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# Editorial

## Nutritional composition & health benefits of organic foods – using systematic reviews to question the available evidence

Natural products vary in their nutritional composition both in their raw and processed states. At a qualitative level, this variability partly underlies the differences in sensory properties of food such as taste, texture and smell. However, at a quantitative level, the inherent variability also adds considerable complexity to research on the nutrient composition of foods. Fruit and vegetable crops vary in their nutritional composition depending on numerous factors such as the growing conditions and season, the fertiliser regime and the methods used for crop protection (*e.g.*, use of pesticides and herbicides). Animal source food products also vary in their nutritional composition depending on factors including the age and breed of the animal, the feeding regime and the season of production. The variability in the nutrient content of the raw food as produced, is then further increased during its storage, transportation and processing prior to consumption.

It is intriguing to question whether certain agricultural practices can influence the nutritional composition of foodstuffs to such an extent that their impacts outweigh the combined influence of the numerous other factors important in defining nutritional composition. Indeed, there are several biologically plausible examples of significant impacts of agricultural production practices on the nutrient composition of foodstuffs. For example, the degree of protection from pests afforded to crops by farmers may influence the synthesis by plants of phytochemicals, such as phenolic compounds and flavonoids, which form part of the plant's inbuilt pest protection system[1]. And similarly, the feeds provided to monograstric animals may alter the type and quantity of fats present in meat; for example, the nutritional quality of pork fat can be improved by feeding pigs with meals high in polyunsaturated fatty acids[2].

Organic farming, is an agricultural production method that has in recent years gained increasing prominence. There has been uncertainty over whether this method produces foodstuffs that are nutritionally distinct from those produced using conventional farming methods. Certified organic farmers produce foods according to a strict set of specified standards, which control the use of chemicals in crop production and medicines in animal production, and are required to pay particular attention to the impact of their farming practices on the wider environment. Organic standards differ between countries, many of which have their own organic certifying bodies, although some regional regulations do exist.

Recently published non-systematic reviews comparing nutrient composition of organically and conventionally produced foods have come to contrasting conclusions. Some have reported that organically produced foodstuffs have higher nutrient content than conventionally produced foodstuffs[3,4], while others have concluded that there are no consistent differences in nutrient content between production methods[5-7]. However, all previous reviews comparing the nutrient content of organic and conventionally produced foods have been incomplete and non-systematic, and very few have undertaken new statistical analysis of existing published data.

The importance of systematic reviews to bring together and critically evaluate all available evidence has long been recognized, and systematic reviews are used internationally to define public health policy[8]. In contrast to non-systematic reviews, which can be biased and incomplete, the prime purpose of systematic reviews of literature is to provide a comprehensive display of all available evidence in a common format. Systematic reviews have clearly defined guidelines for their conduct. The review process starts with the preparation

of a protocol, which among other things explicitly states the research question, the search terms and inclusion/exclusion criteria, and the requirements for defining quality in studies. The review protocol must be peer-reviewed and made available for public scrutiny, and this pre-specification of review methods helps ensure unbiased selection of relevant papers and abstraction of relevant data. The advantages of the systematic approach are clear – reviews are comprehensive, and bias is minimized. Only by systematically reviewing all of the available evidence can a comprehensive and impartial conclusion be drawn, which can be used by policy makers and consumers alike to make informed decisions.

The UK Food Standards Agency, an independent Government department set up by an Act of Parliament in 2000 to protect the public's health, and consumer interests, in relation to food, has been under increasing pressure from various groups to make a statement on the nutritional quality of organic foods, and in late 2007 requested that a systematic review be conducted on this topic. Our team at the London School of Hygiene & Tropical Medicine tendered for, and was awarded, a contract from the UK Food Standards Agency to conduct a systematic review on the nutrient content of organic food, and our results were published in mid-2009[9].

On receipt of the contract, our first act was to constitute an independent expert panel to oversee, and advise on, the process of the review. We then wrote a review protocol which was peer-reviewed and made publically available for comment [*http://www.lshtm.ac.uk/nphiru/research/organic/*]. All relevant articles published with an abstract in English in a peer-reviewed journal since January 1958 (more than 50 yr) were identified. In reality, this involved screening more than 52,000 journal articles before identifying 162 that were relevant to our review question. We then checked the identified publications against our pre-specified quality criteria to determine whether their quality could be classified as satisfactory.

Our quality criteria were defined as the minimum we considered acceptable for scientific publications in this area: a clear definition of what was meant by "organic farming" with relation to the samples being tested; a statement of the cultivar of plant or breed of livestock under investigation; a statement of which nutrients were tested; specification of the laboratory methods used; and finally, identification of the methods used for statistical analysis. An alarming number of studies could not be classified as satisfactory quality, the most common omission was lack of information of the organic farming certifying body under which the foodstuffs were produced. Many studies also failed to state clearly exactly which crop cultivar or animal breed was assessed for nutrient content. In total, only 55 studies (34% of those identified) met our pre-specified quality criteria.

Statistical analysis was hampered by shortcomings in the data presented in published studies. Formal meta-analysis was not feasible as many studies failed to present information on sample size or variability in nutrient content, and analysis by individual foods was also not possible because of a lack of sufficient data on specific foods. Instead, we conducted analysis by nutrient group (*e.g.*, vitamin C or phenolic compounds) and, in order to avoid multiple statistical testing which can result in spurious findings, we restricted our analysis to those 11 nutrient groups that had been reported in 10 or more studies.

The results of our statistical analysis of data extracted from satisfactory quality studies found no evidence of differences between organically and conventionally produced crops for 8 of the nutrient groups analysed including vitamin C, phenolic compounds, magnesium and zinc. We did however, identify some statistically significant differences between production regimen which are also biologically plausible. First, we identified that conventionally produced foods contain more nitrogen, probably because of the greater use of nitrogen fertilisers in conventional than in organic farming methods. Secondly we showed that organic crops contained more phosphate, which may relate to differences in nutrient content of soil between production regimens. Production regimen and particularly differences in fertilisers use and soil management are likely to impact on nutritional composition of crops. What is clear from our analysis however, is that there is currently no evidence of major differences in nutritional content between production regimens and from a public health perspective, the differences that we did identify are not important in the context of a normal healthy diet.

In a second review, using a similar fully peer-reviewed systematic process, we sought to determine if there was any evidence of nutrition-related health benefits from consumption of organic foods [*http://*

*www.lshtm.ac.uk/nphiru/research/organic/*]. Despite an extensive search process which identified more than 92,000 papers, we only found 11 relevant publications that were of extremely variable quality. Our conclusion from this second review is that there is currently no evidence of any nutrition-related health benefits from consuming organic foods.

It would be fair to say that our reviews have received a mixed response and it might prove instructive to examine the reasons for this a little more closely. While many members of the public and the scientific community thanked us for providing much needed clarity on the question of nutrient content, some people felt that differences between production regimen in the chemical residue content of foods was a more important question. We agree that this latter question is indeed important and would probably warrant further systematic review, but it is wrong to criticise our work for not including this topic[10]. We stated very clearly at the outset that we were reviewing only the evidence on nutritional composition and nutrition-related health benefits, which are important questions for the agricultural industry, public health nutritionists and consumers. What is also clear from the numerous responses we have received is that there is a widely-held belief that in contrast to organic farming, conventional farming practices produce poor quality foods and cause widespread environmental degradation. We make no comment at all about environmental factors in our review, as these concerns were beyond the scope of our work, but it would seem that provision of robust scientific evidence that questions personal beliefs is not always welcomed[11].

Systematic reviews are comprehensive and impartial and should be used to answer important policy-relevant questions. Based on the existing evidence, our reviews have drawn into question previous claims of nutritional superiority and nutrition-related health benefits of organic foods, although we have also highlighted the generally poor quality of the evidence base. We urge agricultural scientists working in this area to improve the quality of their research, possibly by collaborating with public health nutritionists and epidemiologists, and hope that we have provided policy makers and consumers with useful evidence to help them make informed choices.

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