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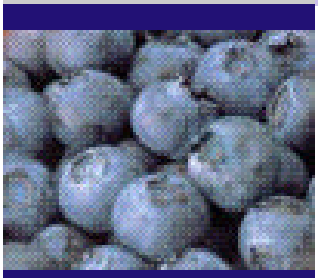
Highbush Blueberry Benefits
Some Recent Research Excerpts



US HIGHBUSH BLUEBERRY COUNCIL

HIGHBUSH BLUEBERRIES

Blueberries and Antioxidant Activity

Antioxidants help to neutralize free radicals, which are unstable molecules that are linked to the development of a number of degenerative diseases and conditions including cancer, cardiovascular disease, cognitive impairment, immune dysfunction, cataracts and macular degeneration. Fruits and vegetables are sources of natural antioxidants and among them blueberries have one of the highest levels of antioxidant activity.

Zheng W, Wang SY. "Oxygen radical absorbing capacity of phenolics in blueberries, cranberries, chokeberries, and lingonberries," Journal of Agricultural and Food Chemistry, 2003, 51:502-509.

Antioxidant activity of phenolic compounds in blueberries and other berries and the activity-structure relationships of flavonoids and phenolic acids using the oxygen radical absorbance capacity assay (ORAC) were investigated. ORAC, anthocyanin and total phenolic content of blueberries (cv. Serra) was 28.9 umol of TE/g, 1.20 mg cyanidin 3-glucoside equivalents/g and 4.12 mg gallic acid equivalents/g respectively. Blueberries contained the phenolic compounds chlorogenic acid, myricetin, quercetin and kaempferol. Chlorogenic acid (20.9% of the ORAC value) was a major contributor to antioxidant activity due to its high concentration in blueberries. The combination of the 11 anthocyanins found in blueberries accounted for 56.3% of the total ORAC value.

Sellappan S, Akoh CC, Krewer G. "Phenolic compounds and antioxidant capacity of Georgia-grown blueberries and blackberries," Journal of Agricultural and Food Chemistry. 2002, 50:2432-2438.

A variety of Rabbiteye blueberry (*Vaccinium ashei)* cultivars and Southern highbush blueberry (*Vaccinium corymbosum)* cultivars were collected and analyzed for flavonoids, phenolic acids, total anthocyanins, total polyphenols, and Trolox-equivalent antioxidant capacity (TEAC). Phenolic acids measured were gallic acid, p-hydroxybenzoic acid, caffeic acid, p-coumaric acid, ferulic acid and ellagic acid. Flavonoids measured were catechin, epicatechin, myricetin, quercetin and kaempferol. Rabbiteye blueberry, Tifblue, had the highest concentration of gallic acid (258.90 mg/100g) and ferulic acid (16.97 mg/100 g). Some cultivars contained ellagic acid, which ranged from 0.75-6.65 mg/100 g FW in the southern highbush and from 0.19-6.02 mg/100 g in the rabbiteye blueberries.

Moyer RA, Hummer KE, Finn CE, Frei B, Wrolstad RE. "Anthocyanins, phenolics, and antioxidant capacity in diverse small fruits: Vaccinium, Rubus, and Ribes," Journal of Agricultural and Food Chemistry, 2002, 50:519-525.

Anthocyanin, phenolic and antioxidant capacity content of nine *Vaccinium*, seven *Rubus* and five *Ribes* species was measured. Within *Vaccinium corymbosum* L., the mean anthocyanin and phenolic content was 208 mg/100 g and 444 mg/100 g, respectively. Fruit size was highly correlated with anthocyanin content. Mean antioxidant activity was 52.3 umol TE/g based on the ORAC assay and 58.6 umol/g based on the FRAP assay. (Continued on back page)

Blueberry Classification

All blueberries belong to the genus *Vaccinium*. The family includes the Highbush (*V. corymbosum* and *V. ashei*) and the Native American "wild" low bush (*V. augustifolium*). All blueberries originated from the wilds. Highbush blueberries represent 57% of total North American blueberry production.

Blueberries and Aging

Studies of older laboratory animals consuming blueberry supplemented diets have shown measurable improvements in memory, coordination and balance. Research at the USDA Human Nutrition Research Center has also shown neuron regeneration in older animals.

Youdim KA, Shukitt-Hale B, Martin A, Wang H, Denisova N, Bickford PC, Joseph JA. "Short-tem dietary supplementation of blueberry polyphenolics: Beneficial effects on aging brain performance and peripheral tissue function," Nutritional Neuroscience 2000, 3:383-397.

This study examined if blueberry extracts were able to ameliorate age-related declines in neuronal and cognitive function in laboratory animals fed a well balanced diet. After consuming diets supplemented with blueberry extract for eight weeks the subjects showed improvement in normal age-related declines in behavioral parameters such as balance, coordination, working memory and reference memory

Joseph JA, Shukitt-Hale B, Denisova NA, Bielinski D, Martin A, McEwen JJ, Bickford PC. "Reversals of age-related declines in neuronal signal transduction, cognitive, and motor behavioral deficits with blueberry, spinach, or strawberry dietary supplementation," Journal of Neuroscience, 1999, 19:8114-8121.

When 19 month old rats were fed 18.6 grams of dried blueberry extract per kilogram of diet for eight weeks, the diet was effective in reversing age-related deficits in several neuronal and behavioral parameters.

Blueberries and Phytoestrogens

Diet studies of populations that consume a high fiber, low fat diet that includes a high intake of phytoestrogens have shown a lower incidence of mortality risk from breast, prostate, and endometrial cancers.

Mazur WM, Uehara M, Wahala K, Adlercreutz H. "Phyto-estrogen content of berries, and plasma concentrations and urinary excretion of enterolactone after a single strawberry-meal in human subjects," British Journal of Nutrition, 2000,83:381-387.

Phytoestrogens, isoflavonoids and lignans, were measured in nine berries including blueberries. No isoflavonoids were found, however, relatively high levels of the lignan secoisolariciresinol (SECO) were found. Blueberries contained 8.35 mg SECO /kg dry weight.

Antioxidant Fruit Power!

The USDA Human Nutrition Research Center on Aging in Boston has developed an assay, called ORAC (oxygen radical absorbance capacity), which quantifies the antioxidant capacity of foods. Fresh blueberries have a high level of ORAC, 2400 per 100 grams. Five servings of some fruits and vegetables in a typical American diet have an ORAC score of 1600. From an antioxidant capacity standpoint, 100 grams (3.5 oz.) of fresh blueberries could deliver the equivalent antioxidant capacity of five servings of some fruits and vegetables — a good reason to include blueberries as part of a varied diet.

Cao G, Booth SL, Sadowski JA, Prior RL. Increases in human plasma antioxidant capacity after consumption of controlled diets high in fruit and vegetables. Am J Clin Nutr. 1998;68:1081-1087.

Prior RL, Cao G, Martin A, Sofic E, McEwen, J, O'Brien C Lischner N, Ehlenfeldt M, Kalt W, Krewer G, Mainland CM. "Antioxidant capacity as influenced by total phenolic and anthocyanin content, maturity, and variety of Vaccinium species," Journal of Agricultural and Food Chemistry, 1998, 46:2686-2693.

Blueberries and Storage

Two studies on the effect of storage on blueberries show positive relationships for antioxidant activity and anthocyanin content..

Connor AM, Luby JJ, Hancock JF, Berkheimer S, Hanson EJ. "Changes in fruit antioxidant activity among blueberry cultivars during cold-temperature storage," Journal of Agricultural and Food Chemistry, 2002,50:893-898.

Antioxidant activity, total phenolic content, anthocyanin content, titratable acid concentration, soluble solids, firmness and percentage of bruised berries were determined for nine blueberry cultivars at harvest and at various postharvest intervals after storage at 5°C. None of the cultivars demonstrated a decrease from its antioxidant activity value at harvest during storage. Antioxidant activity correlated strongly with total phenolics and anthocyanin content which were also stable during cold storage. One cultivar (Elliott) that was harvested immature, demonstrated an increase in antioxidant activity, total phenolic and anthocyanin content in the first three weeks of storage.

Kalt W, Forney CF, Martin A, Prior RL. "Antioxidant capacity, vitamin C, phenolics, and anthocyanins after fresh storage of small fruits," Journal of Agricultural and Food Chemistry, 1999, 47:4638-4644.

Highbush blueberries and other berries were stored at 0, 10, 20, and 30°C for up to eight days to determine the effects of storage temperature on whole fruit antioxidant capacity and total phenolic, anthocyanin, and ascorbate content. Only anthocyanins were significantly affected by storage time and temperature. There was a significant increase in anthocyanin content after eight days at 20°C.

Composition of Blueberries

This true-blue fruit contains health promoting phytochemicals. Blueberries are low in calories, virtually fat-free and are a good source of fiber along with vitamins and minerals.

Prior RL, Lazarus SA, Cao G, Muccitelli H, Hammerstone JF. "Identification of procyanidins and anthocyanins in blueberries and cranberries (*Vaccinium Spp.*) using high-performance liquid chromatography/mass spectrometry, " Journal of Agricultural and Food Chemistry, 2001, 49:1270-1276.

Blueberries were analyzed for procyanidins. Monomers, identified as (+)-catechin and (-)-epicatechin and a series of oligomers were detected. The oligomers consisted of epicatechin units singly-linked (B-type). The procyanidin fraction accounts for up to 32% of the total ORAC measured in blueberries.

Skrede G, Wrolstad RE, Durst RW. "Changes in anthocyanins and polyphenolics during juice processing of highbush blueberries (*Vaccinium corymbosum* L.)," Journal of Food Science, 2000, 65:357-364.

Investigated changes in blueberry anthocyanins and polyphenolics during processing into juice and concentrate. 32% of the anthocyanins were recovered in single-strength juice while flavonol, procyanidin and chlorogenic acid recoveries in juice were 35%, 43% and 53%, respectively. The proportion of polyphenolics remaining in the press-cake residue ranged from 1% to 18%. Anthocyanin profile changed with processing because of varying stability of individual pigments with malvidin glycosides being most stable and delphinidin glycosides the least.

Hakkinen SH, Karenlampi SO, Heinonen IM, Mykkanen HM, Torronen AR. "Content of the flavanols quercetin, myricetin, and kaempferol in 25 edible berries," Journal of Agricultural and Food Chemistry, 1999, 47:2274-2279.

The amounts of quercetin, myricetin, and kaempferol aglycons in 25 edible berries including cultivated blueberries collected in Finland in 1997 were analyzed. One kilogram of fresh blueberries contained 40-50 mg total flavonols, 17-24 mg quercetin, 23-26 mg myricetin, and no detectable kaempferol.

USDA National Nutrient Database for Standard Reference (blueberries, raw). Release 15 (August 2002).

	Nutrients	1/4 cup 36 g (1.25 oz.).	100 g. (3.5 oz.)	
	Food energy	20.00	56.00	kcal
Proximate	Protein	0.24	0.67	g
	Total lipid (fat)	0.14	0.38	g
	Carbohydrate, by difference	5.12	14.13	g
	Dietary fiber	0.98	2.70	g
	Ash	0.08	0.21	g
	Water	30.67	84.61	mg
Minerals	Calcium	2.17	6.00	mg
	Copper	0.02	0.06	mg
	Iron	0.06	0.17	mg
	Magnesium	1.81	5.00	mg
	Manganese	0.10	0.28	mg
	Phosphorus	3.62	10.00	mg
	Potassium	32.25	89.00	mg
	Selenium	0.22	0.60	µg
	Sodium	2.17	6.00	mg
	Zinc	0.04	0.11	mg
Vitamins	Vitamin C	4.71	13.0	mg
	Thiamin	0.02	0.05	mg
	Riboflavin	0.02	0.05	mg
	Niacin	0.13	0.36	mg
	Pantothenic acid	0.03	0.09	mg
	Vitamin B-6	0.01	0.04	mg
	Folate	2.18	6.00	µg
	Vitamin A, IU	36.25	100.00	IU
	Vitamin E	0.36	1.00	mg ATE

g=grams mg=milligrams kcal=kilocalories IU=International Units µg=micrograms ATE=alpha tocopherol equivalent

Five A Day the Blueberry Way!

Selected by Five A Day the Color Way program as part of their plan for healthier living for everyone from children to seniors, blueberries are real fruit, low in calories, virtually fat-free, and are available in many formats to meet manufacturer needs. Choose blueberries, a healthy option in snacks, cereals and a bounty of other food products.. Blueberries add color, natural sweetness, nutrition, and fun to meals and on-the-go snacks.

?? ***A one cup serving of blueberries contains 16% DV of fiber.***

?? ***Blueberries are a source of Vitamins A and C, potassium and folate.***

?? ***Blueberries are very low in fat and sodium. Blueberries contain only 0.38 grams of fat and 6 mg of sodium per 100 gram serving.***

Blueberries and the Urinary Tract

Ofek I, Goldhar J, Sharon N. "Anti-escherichia coli adhesin activity of cranberry and blueberry juices," Advances in Experimental and Medical Biology 1996;408:179-183.

Studies showed that both cranberry and blueberry juice contain a high molecular weight constituent which selectively inhibits mannose resistant adhesins produced by urinary isolates of E. coli by binding to the bacterial surface.

US HIGHBUSH BLUEBERRY COUNCIL

c/o Thomas J. Payne Market Development
865 Woodside Way
San Mateo, CA 94401-1611
Phone: 800-824-6395
Fax: 650-340-8568
Email: info@ushbc.org

We're on the web at:
www.ushbc.org

July is National Blueberry Month

US Secretary of Agriculture, Ann M. Veneman, recently signed a proclamation announcing July 2003 as National Blueberry Month The Proclamation recognizes the pioneering work of New Jersey blueberry farmer, Elizabeth White, and USDA researcher, Dr. Frederick Coville, in the early 1900s. In the last two decades Highbush blueberry production has increased by 65%. Harvested from mid-April through early October, more than 55% of the crop is packaged fresh to meet consumer demand.

US Highbush Blueberry Council

The US Highbush Blueberry Council (USHBC) actively promotes the consumption of cultivated blueberries in the United States and abroad. The Council represents Highbush blueberry producers, handlers and exporters of Highbush blueberries. Activities are funded by an assessment from blueberries grown in the USA and those imported into the USA.

Reference Notes

Only excerpts related to highbush blueberries (*Vaccinium ashei* and *Vaccinium corymbosum* cultivars) are described here. While some components of blueberries, such as anthocyanins, have been more extensively studied, only research using blueberries were selected.

Blueberries and Cancer Inhibition

The National Cancer Institute recommends eating at least five servings of fruits and vegetables a day to help reduce the risk of cancer. Research has shown that several phytochemicals present in blueberries and other fruits and vegetables may help protect against cancer.

Wedge DE, Meepagala KM, Magee JB, Smith SH, Huang G, Larcom LL. "Anticarcinogenic activity of strawberry, blueberry, and raspberry extracts to breast and cervical cancer cells," Journal of Medicinal Food, 2001;4:49-51.

In vitro studies showed that blueberry extracts inhibited cervical cancer cells and breast cancer cells. Blueberry extracts also suppressed mutagenesis by the direct-acting carcinogen methyl methanesulfonate and the metabolically activated carcinogen benzo(a) pyrene.

Blueberries and Antioxidant Activity (continued)

Ehlenfeldt MK, Prior RL. "Oxygen radical absorbance capacity (ORAC) and phenolic and anthocyanin concentrations in fruit and leaf tissues of highbush blueberry," Journal of Agricultural and Food Chemistry, 2001, 49:2222-2227.

The study compared total phenolics and anthocyanins concentrations and antioxidant capacity (ORAC) in 87 highbush blueberry cultivars. Average values for ORAC, phenolics and anthocyanins in fruit were 15.9 ORAC units/g, 0.95 mg gallic acid equivalents/g, and 1.79 mg cyanidin-3-glucoside equivalents/g, respectively.

Wang SY, Jiao H. "Scavenging capacity of berry crops on superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen," Journal of Agricultural and Food Chemistry, 2000, 48:5677-5684.

The fruit juice from the Bluecrop and Elliot cultivars of blueberries and other berries, was evaluated for antioxidant activity against superoxide radicals, hydrogen peroxide, hydroxyl radicals and singlet oxygen. Juice from Elliot blueberries was among the juices with the highest antioxidant capacity against superoxide radicals, hydrogen peroxide, hydroxyl radicals and singlet oxygen.

Cao G, Shukitt-Hale B, Bickford PC, Joseph JA, McEwen J, Prior RL. "Hyperoxia-induced changes in antioxidant capacity and the effect of dietary antioxidants," Journal of Applied Physiology, 1999, 86:1817-1822.

A hyperoxia-induced redistribution of proteins and antioxidants between blood stream, lung, and pleural effusion was partially blocked in lab animals fed a diet supplemented with blueberry extract for eight weeks.

Prior RL, Cao G, Martin A, Sofic E, McEwen, J, O'Brien C Lischner N, Ehlenfeldt M, Kalt W, Krewer G, Mainland CM. "Antioxidant capacity as influenced by total phenolic and anthocyanin content, maturity, and variety of *Vaccinium* species," Journal of Agricultural and Food Chemistry, 1998, 46:2686-2693.

Different cultivars of four *Vaccinium* species were analyzed for total phenolics, total anthocyanins, and antioxidant capacity. Oxygen radical absorbance capacity (ORAC) ranged from 13.9 to 42.3 umol/g in *Vaccinium corymbosum* and *Vaccinium ashei* which was higher than levels found in other fruits and vegetables previously tested.