Nutrient content not a primary issue in choosing to buy organic foods

Dear Sir:

I am writing in response to the recent article by Dangour et al (1). As you may be aware, this article excited a great deal of media interest because it seemed to imply that there was no significant difference between organic and conventionally raised meats and vegetables . . . but it spoke solely of nutrient values. To the uninitiated this might suggest that paying more for organic food was a waste of money. In fact, this interpretation was implicit in the early part of the article, where it was offered as a reason for doing the study in the first place. The question was clearly asked: If it costs more and the nutrient values are not higher, why pay extra for organic food?

It is classically difficult to "extract meaning from the intractable data." I give the authors of this article high praise for the lengths to which they went to select data sources that fit the stringent criteria they had set up for their review. They ultimately selected 55 out of a total of >55,000 articles they considered, a quite remarkable selectivity. They looked for credible sources of data that compared nutrient contents in "organic" and conventionally raised vegetables and livestock. They had to pare down the nutrients for comparison to only 11 in the vegetables and only 2 qualities of meat from livestock.

Out of all this data crunching, they came up with, essentially, no significant difference—a sort of "not enough to matter" conclusion. Ultimately, I think the authors failed to extract any valuable meaning from their data. It appeared to be just a giant number-crunching exercise.

There are several sources of problems with a review of this kind and of this subject. I would suggest a few for consideration: First, whereas I realize the *AJCN* devotes itself to clinical nutritional matters, food is *not* just about nutrition, and people do not buy food simply for its nutrient values. And second, the term *organic* is loaded with subtexts. It has far more than the narrow meanings offered by some regulatory agency.

Both of those factors are absolutely vital in a shopper's choices between organic and conventionally raised foods. And those factors get completely lost when a futile attempt is made to reduce them to tables of data. I don't mean to be rude or arrogant here, but in fact if they aren't considered, then this article is effectively reduced to an academic exercise.

The suggestion that food is primarily about nutrients (which is what the article's conclusion does suggest) says that a big family Thanksgiving dinner could be reduced to a few bottles of pills. In fact, food is about

- Taste (as shown by the fact that almost anything can be sold if it is sweet enough, shown by the billions of dollars spent on both high-fructose corn syrup–laden soft drinks and the similar billions on artificial sweeteners)
- Pleasure (as shown by the constant search for the perfect ambience in restaurants—service, lighting, furniture, and even, perhaps especially, aromas)
- Relationships (as shown by the persistence of emphasis on the value of families eating their meals together, still lived out even today in some homes, hard as that may be for some to believe)

Nutrients are in there somewhere, but most people don't seem to emphasize them as much as these other 3 values.

But then comes the loaded term *organic*. Whereas organic does indeed mean that the farmer is avoiding the use of synthetic pesticides, herbicides, and fertilizers, primarily it means that the farmer cares deeply about the entire ecosystem of his or her farm—the plants, the animals, the water, the air and soil—and wants to be part of the process of making life abundant for them all, forever. In its entirety, this process is difficult to quantify. Many people who buy organic foods want deeply to be a part of that whole process, too. They want to know the farmer, to trust the farmer, and, if possible, to have some active part in his or her farming process.

And finally, nutrient quantities in foods are dependent on many interdependent factors. Ultimately, these get almost totally lost in the statistical jumbling that goes on to produce some charts for publication. For example, assume that a farmer has a field with a certain amount of topography in it, high spots and low spots. The spinach he plants in that field that grows facing south and west gets more sun and thus has a chance for a higher nutrient density than an exactly similar plant facing north and east in the same field. But those high and low spots mean that there is a variation in the soil moisture, which also affects nutrient density. And the manure spreader doesn't distribute the manure perfectly homogeneously, so the soil isn't identical everywhere. And the seeds from the 1950s (when the scope of the review began) aren't the same as the seeds of today. And the spinach doesn't have the same nutrient densities when it's picked young compared with when it's picked old. And the time it's on the shelf in the market makes a huge difference, as does the distance it travels to market.

Hidden in the text of the article is the one tiny bit of information that might just make "organic" preferable for shoppers if nothing else did: The organic vegetables in the study had lower titratable acidity, which means they're generally fresher! And, guess what? They taste better!

The author has no connection with any organization that could be viewed as a conflict of interest with this manuscript's content. He also did not have any financial interest in any of the matters discussed in this letter.

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Methodologic flaws in selecting studies and comparing nutrient concentrations led Dangour et al to miss the emerging forest amid the trees

Dear Sir:

In addition to their questionable methodology, we strongly disagree with the principal conclusion of Dangour et al (1) that ''there is no evidence of a difference in nutrient quality between organically and conventionally produced foodstuffs.'' Dangour et al reviewed dozens of studies that reported hundreds of valid and statistically significant differences in nutrient density, with a significant majority favoring organic farming systems, yet nevertheless concluded that ''there is no evidence . . . .''

Dangour et al considered 162 articles that reported comparisons from field trials, farm surveys, or market basket studies. They excluded 54% of these studies simply because the organic certifying body wasn't stated, thus eliminating many otherwise valid comparison studies. Conversely, they apparently accepted studies with mixed cultivars and breeds because they required only *identification* of the cultivars or breeds not that they be identical within a study. It is well known that there can be large differences in nutrient concentrations between different cultivars of the same crop (2). They also arbitrarily excluded from analysis any nutrient with <10 valid studies, even though for some of these nutrients many more than 10 statistical comparisons had been made (3, Table 2). Therefore, even though the authors are emphatic that there is no evidence for the claims of higher nutrient concentrations in organic crops, what they don't present either in their article or in the online supplemental data are that when all 162 studies are included, phenolic compounds, magnesium, zinc, flavonoids, sugars, and dry matter were also statistically higher in the organic than in the conventional crops (3, Table 2).

A team of scientists convened by The Organic Center (OC) carried out a similar review that was limited to plant-based foods (4). The OC methods and results differ significantly from those of Dangour et al. Across 11 measured nutrients, organic foods contained, on average, 25% higher concentrations of nutrients. For 6 of these 11 nutrients, concentrations in the organic foods averaged $\geq$10% higher; the conventional foods were $\geq$10% higher for only one beneficial nutrient (protein). For reasons noted below, we think the OC methodology was more rigorous and representative of actual differences in contemporary foods.

For ''phenolic compounds,'' Dangour et al grouped and analyzed together measures of total phenolics with numerous individual phenolic and polyphenolic compounds. We think it is inappropriate to analyze a pooled group of individual compounds together with overall measures of nutrient classes. Whereas Dangour et al did not analyze differences in key individual polyphenolic compounds or antioxidant activity, the OC study found differences favoring organic foods for quercetin and total antioxidant activity. It also found higher concentrations of total phenolics, vitamin C, and vitamin E in organic foods but higher concentrations of protein, nitrates (a disadvantage), and β-carotene in conventional foods.

The OC review used more-rigorous selection criteria than did Dangour et al, who simply required some mention of their screening criteria in the published studies they included but did not apply any qualitative thresholds for judging the scientific validity of a study on the basis of stated criteria. The OC study focused on differences in single, specific nutrients or recognized overall measures of nutrient classes (ie, total phenolics, total antioxidant activity) but never included individual nutrients and nutrient classes together in the same analysis. In addition, the OC study limited comparisons to ''matched pairs'' of crops grown on adjacent farms or experimental plots, in the same soil type, with identical cultivars and similar harvest timing. It also carefully screened studies for experimental design and quality of analytic and statistical methods, whereas Dangour et al only required *identification* of analytic and statistical methods. Dangour et al also included some market basket studies, for which it is usually not possible to know the specific farm locations, plant genetics, soil type, or harvest method. For those reasons, the OC study excluded such studies. As a result, the OC team used rigorous screening criteria to select a more relevant set of comparison studies than did Dangour et al.

Both research teams agree that more and higher-quality studies are needed to accurately quantify nutritional differences between organic and conventional foods. The research community is delivering. Since 2008, some 15 new studies have been published, most of which use superior experimental designs and analytic methods, and most often show organic foods as being higher or equal, but rarely lower, in phytonutrients. Therefore, unlike Dangour et al, we conclude that there *is* evidence for differences in nutritional quality between organically and conventionally produced foodstuffs, especially for the more recently recognized and measured antioxidant phytonutrients. The OC team concludes that organic fruit and vegetables, in particular, may offer nutrient-related health benefits. Such nutritional benefits would be in addition to those that may come from reduced exposure to pesticide residues in conventional foods. Consideration of these contaminants, in addition to the environmental benefits of organic farming (beyond the scope of the Dangour et al and OC reviews), warrant attention in working toward Dangour et al's stated goal of helping ''consumers to make informed choices.''

CB is Chief Scientist at The Organic Center, a not-for-profit research and education organization focusing on organic food and farming. PKA has received research funding from The Organic Center. DRD is a retired university research scientist who declared no conflict of interest.

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Reply to DL Gibbon and C Benbrook et al

Dear Sir:

We are grateful for the opportunity to respond to the letters from Gibbon and Benbrook et al.

In his letter, Gibbon dismisses the findings of our systematic review on nutrient content of organic foods (1) and instead emphasizes the importance of the sociocultural factors affecting food choice. We were awarded a contract by the UK Food Standards Agency to conduct a scientifically recognized and rigorous systematic review to answer a simple, and clearly specified, question that has long been debated: Is there a difference in nutrient content between organically and conventionally produced foods? We agree that there are many other factors that influence shopping and eating habits, but these fall outside the scope of our review (2).

Our review brought together for the first time all peer-reviewed published reports on the nutrient content of organic foods, and our conclusions are based on analysis of data presented in the studies that were categorized as satisfactory quality. The findings of our independent review contrast with those reported by Benbrook et al, which is not surprising given the differences in the review methods and in the data analyzed. Our review protocol was prespecified, peer-reviewed, and made publically available for comment in April 2008. Our analysis was based only on data reported in published peer-reviewed articles. Our article was peer-reviewed by multiple subject experts before publication.

To allow us to estimate the size of any differences in the most commonly reported nutrient categories, we selected an easily understood and transparent analysis metric, the absolute percentage standardized difference. We acknowledge that there is no standard way of conducting these analyses, and in response to a request we have reanalyzed the extracted data by using the log of the response ratio as our metric. We now report the results of the reanalysis that replicate our original findings (**Table 1**).

Greater interaction between agricultural scientists and public health nutrition researchers is needed to improve the quality of the existing evidence base and to understand better the strengths and limitations of, and the conclusions that can be validly drawn from, established scientific methods.

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TABLE 1
Comparison of content of nutrients and other nutritionally relevant substances in organically and conventionally produced crops as reported in satisfactory-quality studies

Nutrient category[1]	No. of studies	No. of comparisons	Results of analysis		Higher levels in organic or conventional crops?
			Log response ratio[2]	*P*	
Nitrogen	17	64	−0.07 ± 0.02	0.002	Conventional
Vitamin C	14	65	−0.07 ± 0.07	0.33	No difference
Phenolic compounds	13	80	−0.02 ± 0.08	0.75	No difference
Magnesium	13	35	0.03 ± 0.02	0.14	No difference
Calcium	13	37	−0.07 ± 0.05	0.22	No difference
Phosphorus	12	35	0.07 ± 0.02	0.01	Organic
Potassium	12	34	0.02 ± 0.02	0.38	No difference
Zinc	11	30	0.06 ± 0.04	0.14	No difference
Total soluble solids	11	29	−0.003 ± 0.04	0.94	No difference
Copper	11	30	−0.05 ± 0.13	0.70	No difference
Titratable acidity	10	29	0.06 ± 0.02	0.01	Organic

[1] Nutrient categories are listed by numeric order of the included studies.
[2] All values are means ± SEs (robust).