Assessing organic food quality: Is it better for you?

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ABSTRACT

Any attempt to answer the question 'is organic food better for you?' requires an assessment of the safety, nutritional content and biological value aspects of food quality. Previous reviews have been unable to reach definitive conclusions after failing to ensure only valid comparisons are considered. When methodologically flawed studies are screened out and a complete assessment of nutritional quality is made, collectively, the available evidence supports the hypothesis that organically produced food is superior in terms of safety, nutritional content and nutritional value to that produced non-organically. More research is needed provide to more data further investigating the trends seen in the existing evidence.

Keywords: organic food; food quality; health; nutrient content; nutritional value

INTRODUCTION

Public concern about food quality has intensified in recent years and prompted heated debate about the integrity and safety of food. Demand for organically produced food has grown rapidly, with 'It's better for you' a key motivation for purchase. To assess the accuracy of this statement, attention must be focused on those aspects of food quality that directly affect health – biological value and nutritional quality (which includes food safety), though when comparing foods on these aspects alone, it should be remembered that they represent only a part of a wider concept of food quality (EFRC 1990). Recent literature reviews have identified hundreds of papers examining this question, many of which have reported inconclusive, conflicting or confusing results. The previous reviews, most notably Woese *et al.* (1997), Worthington (1998), Diver (2000), Brandt & Molgaard (2000), and Williams *et al.* (2000), have therefore, on the whole, been either inconclusive or very cautious in their conclusions, pointing out the poor quality and wide variations in style of the available evidence. Consequently the official view has been that there is insufficient evidence to support the claim that "organic food is better for you".

These reviews have, however, failed to ensure that only those studies properly representing organic and non-organic food and farming, and therefore constituting valid comparisons, are considered. By removing methodologically flawed studies and including a complete consideration of the nutritional quality of foods, this review aims to provide a more conclusive answer.

METHODS

Evidence is examined in three areas:

1. *Food safety:* To what extent do organic and non-organic foods contain undesirable components such as potentially harmful pesticide residues, food additives and pathogens?
2. *Nutritional content:* What contribution do organic and non-organic foods make to a varied and balanced diet, providing nutrients such as vitamins, minerals

and antioxidant phytonutrients known to contribute to good health? Comparative studies of nutritional content derive samples from one of three possible sources: field trials, farm surveys and 'shopping basket' surveys.

3. *Nutritional value:* The ultimate test of nutritional quality is the capacity of a food to support health, growth and reproduction. Relevant, then, are studies that assess the health of animals or people fed organically or non-organically grown food.

The available studies comparing nutrient contents were assessed for validity in terms of agricultural practice and scientific analyses. Specifically:

1. *Only data from certified organic produce, certified organic farms, or crops grown in soil in its third year (or more) of organic management* (to allow for the legally required conversion period) are considered valid for comparison purposes.
2. *Agricultural practices in experimental trials must reflect typical practices within the respective methods of agriculture.* Agronomic practices in the comparative crops should be described in the study, as interpretations and practices can vary widely from researcher to researcher, as indeed from farmer to farmer. Care should be taken in field trials and farm surveys to control other influential factors such as soil type, geographical location, crop variety, and growing season. In market surveys, variety and source should be matched as closely as possible, and while these and other factors such as soil type, date of sowing and date of harvest cannot always be determined and controlled in these studies, their consumer relevance is often sufficient to supersede these uncertainties and render them worthwhile comparisons. Studies that compare fertilisation but not crop protection methods or whole systems are accepted as valid comparisons of the two systems (so long as other practices do not invalidate the study), as the method of fertilisation plays such a significant role in the nutrient availability to and growth of crops.
3. *Only comparisons of nutrients on a fresh-weight basis are included.* Comparing nutrient contents on a dry-weight basis eliminates the dilution effect of the higher water contents of some produce, and lack consumer relevance, given that produce is generally purchased and consumed on a fresh-weight basis.
4. *Studies must include relevant quality comparisons.* Studies should compare a variety of essential nutritional components that could therefore have an impact on health. This includes vitamin, mineral (beyond just N, P and K), dry matter and phytonutrient contents.

RESULTS

Food safety

Pesticide residues

Over 400 pesticides are permitted for use in the UK. The incidence and levels of pesticide residues on foods are monitored annually. 28.6% of all foods tested in 1999 were found to contain pesticide residues, and 48% of all fruit and vegetables tested (MAFF 2000). The levels found are typically very low. Just 1.6% of all foods and 3% of fruit and vegetables exceeded the MRL – maximum residue limit – in 1999. Seven pesticides are permitted for restricted use in organic farming.

Organic produce is usually found to contain no pesticide residues. When residues are present, they are typically of significantly lower incidence and levels than those found in non-organic produce (MAFF 1999, Schüpbach 1986, Reinhardt & Wolf 1986), and result mostly from environmental pollution from non-organic agriculture (Woese et al. 1997, Bitaud 2000).

'Rigorous safety assessments' are made of all pesticides and it is asserted that these incidences and levels do not represent a threat to food safety (FSA 2001). However no such 'rigorous safety assessment' has or can be made of the infinite number of mixtures of compounds consumers are typically exposed to. Individual samples contained up to seven different pesticides in 1999. Synergies resulting in greatly increased toxicity of pesticides and other agricultural compounds have been observed (Boyd et al. 1990, Porter et al. 1993, Porter et al. 1999, Thiruchelvam et al. 2000). Dietary exposure to pesticide residues has been linked to gastrointestinal and neurological complaints (Ratner et al. 1983), breast milk contamination (Aubert 1975) and some sperm quality parameters (Juhler et al. 1999, Abell et al. 1994, Jensen et al. 1996). The British Medical Association urges a precautionary approach "because the data on risk to human health from exposure to pesticides are incomplete" (BMA 1992).

Food additives

While more than 500 additives are permitted for use in processed foods, only 30 or so are permitted in organic processing. Organic standards prohibit additives and ingredients implicated in various health concerns, including hydrogenated fats, phosphoric acid, aspartame, MSG and artificial colourings, linked with heart disease (Willet et al. 1993), osteoporosis (Wyshak 2000), headaches (Lipton 1989), asthma (Rumsaeng & Metcalf 1999) and hyperactivity (Ward et al. 1990) respectively.

Food poisoning

There is no evidence linking organically produced foods with an increased risk of food poisoning. Methods employed in organic farming such as lower stocking rates and careful composting of manure are designed to minimise pathogenic risks, and investigations have confirmed that organic produce carries a no greater risk than non-organic produce (FSA 2000, Williams et al. 2000, PHLS 2001).

Nutritional content

Evaluation of validity of studies

Of the 99 studies found, claiming or claimed to make a direct comparison of the nutritional quality of organic and non-organic produce, 70 were rejected as invalid comparisons for the following reasons: insufficient duration (27), incorrect or unknown practices (23), absence of relevant quality comparisons (14) and republished results of previous experiments (6). Of the 29 remaining valid studies, 14 compare mineral contents, 13 compare vitamin C contents and 19 compare the dry matter content of organic and non-organic produce.

Results

Against a background of declining mineral levels in fresh produce over the last sixty years (Mayer 1997), and given that many people fail to achieve the recommended daily allowance for a variety of nutrients (MAFF 1996, Clayton 2001), the nutrient contents of organic and non-organic produce are worthy of comparison. Due to the heterogeneous nature of the data set, only trends, firstly within and then among the available valid studies, were examined.

Table 1. Overall trends demonstrated within all available valid studies[1] comparing the nutrient contents of organically and non-organically grown fruit and vegetables

Comparison	Non-organic higher	No difference	Organic higher
Dry matter	1	8	10
Minerals[2]	1	6	7
Vitamin C	0	6	7

[1] see Heaton (2001) for full references and summaries of all 99 reviewed studies
[2] K, Ca, Mg, P, Fe, Cu, Mn, Zn, S, B, Cr, Co, Mo, Ni, Se, Si, St & Va (in descending order of numbers of comparisons)

Not all agree that the available data set cannot be combined and statistically analysed. Worthington (2001) has compiled the data and employed the Wilcoxon signed-rank test to confirm that Magnesium (+29%), Vitamin C (+27%), Iron (+21%) and Phosphorus (+13%) are found in significantly higher levels in organic produce ($P<0.01$). Every mineral compared was found to be higher in organic produce, yet the remainder failed to attain statistical significance due mostly to the insufficient comparisons available. Based on current dietary patterns, the differences demonstrated can mean the difference between achieving the recommended daily allowance for these nutrients or failing to.

Phytonutrients

Phytonutrients with known beneficial (often antioxidant) effects on human health are expected to be higher in organic produce for various reasons, including varietal choice, crop maturity and crop protection methods. This has been confirmed for lycopene in tomatoes (Pither & Hall 1990), polyphenols in potatoes (Hamouz et al. 1999), flavonols in apples (Weibel et al. 2000) and resveratrol in red wine (Levite et al. 2000). A recent review (Brandt & Mølgaard 2001) tentatively estimated, based on the currently available evidence, that organic produce will tend to contain 10-50% higher phytonutrients than non-organic produce.

Nutritional value

Animal feeding trials have consistently demonstrated improved health in animals fed organically produced food compared to those fed non-organically produced food (Worthington 1998). Observed benefits have included significantly improved growth rates (Edelmuller 1984), reproductive health (Aehnelt & Hahn 1978), recovery from illness (Plochberger 1989), and general health (Staiger 1988) in those animals fed organically produced feed.

While similar controlled studies in humans are difficult, clinical experience and recorded observations have suggested similar benefits in human reproductive health (Foresight), recovery from illness (Plaskett 1999) and general health (Daldy 1940) from the consumption of organically produced food.

CONCLUSION

There has now been sufficient analysis of the existing data. Collectively, the available valid evidence supports the consumer intuition that organically produced foods are superior in terms of food safety, nutritional content and nutritional value to non-organically produced foods. More primary research is now needed to confirm and further the findings of this review, specifically, to quantify the differences in nutritional content and further examine which nutrients are significantly higher or lower in organic produce compared to non-organic produce; and to further investigate, under controlled conditions, the link between organic food consumption and human health.

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