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 foods.” 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 ≥10% higher; the conventional foods were ≥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 all 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 phytoneutrients. 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 phytoneutrients. 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.”

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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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REFERENCES

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

<table>
<thead>
<tr>
<th>Nutrient category</th>
<th>No. of studies</th>
<th>No. of comparisons</th>
<th>Log response ratio</th>
<th>P</th>
<th>Higher levels in organic or conventional crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>17</td>
<td>64</td>
<td>−0.07 ± 0.2</td>
<td>0.002</td>
<td>Conventional</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>14</td>
<td>65</td>
<td>−0.07 ± 0.7</td>
<td>0.33</td>
<td>No difference</td>
</tr>
<tr>
<td>Phenolic compounds</td>
<td>13</td>
<td>80</td>
<td>−0.02 ± 0.08</td>
<td>0.75</td>
<td>No difference</td>
</tr>
<tr>
<td>Magnesium</td>
<td>13</td>
<td>35</td>
<td>0.03 ± 0.02</td>
<td>0.14</td>
<td>No difference</td>
</tr>
<tr>
<td>Calcium</td>
<td>13</td>
<td>37</td>
<td>−0.07 ± 0.05</td>
<td>0.22</td>
<td>No difference</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>12</td>
<td>35</td>
<td>0.07 ± 0.02</td>
<td>0.01</td>
<td>Organic</td>
</tr>
<tr>
<td>Potassium</td>
<td>12</td>
<td>34</td>
<td>0.02 ± 0.02</td>
<td>0.38</td>
<td>No difference</td>
</tr>
<tr>
<td>Zinc</td>
<td>11</td>
<td>30</td>
<td>0.06 ± 0.04</td>
<td>0.14</td>
<td>No difference</td>
</tr>
<tr>
<td>Total soluble solids</td>
<td>11</td>
<td>29</td>
<td>−0.003 ± 0.04</td>
<td>0.94</td>
<td>No difference</td>
</tr>
<tr>
<td>Copper</td>
<td>11</td>
<td>30</td>
<td>−0.05 ± 0.13</td>
<td>0.70</td>
<td>No difference</td>
</tr>
<tr>
<td>Titratable acidity</td>
<td>10</td>
<td>29</td>
<td>0.06 ± 0.02</td>
<td>0.01</td>
<td>Organic</td>
</tr>
</tbody>
</table>

Nutrient categories are listed by numeric order of the included studies.

All values are means ± SEs (robust).