The Pharma Innovation Journal 2022; 11(6): 2263-2268

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 2263-2268

www.thepharmajournal.com
Received: 14-03-2022
Accepted: 25-05-2022

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Significance of natural anthocyanin on health and disease

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Abstract
Anthocyanins are coloured water-soluble pigments belonging to the phenolic group. Anthocyanins are blue, red, or purple colour pigments found in plants especially flowers, fruit and tubers. The paper focuses on the natural anthocyanin that is present in black carrot and it highlights its significance. Along with this in this paper the effect of anthocyanin on health is discussed.

Keywords: Natural anthocyanin, water-soluble pigments, plants especially flowers, fruit and tubers

Introduction
Anthocyanin is also called as the flavylium (2-phenylchromenylium) ion. When the anthocyanin is alkaline in nature it appears blue while it appears red when in acidic nature. Black carrots was originated from middle Asia. Carrot has been ranked tenth among 38 fruits and vegetables in terms of their nutritive value. Five major anthocyanin pigment that are present in black carrots are two nonacylated, cyanidin 3- xylosyl glucosyl galactoisde and cyanidin 3- xylosyl- galactoside and three derivatives of cyanidin acylated with sinapic acid (cyanidin 3-sinapoylxylosyl glucosyl galactoside), ferulic acid(cyaniding 3- feruloyl xylosyl glucosyl galactoside) and p- coumaric acid (cyaniding 3- p- coumaroyl xylosyl glucosyl galactoside). (Laleh GH, Frydoonfar H, Heidary R, *et al*.).

Review of literature
Hock Eng Khoo a,b, Azrina Azlan a,b, Sou Teng Tang a and See Meng Lim (2017) Anthocyanins are colored water-soluble pigments belonging to the phenolic group. The pigments are in glycosylated forms. Anthocyanins responsible for the colors, red, purple, and blue, are in fruits and vegetables. Berries, currants, grapes, and some tropical fruits have high anthocyanins content. Red to purplish blue-colored leafy vegetables, grains, roots, and tubers are the edible vegetables that contain a high level of anthocyanins. Among the anthocyanin pigments, cyanidin-3-glucoside is the major anthocyanin found in most of the plants. The colored anthocyanin pigments have been traditionally used as a natural food colorant. The color and stability of these pigments are influenced by pH, light, temperature, and structure. In acidic condition, anthocyanins appear as red but turn blue when the pH increases. Chromatography has been largely applied in extraction, separation, and quantification of anthocyanins. Besides the use of anthocyanidins and anthocyanins as natural dyes, these colored pigments are potential pharmaceutical ingredients that give various beneficial health effects. Scientific studies, such as cell culture studies, animal models, and human clinical trials, show that anthocyanidins and anthocyanins possess antioxidative and antimicrobial activities, improve visual and neurological health, and protect against various non-communicable diseases. These studies confer the health effects of anthocyanidins and anthocyanins, which are due to their potent antioxidant properties. Different mechanisms and pathways are involved in the protective effects, including free-radical scavenging pathway, cyclooxygenase pathway, mitogen-activated protein kinase pathway, and inflammatory cytokines signaling.
Paz Robert, Tamara Gorena, Nalda Romero, Elena Sepulveda, Jorge Chavez & Carmen Saenz (2010) Pomegranate (*Punica granatum*) bioactive compounds (polyphenols and anthocyanins) of juice (PJ) and ethanolic extracts (PE) were encapsulated with maltodextrin (MD) or soybean protein isolates (SPI) by spray drying using a 22 statistical factorial design for each systems studied (PJ–MD, PJ–SPI, PE–MD and PE–SPI) considering the proportion of coating material and the inlet temperature as independent variables.

polyphenols encapsulating efficiency was significantly better in SPI matrix whereas for anthocyanins was in MD matrix. By the other hand, during the storage, the MD microcapsules provided a significant greater protective effect on the polyphenols and anthocyanins than SPI, as was shown by the lower degradation rate constants.

Zhongxiang Fang, Bhesh Bhandari (2011) Bayberry juice was spray dried with maltodextrin (DE 10) as a carrier and then stored under different temperature and water activities (aw). The retention of the total phenolic content (TPC) and total anthocyanins (ACN) during the drying process were about 96% and 94%, respectively, suggesting spray drying was a satisfactory technique for drying heat sensitive polyphenols. Under an aw of 0.11–0.44, the TPC and ACN in bayberry powders decreased by about 6–8% and 7–27%, respectively, after 6 months storage at 4 C; at 25 C for the same storage period the decreases were between 6–9% and 9–37%, respectively, while at 40 C the decreases were in the range 7–37% and 9–94%. The anthocyanin component was more readily degraded relative to other phenolic compounds. The results suggest that bayberry powder should be stored at less than 25 C and aw of 0.33, on account of greater polyphenol stability under such conditions.

Sources of anthocyanins

Berries, currants, grapes, and some tropical fruits have high anthocyanins content. Red to purplish blue-colored leafy vegetables, grains, roots, and tubers are the edible vegetables that contain a high level of anthocyanins. Anthocyanins are found in flowers and fruits. Red, blue or purple colour flowers have the anthocyanins. The red flowers like hibiscus, rose, etc are edible. Among the anthocyanin pigments, cyanidin-3-glucoside is the major anthocyanin found in most of the plants. Moreover anthocyanin rich black carrot, red cabbage are potential functional foods that are consumed to prevent diseases.

Effect of anthocyanin on health

Antioxidant

The health and therapeutic effects of anthocyanin are mainly contributed by its antioxidative activities. As reported in the literature, anthocyanin chalcones and quinoidal bases with a double bond conjugated to the keto group are efficient antioxidants in scavenging free radicals. Also, the glycosylated B-ring structure of anthocyanin contributes to the high antioxidant activity, where orthohydroxylation and methoxylation substantially increase the antioxidant

A previous study reports the antioxidant activity of malvidin-3-glucoside that was determined by metalcatalyzed lipid peroxidation models in comparison with other antioxidants. The result shows that the quinoidal-base and pseudo- base of malvidin-3-glucoside significantly inhibited peroxidation of linoleate by myoglobin compared with catechin. In the presence of hydrogen peroxide- activated myoglobin, malvidin- 3-glucoside had the highest antioxidant activity, followed by catechin, malvidin, and resveratrol. In term of glycosylated anthocyanin, addition of an extra glucose to cyanidin-3-xylosyl-galactoside forms cyanidin- 3-xylosyl-glucosyl-galactoside with an ORAC value lower than the anthocyanin without addition of an extra sugar. Acylation of malvidin-3- glucoside with p-coumaric acid has antioxidant activity assessed by linoleic acid oxidation higher than the non-acylated counterpart.

Effect of anthocyanin on diseases

1. Cardiovascular health

Epidemiological studies show the relationships between anthocyanin-rich foods and CVDs, as well as the relationship between total anthocyanin intake and risk of developing these cardiovascular-related diseases. Anthocyanins also demonstrate *in vitro* anti-thrombotic effect. The anti-thrombotic effect is supported by another study that anthocyanin-containing maize seed (20% seed in the diet) fed rats for eight weeks are less susceptible to ischemia-reperfusion injury and reduction of infarct size with increased myocardial antioxidant enzyme. Also, Bell and Gochenaur reveal that anthocyanin-rich extracts of chokeberry and bilberry, but not elderberry, possess vasorelaxation properties. Moreover, there is also no alteration of coronary response to nitric oxide which is a potent vasodilator agent. In a clinical trial, the researchers suggest that consumption of anthocyanin-rich strawberries for one month improves lipid profile and platelet function in healthy volunteers. Nonetheless, the effects may be attributed to the presence of non-anthocyanin compounds in strawberries, such as vitamin C and phenolic compounds. Moreover, the study should have control groups for comparison. However, Curtis *et al.* [119] indicate the consumption of 500 mg/day of elderberry extract for 12 weeks is ineffective in reducing the risk of CVD in healthy postmenopausal women. There is also no change in metabolic processing following 12 weeks of elderberry intake compared with acute intake.

2. Anticancer

Anthocyanins have been extensively studied for their anticancer properties, as well as antiangiogenesis, based on *in vitro* and cell culture studies, and animal models. Angiogenesis is the key for cancer development, where it is an important step in the transition of tumors from a benign state to a malignant one. In cancer prevention, antiangiogenesis is the process that prevents formation of new blood vessels that supply oxygen to the tumor cells. Several phytochemicals, including flavonoids and anthocyanins, are potential antiangiogenic agents. Anthocyanins have been extracted and isolated from different plant sources for investigating their anticancer ability on esophagus, colon, breast, liver, haematological and prostate cancers. The evidence from a previousstudy shows that 5% whole freeze-dried black raspberries and the anthocyanin-rich fraction supplemented to N-nitrosomethylbenzylamine- induced F344 rats have chemopreventive potential, where the treatment groups inhibit cell proliferation, inflammation, angiogenesis, and induce apoptosis in both preneoplastic and papillomatous esophageal tissues. Thus anthocyaninshave chemoprophylaxis potential.

In another study, supplementation of anthocyaninrich extracts of bilberry, chokeberry, and grape (containing 3.85 g anthocyanins per kg diet) for 14 weeks significantly reduced azoxymethane-induced aberrant crypt foci by 26– 29% in 3–4 week-old male-specific pathogen-free F344 rats. This reduction is associated with reduced cell proliferation and decreased expression of the COX- 2 gene. The result also shows that the urinary 8-OHdG levels were similar among rats fed with different diets.

3. Antidiabetes

The antidiabetic effect of anthocyanins from plants has been

widely studied. Anthocyanin-rich Cornus fruits have been used in traditional Chinese prescription medicines to treat diabetes. Primary bioactive components reported in Cornus fruits are the glycosides of cyanidin, delphinidin, and pelargonidin. Jayaprakasam *et al*. report that cyanidin-3-glucoside and delphinidin-3-glucoside effectively aided insulin secretion from rodent pancreatic β-cells (INS-1 832/13) *in vitro* compared with the other anthocyanins and anthocyanidins studied.

Another study demonstrates that pelargonidin and pelargonidin-3-galactoside caused a 1.4-fold increase in insulin secretion at 4 mM glucose concentration representative of the normal glucose level in human.

The ability of the anthocyanins to induce insulin secretion is in the increasing order of pelargonidin-3-galactoside, cyanidin-3-glucoside, and delphinidin-3-glucoside. This finding demonstrates that the number of hydroxyl groups on the B-ring of anthocyanins plays a crucial role in their ability to secrete insulin. Nevertheless, cyanidin, delphinidin, pelargonidin, malvidin, and petunidin do not potentiate significant insulin secretion.

In a clinical trial of 24 weeks involving 58 diabetic patients, the subjects in the anthocyanin group consumed two anthocyanin capsules (160 mg anthocyanins) twice daily purified from bilberry and blackcurrant. The results show that anthocyanin group had a significantly lower fasting plasma glucose and insulin resistance index, as well as significantly elevated serum adiponectin and β-hydroxybutyrate concentrations compared to the placebo supplementation. However, the authors did not elucidate the mechanism involved for the prevention of insulin resistance in the diabetic patients.

4. Anti-obesity effect

Anthocyanidin and anthocyanin pigments possess antiobesity properties. Based on a previous study, obese mice fed a diet rich in cyanidin-3- glucoside from purple corn for 12 weeks have reduced body weight, as well as decreases in white and brown adipose tissue weights. The study demonstrates that hyperglycemia, hyperinsulinemia, hyperleptinemia, and an increase in the tumor necrosis factor (TNF-a) mRNA level occurred in the obese rats are normalized when treated with purple corn diet. The purple corn also suppresses mRNA levels of enzymes involved in fatty acid and triacylglycerol synthesis and lowered sterol regulatory element binding protein-1 mRNA level in the white adipose tissue. These downregulations may contribute to a low triacylglycerol accumulation in white adipose tissue. Obesity is strongly associated with adipocyte dysfunction. Therefore, regulation of protein secretion from adipocyte or the adipocyte-specific gene expression is one of the most important targets for prevention of obesity.

5. Visual health

Anthocyanin pigments are important nutraceuticals in maintaining good vision. Anthocyanin-rich berries are traditionally known for the goodness to eyes and are often associated with night vision. Most of the berries have high anthocyanins content. Oral administration of bilberry extract (contained about 39% anthocyanins) to six weeks old C57BL/6 mice has been shown to preventimpairment of photoreceptor cell function during retinal inflammation [91]. In another study, 132 patients with normal tension glaucoma were supplemented with two anthocyanins capsules (60.0 mg anthocyanin in each capsule) from bilberry daily and have improvedvisual function, based on the Humphrey visual field test and minimal angle of resolution best-corrected visual acuity assessment.

Some other berries demonstrate a protective effect for eyesight. Blackcurrant anthocyanin supplementation (50 mg/day) for 24 months increased ocular blood flow in 19 patients with open-angle glaucoma, however, there were no significant changes in the intraocular pressure. Supplementation of anthocyanins (50 mg/kg body weight) from the seed coat of black soybean to N- methyl-N-nitrosourea-induced retinal degenerative rats also prevents retinal degeneration, and also suppresses human lens epithelial cell death under hydrogen peroxide-induced oxidative stress by 50–200 μg/ml of the extract. Anthocyanin also predominates around 70% in purple corn seed, where purple corn seed extract decreases lens opacity together with lower malonaldehyde levels.

Table 1: Effect of spray drying on anthocyanin and polyphenols

Sr. No	Title of study	methodology	Outcome	Result	Author
1.	Encapsulation of polyphenols and anthocyanins from pomegranate (*Punica granatum*) by spray drying	Pomegranate (*Punica granatum*) bioactive compounds (polyphenols and anthocyanin's) of juice (PJ) and ethanolic extracts (PE) were encapsulated with maltodextrin (MD) or soybean protein isolates (SPI) by spray drying using a 22 statistical factorial design for each systems studied (PJ–MD, PJ–SPI, PE–MD and PE–SPI) considering the proportion of coating material and the inlet temperature as independent variables. The stability of the bioactive compounds microcapsules powders obtained under optimal conditions for each system was studied at 60 °C in oven for 56 days.	The polyphenol s encapsulating efficiency was significantly better in SPI matrix whereas for anthocyanin's was in MD matrix.	During the storage, the MD microcapsules provided a significant greater protective effect on the polyphenols and anthocyanin's than SPI, as was shown by the lower degradation rate constants.	Az Robert, Tamara Romero, Elena Chavez, Carmen Saenz,
2.	Effect of spray drying and storage on the stability of bayberry polyphenols	Bayberry juice was spray dried with maltodextrin (DE 10) as a carrier and then stored under different temperature and water activities (aw).	The retention of the total phenolic content (TPC) and total anthocayni ns (ACN) during the drying process were about 96% and 94%, respectively, suggesting spray drying was a satisfactory technique for drying heat sensitive polyphenols. Under an aw of 0.11–0.44, the TPC and CAN in bayberry powders Decreased by about 6–8% and 7–27%, respectively, after 6 months storage at 4 °C; at 25 °C for the same Storage period the decreases Were between 6–9% and 9-37%, respectively, while at 40 °C the decreases were in the range 7-37% and 9-94%.	The anthocyanin component was more readily degraded relative to other phenolic compounds. The results suggest that bayberry powder should be stored at less than 25 °C and aw of 0.33, on account of greater polyphenol stability under such conditions.	Zhongxiang Fang Bhesh Bhandaria
3.	Effect of spray drying on phenolic compounds of cranberry juice and their stability during storage	The stability of cranberry phenolics after spray drying (185 °C) and during storage, and their changes correlated with different wall materials (gum Arabic (GA), maltodextrins (M1, 10–13 DE; M3, 17–20 DE), and blend of GA and M1 (GAM1). The storage trial was conducted at 4, 25 and 45 °C for 12 weeks.	The total phenolic content (TPC), proanthocy anins and antioxidant capacity (AOC) increased after spray drying. The GMA1 powder achieved the highest recovery of TPC, anthocyanin (ANC) and AOC. During storage, the phenolics fluctuated and peaked at 8–10 weeks	The increase in TPC was due to decomposition of phenolic polymers. After storage of 12 weeks at 25 °C, the phenolic composition remained similar to the initial amount in all powders.	Jingying Zhang Chuang Z Siew Young Quek
4.	Microencapsulation by spray-drying of bioactive compounds extracted from blackberry (Rubus fruticosus)	Blackberry aqueous extract acidified with 2 % citric acid was spray-dried using gum Arabic (GA) and polydextrose (PD) as encapsulating agents at concentrations of 10 and 15 % and temperatures of 140 to 160 °C. All powders presented high solubility, ranging from 88.2 to 97.4 %, and the encapsulation conditions did not significantly affect the hygroscopicity.	The powders produced with gum Arabic showed higher brightness than those with polydextrose. The anthocyani ns retention in the microcapsu les was 878.32 to 1300.83 mg/100 g, and the phenolics was 2106.56 to 2429.22 mg (GAE)/100g. The antioxidant activity was quantified according to DDPH and ABTS methods, with values ranging from 31.28 to 40.26 % and 27 to 45.15 %, respectively. The microscopy showed spherical particles for both encapsulating agents, and smooth surface with some concavities with the gum Arabic, and smooth or slightly rough surface when using polydextrose.	The results showed that the best encapsulation condition was atomization at 140 °C and 15 % gum Arabic.	Renata Trindade Rigon & C Noreña
5.	Chokeberry polyphenols preservation using spray drying: effect of encapsulation Using	Chokeberry fruits and juice by-product (waste) extracts were spray-dried by using two carriers, maltodextrin. *In vitro* simulated digestion model was used as an	Chokeberry polyphenols stability might be improved using spray drying technique, and maltodextrin showed better properties.	The moisture content varied between 3.39 and 4.61%, zeta potential had negative values (35-39 mV),	Nada Ćujić-Nikolić, Nemanj Katarina

	maltodextrin and skimmed milk on their recovery following in vitro digestion	indicator of polyphenolics bioavailability.		maltodetrin powders were smaller (4.27–5.12 µm) compared to skim ones (8.50–11.01 µm). All microparticles exhibited high encapsulation efficiency of total polyphenols and anthocyanins (73–97% and 63–96%, respectively).	Šavikin, Ana Kaluš Viktor Nedović, Jelena Sama Janković
6.	Application of to produce an Sensory physicochemic Khashayar Sarabandi Seid M gum Arabic encapsulated evaluational properties of Sadeghi Mahoonak AdelehMo and maltodextrin for encapsulation of eggplant peel extract as a natural antioxidant and color source.	Powder loaded with eggplant peel extract as a natural source of color and antioxidants through gum Arabic and maltodextrin. The effect of spray drying inlet temperature (140–170 °C) and various carriers (maltodextrin, gum Arabic, and their combination) on powder production yield, physical properties, flowability, color, total phenolic content (TPC), antioxidant activity, infrared spectroscopy (FTIR), microstructure and particle size were investigated.	Indicated that addition of encapsulated eggplant extract into the formulation of gummy candy improved its color and overall acceptability.	Powders were influenced by the carrier type and inlet temperature. Obtained powders by maltodextrin at 170 °C showed the highest TPC (5.2 mg/g), DPPH (73.4%), ABTS (90.5%), TEAC (2.5 mM), hydroxyl radicals scavenging activity (79.1%) and reducing power Abs700) among all samples. FTIR spectroscopy indicated that the extract was encapsulated by the carriers.	

Conclusion

Anthocyanins are the colored pigments that are present in plants especially flowers and fruits. Black carrots are rich in anthocyanin and black carrots contain five major anthocyanin pigments. Anthocyanin have an antioxidant properties and also have effect on cardiovascular health. They play a role in preventing diabetes, obesity and also have an impact on visual health like eyesight and in vision.

References

1. Schieber A, Stintzing FC, R. Carle, By-products of plant food processing as a source of functional compounds—recent developments, Trends Food Sci. Technol. 2001;12:401-413.
2. Balasundram N, Sundram K, Samman S. Phenolic compounds in plants and agriindustrial by-products: antioxidant activity, occurrence, and potential uses, Food Chem. 2006;99:191-203.
3. Bahmani A, Jafari SM, Shahidi S, Dehnad D. 2016;40:815-827.
4. Alonso-Salces RM, Ndjoko K, Queiroz EF, Ioset JR, Hostettmann K, Berrueta LA, *et al*. On-line characterisation of apple polyphenols A. 2004;1046:89-100.
5. Amakura Y, Umino Y, Tonogai Y. Journal of Agricultural and Food Chemistry. 2000;48:6292-6297.
6. Bao JS, Cai YZ, Sun M, Wang GY, Corke H. Anthocyanins, flavonols, and free radical scavenging activity of Chinese bayberry (*Myrica rubra*) extracts and their color properties and stability. Journal of Agricultural and Food Chemistry, 2005.
7. Azuma K, Ohyama A, Ippoushi K, Ichiyanagi T, Takeuchi A, Saito T, *et al*. Structures and antioxidant activity of anthocyanins in many accessions of eggplant and its related species, J. Agric. Food Chem.
8. Boulekbache-Makhlouf L, Medouni L, Medouni-Adrar, L, Arkoub S, Madani K. Effect of solvents extraction on phenolic content and antioxidant activity of the byproduct of eggplant, Ind. Crop. Prod. 2013;49:668-674.
9. Barrett DM, Somogyi L, Ramaswamy HS. 2004.
10. Laleh GH, Frydoonfar H, Heidary R, *et al*. The effect of light, temperature, pH and species on stability of anthocyanin pigments in four Berberis species. Pak J Nutr. 2006;5(1):90-92.
11. Blumberg JB, Camesano TA, Cassidy A, Kris-Etherton P, Howell A, Manach C, *et al*. Cranberries and their bioactive constituents in human health. Adv Nutr, 2013.
12. Carneiro HCF, Tonon RV, Grosso CRF, Hubinger MD. 2013.
13. Tzulker R, Glazer I, Bar-Ilan I, Holland D, Aviram M, Amir R. Antioxidant activity, polyphenols content, and related compounds in different fruit juices and homogenates prepared from 29 different pomegranate accessions. Journal of Agricultural and Food Chemistry, 2007.
14. Vardin H, Fenercioglu H. Study on the development of pomegranate juice processing technology: clarification of pomegranate juice. Nahrung/Food, 2003.
15. Wagner L, Warthesen J. Stability of spray-dried encapsulated carrot carotenes. Journal of Food Science. 1995;60:1048-1053.
16. Wu T.-H, Yen F.-L, Lin L.-T, Tsai T.-R, Lin C.-C, Cham T-M. Preparation, physicochemical characterization, and antioxidant effects of quercetin nanoparticles. International Journal of Pharmaceutics, 2008.
17. Yunfeng L, Changjiang G, Yang J, Wei J, Xu J, Cheng S. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. Food Chemistry, 2006.