

Best before?

Is the way we produce and process food making it less nourishing, asks Chloe Lambert

VEGAN, low carb, Palaeo, 5:2. The quest for the healthiest diet shows no sign of abating. We now know more than ever about what food does to the body and the importance of antioxidants, healthy fats and a low glycaemic index.

But what if, all the while, our food has been getting less nutritious? What if modern intensive farming methods – many of which solved malnutrition problems when they were first introduced – have affected the mineral and vitamin content of what we eat? Could having a constant supply of varied produce be compromising its goodness?

Some of the most eye-catching work in this area has come from Donald Davis, a now-retired biochemist at the University of Texas. In 2011, he compared the nutrients in US crops from 1950 and 2009, and found notable declines in five nutrients in various fruits, including tomatoes, eggplants and squash. For example, there was a 43 per cent drop in iron and a 12 per cent decline in calcium. This was in line with his 1999 study – mainly of vegetables – which found a 15 per cent drop in vitamin C and a 38 per cent fall in vitamin B2 (see table, page 36).

Fruit and vegetables grown in the UK have shown similar depletions. A 1997 comparison of data from the 1930s and 1980s found that calcium in fresh vegetables appeared to drop by 19 per cent, and iron by 22 per cent. A reanalysis of the data in 2005 concluded that 1980s vegetables had less copper, magnesium and sodium, and fruit less copper, iron and potassium.

Davis and others blame agricultural practices that emphasise quantity over quality. High-yielding crops produce more food, more rapidly, but they can't make or absorb nutrients at the same pace, so the nutrition is diluted. "It's like taking a glass of orange juice and adding an equal amount of

water to it. If you do that, the concentration of nutrients that was in the original juice is dropped by half," says Davis.

But the idea that modern agriculture produces crops that are less nourishing remains controversial, and "then and now" nutritional comparisons have been much criticised. The differences found may be down to older, less accurate methods of assessing nutrition, and nutrient levels can vary widely according to the variety of plant, the year of harvest and the time of harvest.

Other studies have sought to get round this by comparing old and new varieties of a crop grown side by side. In 2011, researchers at the US Department of Agriculture measured the concentrations of 11 minerals in 14 commercial varieties, or cultivars, of broccoli launched between 1950 and 2004.

They found no clear relationship between mineral levels and the year that a particular cultivar was released, but there was evidence of a dilution effect: bigger broccoli heads favoured today had lower levels of some minerals relative to a 1950 variety called Waltham 29 (see table, page 36). But, as the study also noted, Waltham 29 is less tough than modern cultivars and so would be unlikely to succeed if grown in the same way.

And there lies the rub. Even if the arrival of intensive agriculture has meant that our vegetables contain slightly less nutrients than those our grandparents ate, it has also led to a huge increase in food supply, which has undoubtedly had a positive effect on our diet and health.

"Some evidence suggests that some nutrients have fallen, particularly trace elements such as copper in vegetables," says Paul Finglas, who compiles nutritional data on UK food at the Institute of Food Research in Norwich. "Foods are now bred for yield, and not necessarily nutritional composition. ➤

What's really on your plate

How have modern farming methods affected the nutrients in common foods?

Beef

Beef from cattle reared outdoors on grass is less fatty and contains more omega-3 fatty acids than cattle reared indoors and fed mainly grain. However, consumers preferred the taste of latter, according to a 2014 study.



Milk

Milk from cows reared the old-fashioned way – mainly feeding on grass outdoors – has a better nutritional profile of proteins, fatty acids and antioxidants than milk from cows reared indoors and fed intensively.



Pasta

Today's pasta might be less nutritious thanks to modern, fast-growing wheat varieties introduced in the 1960s. Levels of zinc, iron and magnesium remained constant in wheat grain from 1865 to the mid-1960s, then decreased significantly as yields shot up.



Spinach

Spinach is a good source of iron, but its iron content was once thought to be 10 times higher. That was the result of a historical error that may have been perpetuated by the spinach-derived superpowers of the cartoon character Popeye. There is no clear data about whether the iron content of spinach is changing due to modern agriculture, although fluorescent lighting in shops does boost its vitamin levels.



Carrots

Carrots from the 1940s contained less than half the vitamin A levels of carrots grown in the US 50 years later. The reason? A preference for more orangey carrots. The colour comes mainly from the pigment beta-carotene, which the body can use to make vitamin A.



Eggs

Eggs have been the subject of health scares over cholesterol, but now they are promoted as a health food. A 2012 study found that UK eggs are getting more nutritious, with lower fat and cholesterol compared to eggs from 1989 – probably because of smaller yolk sizes. They also contained more selenium and vitamin D than in the past, thanks to improved hen feed.



But I don't think that is a problem, because we eat a wider range of foods today than we did 10 years ago, let alone 40 years ago".

Eric Decker, professor of food science at the University of Massachusetts in Amherst, agrees. If nutrients are declining, the losses aren't significant enough to warrant any concerns over health, he says. "Over the last century, lifespans have got longer, people are bigger and stronger, and a lot of that has to do with the food supply being better."

Even Davis agrees that any differences in nutrient levels are relatively small. "Despite their declines, fruit and vegetables are still our richest source of many nutrients, and you can make up for it by eating more," he says. "But we know that even in developed countries, many people don't get the recommended amounts of some of the nutrients we are talking about – such as iron, magnesium, calcium. They aren't overt deficiencies in the usual sense, but they increase susceptibility to lots of different problems."

Other crops are also getting subtly less nutritious. The introduction of semi-dwarf, higher-yielding varieties of wheat in the green revolution of the 1960s means that modern crops contain lower levels of iron and zinc than old-fashioned varieties.

And as farmers strain to feed ever more mouths in the face of environmental change, the problem may become worse. Last year, researchers at Harvard University warned that crops grown in the future will have significantly less zinc and iron, due to rising levels of carbon dioxide from fossil fuel use.

"Rising carbon dioxide levels will mean future crops are less nutritious"

The team grew 41 different types of grains and legumes, including wheat, rice, maize, soybeans and field peas, under CO₂ levels crops are likely to experience 40 to 60 years from now. They found that under these conditions, wheat had 9 per cent less zinc, 5 per cent less iron and 6 per cent less protein than a crop grown at today's CO₂ levels. Zinc and iron – but not protein – were also lower in legumes grown under elevated CO₂.

If the food we grow has changed subtly over time, what difference, if any, does the journey from field to plate make? Even an apparently natural product like a lettuce or tomato will have been manipulated to some degree before we buy it. Does it matter, nutritionally?

Fruit and vegetables in supermarkets might look shiny and fresh, but often they were picked several days earlier. Some nutrients, particularly vitamin C and folic acid, begin to oxidise as soon as picking happens, but manufacturers use chilling and packaging techniques to minimise the resulting losses. Lots of these reactions are driven by enzymes, and if you want to slow an enzyme reaction right down you chill it. That's why the cool chain is so important," says Carol Wagstaff, who studies crop quality at the University of Reading, UK.

That said, if you are choosing between organic leeks from a distant country or locally grown, non-organic ones, always opt for home-grown, she says. "From a nutritional standpoint, go for the shortest possible supply chain rather than the production method."

A 2003 study evaluated the nutritional content of broccoli kept in conditions that simulated commercial transport and distribution: film-wrapped and stored for seven days at 1 °C, followed by three days at 5 °C to replicate a retail environment. By the end, the broccoli had lost between 71 and 80 per cent of its glucosinolates – sulphur-containing compounds shown to have cancer-fighting properties – and around 60 per cent of its flavonoid antioxidants.

Many kinds of mass-produced fruit and veg – most famously tomatoes – are picked unripe so that they bruise less easily during transit. They are then sprayed with ethylene to ripen them. Some studies suggest that tomatoes harvested early have lower antioxidant activity and less flavour. "If a fruit left on a plant until the end of its life cycle, it's able to recycle all the energy from the plant," says Wagstaff. "If you pick it early you truncate that process and get less sugars into the fruit, which are needed to bind the nutrients."

Supermarket tomatoes are often labelled as "vine-ripened", but that doesn't always mean what you hope, she says. "It may be ripened on the vine but the vine may not have been attached to the plant." However, Wagstaff stresses that the downsides of early picking are small and an unavoidable consequence of consumer demand. "If you pick a tomato that you have grown at home, it tastes fabulous because it's absolutely ready to eat," she says. But there's no way you could do that at a commercial level because of the bruising that could occur if ripe fruits were transported through a typical supply chain. There has to be a compromise somewhere."

Another complication is that each method of shipping and storing foods has different

The bellyache over modern bread

Humans have been making bread for 10,000 years, but the way we do it has changed dramatically in the last half-century. In 1961, a new method of mass-producing bread was devised at the Chorleywood laboratories, just north of London. It used extra yeasts, additives called processing aids and machinery to slash fermentation times, so a loaf could be made in just a few hours. Around 80 per cent of bread consumed in the UK is now made this way, and the Chorleywood process is used to some extent in many other countries.

But there are concerns that such methods have altered the digestibility of bread, and this may explain why many people with irritable bowel syndrome name bread as a trigger. For a significant subset of those with IBS, the condition is thought to be linked to gut bacteria reacting to fermentable foods, causing gas and bloating.

Last year, Jeremy Sanderson at King's College London and colleagues compared the effects of fast and slow-fermented breads on gut

microbiota from donors with IBS and those free from it. They found that sourdough bread – which is left to rise for several hours using its natural yeasts – produced "significantly lower cumulative gas" in the IBS donors' microbiota than fast-fermented bread. The theory is that if bread is left to ferment for longer, its carbohydrates will reach the gut in a predigested state and gut bacteria won't react so much. "If you under-ferment bread and add a lot of yeast, it's hardly surprising this will set up problems for people who have a problem with fermentation in their gut," says Sanderson.

Slow-fermented breads may benefit other groups too: sourdough produces a lower glucose response in the body than other breads. What's not yet clear is whether eating slow-fermented breads would lead to a general improvement in the gut flora of healthy people. "That's difficult, but it's a reasonable hypothesis," says Sanderson. "After all, bread-making probably evolved to match what the gut could cope with."

On the breadline: has mass production made a staple food a no-no for some?



MICHAEL ROSENFELD/CETTY

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A 2003 study evaluated the nutritional content of broccoli kept in conditions that simulated commercial transport and distribution: film-wrapped and stored for seven days at 1 °C, followed by three days at 15 °C to replicate a retail environment. By the end, the broccoli had lost between 71 and 80 per cent of its glucosinolates – sulphur-containing compounds shown to have cancer-fighting properties – and around 60 per cent of its flavonoid antioxidants.

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MICHAEL ROSENFIELD/GETTY

The great organic debate

If modern, high-intensity farming is causing food to lose some of its goodness, could organic food offer an alternative?

It's a controversial question. Antioxidant levels are higher in organically grown plants, according to a meta-analysis of existing studies published last year. However, in 2012 researchers at Stanford University in California found no strong evidence that organic foods are more nutritious.

"In general, for minerals, the differences [between organic and inorganic] are pretty small," says biochemist Donald Davis. One reason for the nutrient declines seen in some of today's vegetables is down to breeding - making broccoli heads larger, for example - and organic growers tend to plant the same varieties as non-organic growers, he says.

Another complication is that it is difficult to make a direct comparison of organic and non-organic crops. "You have to take enough samples to grow on a very controlled patch, and expose

them to exactly the same treatment," says Paul Finglas of the UK's Institute of Food Research in Norwich. "There may well be some evidence that some organic foods are different - such as in vitamin C - but it's not going to make a big nutritional impact."

Things look better for organic buyers when it comes to milk. Recent UK and US studies found that organic milk from cows reared outdoors had higher amounts of antioxidants and omega-3s. The difference is down to diet. "Cattle on organic farms are provided much more access to pasture and fed a much higher proportion of forage-based feeds," says Charles Benbrook, who showed in 2013 that organic milk produced in the US contains a healthier ratio of omega-3 to omega-6 fatty acids than non-organic milk (see "Fat lot of good", opposite). "Grass and legume forages are the building blocks for omega-3 fatty acids, while corn - which plays an important role on conventional farms - is the basis for omega-6."

A subtle colour change means that some carrots give us more vitamin A



Unsavoury dip

How does fruit and veg from 1950 compare with those grown half a century later? A US survey of 43 crops found a decline in six key nutrients

Vitamin C



15%

Iron



15%

Vitamin B2



38%

Calcium



16%

Protein



6%

Phosphorus



9%

Heads you lose

Is broccoli as good for us as it used to be? A 2004 variety, Green Magic, contains significantly lower levels of mineral nutrients than one called Waltham 29, launched in 1950

Iron



18%

Magnesium



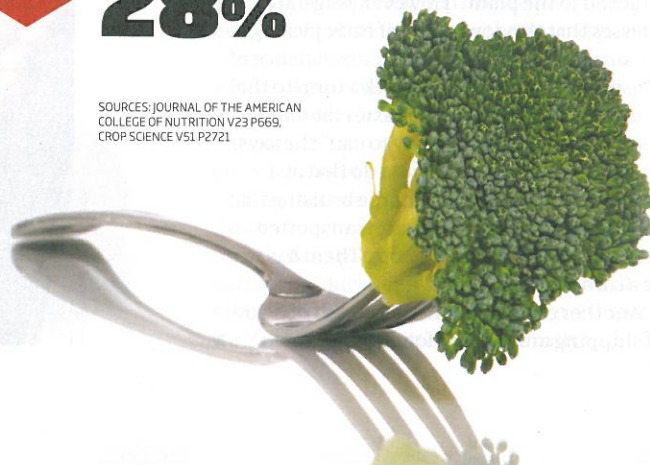
30%

Zinc



28%

SOURCES: JOURNAL OF THE AMERICAN COLLEGE OF NUTRITION V23 P669, CROP SCIENCE V51 P2721



cts on the compounds they contain. Vitamin C, for example, breaks down in the light, whereas glucosinolates – found in cruciferous vegetables like broccoli and cabbage – deplete in the light. “That’s one of the problems with hydroponic agriculture,” says Wagstaff. “By its very nature you have an enormous diversity of varieties and species. In an ideal world, each variety would have a tailored supply chain.”

Available light

In the case of spinach, it is the fluorescent lighting in supermarkets that can be beneficial. A 2010 study found that spinach leaves stored in simulated retail conditions had higher levels of vitamins C, E, K and folic acid. After nine days of continuous light exposure, folic acid increased between 84 and 100 per cent. In spinach stored in darkness, nutrient levels stayed the same or fell. They may not be fashionable, but frozen vegetables are often nutritionally superior to fresh, says Wagstaff. “Frozen vegetables are extremely good in terms of nutritional value because it really has been in suspended animation from the point of harvest,” she says. “You can leave it on the plant longer, so it’s at a better ripening stage when it’s picked.”

Peas can lose half of their vitamin C in the first 48 hours after harvesting, but if frozen within 2 hours of picking they retain it. Frozen peas are much more nutritious than those you buy ready to shell,” says Catherine Collins, principal dietician at St George’s Hospital in London. What’s more, frozen vegetables often have fewer additives. “Freezing is a preservative,” she says. Similarly, processing has become a buzzword in the context of food, but there are some cases where it enhances a food’s health benefits. In fact, you arguably get more benefits from processed tomatoes, such as in purees, sauces or ready chopped vegetables, than fresh.

Processed tomatoes tend to be harvested at a riper stage. In addition, lycopene – a phytochemical found in tomatoes – has been shown to protect against cancer – is much more readily absorbed by humans from tomato paste than fresh tomatoes. “The more processed a tomato is, the more lycopene is available,” says Collins. “Processed tomatoes are often very concentrated, so you’re actually getting a greater quantity than you would use if you made your own sauce.” However, she notes that the heating used in processing destroys vitamin C.

Fat lot of good

Nutritional deficiencies shouldn’t be an issue for consumers in rich countries, but one area of concern is the low intake of omega-3s. These essential fatty acids, particularly long-chain omega-3s found in oily fish and shellfish, are vital for growth and development.

The average intake among adults in the US and UK falls far short of the recommended amount, largely due to the fact that many people eat little or no seafood. “Omega-3 is probably one nutrient that [Western] people have a deficiency in – at least, they’re not at the optimum level,” says Eric Decker, a food scientist at the University of Massachusetts.

Meanwhile, people are consuming more omega-6 acids, found in vegetable oils. These are important too, but in excess amounts they can trigger the body’s inflammatory response.

What’s worrying some is that changes in farming methods are making some foods lower in omega-3s and higher in omega-6s. This has been

shown most clearly in fish. Half of all fish consumed globally now come from aquaculture, and farmed fish have a different nutritional profile to wild-caught varieties. Wild salmon, for example, is an excellent source of omega-3s, because it feeds on smaller fish that have eaten omega-3 rich algae. But farmed fish are increasingly fed vegetable oil, boosting their omega-6 levels.

Last year, a study of salmon sold in the UK found that farmed salmon had twice the amount of fat as wild salmon, a lower proportion of omega-3s and significantly more omega-6 fatty acids – although the authors stress that farmed salmon is still a good source of omega-3s. Similar trends have been seen in organic and non-organic milk and beef (see “What’s really on your plate”, page 36), though these contain far less omega-3 than fish.

Fortification is one way to tackle this problem – hence the array of omega-3 enriched products, such as juice and yogurt, now on the market.

Processed tomatoes have been on sale for more than a century – Heinz ketchup was launched in 1876 – but a much more recent trend is the sale of “fresh-cut” fruit and vegetables – peeled potatoes, ready chopped carrots and bagged salads. One in five adults in the UK regularly buy fruit and vegetables in this form every week, according to market research firm Mintel. Surely this cutting and peeling speeds up the degradation of nutrients?

Although salad leaves that have been picked and stored for several days before being eaten are a bit less nutritious than a freshly harvested lettuce, chilling and using packaging to reduce oxygen exposure may slow the nutrient loss. And any loss of nutrients must be weighed against the fact that these products may encourage people to eat better overall.

“There is a chance that ready prepared vegetables may have a lower content of some vitamins,” says Judy Buttriss, director general of the British Nutrition Foundation in London.

“But if their availability means that such vegetables are consumed in greater quantities, then the net effect is beneficial.”

The bottom line is that although aspects of today’s food production, processing and storage might make what we eat a bit less nutritious, they are also making foods more available – and this is far more important. The majority of us consume far less fruit and vegetables than we ought to. We eat too much fat, sugar and salt and not enough oily fish.

“The most important thing you can do is eat more fruits, vegetables and wholegrains, and cut down on highly refined, human-made foods, vegetable oils and added sugars,” says Davis. “If you’re worrying about nutrient losses from cooking or whether your food is straight from the farm – those differences are minor compared to the differences you’d get from eating unprocessed foods.” ■

Chloe Lambert is a freelance writer based in London, UK. For references cited see our online article at <http://bit.ly/FactoryFood>