

The Longwood Herbal Task Force
(<http://www.mcp.edu/herbal/default.htm>) and
The Center for Holistic Pediatric Education and Research
(<http://www.childrenshospital.org/holistic/>)

Bilberry (*Vaccinium myrtillus*)

Kathi J. Kemper, MD, MPH

Principal Proposed Uses: Ocular disorders; mild, non-specific diarrhea

Other Proposed Uses: Oral irritations, vascular disorders

Overview

The major American use for bilberry fruit is to treat ocular disorders; it is used to aid night vision, prevent the development and progression of cataracts, treat diabetic retinopathy and macular degeneration, and prevent glaucoma. European herbalists also rely on bilberry to treat mild diarrhea and mild oral irritation. Its constituents include tannins, anthocyanosides and flavonoids. There are actually very few scientific studies evaluating bilberry's physiologic effects in humans; most of these are case series and few are published in English. Bilberries are eaten as food and are presumed to be safe for use with other medications and during pregnancy, lactation and childhood. However, the results of some animal studies suggest that patients with diabetes and those taking anticoagulants should be closely monitored if they begin consuming large quantities of bilberry extract.

Historical and Popular Uses

Bilberry is often referred to as the European blueberry and has long been eaten in jams, pies, cobblers and cakes. It also enjoys a long medical history. Hildegard of Bingen, the famous Fifteenth Century nun, musician and herbalist, recommended bilberry to induce menses. It has been used historically as a treatment for fevers, coughs, renal stones and urinary tract infections, intestinal and liver disorders, hemorrhoids, and infections of the skin and mucus membranes. It was also used to treat a variety of eye disorders including myopia, eyestrain, impaired night vision and cataracts.

During World War II, bilberry became popular among the pilots of Britain's Royal Air Force (RAF); they claimed that eating bilberry jam prior to nighttime bombing raids improved their vision¹. Nowadays, bilberry is widely used in Europe for the prophylaxis and treatment of a variety of ocular disorders including cataracts, diabetic retinopathy, glaucoma, macular degeneration, and impaired night vision. Some European surgeons recommend it prophylactically to enhance the healing of surgical wounds. Herbalists recommend it as a vulnerary to prevent and treat bruising, hemorrhoids, varicose veins and a variety of vascular disorders. A decoction of the berries has traditionally been used for diarrhea, and an infusion from the leaves has been used for urinary tract infections²⁻⁴. In 1997, bilberry products were among the top 20 for herb sales in the US⁵.

Botany

Medicinal species: Vaccinium myrtillus. There are over 400 other *Vaccinium* species including blueberry (*V. angustifolium*) and cranberry (*V. macrocarpus*).

Common names: Bilberry, blaeberry, heidelberry, huckleberry, hurtleberry, whortleberry

Botanical family: Ericaceae

Plant description: Bilberry is a one-foot tall, thickly branched, deciduous perennial shrub, closely related to the blueberry. The plant flowers in late spring; the fruit is ripe between July and September. The berries are black, juicy and coarsely wrinkled, with purple flesh and brownish-red seeds. Both the berries and leaves are used medicinally; the leaves are used like uva ursi to prevent and treat urinary tract infections⁶.

Where it's grown: Bilberry is native to northern and central Europe and northern North America. It is now grown in eastern Europe, the former USSR, Poland and Albania. It grows well in woods and moist meadows.

Biochemistry

Bilberry: Potentially Active Chemical Constituents

- Flavonoids: hyperoside, isoquercitrin, quercitrin, astragaline⁷
- Anthocyanosides (myrtillin, malvidin, cyanidin, delphinidin and others)⁸
- Catechin tannins (2-10%)^{3, 9}
- Others: carbohydrates including invertose, organic acids, pectins, alkaloids

Bilberry's bioflavonoids are potent antioxidants, scavenging free radicals and reducing inflammation¹⁰⁻¹². Bilberry is similar in its antioxidant effects to green tea, grape seed extract, pine bark extract and ginkgo¹³. Bilberry's flavonoids appear to reduce capillary permeability and fragility, possibly by supporting the surrounding connective tissue and endothelium^{6, 14}. At high doses, flavonoids can impair platelet aggregation and affect clotting times^{6, 15}.

Bilberry contains at least 15 different anthocyanosides which are flavonoid derivatives of anthocyanins, the blue and red pigments found in many leaves and fruits including cranberries, huckleberries, strawberries, blueberries, black cherries, red grapes, raspberries, and red cabbage^{11, 16, 17}. These compounds are also antioxidants that appear to enhance collagen cross-linkages, promote collagen synthesis, and inhibit collagen degradation, thereby stabilizing connective tissue¹⁸. They are stable in boiling water and in dry heat for many days^{19, 20}. Bilberry's combination of antioxidant and collagen stabilizing effects would suggest that it might be a helpful vulnerary (wound healing agent) and has led to its use in treating microvascular disorders in which inflammation and collagen degradation play a role.

Tannins are used medicinally as astringents and to treat diarrhea⁴. When tannin concentrations exceed 10%, they may cause significant gastrointestinal distress; amounts in bilberry are typically less than 10%^{3, 21}. Bilberry's tannin content probably accounts for its historical use in treating diarrhea, oral ulcers and sore throats⁹.

Experimental Studies

Bilberry: Potential Clinical Benefits

1. Cardiovascular: Vasoprotective
2. Pulmonary: none
3. Renal and electrolyte balance: none
4. Gastrointestinal/hepatic: Antidiarrheal, antiulcer
5. Neuropsychiatric: Cataracts, diabetic retinopathy and macular degeneration, impaired night vision
6. Endocrine: Diabetes
7. Hematologic: Inhibition of platelet aggregation (See Cardiovascular)
8. Rheumatologic: none
9. Reproductive: none
10. Immune modulation: Anti-inflammatory
11. Antimicrobial: Urinary tract infection (see Cranberry), antiviral
12. Antineoplastic: Antineoplastic (experimental use)
13. Antioxidant: Antioxidant
14. Skin and mucus membranes: Vulnerable
15. Other/Miscellaneous: none

NOTE: Most of the research on bilberry is not available in English. Most studies are cited here based on English translations of the abstracts only.

1. **Cardiovascular:** Vasoprotective

- i. *In vitro data:* Bilberry's anthocyanosides (also called *Vaccinium myrtillus* anthocyanosides, or VMAs) induced relaxation and dilation of coronary and systemic arteries in one Italian study²²; anthocyanosides counteracted the contractile responses to acetylcholine in another study²³. High doses of anthocyanosides also inhibited platelet aggregation *in vitro*^{15, 24-26}.
- ii. *Animal data:* Anthocyanosides decreased vascular permeability in rabbits with cholesterol-induced atheromas by enhancing collagen cross-linking²⁷. Pretreatment with anthocyanosides preserved the blood-brain barrier in rats with induced hypertension,

limiting the typical vascular permeability normally caused by hypertension¹⁴. In the animal model of ischemia/reperfusion injury, pretreatment with bilberry extracts significantly decreased microvascular impairment²⁸.

In rat studies, bilberry's anthocyanosides promoted increased rhythmic contraction of arterioles, enhancing microvascular blood flow in striated muscles²⁹.

iii. *Human data*: In a case series of 47 adults with a variety of circulatory problems (atherosclerosis, a tendency to bruise easily, hemorrhoids and varicose veins), bilberry extracts reportedly improved circulation and reduced symptoms¹⁶. These studies have been interpreted by some herbalists to mean that bilberry is a useful treatment for circulatory problems and for dysmenorrhea.

2. **Pulmonary**: none

3. **Renal and electrolyte balance**: none

4. **Gastrointestinal/hepatic**: Antidiarrheal, antiulcer

a. Antidiarrheal: This traditional European remedy for both adult and pediatric diarrhea has not undergone scientific evaluation, but could be rationalized based on the modest tannin content of the berries^{3, 5, 30-32}.

b. Antiulcer

i. *In vitro data*: none

ii. *Animal data*: When lab animals were given large doses of one of bilberry's anthocyanosides (600 mg BID of IdB 1027 [cyanidin chloride] for ten days), there was a significant increase in gastric mucosal release of the anti-inflammatory prostaglandin E₂³³. In animals with experimental models of acute and chronic ulcers that were treated with the same compound, antiulcer activity was observed^{34, 35}.

iii. *Human data*: There are no controlled trials evaluating the effects of bilberry in treating gastric or duodenal ulcers in adults or children.

5. **Neuropsychiatric**: Cataracts, diabetic retinopathy and macular degeneration, impaired night vision. Bilberry is used for multiple ocular disorders; in Italy, bilberry's anthocyanosides have even been recommended as a treatment for myopia³⁶. Bilberry's benefits have been attributed to its effects on microvascular circulation, where it improves oxygen delivery and

works as an anti-inflammatory and antioxidant; the anthocyanosides also appear to assist in recovery of rhodopsin, a critical factor in night vision.

a. Cataracts: Because some cataracts have been attributed to damage by free radicals, there has been a great deal of interest in antioxidants, such as bioflavonoids, that protect against free radical damage to the lens.

i. *In vitro data*: none

ii. *Animal data*: none

iii. *Human data*: In a case series of 50 elderly Italian patients with early stage cataracts, taking a combination of bilberry extract and vitamin E was associated with cessation of the progression of disease in 97%³⁷. There are no controlled trials evaluating bilberry's effects in preventing or treating cataracts.

b. Diabetic retinopathy and macular degeneration: Based on bilberry's bioflavonoid content, some herbalists recommend it for patients with macular degeneration. Bilberry extracts are widely used in Europe to prevent and treat diabetic retinopathy³⁸.

i. *In vitro data*: none

ii. *Animal data*: none

iii. *Human data*: In an Italian study, 12 adult diabetics were treated with 600 milligrams of anthocyanosides daily for two months; before and after treatment, gingival samples were analyzed for connective tissue synthesis. Following treatment, there was a significant decrease in the biosynthesis of connective tissue. The authors interpreted these results to mean that anthocyanosides could protect diabetics from retinopathy³⁹. In an Italian study of 30 subjects (ten normal adults, ten diabetics without retinopathy and ten diabetics with retinopathy), treatment with bilberry extracts improved macular recovery time in the normal subjects and in the diabetics without retinopathy⁴⁰. In another case series of 31 patients suffering from various types of retinopathy, treatment with bilberry extract was associated with a reduced tendency toward retinal hemorrhage. One controlled trial reported positive results with bilberry treatment of diabetics with hypertensive retinopathy; these results were reported in abstract form in Italian⁴¹. There are no English language reports

evaluating the effectiveness of bilberry in treating diabetic retinopathy or macular degeneration.

c. Impaired night vision

i. *In vitro data*: none

ii. *Animal data*: In rabbits, anthocyanoside treatment sped the regeneration of rhodopsin in the retina and improved their ability to adapt to darkness¹.

iii. *Human data*: In World War II, pilots from Britain's Royal Air Force swore by the benefits of bilberry jam in improving their vision for night flights. In one study from the 1960's, patients given a combination of bilberry (400 mg/day) and beta-carotene (20 mg/day) had improved night vision and adaptation to changes in light intensity⁴². In case series of airline pilots, truck drivers and air traffic controllers, daily use of standardized bilberry extracts improved night vision, quickened adjustment to changes in light intensity, and sped restoration of visual acuity following exposure to glaring light^{16, 38, 43, 44}. However, there are no English language publications of controlled trials evaluating bilberry's benefits in improving night vision.

6. **Endocrine:** Diabetes. Bilberry fruit and leaves have been used in several folk remedies as a treatment for diabetes in adults.

i. *In vitro data*: none

ii. *Animal data*: Diabetic dogs and rats exhibited lower blood sugar levels when treated with bilberry leaves, even when given intravenous glucose concurrently³⁸.

iii. *Human data*: There are no controlled trials evaluating the effects of bilberry fruits or leaves on blood sugar levels or diabetic control in adults or children, nor any studies evaluating bilberry's potential interaction with standard diabetic medications.

7. **Hematologic:** Inhibition of platelet aggregation. See **Cardiovascular**.

8. **Rheumatologic:** none

9. **Reproductive:** none

10. **Immune modulation:** none

11. **Antimicrobial:** Many of the anthocyanosides found in bilberry are closely related to the proanthocyanidins thought to be responsible for cranberry's effects in impeding bacterial adhesion to bladder epithelium. Bilberry fruits and leaves have historically been used to treat a variety of infectious disorders.

- i. *In vitro data*: In cell cultures, bilberry extracts inactivated tick-borne encephalitis virus, but bilberry had no impact on infection rates *in vivo*^{45, 46}.
- ii. *Animal data*: none
- iii. *Human data*: There are no controlled trials specifically evaluating the antimicrobial effects of bilberry in adults or children.

12. Antineoplastic: Antineoplastic

- i. *In vitro data*: Bilberry, like cranberry, lingonberry and low bush blueberry, exhibited potential anticarcinogenic activity during *in vitro* screening tests⁴⁷.
- ii. *Animal data*: none
- iii. *Human data*: There are no controlled trials evaluating the antineoplastic effects of bilberry.

13. Antioxidant: Antioxidant

- i. *In vitro data*: Bilberry has similar antioxidant effects as green tea, pine bark extract, grape seed extract, blueberries and ginkgo^{13, 48}. The anthocyanoside fraction inhibited lipid peroxidation, scavenged superoxide anions, and removed hydroxyl radicals^{49, 50}.
- ii. *Animal data*: Like vitamin E, anthocyanins protected liver cells from oxidant damage induced by carbon tetrachloride in animal studies⁵¹.
- iii. *Human data*: There are no human trials evaluating bilberry's antioxidant effects.

14. Skin and mucus membranes: Vulnerary: Historically, bilberry has been recommended as a treatment for easy bruising, hemorrhoids, and skin lesions; however, these uses have not been evaluated in controlled trials.

- i. *In vitro data*: none
- ii. *Animal data*: none
- iii. *Human data*: In a case series of 47 adults with a variety of circulatory problems (atherosclerosis, a tendency to bruise easily, hemorrhoids and varicose veins), bilberry extracts reportedly improved circulation and reduced symptoms such as edema, feelings of heaviness and pain, and skin dystrophy^{16, 38}. There are no randomized, controlled trials evaluating bilberry's effects as a wound-healing agent.

15. Other/miscellaneous: none

Toxicity and Contraindications

All herbal products carry the potential for contamination with other herbal products, pesticides, herbicides, heavy metals, and pharmaceuticals. This is particularly concerning for imports from developing countries.

Furthermore, allergic reactions can occur to any natural product in sensitive persons.

Allergic reactions have not been reported.

Potentially toxic compounds in bilberry: None

Acute toxicity: Very rare. Consuming very large amounts may cause stomach upset and increase clotting times⁶.

Chronic toxicity: None reported

Limitations during other illnesses or in patients with specific organ dysfunction: None reported, but based on bilberry's effects on blood glucose and platelet adhesion in animals, caution should be used in patients with bleeding disorders, diabetes, or hypoglycemia.

Interactions with other herbs or pharmaceuticals: None reported, but based on bilberry's effects in animals, caution should be used by patients taking anticoagulant or antihyperglycemic medications or herbs.

Safety during pregnancy, lactation and/or childhood: Presumed safe based on food use

Typical Dosages

Provision of dosage information does NOT constitute a recommendation or endorsement, but rather indicates the range of doses commonly used in herbal practice.

Doses are given for single herb use and must be adjusted when using herbs in combinations.

Doses may also vary according to the type and severity of the condition treated and individual patient conditions.

Adult doses: There is disagreement on the optimal form and dose of bilberry. Reputable physicians and herbalists recommend a range of doses:

Standardized extract (25% anthocyanosides): 80-160 mg BID–TID^{1, 2, 6, 38}

Capsules: 1,000 mg BID⁴

Dried berries: 1–2 teaspoons, chewed twice daily⁴

Tea: 5-10 grams of crushed berries in 1 cup water, boiled for ten minutes and strained.

May be drunk as tea or applied topically up to six times daily.

NOTE: Dried bilberries contain a higher tannin content and lower sugar content than fresh berries and are the preferred form for treating diarrhea and oral irritations.

Pediatric dosages: Unknown

Availability of standardized preparations: Yes; extracts should be standardized to contain 25% anthocyanosides.

Dosages used in herbal combinations: Variable

Proprietary names: Alcodin, Angiorex, Antocin, Difrarel, Herbal Eye Care Formula, Largitor, Mitrilene Forte, Myrtaven, Myrticol, Retinol, Tegens

Multi-ingredient preparations containing bilberry: Alfa Mirtillo, Alvear Sport, Amersan, Antomiopic, Bebimix, Diacure, Difrarel, Herbal PMS formula, Mirtilene, Mirtilus, Prophthal, Ultravisin, Vitalmix

See Also:

Bilberry Clinician Information Summary: <http://www.mcp.edu/herbal/bilberry/bilberry.cis.pdf>

Bilberry Patient Fact Sheet: <http://www.mcp.edu/herbal/bilberry/bilberry.ph.pdf>

REFERENCES

1. Brown DJ. Herbal prescriptions for better health : your everyday guide to prevention, treatment, and care. Rocklin, CA: Prima Publishing, 1996.
2. Flynn R, Roest M. Your guide to standardized herbal products. Prescott, AZ: One World Press, 1995.
3. Weiss RF. Herbal medicine. Gothenburg, Sweden: AB Arcanum, 1988.
4. Peirce A. The American Pharmaceutical Association practical guide to natural medicines. New York: William Morrow and Company, Inc., 1999.
5. Blumenthal M. The complete German Commission E monographs : therapeutic guide to herbal medicines. Austin: American Botanical Council, 1998.
6. Ottariano SG. Medicinal herbal therapy : a pharmacist's view. Portsmouth, NH: Nicoln Fields Pub., 1999.
7. Fleming T. PDR for herbal medicines. Montvale, NJ: Medical Economics Company, Inc., 1998.
8. Schulz V, Hansel R, Tyler VE. Rational Phytotherapy: A Physicians' Guide to Herbal Medicine. Berlin: Springer, 1997:306.
9. Bissett NG. Herbal drugs and phytopharmaceuticals. Stuttgart: MedPharm CRC Press, 1994:566.
10. Anderson O. Anthocyanidins in fruits of *Vaccinium uliginosum* L (bog whortleberry). *J Food Sci* 1987; 52:665-60,680.
11. Baj A, Bombarelli E. Qualitative and quantitative evaluation of *Vaccinium myrtillus* anthocyanins by high-resolution gas chromatography and high performance liquid chromatography. *J Chromatography* 1983; 279:365-72.
12. Lietti A, Cristoni A, Picci M. Studies on *Vaccinium myrtillus* anthocyanosides. I. Vasoprotective and antiinflammatory activity. *Arzneimittelforschung* 1976; 26:829-32.
13. Pietta P, Simonetti P, Mauri P. Antioxidant activity of selected medicinal plants. *J Agricultural Food Chem* 1998; 46:4487-90.
14. Detre Z, Jellinek H, Miskulin M, Robert AM. Studies on vascular permeability in hypertension: action of anthocyanosides. *Clin Physiol Biochem* 1986; 4:143-9.
15. Zaragoza F, Iglesias I, Benedi J. Comparison of thrombocyte anti-aggregant effects of anthocyanosides with those of other agents. *Arch Pharmacol* 1985; 11:183-88.
16. Foster S. Bilberry: food and medicine. *The Herb Companion* 1997:68-69.
17. Goiffon J, Brun M, Bourrier M. High-performance liquid chromatography of red fruit anthocyanins. *J Chromatography* 1991; 537:101-22.
18. Jonadet M, Meunier MT, Bastide J, Bastide P. Anthocyanosides extracted from *Vitis vinifera*, *Vaccinium myrtillus* and *Pinus maritimus*. I. Elastase-inhibiting activities in vitro. II. Compared angioprotective activities in vivo. *J Pharm Belg* 1983; 38:41-6.
19. Martinelli E, Scilingo A, Pifferi G. Computer-aided evaluation of the relative stability of *Vaccinium myrtillus* anthocyanins. *Analytic Chimica Acta* 1992; 259:109-13.

20. Petri G, Krawczyk U, Kery A. Spectrophotometric and chromatographic investigation of bilberry anthocyanins for qualification purposes. *Acta Pharm Hung* 1994; 64:117-22.
21. Friedrich H, Schonert J. Tannin-producing substances in the leaves and fruits of the bilberry. *Arch Pharm (Weinheim)* 1973; 306:611-8.
22. Bettini V, Aragno R, Bettini M, Braggion G, calore L, Penada G. Anoxia and coronary vasodilation by *Vaccinium myrtillus* anthocyanosides. *Cuore* 1992; 9:343-53.
23. Bettini V, Aragno R, Bettini M, Braggion G, Calore L, Concolato M. Vasodilator and inhibitory effects of *Vaccinium myrtillus* anthocyanosides on the contractile responses of coronary artery segments to acetylcholine: Role of the prostacyclins and of the endothelium-derived relaxing factor. *Fitoterapia* 1991; 62:15-28.
24. Fdez M, Zaragoza F, Alvarez P. In vitro platelet aggregation effects of anthocyanosides of *Vaccinium myrtillus* L. *Anales de la Real Academia de Farmacia* 1983; 49:79-90.
25. Morazzoni P, Bombardelli E. *Vaccinium myrtillus* L. *Fitoterapia* 1996; 67:3-29.
26. Bottecchia D. Preliminary report on the inhibitory effect of *Vaccinium myrtillus* anthocyanosides on platelet aggregation and clot retraction. *Fitoterapia* 1987; 48:3-8.
27. Kadar A. Influence of anthocyanoside treatment on the cholesterol-induced atherosclerosis in the rabbit. *Paroi Arterielle* 1979; 5:187.
28. Bertuglia S, Malandrino S, Colantuoni A. Effect of *Vaccinium myrtillus* anthocyanosides on ischaemia reperfusion injury in hamster cheek pouch microcirculation. *Pharmacol Res* 1995; 31:183-7.
29. Colantuoni A, Bertuglia S, Magistretti MJ, Donato L. Effects of *Vaccinium Myrtillus* anthocyanosides on arterial vasomotion. *Arzneimittelforschung* 1991; 41:905-9.
30. Schilcher H. *Phytotherapy in paediatrics : handbook for physicians and pharmacists : with reference to commission E monographs of the Federal Department of Health in Germany : includes 100 commission E monographs and and 15 ESCOP monographs.* Stuttgart: medpharm Scientific Publishers, 1997:181.
31. Robbers JE, Tyler VE. *Tyler's Herbs of choice : the therapeutic use of phytomedicinals.* New York: Haworth Herbal Press, 1999:x, 287.
32. Tolan L, Barna V, Szigeti I, Tecsá D, Gavris C, Csernatony O, et al. The use of bilberry powder in dyspepsia in infants. *Pediatrics (Bucur)* 1969; 18:375-9.
33. Mertz-Nielsen A. A natural flavonoid, IdB 1027, increases gastric luminal release of prostaglandin E2 in healthy subjects. *Ital J Gastroenterol* 1990; 22:288.
34. Magistretti MJ, Conti M, Cristoni A. Antiulcer activity of an anthocyanidin from *Vaccinium myrtillus*. *Arzneimittelforschung* 1988; 38:686-90.
35. Cristoni A, Magistretti MJ. Antiulcer and healing activity of *Vaccinium myrtillus* anthocyanosides. *Farmaco [Prat]* 1987; 42:29-43.
36. Braggio F, Mazzacane D. Study on the effect of procyanidolic oligomers on retinic sensibility of myopic patients. *Annali di Ottalmologia e Clinica Oculistica* 1988; 114:407-18.

37. Bravetti G. Preventive medical treatment of senile cataracts with Vitamin E and anthocyanosides: clinical evaluation. *Annali di Ottalmol Clin Ocul* 1989; 115:109 -16.
38. Murray M. Bilberry (*Vaccinium myrtillus*). *American Journal of Natural Medicine* 1997; 4:18-22.
39. Boniface R, Robert A. Influence of anthocyanosides on human connective tissue metabolism. *Klinische Monatsblätter für Augenheilkunde* 1996; 209:368-72.
40. Mosci C, Fioretto M, Polizzi A, De Marco R, Zingirian M. The influence of procyanidolic anthocyanosides on macular recovery time and oscillatory potentials in the diabetic subject. *Annali di Ottalmologia e Clinica Oculistica* 1988; 114:473-79.
41. Perossini M, Guidi G, Chiellini S, Siravo D. Diabetic and hypertensive retinopathy therapy with *Vaccinium myrtillus* anthocyanosides. *Annali di Ottalmologia e Clinica Oculistica* 1988; 113:1173-90.
42. Fiorni G, Biancacci A, Graziano F. Perimetric and adaptogenic modifications of anthocyanosides and beta-carotene. *Ann Ottal Clin Ocul* 1965; 91:371-86.
43. Urso G. Effect of *Vaccinium myrtillus* anthocyanosides associated with betacarotenes on light sensitivity. *Ann Ottalmol Clin Ocul* 1967; 93:930-8.
44. Jayle GE, Aubry M, Gavini H, Braccini G, De la Baume C. Study concerning the action of anthocyanoside extracts of *Vaccinium Myrtillus* on night vision. *Ann Ocul (Paris)* 1965; 198:556-62.
45. Fokina GI, Frolova TV, Roikhel VM, Pogodina VV. Experimental phytotherapy of tick-borne encephalitis. *Vopr Virusol* 1991; 36:18-21.
46. Fokina GI, Roikhel VM, Frolova MP, Frolova TV, Pogodina VV. The antiviral action of medicinal plant extracts in experimental tick- borne encephalitis. *Vopr Virusol* 1993; 38:170-3.
47. Bomser J, Madhavi DL, Singletary K, Smith MA. In vitro anticancer activity of fruit extracts from *Vaccinium* species. *Planta Med* 1996; 62:212-6.
48. Prior R, Cao G, Martin A, Emin S, McEwen J. Antioxidant capacity as influenced by total phenolic and anthocyanin content, maturity, and variety of *Vaccinium* species. *J Agricult Food Chem* 1998; 46:2686-93.
49. Martin-Aragon S, Basabe B, Benedi J, Villar A. Antioxidant action of *Vaccinium myrtillus* L. *Phytotherapy Research* 1998; 12:S104-S106.
50. Laplaud PM, Lelubre A, Chapman MJ. Antioxidant action of *Vaccinium myrtillus* extract on human low density lipoproteins in vitro: initial observations. *Fundam Clin Pharmacol* 1997; 11:35-40.
51. Mitcheva M. Biochemical and morphological studies on the effects of anthocyanins and vitamin E on carbon tetrachloride induced liver injury. *Cell Microbiol* 1993; 39:443.