FACTS BEHIND THE HEADLINES

Is organic food better for our health?

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There has been a huge increase in the market for organic foods in the UK over recent years, and there seems to be a growing interest in organic food and farming from both the public and the media. Over the past 10 years, sales of organic food in the UK have increased ten-fold from just over £100 million in 1993/94 to £1.12 billion in 2003/04 (DEFRA 2004). Retail sales of organic food products in the UK were worth approximately £1.6 billion in 2005, which was an increase of 30% from the previous year (Soil Association 2006). As well as the more traditional organic fruit and vegetables, there has recently been a significant increase in sales of organic milk, poultry, meat and processed foods. However, as a percentage of the total food market, organic food still remains a relatively small sector, at around 1–2% of total food sales (DEFRA 2003).

There are a number of different reasons why consumers may choose to buy organic food, including concerns about the environment and the use of pesticides, concerns about intensified farming methods, or the perception that organic food is safer or more nutritious than conventionally produced food. Furthermore, as some sectors of the population have become more interested in health and wellbeing, there has been an increased demand for more 'natural', less processed foods. This may also have contributed to the increased demand, as many people perceive organic foods as a more 'natural' alternative. Even though organic foods tend to be much higher in price (mainly owing to the lower productivity of organic crops), they seem to have become increasingly popular.

What is organic food?

The term 'organic' is used to describe food grown without the use of most artificial fertilisers or pesticides and in a way that emphasises crop rotation, making the most of natural fertilisers and ensuring that the life of the soil is maintained. There is also an emphasis on animal welfare with minimal use of conventional veterinary medicines. The Compendium of UK Organic Standards has the following definition of organic farming: 'Organic production systems are designed to produce optimum quantities of food of high nutritional quality by using management practices which aim to avoid the use of agro-chemical inputs and which minimise damage to the environment and wildlife' (DEFRA 2006).

The Department for Environment, Food and Rural Affairs (DEFRA) is responsible for regulations governing the production of organic foods and the administration of organic schemes in the UK. All food sold as 'organic' must be produced according to European laws on organic food production. These laws stipulate that food sold as organic must come from growers, processors or importers who are registered and approved by organic certification bodies (such as the Soil Association). These are in turn registered by DEFRA or a similar control body elsewhere in the European Union.

Organic certification bodies appoint inspectors to visit farms and check that, for example, only fertilisers or pesticides that are approved for organic production have been used, and that land has been farmed organically for the conversion period (normally 2 years) before food is sold as organic.

Food safety concerns and organic food

Consumer concerns over the quality and safety of foods are considered to be one of the primary reasons for the increasing demand for organically produced food, which consumers perceive as healthier and safer (Magkos *et al.* 2006).

One area in which there has been much debate is over the use of pesticides. Organic farming methods avoid the use of artificial fertilisers and pesticides, and organic fruits and vegetables would be expected to contain fewer agrochemical residues than conventionally grown

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crops. However, the significance of this difference is questionable, as actual levels of contamination in both organically and conventionally grown foods are generally well below acceptable limits. Some organically produced vegetables have also been found to have lower nitrate levels; however, whether or not dietary nitrate, at current levels of exposure, poses a threat to human health is again a matter of debate (Magkos *et al*. 2006).

All pesticides are rigorously assessed to ensure that they do not pose any significant risk to human health or the environment before they are approved. Pesticide residues in the food chain are also regularly monitored to check they are within safe and legal limits (FSA 2006). The results from recent surveys of residues in food and drink found residues to be absent in about 70% of tested produce. In almost 30% of remaining samples, residues were below the statutory limits (maximum residue level), therefore posing no safety concerns for consumers (Pesticide Residues Committee 2006).

With regard to other areas of food safety, such as endogenous plant toxins and pathogenic microorganisms, there are currently limited data available. Therefore, additional research in this area is still needed, but so far there is little evidence to suggest that organic food is any 'safer' than conventionally produced food.

Are there any nutritional differences between organic and non-organic foods?

There appears to be a perception among many consumers that organic foods are more nutritious and therefore healthier than conventionally produced foods. However, to date there are limited data to support this view. There have been few well carried out research studies comparing the nutrient content of organic and 'non-organic' foods, and much of the available evidence appears to be based on poor study design or poor methodology.

All foods show natural variation in nutrient levels, which depend on many different factors, such as the soil, climate, crop variety, degree of ripeness or the way animals are fed. The freshness, storage conditions and processing of foods also affect the nutrient content. Even processed foods which are produced under very controlled conditions show some variability owing to differences in the composition of ingredients and variations in processing, packaging and storage. Therefore, it can be difficult to carry out well-controlled studies to show whether organic foods differ from conventionally produced foods in nutrient content.

Most of the studies carried out comparing organic and non-organic foods are either a comparison of food products purchased from retail markets, or a comparison of foods that come directly from farm production units, or a comparison of food samples grown as part of scientific research (Magkos *et al*. 2003). Such approaches do not necessarily take into account confounding factors. Valid comparison studies between organic and conventionally produced foods require that the plants are cultivated in similar soils, under similar climatic conditions, are sampled at the same time and are analysed using the same validated methods (Kumpulainen 2001).

A review of the literature comparing the nutritional quality of organic *vs*. non-organic foods has been carried out by Williams (2002). This incorporated findings from two earlier review papers by Woese *et al*. (1997) and Worthington (1998). Studies comparing foods produced by these two different systems of agriculture date back to 1924, although 'serious shortcomings' in methodology are reported for many of the earlier studies (Woese *et al*. 1997). Overall, studies comparing organic and conventionally produced cereals, potatoes and vegetables have found no significant differences in mineral, trace element or B vitamin levels; and no differences in levels of vitamin A or beta-carotene have been found in vegetables.

However, there is moderately strong and consistent evidence for lower levels of vitamin C in conventionally produced potatoes. Also, 50% of studies analysing vegetables found higher levels of vitamin C in organically produced vegetables (particularly leafy vegetables), while no studies have shown lower levels of vitamin C in organic potatoes or vegetables. There is also evidence for higher nitrate concentrations in conventionally produced vegetables, particularly green leafy vegetables (Woese *et al*. 1997). Similar findings were reported by Worthington (1998). Despite many limitations in the quality of the published data, overall there is a *trend* for higher nutrient levels in organic produce, including vitamin C and some other micronutrients (range 9–42%), although this does not apply to all nutrients or all crops, and much more good-quality research is needed to confirm these findings (Williams 2002).

Another review paper published slightly more recently (Magkos *et al*. 2003) also concluded that there is a trend towards higher vitamin C content in organically grown potatoes and leafy vegetables. It also found a trend towards lower protein content, but higher-quality protein (*i.e*. a higher proportion of essential amino acids) in some organically produced legumes and cereal crops, such as wheat, rye and corn. However, it must be emphasised that there have only been a small number of comparative studies of cereals and legumes

and not all studies have reached the same conclusion (Magkos *et al*. 2003).

In contrast to studies comparing nutrient levels, there have been relatively few studies that have looked at phytochemicals, such as flavonoids, glucosinolates or carotenoids, in organic and non-organic foods. Phytochemicals are non-nutrient components in food with potential health benefits, and there is a growing body of research into their health effects, although this is an emerging area and much more research is still needed (see BNF 2003). Because many of these components are produced by plants as stress responses or protection against harmful pests, it could be hypothesised that differences in growing conditions might result in different levels of phytochemicals in plant foods (Williams 2002). Indeed, there have been some reports of higher levels of phytochemicals in organically produced fruit and vegetables (*e.g*. Asami *et al*. 2003), but results are generally inconsistent and therefore it is not yet possible to draw definitive conclusions from the evidence available.

With regard to animal-derived foods, such as milk and meat, again there have been few studies comparing organic and conventionally produced foods. Organic livestock farming is a relatively new development, compared with the organic production of fruit and vegetables, and therefore there are limited comparative data available. The main difference between the two types of farming methods is in the type of animal feed given (Magkos *et al*. 2003). Magkos and colleagues reviewed a small number of previous studies assessing the nutrient content of organic and non-organic milk; however, no significant or consistent differences were found in protein, fat or micronutrient content between the two types of milk. Although it is difficult to interpret the results from these types of studies; even if significant differences had been found, these could be attributed to species differences or genetic variation between animals of the same species that were compared for the nutrient composition of their milk (Magkos *et al*. 2003).

There have been a small number of more recent studies comparing organic and conventionally produced milk. A study carried out in Italy found significantly higher levels of alpha-linolenic acid (ALNA), conjugated linoleic acid, alpha-tocopherol (vitamin E) and beta-carotene in organic buffalo milk and mozzarella cheese, compared with non-organic dairy products. The authors suggest that these differences may be attributable to the animals' diets; however, the higher vitamin concentration could also be a function of the lower milk yield in organic cattle (Bergamo *et al*. 2003). Research carried out by the Danish Institute of Agricultural Sciences evaluated the fatty acid and vitamin content of organic and non-organic milk that had been processed in the same dairy plant. The analyses demonstrated significantly higher levels of alpha-tocopherol in 7 out of 10 samples of organic milk; beta-carotene levels were also found to be significantly higher in organic milk. Again, the differences are thought to be attributable to the animals' diets, with organic cattle consuming more grass and leguminous plants (compared with maize silage used in the conventional production) (Nielsen & Lund-Nielsen 2005).

There has also been a recent study in the UK comparing milk produced from organic and conventional dairy farms. The study reported a higher proportion of polyunsaturated fatty acids (PUFAs) to monounsaturated fatty acids in the organically produced milk, particularly the *n*-3 fatty acid ALNA. The ratio of *n*-6 to *n*-3 PUFA was also found to be lower in the organic milk, compared with the conventionally produced milk, which is considered to be beneficial (see Lunn & Theobald 2006). However, as well as farming method, the fatty acid composition of the milk was found to be affected by time of year, average milk yield of the herd, breed and access to grazing (Ellis *et al*. 2006).

Although these findings regarding organic milk are interesting, there have been no reports of differences in many other nutrients found in milk, such as calcium, zinc, vitamin B_2 or vitamin B_{12}. Milk and dairy foods are considered to be an important source of calcium and vitamins B_2 and B_{12}, whereas they are not a major source of ALNA, vitamin E or beta-carotene, which are found in a variety of other foods. Therefore, consuming organic milk is unlikely to make a huge difference to diet in terms of micronutrient intakes. Furthermore, although organic milk was found to have higher levels of ALNA, conversion of this shorter-chain *n*-3 PUFA to the longer-chain fatty acids found in oil-rich fish (eicosapentaenoic acid and docosahexaenoic acid), associated with particular heart health benefits, appears to be limited in humans (see Lunn & Theobald 2006).

With regard to organically produced meat, again the available data are extremely limited. Organic standards require that the feed ration for non-ruminants is 80% organic and 90% organic for ruminants. For ruminants, at least 60% of dry matter must be from fresh or conserved forage (DEFRA 2004). The feeding regimen of the animal has a strong influence on the fatty acid composition of the meat. For example, meat from ruminant animals fed on grass throughout the year has been found to have a higher concentration of PUFAs, particularly the *n*-3 fatty acid ALNA (see Williamson *et al*. 2005). Forage-based organic diets therefore have the potential to affect the fatty acid composition of organically produced meat, increasing levels of *n*-3 PUFAs and decreas-

ing levels of saturated fatty acids. However, valid comparison studies are required to verify any nutritional differences between organic and non-organic meat.

In addition to studies comparing the nutrient composition of organic and non-organic foods, there have also been some controlled animal feeding studies and a small number of observational studies in humans, comparing health outcomes after consuming an organic or non-organic diet. The evidence from these types of studies was reviewed by Williams (2002). Animal feeding studies have compared weight gain and reproductive performance in small animals, such as rats, mice and rabbits, after consuming organic or conventionally produced feed. There is modest evidence to suggest that organic feed may have some beneficial effects on animal health with respect to reproduction and pregnancy outcome. However, studies carried out in animals are limited in number and study design, and provide some conflicting conclusions. Furthermore, it is thought that the small differences in nutrient composition already discussed would be unlikely to make a difference to, for example, animal reproductive performance. There have been few observational studies carried out in humans and so far no large-scale studies. Unfortunately, much of the available evidence in humans is from early studies and limited by poor study design and confounding by other lifestyle variables (Williams 2002).

Conclusions

Organic farming represents a sustainable method of agriculture that avoids the use of artificial fertilisers and pesticides and makes use of crop rotation and good animal husbandry to control pests and diseases. People may choose to purchase organic food for a variety of different reasons, including concerns about the environment, animal welfare, pesticide levels or food additives.

There are of course other issues to consider with regard to the increasing interest in organic food, such as the fact that currently much of the organic food available in the UK is imported in order to meet growing demand. Imports still account for an estimated 56% of organic sales in the UK (DEFRA 2004). This brings into question the issue of food miles and the impact that this has on the environment. Furthermore, organic standards in other countries may not be the same as those in the UK or the rest of the European Union.

Studies comparing the nutrient composition of organic and non-organic foods are limited in number, and there is a lack of good-quality research in this area. Few differences in nutrient composition between organic and non-organic foods have been reported, although there is some evidence that organically produced potatoes and leafy vegetables may have a higher vitamin C content and lower nitrate levels. There have also been studies showing some nutritional differences between organic and non-organic milk.

Although these findings are interesting, there are many important nutrients for which no significant differences have been found (*e.g.* calcium in milk). Furthermore, the few differences in nutrient composition that have been reported are unlikely to have a significant impact on human health. However, much more research is still needed, particularly to determine whether there are any nutritional differences between organic and non-organic fish, meat and other animal products. More research is also required in the area of phytochemicals, such as flavonoids and carotenoids (if the potential health benefits are found to be evident).

Therefore, from a nutritional perspective, there is currently not enough evidence to recommend organic foods over conventionally produced foods. In terms of maintaining good health, it is more important to consume a healthy, balanced diet which is rich in fruit and vegetables, regardless of whether the foods have been produced organically or not.

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