

Polyphenols in Berries

Antioxidant powerhouse



Berries such as blueberries and cranberries have high concentrations of polyphenolic compounds, vitamins and minerals—phytochemicals thought to be the bioactive compounds associated with reduced risk of cardiovascular disease and cancer.¹ Many of these fruits have a long tradition in European and North American folk medicine.

Canada is the second largest producer of cranberries (*Vaccinium macrocarpon*) in the world², with production in British Columbia, Quebec, Nova Scotia, New Brunswick and Ontario.

Canada grows two different species of blueberries commercially — wild (low-bush) blueberries (i.e. *Vaccinium angustifolium*), which are less than 20 cm high and grow in cool climates in acidic soils, and cultivated (highbush) blueberries (*Vaccinium corymbosum*) which grow more than 2 metres high. Wild blueberries are grown in Quebec, Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland. Cultivated blueberries are grown in British Columbia.³

Berries contain a wide array of phytochemicals⁴—polyphenols, stilbenes, tocopherols, carotenes and others. Of these, the polyphenols, and particularly the anthocyanins (a flavonoid), contribute substantially to their antioxidant capacity. Anthocyanins are what give the intense colour to many fruits and vegetables such as blueberries, cranberries, purple potatoes and red cabbage.



Health Benefits

Polyphenolic antioxidants are considered premier disease fighters that protect the body against free radicals or unstable molecules that cause cell damage leading to chronic and degenerative diseases.⁵ Most dark coloured fruits have a high antioxidative capacity.^{6,7}

Cranberries have been used widely for several decades for the prevention and treatment of urinary tract infections.⁸ They contain proanthocyanidins (or condensed tannins) which prevent the adhesion of bacteria to cell walls^{9,10}, potentially reducing risk of bacterial infections.¹¹ This is the proposed mechanism for the positive association between cranberries and urinary tract health¹², its ability to inhibit stomach ulcers caused by *Helicobacter pylori*^{13,14} and its protective effect against gum disease and dental caries.^{15,16}



Canadian researchers have shown a blueberry-rich diet may improve stroke outcomes in rats¹⁷ and that blueberry and cranberry proanthocyanidins may assist in controlling tumor formation in some cancers.^{18,19} A recent study showed wild blueberry polyphenolic compounds were active against all stages of cancer: initiation, promotion and proliferation.^{20,21} Cranberry meal extract may also

be a novel anticancer agent.⁵ The health potential of berry processing waste products is also under investigation.

Cranberries and blueberries may also impact cardiovascular health by enhancing removal of cholesterol from blood and inhibiting oxidation of low-density lipoproteins²²⁻²⁵. Recently attention has focused on anti-inflammatory properties of flavonoid polyphenolics and their positive contribution to overall health.²⁶

Dark-coloured berries may enhance memory, protect hearts and reduce risk of cancer.

Berries and their isolated active compounds have been shown to exhibit potentially beneficial effects in diabetes²⁷, memory enhancement²⁸, neurodegenerative diseases of aging²⁹, radiation protection³⁰, and as an anti-influenza agent.¹⁶

A new addition to Canada's production is the Saskatoon berry (*Amelanchier alnifolia*), a deep blue-purple tree berry. Primarily grown on the Canadian prairies, fresh, frozen and processed products are sold throughout Canada and the United States. Canada achieved market access for Canadian exports of Saskatoon berries throughout the European Union in 2004. Research on antioxidative capacity show this berry has potential health benefits similar to blueberries and cranberries.^{31,32}

Canadian Suppliers



- **Atoka Cranberries**
Manseau, QC | www.atoka.qc.ca
- **British Columbia Blueberry Council**
Abbotsford, BC | www.bcblueberry.com
- **British Columbia Cranberry Growers Association**
Abbotsford, BC | www.bccranberrygrowers.com
- **Fruit d'Or, Inc**
Notre-Dame de Lourdes, QC | www.fruit-dor.ca
- **Fruit Growers Association of Alberta**
www.albertafruit.com/farms
- **Johnson's Cranberry Marsh**
Bala, ON | www.cranberry.ca
- **Prairie Berries**
Keeler, SK | www.prairieberries.com
- **Riverbend Plantation**
Saskatoon, SK | www.saskatoonberry.com
- **Vaccinium Technologies**
Fredericton, NB | www.bioatlantech.nb.ca/business_vaccinium.html
- **Wild Blueberry Association of North America (WBANA)**
www.wildblueberries.com

Canadian Research Expertise

Agriculture and Agri-Food Canada Food Research and Development Centre

St. Hyacinthe, QC

- Improving process to dry cranberries and blueberries (**M. Marcotte**)

Atlantic Food and Horticulture Research Centre (AFHRC)

Kentville, NS

- Developing technology to improve sustainable production and quality of wild blueberries (**K. MacKenzie**)
- Studying blueberry chemistry, human health bioactives of fruit polyphenolics, polyphenolic separation, health-related bioassays, animal and human studies (**W. Kalt**)

Pacific Agri-Food Research Centre

Summerland-Agassiz, BC

- Discover, extract, concentrate/isolate, and characterize flavonoids from selected fruits, vegetables and grains; determine antioxidant and anti-inflammatory activities of flavonoid-rich extracts and/or purified/concentrated compounds and metabolites; and develop and commercialize, with industry partners, products rich in flavonoids (**G. Mazza**)
- Behavioural ecology, pheromone communication and integrated pest management of blueberry and cranberry pests (**S. Fitzpatrick**)

University of Prince Edward Island Atlantic Canada Network on Bioactive Compounds

Charlottetown, PE

Pursuing commercial applications for products recovered from wild blueberries and wild rosehips

- Purification and analysis of blueberry bioactive fractions (**W. Kalt**)
- Demonstration of health-promoting activity of specific blueberry fractions (**M. Sweeney-Nixon, K. Gottschall-Pass, S. MacKinnon**)
- Effect of blueberry bioactives on gene expression (**C. Nelson**)

University of British Columbia

Vancouver, BC

- Characterizing mechanisms of antioxidant and prooxidant activity for many naturally occurring animal and plant constituents (**D. Kitts**)

Université Laval Institute of Functional Foods and Nutraceuticals (INAF)

Quebec, QC

- Studying the effect of natural antioxidants (from small fruits) and oxidative stress on the central nervous system and neurodegenerative diseases like Alzheimer's, and Parkinson's (**C. Ramassamy**)
- Effect of dietary antioxidant supplementation (i.e. cranberries) on cardiovascular disease indicators (**C. Couillard**)
- Antioxidant capacity of cranberries (**J. Makhlof**)



University of Manitoba

Winnipeg, MB

- Antioxidants in foods and human health; plant polyphenols (**T. Beta**)

University of Moncton

Functional Foods Laboratory

Moncton, NB

- Optimizing extraction of flavonoids from small fruits, such as blueberries and cranberries (**C. Matar**)

University of Western Ontario

London, ON

- Investigating new products (i.e. cranberry flavonoid extracts) for their potential use as anticancer agents (**P.J. Ferguson**)

Applications

Times have changed when it comes to berries and their use. Traditionally, blueberries and cranberries were only processed into jams, jellies, drinks, juices, concentrates, purees, syrups, pie fillings and sauces, as well as being canned and frozen.

Now, innovative ingredients include powders for dry-mix beverages, nutrition supplements and confectionary products. Blueberries and cranberries infused with real fruit flavours and sweetened dried cranberries are used in bakery products, nutrition bars, trail and snack mixes, cereals and muesli. Berry extracts are used as colouring and flavouring agents. Concentrated standardized extracts, designed to deliver specific concentrations of active proanthocyanidins, are included as ingredients in new product formulations.



The Canadian Advantage in the Global Marketplace

Quality
is in our **nature**

Natural Resources • Canada's abundant natural resources are proven building blocks for a high tech industry that produces an array of high quality agri-food products.

World-Class Standards • Canada's regulatory and food inspection systems are internationally recognized, resulting in world-class standards and products that are safe, nutritious and high quality.

Innovative Research • Canada has developed a strong network of research facilities across the country where scientific innovators are focused on developing leading-edge products and new technologies.

Collaborative Teamwork • Collaboration among governments, health institutions, universities and industry has helped this vibrant sector prosper by encouraging innovation and manufacturing of diverse agri-food products with proven health benefits.

To learn more about Canada's functional food and natural health products industry, visit: www.agr.gc.ca

Agriculture and Agri-Food Canada
1341 Baseline Rd., Tower 5, 2nd Floor
Ottawa, Ontario K1A 0C5
E-mail: ffn-afn@agr.gc.ca

References

1. Seeram, N.P. 2008. *J. Agric. Food Chem.* 56:627-629.
2. Foreign Agricultural Service, USDA GAIN Report #CA1144. 2001. Canadian Cranberries.
3. Agriculture and Agri-Food Canada. 2004. http://www.agr.gc.ca/misb/hort/sit/pdf/fru_02_03_e.pdf
4. Prior, L. *et al.*, 1998. *J. Agric. Food Chem.* 46:2686-2993.
5. Hoelzl, C. *et al.*, 2005. *J. Physiol. Pharmacol.* 52, Supp.2:49-64.
6. Kalt, W. *et al.*, 1999. *J. Food Sci.* 65:390-393.
7. Kalt, W. *et al.*, 2001. *J. Agric. Food Chem.* 49:4761-4767.
8. Jepson, R. and J. Craig. 2008. *Cochrane Database Syst. Rev.* Jan. 23(1): DC001321.
9. Liu, R.H. *et al.* 2006. *Biotechnol. Bioeng.* 93:297-305.
10. Howell, A.B. *et al.*, 2005. *Phytochemistry* 66:2281-2291.
11. Sharon, N and I. Ofek. 2002. *Crit. Rev. Food Sci. Nutr.* 42:291-299.
12. Foo, L.Y. *et al.*, 2000. *Phytochemistry* 54:173-181.
13. Burger, O. *et al.*, 2002. *Crit. Rev. Food Sci. Nutr.* 42:279-284.
14. Chatterjee, A. *et al.*, 2004. *Mol. Cell Biochem.* 265:19-26.
15. Weis, E.I. *et al.*, 2004. *Crit. Rev. Food Sci. Nutr.* 42:285-292.
16. Weis, E.I. *et al.*, 2005. *Antiviral Res.* 66:9-12.
17. Sweeney, M. *et al.*, 2002. *Nutr. Neurosci.* 5:427-431.
18. Matchett, M.D. *et al.*, 2005. *Biochem. Cell Biol.* 83:637-643.
19. Murphy, B.T. *et al.*, 2003. *J. Agric. Food Chem.* 51:3541-3545.
20. Hou, D.X. 2003. *Curr. Mol. Med.* 3:149-159.
21. Kraft, T.F.B. *et al.*, 2005. *J. Food Sci.* 70:S159-166.
22. Chu, Y.F. and R.H. Liu. 2005. *Life Sci.* 77:1892-1901.
23. Reed, J. 2002. *Crit. Rev. Food Sci. Nutr.* 42 (supp): 301-316.
24. Rimando, A.M. *et al.*, 2004. *R J. Agric. Food Chem.* 52:4713-4719.
25. McKay, D.L. and J.B. Blumberg. 2007. *Nutr. Rev.* 65:490-502.
26. Manthey, J.A. 2000. *Microcirculation.* 7:S29-34.
27. Chambers, B.K. and M.E. Camire. 2003. *Diabetes Care.* 26:2695-2696.
28. Andres-Lacueva, C. *et al.*, 2005. *Nutr. Neurosci.* 8:111-120.
29. Neto, C.C. 2007. *Mol. Nutr. Food Res.* 51:652-664.
30. Rabin, B.M. *et al.*, 2005. *Gravit. Space Biol. Bull.* 18:71-77.
31. Wang, J. and G. Mazza. 2002. *J. Agric. Food Chem.* 50:4183-4189.
32. Hosseinian F.S. and T. Beta. 2007. *J. Agric. Food Chem.* 55:10832-10838.

Author: C.A. Patterson, PhD, PAg
The Pathfinders Research & Management Ltd.

Reference in this fact sheet to companies or products, or the inclusion of images containing products and product names is not to be considered an endorsement by Agriculture and Agri-Food Canada.

© Her Majesty the Queen in Right of Canada, 2008

AAFC NO. 10078E