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Organic Food: What You Should Know about Nutritional Quality and Safety

Organic farming is narrowly defined as farming without the use of synthetic pesticides and fertilizers, or genetically modified organisms, antibiotics, and growth hormones. Organic farms strive to achieve sustainable farming by enhancing soil fertility and biological diversity, providing attentive care to livestock, and using renewable resources. Organic farmers also rely on crop rotation, cover crops and balanced host/predator relationships (1).

Organic food produced in Canada includes grains, fruit, vegetables or greenhouse products, and maple products. In 2006, nearly 12,000 farms reported producing organic, though not always certified, agricultural products. The production of certified organic products, however, has increased by about 60% since 2001. The total number of organic farms still remains small at about 1.5% of all farms (2).

The focus of this Current Issues is on nutritional quality of organic food and its safety with respect to microbial contamination. Dietitians may wish to explore other issues such as pesticides and health and taste perceptions in organic foods.

What should dietitians know about nutritional quality of organic food?

With the exception of phytochemicals, the belief that organic food has a higher nutritional quality than conventional food cannot be either supported or refuted by scientific evidence.

The nutritional quality of the Canadian diet and how to improve it is a long-standing issue for practitioners. Two studies have reported that vitamin and mineral content of vegetables and fruit have declined in the last 60 years (3, 4), but Canadians are more likely to have marginal intakes of micronutrients if they eat too few vegetables and fruit.

Definitive conclusions, however, cannot be drawn from comparative studies of the nutritional content of organic and conventional foods because of limited background detail, poor study quality (for example, failure to control confounding factors), and questionable peer review. The bulk of the research is centered on vegetables and fruit. Grains, meat, milk, and oils are not studied as often.

Some studies examine retail foods, and because of food handling and varietal issues, retail studies are of poorer quality (5).

In a systematic review, Woese et al. (6) determined that while organic cereal grains or their products had less protein, it was of higher quality (better amino acid scores) than conventionally grown cereal grains or their products. Later research by Zorb et al. (7) noted that the concentrations of 44 metabolites, including amino acids, did not differ in a comparison of organic and conventional wheat grains.

Woese et al. (6) made the observation that a number of studies indicated that the vitamin C content of organic crops was higher than conventional 50% of the time, and equal to conventional the other 50% of the time. Williams (8) also found that vitamin C levels were higher in organic produce, a finding the author suggested was likely associated with the lower water content of organic produce. No differences were detected for vitamin A, beta-carotene, or B vitamins.

According to Kristensen and colleagues, whose analysis included dried foods such as carrots, kale, peas, potatoes, and apples, plant cultivation methods have little impact on the elemental content of foodstuffs (9).

Benbrook et al. (10) conducted a review of the literature, *Nutritional Superiority of Organic Food*, for The Organic Center that attempted to clarify some of the issues about nutrient content differences between organic and conventional foods. They examined available data for foods such as grains, carrots, tomatoes, peppers, spinach, eggplant, apples, corn, potatoes, strawberries, and oranges. For the total protein analysis, oat grains were analyzed. The amount of data available varied considerably for the different foods, but the study authors summarized nutrient content differences using a ratio of organic to conventional nutrient content (see Table 1 on next page).

The report title is somewhat of a misnomer because no significant differences were found for any nutrient or characteristic except total protein and nitrate. A recent systematic review of the nutritional quality of organic foods determined that nitrogen content was significantly higher in conventional food, and phosphorus and titratable acidity was significantly higher in organic food. These differences were attributed to differences in fertilizer use

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Table 1. Nutrient content or nutritional characteristic of selected organic and conventional crops.*

<i>Nutrient or characteristic</i>	<i>Number of comparisons**</i>	<i>Average Ratio of Organic to Conventional</i>
Total protein	27	0.90
Nitrate	18	0.56
Vitamin E	13	1.15
Vitamin C	46	1.10
Potassium	33	1.00
Phosphorus	32	1.07
β-carotene	8	0.92
Kaempferol	11	1.05
Quercetin	15	2.37
Total phenolics	21	1.11
Antioxidant capacity	8	1.24

*Adapted from Benbrook et al., 2008

**Data were collected from a variety of vegetables and fruit for which matched pairs of organic and conventional crops were available. Oat grains were also analyzed.

There was no evidence of a difference in vitamin C, phenolic compounds, magnesium, potassium, calcium, zinc, copper, and total soluble solids. The phenols included in the phenolic compounds category were not specified (11).

In the study by Benbrook and colleagues (10), a trend toward higher content of quercetin, an important phytochemical, and antioxidant capacity was reported for organic foods. Other studies (12, 13) have shown that plant phenols, secondary metabolites that play a role in plant defense mechanisms, and serve as antioxidants in human nutrition, were higher in organic produce. In organic produce, quercetin levels were found to be $27 \pm 3 \mu\text{g}/24 \text{ h}$ food intake compared to $19 \pm 2 \mu\text{g}/24 \text{ h}$ food intake for conventional produce ($P < 0.01$). Asami et al. (12) acknowledges that varietal differences could have accounted, in part, for plant phenol results. Yet, organic farmers typically choose plant varieties that are more naturally resistant to pests, so these varieties naturally have higher levels of phenols.

One study (14) found that total polyphenol content, particularly quercetin, was higher in conventional yellow plums, and myricetin and kaempferol were higher in organic yellow plums. Lairon (15) concluded from a review of the literature that the majority of studies indicate that phytochemicals are higher in organic food.

What, specifically, affects nutritionally quality of food plants?

In addition to the above factors, plant polyphenol levels are affected by other growing conditions as well as the size and degree of ripeness of the fruit or vegetable in which the measures are being made.

Benbrook et al. (10) noted as well that there are many reasons for crop differences in nutrient content. The nutrient content of food plants is governed by several factors that include:

- Availability of nutrients in soil
- Soil texture
- Presence of organic matter in soil
- Temperature during growing season
- Amount of light during growing season
- Seed variety
- Planting and harvesting dates and,
- Post harvest handling (transportation and storage conditions).

Organic farmers rely on crop rotation, cover crops to prevent erosion, the planting of green manures that are then ploughed into the field to enrich the nutrient content of soil, and the use of compost (animal and plant) to maintain soil fertility (6). These techniques do improve nutritional quality, and other farmers use these same

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techniques in mixed farming operations in partial substitution for chemical fertilizers. Therefore, on farms ranging from conventional to mixed to organic practices, all techniques contribute to varying levels in nutrient content of foods.

How do consumers know if foods are organic?

Organic food has been labelled according to voluntary standards and certification bodies, but in June 2009, new mandatory guidelines were implemented for organic food that is traded inter-provincially or internationally. The Canadian Food Inspection Agency works in cooperation with certification bodies to ensure that Canada-wide standards are met (16).

What about the safety of organic food?

All food production is subject to contamination that carries a risk of foodborne illness. One issue that has been widely discussed is that the use of animal manure in organic farming might result in a higher incidence of bacterial contamination. However, any increase in the food safety risk for organic produce would be due to the use of improperly composted matter. The Canadian General Standards Board published the Canadian Standards for Organic Agriculture in 1999. This document can be used by organic certification bodies to ensure that appropriate practices are followed (17).

The Institute of Food Science and Technology (18) also notes that insect infestations can lead to crop damage and the risk of moulds and mould toxins spoiling organic produce. However, a review of the literature (15) indicated that, in cereal grains, mycotoxins were at similar levels within both organic and conventional production methods. A trend toward higher levels of salmonella contamination in retail chicken has been observed when antibiotics are not routinely used on the farm (19), but no differences were found in produce such as spring mix salad greens grown conventionally or organically (20). A well-managed organic farm should not produce foods that carry any higher risks than a well-managed conventional farm.

Dietitian Practice Points

- Some organic foods may be higher in certain nutrients, but the evidence is not consistent enough to make conclusive statements.
- With respect to microbial contamination, organic foods are as safe as conventional foods with the exception that, where antibiotics are not used, higher levels of salmonella contamination are noted in retail chicken.
- Purchasing organic food is a personal choice which may depend upon its availability, price, sensory qualities and personal values, such as a preference for this food production method. Dietitians of Canada has released a position statement on community food security that highlights aspects of low-input farming methods and their relationship to the broader issue of food security (21).
- Dietitians and other health professionals should continue to encourage people to consume a diet high in vegetables and fruit. Learning more about how farming practices can affect nutritional quality will help dietitians and other health professionals address client concerns.
- Consult DC's Practice-Based Evidence in Nutrition for additional information as there are several related key practice questions on this topic.

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