


A photograph of a red-stemmed leafy vegetable, possibly a chard, growing in a field of green grass. The plant has a thick, reddish-brown stem and large, green, slightly crinkled leaves. The base of the plant is in dark, rich soil, and the surrounding area is filled with a dense patch of bright green grass. The overall scene is set against a plain white background.

Organic versus Non-organic

**A NEW EVALUATION OF
NUTRITIONAL DIFFERENCE**

Crops



*“Switching to organic
crop consumption is
equivalent to eating
one or two additional
portions of fruit or
vegetables per day”*



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Clear, new evidence

A landmark paper in the *British Journal of Nutrition* concludes that organically grown crops – e.g. fruit, vegetables and cereals – contain significantly higher concentrations of nutritionally desirable antioxidants and lower levels of undesirable cadmium (a toxic heavy metal) and pesticide residues.

Nutritional benefits

The Newcastle University-led study is the most up-to-date analysis of research into the nutrient content in organic compared to conventionally produced foods, synthesising the results of many more studies than previous analyses. The results of this meta-analysis showed that organic crops were of a much higher nutritional quality than their non-organic counterparts.

Strong evidence

The peer-reviewed scientific study is the most extensive analysis of the nutrient content of organic and non-organic foods ever undertaken. Its findings contrast strikingly with some earlier papers, all of which were based on a far smaller body of evidence.

The analysis is a valuable and timely addition to the ongoing scientific discussion about the benefits of organic food, and makes an important contribution to the information currently available to consumers.



At a glance – organic vs non-organic

- **Production method affects quality:** This new analysis is the most extensive and reliable to date and clearly supports the view that the quality of food is influenced by the way it is produced.
- **More of the good, less of the bad:** Organic crops and processed foods (such as bread, baby food, fruit juice and wine) have more desirable antioxidants/(poly)phenolics and less potentially harmful cadmium, nitrogen and pesticide residues than their non-organic counterparts.
- **Health benefits:** Plant antioxidants and (poly)phenolics are of scientific interest due to strong evidence of beneficial effects on human health, including potential protection against cancers, diabetes and cardiovascular and neurodegenerative diseases.*
- **Reduction in pesticides:** Organic food consumption can reduce exposure to synthetic pesticide residues. This study found that the frequency of occurrence of detectable pesticide residues was four times higher in conventionally produced rather than organic crops.*
- **Organic IS different:** The new study, therefore, clearly shows that there are meaningful nutritional differences between organic and non-organic food.

*See page 18 for more information.

Why is this study different?

The Newcastle University-led study, *Nutritional Composition of Organic Crop Foods*, is the most comprehensive scientific review of the organic versus non-organic debate so far. Its conclusions contrast markedly with other widely cited studies of the past decade in finding such significant differences in the nutritional composition of organic versus non-organic food, and there are several likely reasons for this.

More recent data

It is the first analysis to extensively review the results of hundreds of studies that have been published in the past few years. More than one-half of the publications analysed in this study were published after 2006 and therefore not included in the UK Food Standard Agency-sponsored study (Dangour *et al.*¹).

More reliable methodology

The statistical methods used in the Newcastle University-led study were an advance over previous research syntheses that did not balance out the contribution of larger studies versus smaller ones. As well as having less evidence and not accounting for the amount of information, earlier syntheses used less reliable methodologies and inclusion criteria, and some included results from the same experiment multiple times.

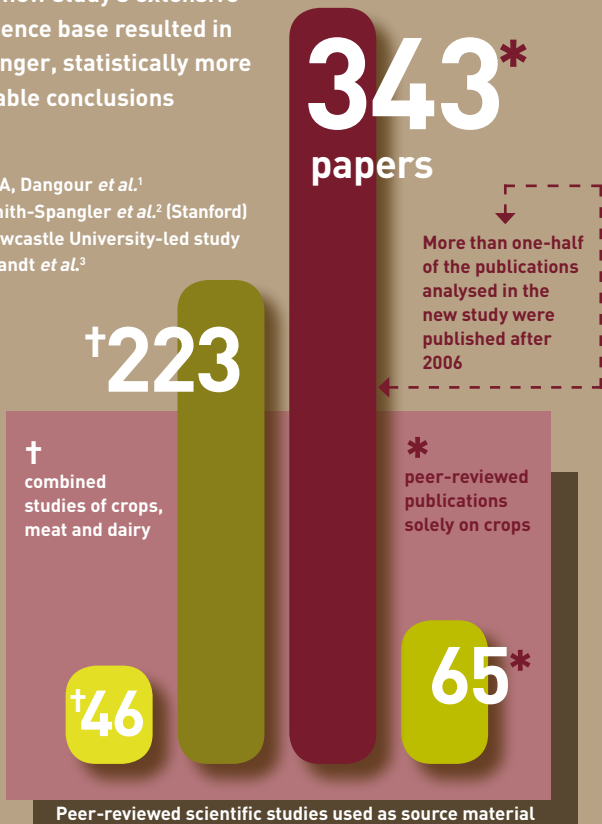


The Newcastle University-led study has a larger evidence base

The new study's extensive evidence base resulted in stronger, statistically more reliable conclusions

KEY

- FSA, Dangour *et al.*¹
- Smith-Spangler *et al.*² (Stanford)
- Newcastle University-led study
- Brandt *et al.*³



Key findings

The Newcastle University-led study is based on a systematic review and analysis of data from 343 crops-focused papers using state-of-the-art meta-analysis methods. This involves scientists combining and then carrying out a statistical analysis of all available published data, to provide much more comprehensive data for differences than a single study can.

The aim of this study was to identify and quantify compositional differences between organic and conventional crops that are of potential relevance to human health.

The analysis presents strong evidence that switching to food

produced using organic standards can lead to increased intake of nutritionally desirable antioxidants, without increased calories, as well as reduced intake of potentially harmful cadmium and pesticides.



“The quality of food is directly influenced by the way it is produced”

Antioxidants/(poly)phenolics

Organic crops (primarily cereals, vegetables and fruit) and processed foods (e.g. bread, baby food, fruit juice and wine) have significantly higher concentrations of nutritionally desirable antioxidants/(poly)phenolics compared with their conventionally produced counterparts.

These include phenolic acids (19% higher), flavanones (69% higher) stilbenes (28% higher), flavones (26% higher), flavonols (50% higher) and anthocyanines (51% higher).



Antonio Gravani/Fotolia

A switch to consuming organic crops would allow a 20–40% (and for some compounds up to a 70%) increase in antioxidant/(poly)phenolic consumption without an increase in calorie intake.

Toxic heavy metals

The meta-analysis detected substantially (48%) lower concentrations of the toxic heavy metal cadmium in organic (as opposed to non-organic) crops, but no significant differences for other toxic metals (e.g. arsenic and lead). Cadmium is one of only three heavy metals that has a maximum permitted contamination level in food, set by the European Commission.*



Goodluz/Fotolia

*See page 18 for more information.

Nitrogen

Nitrogen concentrations were found to be significantly lower in organic crops, specifically, concentrations of total nitrogen were 10%, nitrate 30% and nitrite 87% lower in organic compared to conventional crops. High nitrate and in particular nitrite intake has been linked in some studies to an increased risk of certain cancers (e.g. stomach cancer) but there is significant ongoing debate about the health impacts of high nitrate/nitrite intake. Nitrate and nitrite are known to accumulate in plants grown under high-nitrogen-input fertiliser regimes, which are prohibited by organic farming standards.

Stockphoto-graf/Fotolia

Pesticides

The frequency of occurrence of detectable pesticide residues is four times higher in conventional crops. Conventionally produced fruit had the highest pesticide frequency (75%) compared to conventional vegetables (32%) and crop-based compound foods (45%).



Ewald Fröchy/Fotolia

The authors suggest that the finding of some pesticide residues in 10% of organic crop samples was mainly due to cross-contamination from pesticides sprayed in neighbouring conventionally managed fields.

A red tractor is visible in the background, working in a field. In the foreground, a large, round hay bale is partially visible on the right side. The background shows a vast, open landscape under a clear sky.

Organic farming standards

Organic crop production standards are strictly regulated in the European Union, the United States and many other countries. Any food product labelled ‘organic’ must meet these standards and comply with inspection regulations. According to EU guidelines, organic farming practices are “designed to minimise the human impact on the environment, while ensuring the agricultural system operates as naturally as possible”. Practices include wide crop rotation, very strict limits on chemical synthetic pesticide* and synthetic fertiliser use, and the selection of plant and animal species that are resistant to disease and adapted to local conditions.

The EU organic sector is expanding rapidly and now features more than 186,000 organic farms.

**See page 18 for more information.*

What are antioxidants and (poly)phenolics?

INTESTINAL CELL

FREE RADICALS
(by-products from
food and chemicals)

Free radicals
lead to cell
damage and
mutations

protein

nucleus

ANTIOXIDANTS
Absorb free radicals

Antioxidants are compounds that interact with and neutralise free radicals, thus preventing them from causing damage to cells in the body, which are linked to many chronic health problems. Naturally occurring plant-based (poly)phenolics are the most abundant antioxidants in the diet; the main classes include phenolic acids, flavonoids, stilbenes and lignans. Primary dietary sources are fruits such as apples, grapes and berries, linseeds, and plant-derived drinks such as juices, tea, coffee and red wine. Vegetables, cereals, chocolate and dry legumes also contribute.

Plant (poly)phenolics are the subject of increasing scientific interest because of strong evidence of their beneficial effects on human health.*

*See page 18 for more information.

What does this mean for consumers?

By presenting strong evidence that choosing food produced using organic standards can lead to increased nutrition, the new findings make an important contribution to the information currently available to consumers.

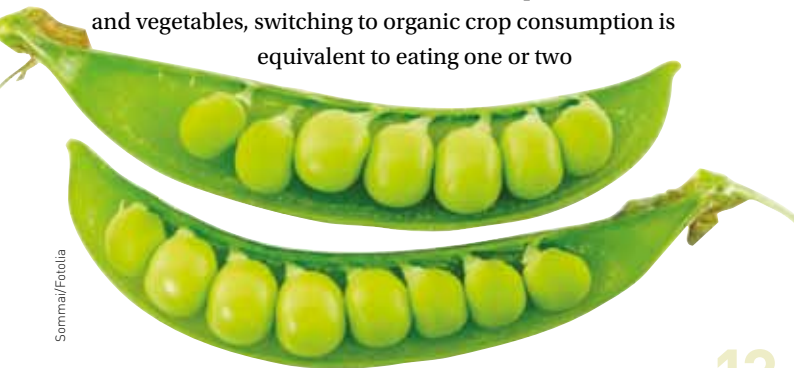
Higher concentrations of antioxidants/(poly)phenolics

There is strong scientific evidence that there are health benefits to eating a diet rich in (poly)phenolics and antioxidants. Studies have linked an increased intake to protection against chronic diseases, including cardiovascular and neurodegenerative diseases and certain cancers.

While no one should decrease their consumption of fruit and vegetables, switching to organic crop consumption is equivalent to eating one or two



Kornienko/Fotolia



Sommai/Fotolia



additional portions of fruit or vegetables per day because, with greater nutrient and antioxidant density, every mouthful of fruit and vegetables produced organically can count for more.

Lower concentrations of cadmium

Cadmium is known to accumulate in the body (especially the liver and kidneys) and is one of only three toxic metal contaminants (along with lead and mercury) for which the European Commission has set maximum permitted contamination levels.

Any reduction in cadmium consumption is positive.



Lower concentrations of nitrite and nitrate

The significantly higher nitrite concentrations in conventional crops are believed to be nutritionally undesirable since they have been described as potential risk factors for stomach cancer and other conditions in humans. However, there is ongoing debate about the potential health impacts of crop-based dietary nitrate intake.

Less chemical pesticide residues

While it is generally accepted that organic food contains little or no pesticides compared to non-organic, few comparative studies have been done in this area. The Food Standards Authority and other regulators maintain that pesticide residues below the minimum levels set by the EU do not pose risks to consumers. This would suggest that the large difference in chemical pesticide residues between organic and conventional crops has no nutritional or health significance.

However, a significant proportion of crop samples monitored by the European Food Standards Authority continues to have pesticide residues above these minimum levels.*

Though further study of the potential health benefits associated with reducing pesticide exposure is required, lower exposure is widely considered desirable for health.

*EFSA 2011 *Report on Pesticide Residue in Food*, 12(5):3694 [511 pp.]



Into the future...

This latest analysis is the most extensive and reliable carried out to date comparing the nutrient content in organic and conventionally produced foods, and provides clear evidence of significant compositional differences.

Further research is needed

Future research is required to understand more about the compositional differences between organic and conventional crops, and the impacts of e.g. crop types and varieties, soil management and crop production methods, as well as soil and weather conditions.



RTimages/Fotolia

Very few studies have been published in which the effects of organic food consumption on animal or human health, are specifically assessed. The findings of this analysis clearly demonstrate the urgent need to carry out further research to identify and quantify the health impacts of switching to organic food.

“With greater nutrient and antioxidant density, every mouthful of fruit and vegetables produced organically can count for more”

Finding out more

To read the full paper, as published in the *British Journal of Nutrition*, go to: <http://research.ncl.ac.uk/nefg/QOF>

This includes further information and annexes, and summary information in English, German, French, Italian, Greek, Polish, Czech and Finnish.

Higher antioxidant concentrations, and less cadmium and pesticide residues, in organically grown crops: a systematic literature review and meta-analysis. Leifert C. *et al.* (2014) *British Journal of Nutrition*, July 2014.

The authors of this latest study welcome continued public and scientific debate on this important subject.

The entire database generated and used for this analysis is freely available on the Newcastle University website (<http://research.ncl.ac.uk/nefg/QOF>) for the benefit of other experts and interested members of the public.

Links

www.nealsyardremedies.com

www.soilassociation.org

www.sheepdrove.com



Additional information

Scientific evidence for health benefits of antioxidants and (poly)phenolics

Del Rio D, Rodriguez-Mateos A, Spencer JPE *et al.* (2013) Dietary (poly)phenolics in human health: structures, bioavailability, and evidence of protective effects against chronic diseases. *Antioxid Redox Signal* **18**, 1818–1892.

Wahlqvist ML (2013) Antioxidant relevance to human health. *Asia Pac J Clin Nutr* **22**, 171–176.

More detail on the strict limits on synthetic pesticide use in organic farming

In the UK, according to the Soil Association standards, organic farmers can use around six pesticides (compared to over 100 in non-organic farming). In practice, most of the organic sprays are used on just a few crops – potatoes, vines and apples – and in greenhouses. The substances you are allowed to use are based on naturally occurring substances – sulphur, copper and soft soap, for example. There are strict limits on the quantities that can be used, for example, non-organic farmers apply far more copper to treat soils with a copper deficiency (it occurs naturally in soils) than organic farmers apply as a fungicide.

Why organic produce contains some pesticide residues

Organic farming prohibits the use of almost all pesticides. However, some persistent pesticides, generally now banned, like PCBs and DDT, are present everywhere in the environment and are unavoidable. Occasionally, pesticides used on neighbouring non-organic farms can drift onto organic crops, although all organic farms have to have barriers such as hedges, roadways or margins to protect their crops. If it occurs, most contamination is likely to occur after food has left the farm, during transportation, cleaning, processing and packing.

Toxic heavy metals in organic produce

Traces of cadmium and toxic metals are found naturally in soils and the environment, and concentrations in food usually stay well below the maximum levels permitted by EC regulations. However, cadmium levels may be raised significantly by farmers using high-mineral-phosphorus fertiliser inputs, as is common practice in conventional farming systems. Cooper J, *et al.* (2011) Effect of organic and conventional crop rotation, fertilization, and crop protection practices on metal contents in wheat (*Triticum aestivum*). *J Agric Food Chem* **59**, 4715–4724.

Previous organic food research

This new analysis of organic versus conventional crops is based on 343 relevant peer-reviewed publications solely on crops. In contrast, the UK Food Standards Authority-commissioned study by Dangour *et al.*¹ considered 46 publications across crops, meat and dairy, and the Brandt *et al.*³ reviewed 65 in their crop-focused analyses. The Smith-Spangler *et al.* (Stanford)² study extracted data from 223 studies in their combined analysis of crops, meat and dairy.

REFERENCES

1. Dangour AD, Dodhia SK, Hayter A *et al.* (2009) Nutritional quality of organic foods: a systematic review. *Am J Clin Nutr* 90, 680–685.
2. Smith-Spangler C, Brandeau ML, Hunter GE *et al.* (2012) Are organic foods safer or healthier than conventional alternatives?: a systematic review. *Ann Intern Med* 157, 348–366.
3. Brandt K, Leifert C, Sanderson R *et al.* (2011) Agroecosystem management and nutritional quality of plant foods: the case of organic fruits and vegetables. *Crit Rev Plant Sci* 30, 177–197.



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Transforming the way we way we eat, farm and care for our natural world. The Soil Association is the UK's leading charity for healthy and planet-friendly food and farming.

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“The crucially important thing about this research is that it shatters the myth that how we farm does not affect the quality of the food we eat.”

Helen Browning OBE, Chief Executive, Soil Association



Neal's Yard Remedies is a proud supporter of the Newcastle University-led study and its findings

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