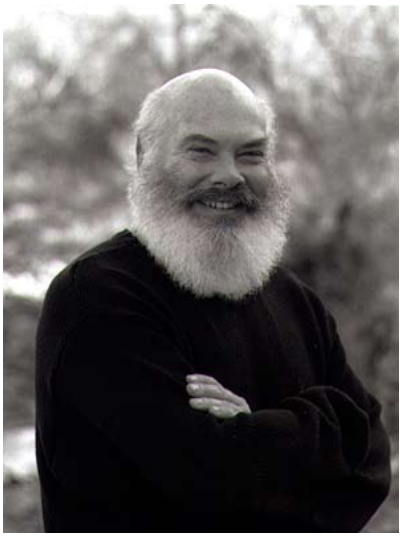
New Evidence Confirms the Nutritional Superiority of Plant-Based Organic Foods

by Charles Benbrook, Xin Zhao, Jaime Yáñez, Neal Davies and Preston Andrews

March 2008

table of contents

Foreword



By Andrew Weil, MD

Developing a healthy lifestyle requires information and motivation to apply it. Your everyday choices about eating, physical activity and stress management, for example, all influence how you will feel tomorrow and your health risks later in life. It is our choices that individually and collectively determine how gracefully you will age.

Adopting healthy routines, and sticking to them, is key. A practical tip I often give is to spend more time in the company of people who have those routines down. If you want to improve your diet, eat with people who know about and are in the habit of making healthy food choices. Eating well is a foundation of good health. It can help you feel well, give you the energy you need, and cope with routine ailments, from colds to lack of sleep. Long term, it will reduce the risk and delay the onset of the chronic age-related diseases.

For years I have urged people to include several servings of fresh organic fruits and vegetables in their daily diets, and to choose produce that covers all parts of the color spectrum. The medical evidence linking fruits and vegetables to good health is overwhelming. And now, so too is the new evidence that organic fruits and vegetables deliver more nutrients per average serving, including the all-important protective phytonutrients like polyphenols and antioxidant pigments.

Getting in the habit of choosing organic food whenever you can will ensure that you and your family get the nutritional benefits nature provides. It is a cornerstone on which to structure a lifestyle that will promote and maintain health lifelong.

Andrew Weil, MD
Board Member, The Organic Center
Director of the Program in Integrative Medicine
University of Arizona
March 2008

I. Executive Summary

"We just don't know…" or

"There is not enough high quality data to reach conclusions" have been the common answers given over the last few years when nutritionists and agricultural scientists have been asked the question on the minds of many consumers -- "Are organic foods more nutritious?"

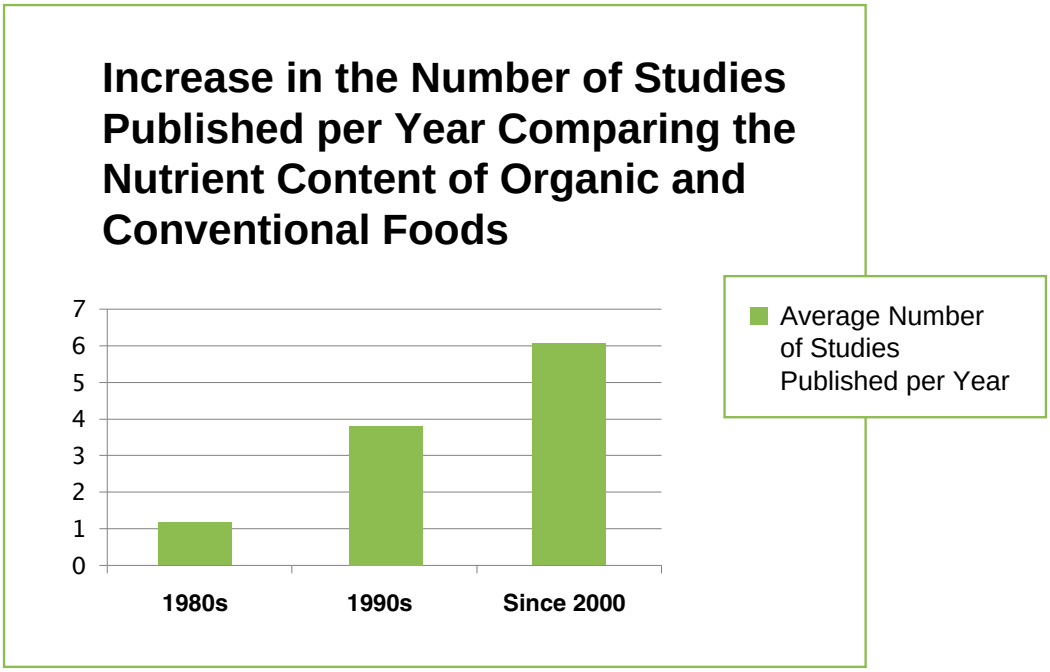
In fact, this sort of ambivalent answer accurately reflects, for the most part, the major conclusions reported in five published scientific literature reviews of studies comparing the nutritional quality of organic and conventional food. These reviews all appeared between 2001 and 2003. The most recent of the five reviews came out in 2003 and covered comparative studies through the end of 2001.

In the six years since 2001, more than forty new studies have been published, increasing the number of peer-reviewed studies comparing the nutritional quality of organic and conventional foods to over 100. Figure 1 shows the steady increase in the number of studies published per year over the last three decades.

Not only has the number of studies doubled since 2000, the quality of the studies has also improved immensely, as has the sensitivity of the analytical methods used to measure nutrients contained in foods.

Most studies in the 1980s focused simply on mineral and vitamin levels, while almost all studies published since 2000 include measures of minerals, vitamins, and health-promoting polyphenols and total antioxidant capacity.

Figure 1.



A Fresh Look

We identified all peer-reviewed studies published in the scientific literature appearing since 1980 comparing the nutrient levels in organic and conventional foods and screened them in two ways for scientific validity. We assessed how the studies defined and selected organic and conventional crops for nutrient level comparisons. From 97 published studies, we identified 236 scientifically valid "matched pairs" of measurements that include an organic and a conventional sample of a given food.

Our first screen took into account the experimental design of each study, the need for the same cultivars to be planted in both the organic and conventional fields, the degree of differences in soil types and topography, the focus of the study and where it was carried out, the definition of organic farming, and years the organic field in a matched pair had been managed organically.

For each crop addressed in a given study, we determined whether the study was "high quality," "acceptable" or "invalid" based on explicit inclusion and exclusion criteria and a rating system. The criteria were chosen to help restrict our analysis of nutrient levels across multiple studies to just those experiments producing the highest quality data. We believe our screening method achieved this objective, but acknowledge that there are many alternative ways to accomplish the same goal.

There were 135 study-crop combinations covered in the 97 studies. Based on our screen, 70% of the study-crop combinations were deemed "acceptable" or "high quality" (94 out of 135), and hence "valid", while 41 were deemed "invalid" for the purposes of this study.

We also screened the 94 valid study-crop combinations for the accuracy and reliability of the analytical methods used to measure nutrient levels. This screen factored in the base resolution, standard deviations, and reliability of the chromatographs and other measurement techniques. Fifty-five study-crop-analytical method combinations were deemed "invalid" for a specific nutrient measurement. (Other nutrient measurements from the same study-crop combination could be deemed valid).

Seventeen criteria and decision rules were also established and adhered to in selecting the most appropriate matched pairs from a given study to include in our cross-study comparisons of nutrient levels. We needed these criteria because some studies reported results on a dozen or more different combinations of production system alternatives, variable rates of fertilizer, different harvest dates, and alternative food formulations (i.e. fresh, dry, frozen, pureed).

We used these 17 decision rules to select the matched pairs from a given study-crop combination that most closely reflected food in its fresh form, grown using routine or typical organic and conventional practices.

As a result of these screens and selection criteria, we had an adequate number of valid matched pairs (at least eight) to compare the levels of 11 nutrients in organic and conventional foods. The nutrients included:

- Four measures of antioxidants (total phenolics, total antioxidant capacity, quercetin, kaempferol),
- Three precursors of key vitamins (Vitamins A, C, and E),
- Two minerals (potassium and phosphorous),
- Nitrates (higher levels are a nutritional disadvantage), and
- Total protein.

Key Findings

There were 236 valid matched pairs across the 11 nutrients. The organic foods within these matched pairs were nutritionally superior in 145 matched pairs, or in 61% of the cases, while the conventional foods were more nutrient dense in 87 matched pairs, or 37%. There were no differences in 2% of the matched pairs.

The organic samples contained higher concentrations of the very important polyphenols and antioxidants in about three-quarters of the 59 matched pairs representing those four phytonutrients. Increasing intakes of these nutrients is a vital goal to improve public health since daily intakes of antioxidants and polyphenols are less than one-half of recommended levels.

Matched pairs involving comparisons of potassium, phosphorous, and total protein levels accounted for over three-quarters of the 87 cases in which the conventional samples were nutritionally superior. While a positive finding, these three nutrients are clearly of lesser importance than the other eight nutrients because, in general, these nutrients are adequately supplied in the average American diet.

The magnitude of the differences in nutrient levels strongly favored the organic samples. One-quarter of the matched pairs in which the organic food contained higher levels of nutrients exceeded the level in the conventional sample by 31% or more. Only 6% of the matched pairs in which the conventional sample was more nutrient dense exceeded the levels in the organic samples by 31% or more.

For five nutirents, Figure 2 shows the percent of total matched pairs for which the orangic sample nutrient level exceeded the conventional sample level by eleven percent or more. Almost one-half of the 57 organic samples in these matched pairs exceeded the conventional sample nutirent level by 21% or more.

Another perspective reinforces the basic point. About 22% of the 145 matched pairs in which the organic samples were more nutrient dense fell within a difference of only 0% to 10%, which can be regarded as minor. Almost two-thirds of the conventional matched pairs found to be more nutrient dense fell within the 0% to 10% difference range.

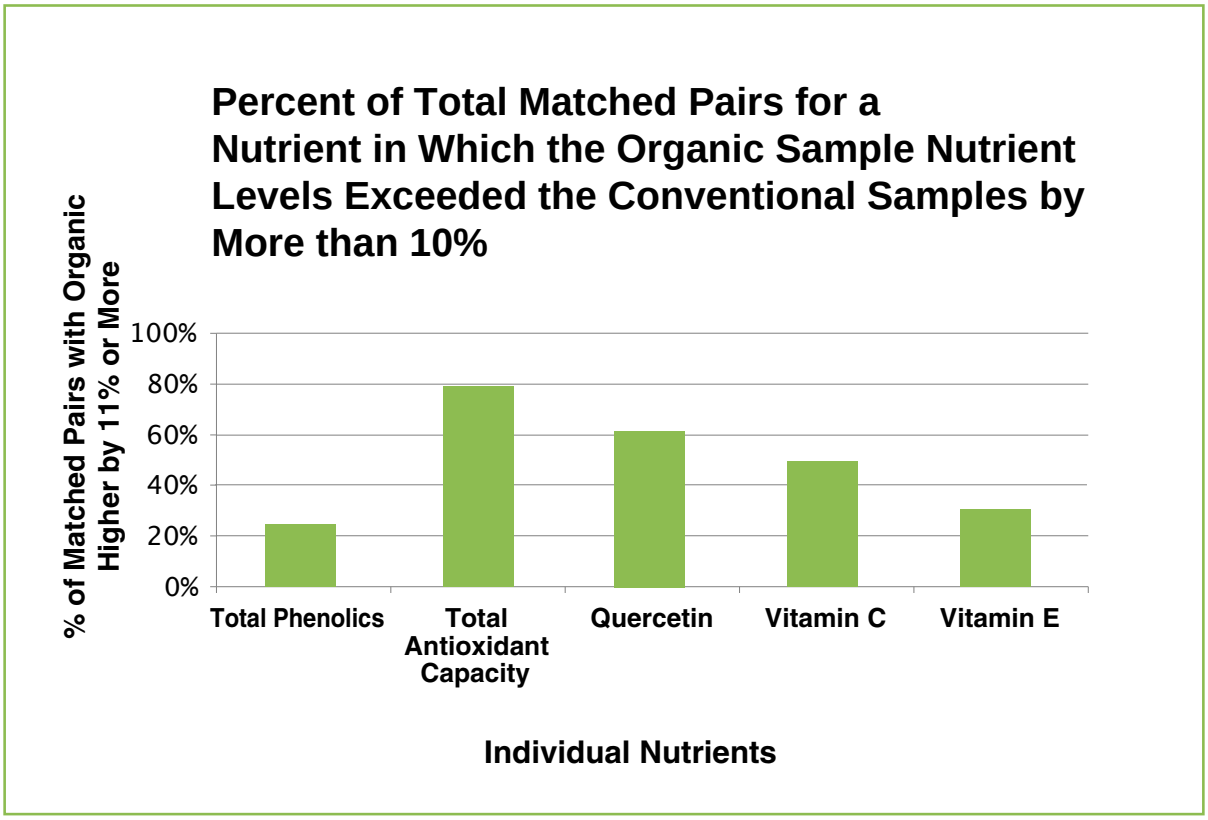
Across all 236 matched pairs and 11 nutrients, the nutritional premium of the organic food averaged 25%. The differences documented in this study are sufficiently consistent and sizable to justify a new answer to the original question–

Yes, organic plant-based foods are, on average, more nutritious.

Over the next few years another 20-30 studies will likely be completed and published. The Organic Center will add the results of these studies to our database, subject them to the same sort of scientific-merit screens, and then update and refine the analysis reported herein.

Soon, there will be enough high quality studies to reach the threshold of eight valid matched pairs for several more nutrients. Greater numbers of matched pairs for primary nutrients like antioxidants and Vitamin C will allow estimation of

Figure 2.



differences in key nutrients by crop and food – the average difference, for example, in the total antioxidant capacity of organic and conventional apples, or Vitamin C in oranges.

Over time the Center's database will grow to the point where we can explore linkages between specific organic and conventional production practices and the nutrient density of foods. This will open an exciting chapter in the continuous improvement of organic farming systems.

For every farm and agricultural region there are unique combinations of genetics, soils, climate, and practices waiting to be discovered that have the potential to produce exceptionally nutrient dense and flavorful foods. These are the kinds of fruits and vegetables needed to lure children — and adults — away from high-fat, sugar-laden foods, and in the course of doing so set the stage for sustained improvement in public health.