Rich in flavonoids in flavour, berries rival nuts as nature's most nutrient-dense functional food, writes **Sharon Natoli.**

Berries

Recent research shows berries have the potential to provide health benefits for numerous conditions — preventing the development and progression of cardiovascular disease and cancer[1], reducing the risk of diabetic retinopathy, fibrocystic disease, cataracts and age-related macular degeneration[2] and preventing Alzheimer's and Parkinson's disease.[3]

Berries are rich in anti-oxidants and non-nutrient-based phenolic compounds.[4] These components provide the anti-inflammatory, anti-carcinogenic and anti-mutagenic properties that may be responsible for many of the health benefits of berries.[4] Berries are also a rich source of dietary fibre, contain small amounts of iron, zinc and calcium, and are low in fat (<1 g/100 g), indicating they have a valuable place in a healthy, well-balanced diet.

Anti-oxidant properties

The berries shown in the table below have significantly higher anti-oxidant properties than fruits such as apples and kiwi fruit.[5] The key anti-oxidant compounds found in berries are:

- phenolic compounds — including anthocyanins, proanthocyanins and egalitannins[6,7]
- carotenoids — one serve of blackberries provides 315 mcg of beta-carotene equivalents
- vitamin C — one serve of blackberries

Nutrient content of raw berries (per 100 g)

Figures from AusNut, Foodworks version 3.01, Xyris Software, unless otherwise indicated

Berry	Energy (kJ)	Protein (g)	Fat (g)	CHO (g)	Fibre (g)	Vit C (mg)	Folate (mcg)	β-carotene (mcg)	Vit A (mcg)	Potassium (mg)	Magnesium (mg)	Calcium (mg)	Iron (mg)	Zinc (mg)
Blackberry, raw	210	1.4	0.3	7.5	6.1	38	36	320	53	114	30	30	0.4	0.2
Blueberry, raw	218	0.6	0.1	11.3	1.8	13	5	120	20	66	4	4	0	0.1
Boysenberry, canned in light syrup*#	258	0.6	0.4	12.6	2.2	6	25	113	19	105	8	15	0.8	0.3
Loganberry, raw	293	1.5	0.3	4.9	8.1	22	34	25	4	161	21	27	0.6	0.3
Mulberry, raw	139	2.2	0.2	4.3	2.2	10	24	10	2	310	12	20	0.3	0.2
Raspberry, raw	196	1.2	0.4	6	5.4	26	33	0	0	133	20	23	0.7	0.4
Strawberry, raw	99	1.7	0.1	2.7	2.2	45	14	25	4	130	8	13	0.6	0.2
Cranberry, raw#	230	0.4	0.5	12.2	4.4	21	–	–	–	81	–	26	0.4	–

* Nutrients unavailable in the raw form # Nutrient analysis from USDA nutrient database http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl

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or strawberries provides more than 90 per cent of the RDI for men and 120 per cent of the RDI for women.

Phenolic compounds include polyphenol flavonoids, monophenols and catechins.[1] These are complex organic molecules produced in plants for protection against diseases, sunlight and other elements. They also provide the vibrant red, purple and blue colour to berries, as well as flavour and aroma.[1,8] Phenols act as anti-oxidants, scavenging for hydroxyl radicals, superoxide anions and lipid peroxy radicals.[6] Procyanidins and catechins found in blueberries, cranberries, raspberries, blackberries and strawberries have been shown to significantly increase serum anti-oxidant activity and vitamin C concentrations, and improve resistance to LDL oxidation.[9]

Cancer

Carcinogenesis and oxidative lesions to DNA accumulate with age, increasing the risk of cancer. The anti-oxidant and vitamin A content of berries, along with various other components, may reduce the oxidative damage that occurs with age and therefore reduce cancer risk.[1,10]

Research has shown anthocyanins found in six berry types — strawberry, blueberry, bilberry, cranberry, elderberry and raspberry — significantly reduced tumour growth in animals.[11] A formula combining extracts of these berries provided a 50 per cent reduction in tumour growth *in vitro*.[11] This study indicated that the strong anti-carcinogenic potential of berries may be attributable to the anthocyanin content, and the potential of these compounds for protecting DNA integrity.[11]

Blueberry extracts have also been investigated for their anti-angiogenesis properties. Atalay et al showed that blueberry extracts reduced angiogenesis both *in vitro* and *in vivo*, and therefore may play a role in preventing and treating cancer.[11,12] Cultivated strawberry

extracts have also significantly inhibited the proliferation of human liver-cancer cells *in vitro*. This response was dose-dependent, although the anti-proliferative activity was not related to the anti-oxidant content of the strawberry extract.[13] Raspberries, with their high vitamin C and phenolic content, have been shown to significantly reduce human liver-cancer cell production *in vitro*, although the exact mechanisms and components responsible are not clear.[14]

Another possible anti-cancer agent found in berries is resveratrol (3,5,4–trihydroxystilbene). This compound is abundant in blueberries and cranberries.[15] The skin of the berry is the richest source of resveratrol, which can suppress the growth of a range of cancer cells, including lymphoid, myeloid, prostate, stomach, colon, breast, pancreas and ovarian cancers.[16]

Antimicrobial agents

Scientific investigations have shown that various berries are potentially useful for inhibiting the growth of intestinal pathogens. Raspberries provide the greatest inhibition of the various Gram-positive and Gram-negative human pathogens.[17] Staphylococcus and salmonella are most likely to be reduced with berry-juice consumption, and it has been shown that the organic acids, more than the phenolic compounds, are responsible for these inhibitory benefits. Only cranberries have been shown to inhibit listeria.[18] Commercially available juices of raspberries, cranberries and blackberries have been shown to reduce the growth of several micro-organisms[18], therefore demonstrating the potential of these fruits for improving and maintaining human health.

Cranberries are beneficial in the treatment of urinary tract infections (UTIs) — see *JCM* 2003;2(1):50–2, 2004;3(4):66. Human intervention trials have shown that 50 mL of cranberry juice taken for 180 days can reduce UTIs by 20 per cent.[9] Furthermore, vitamin C concentrations and anti-oxidant activity significantly improved with one 500 mL dose of cranberry juice.[9] The exact mechanism by which this fruit resolves UTIs is not precisely clear.[19]

Other health benefits

Blueberries and strawberries have long been known to improve memory and reduce development and progression of neurodegenerative disorders such as Alzheimer's disease [see *JCM* 2004; 3(1):18–9]. Several *in-vitro* and animal-based studies have shown that blueberry extracts can induce significant reductions in cerebral-cell death.[20]

Blueberry extracts have also been demonstrated to improve spatial memory biomarkers and improve cognitive function in rats.[21] Rat studies to investigate the effects of blueberries and strawberries on neuronal and behavioural deficits during ageing showed that they do have beneficial effects on age-related neuronal signalling and behavioural decrements.[3,22,23] This research indicates the potential of these berries to prevent conditions such as Alzheimer's disease.[3]

Cooking and processing

Processing allows some of the anti-oxidants found in berries, such as the phenolic compounds, to be more easily absorbed. However, other compounds, such as vitamin C, are easily destroyed through cooking and prolonged storage, especially cooking at high temperatures and storage at low temperatures. Freezing raw berries reduces nutrient levels, especially vitamin C, but does not reduce anti-oxidant capacity.[24,25] Canning causes the most damage to the nutrient content of berries.

Processing strawberries to juice and nectar reduces the vitamin C content by over 20 per cent[26] while heating causes the greatest reduction in vitamin C. Juicing of strawberries results in a total loss of 35 per cent of the vitamin C and 27 per cent of the total phenolic content, but anthocyanin content increases during processing.[26]

Drying also affects the nutrient content of berries. One study reported that the phenol content of cranberries significantly increased from 663 mg/100 g to 870 mg/100 g after being dried.[6] However, drying almost halves the fibre and calcium content of cranberries, and more than doubles the energy content.[6]

The variety of berry and the particular processing and storage conditions all determine the extent to which nutrients are affected. A recent study of a range of

Which berry is that?[29]

Blackberries *Rubus fruticosus* • native to Britain, US and Africa • best in late summer and autumn	• rich source of vitamin C and fibre • highest source of folate, beta-carotene, vitamin A and calcium of all berries • ½ cup provides 100% vitamin C RDI
Blueberries *Vaccinium spp.* • native to US and east Asia • available most of the year	• good source of vitamins C and A • rich in flavonoids, anthocyanins and other phenolics • may improve brain function and reduce aged-related diseases
Boysenberry *Rubus ursinus* • best in autumn and summer	• good source of vitamin C and fibre • thought to be a combination of blackberry, loganberry and raspberry
Cranberries *Vaccinium macrocarpon* • native to US and Europe • available summer and autumn	• good source of vitamin C and fibre • very high in anti-oxidants • may help treat UTIs
Loganberry *Rubus loganbaccus* • grown in temperate climates • available midsummer	• excellent source of fibre and folate • good source of vitamin C and magnesium
Mulberry *Morus nigra* • native of Iran and Nepal • available summer	• excellent source of vitamin C and fibre • rich in potassium
Raspberries *Rubus idaeus* • native of Europe and US • black, red and yellow varieties	• rich source of anti-oxidants and fibre • may have anti-cancer and anti-ageing properties
Strawberries *Fragaria virginiana, F. chiloensis* • native to US • available all year round but best in summer	• highest vitamin C content of all berries • very low in carbohydrate and energy • contains anti-cancer and anti-ageing properties

strawberries and cranberries showed that the ellagic-acid and flavonoid content was reduced by 20 and 15–20 per cent respectively after processing to jams.[24,26]

Temperatures of 0–15°C provide optimal conditions for the phenolic content and the anti-oxidant capacity of berries to increase.[2,27] The amount of oxygen that berries are exposed to during storage also significantly affects their nutrient content.[24] Longer storage time is thought to increase phenolic content because organic acids in the berries break down over time and the phenolic compounds form from the breakdown products.[2] To minimise the loss of nutrients from berries, storage between 2–4°C is recommended, for up to five weeks post-harvest.[2]

Caution – salicyclates

Almost all berries are high in salicylates, which can cause food intolerances in some people. There is evidence that strawberries may induce allergies in some people due to cross-reactions between birch-pollen antibodies and the fruit proteins[28], however allergy to berries is relatively uncommon.

Conclusion

Berries are an excellent source of many nutrients important for good health. They provide vitamins such as C and A, and are also abundant in phenolic compounds that contribute to their high anti-oxidant capacity. Conditions related to oxidative stress may potentially be prevented or treated by these anti-oxidants. Storage and processing of berries does damage some nutrients but tends to improve the anti-oxidant capacity under certain conditions. The extent of the health benefits provided by berries is not fully understood and further study is required to determine their potential medicinal properties. ◗

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The Editor thanks **James Joseph**, PhD, Lead Scientist and Neuroscience Lab Chief, Jean Mayer–USDA Human Nutrition Research Center on Aging at Tufts University, Boston; and **N Tikky Wattanapenpaiboon**, PhD, Asia Pacific Health & Nutrition Centre, Monash Asia Institute, Monash University, for their kind assistance in the peer review of this article