

Anthocyanins: Facts and fiction

Introduction

The capacity of some plant-derived food to reduce the risk of chronic diseases has been associated, at least in part, to the occurrence of metabolites (phytochemicals) that have been shown to exert a wide range of biological activities. These metabolites have low potency as bioactive compounds when compared to pharmaceutical drugs, but they may have a noticeable long-term physiological effect because they are ingested regularly and in significant amounts as part of the diet. Phytochemicals that are present in the diet, and have been associated to health benefits, include various groups of polyphenols (anthocyanins, flavones, flavan-3-ols, isoflavones, stilbenoids, ellagic acid, etc.). Their bioactivity has been associated to their antioxidant properties (i.e. capacity to inhibit the destructive effects of oxidation) which are involved in the onset development of many of the chronic degenerative diseases (cancer, ageing, inflammation, etc.).

Marketing studies carried out by diverse industries have shown an increasing demand among consumers for health-promoting food products as well as for non-food products (i.e. dietetics and pharmaceuticals) containing the active principles present in these health-promoting foods. In the past few years, many food bioactive constituents have been commercialized in the form of pharmaceutical products (pills, capsules, solutions, gels, liquors, powders, granulates, etc.) that incorporate food extracts or phytochemical-enriched extracts to which a beneficial physiological function has been directly or indirectly attributed. These range of products cannot be truly classified as 'food' and a new hybrid term between nutrients and pharmaceuticals, 'nutraceuticals', has been coined to designate them.

This type of health-promoting products is getting more popular among health-conscious consumers and, thus, a large list of nutraceuticals containing phytochemicals from foods is now available in the market. Some of the most common phytochemicals found in the nutraceutical market are polyphenols such as anthocyanins, proanthocyanidins, flavonols, stilbenes, hydroxycinnamates, coumarins, ellagic acid and ellagitannins, isoflavones, lignans, etc.

Anthocyanins: The fiction

The health-promoting effects of berries and anthocyanins are being increasingly exploited to market products such as nutraceuticals and dietary supplements. These products are commercially available and some information on the composition and health claims is provided with the product mostly via internet. The main dietary origin of these products is either single berry extracts (e.g. bilberry or wild blueberry) or natural combinations of various berries (blend of blueberry, strawberry, cranberry, wild bilberry, elderberry, and raspberry extracts). Often, they are also combined with other food components and are commercialized as powders, capsules, or tablets. These products are marketed as a source of anthocyanins, and, within the description, the composition is frequently indicated as total mg or percentage of anthocyanins in the product. It is possible to find dietary supplements with a declared content of anthocyanins ranging from <1% to >25%, or tablets containing from 40 mg up to 250 mg of anthocyanins. In addition to anthocyanins, many other compounds are also present in these supplements, and even at higher proportions than those of the anthocyanins themselves. Non specified polyphenols can amount up to 70% of the product. Sometimes, the percentage of other fairly bioactive polyphenols (e.g. proanthocyanidins, hydroxycinnamic acids, or flavonols) is also stated. In addition to compositional information, nutraceutical companies provide information on recommended doses for many of these berry-based products, and it varies from 1 to 2 capsules or 40 to 200 mg daily or twice a day with meals or with water or any other beverage. For most of these berry-based nutraceuticals the composition in anthocyanins or any other components and the recommended doses have not been properly established and standardized.

One of the main claims about these anthocyanins-based nutraceuticals or supplements is their high level of antioxidant capacity. Additionally, the health claims ascribed to berry nutraceuticals comprise a long list that includes statements such as: '... promotes healthy brain function and mental clarity, healthy vision, cardiovascular health, and healthy blood sugar levels. It also prevents the effects of premature aging...', '... reduces oxidative damage and inflammation in the nervous system. It prevents LDL oxidation in blood vessels, reduces the risk of retinopathy and decreases eye fatigue...', '...helps maintain healthy brain function...', '...Natural vision enhancer that prevents retinopathy; improves capillary fragility and reduces inflammation...', '...Supports vision, improves blood glucose levels and memory...', '...may prevent some effects of premature aging, healthy brain function and mental clarity, cardiovascular health, healthy vision, provide support for joint discomfort, maintain healthy blood glucose levels and reduce the risk of some cancers.'

Together with **these claims**, a final statement is added to clarify that none of the statements have been evaluated by the FDA, that these products are not medically proven to cure, mitigate, treat or prevent any disease, that the information provided is for general knowledge, and that **it** is up to the consumer to research and make informed decision by obtaining advice from health care professionals. Both producers and consumers would benefit from having more accurate and comprehensive information on the type, levels, doses, and health benefits that may be expected from the regular consumption of these nutraceuticals and supplements.

Anthocyanins: The facts

A growing number of scientific reports suggest that anthocyanins, and anthocyanin-rich berries or derived extracts, exhibit a wide range of protective effects with potential benefits for human and animal health. **It** has been recognized that some of these effects may be related to the chemical characteristics and inherent associated antioxidant capacity of these compounds, but other mechanisms of action may be responsible for the observed health benefits. Most of the evidence accumulated in recent years is based on results from *in vitro* studies and animal testing. Additional data from human trials are slowly emerging. The biomedical properties ascribed to either pure anthocyanins, or to anthocyanin-rich berries or extracts include a large list of beneficial effects on: visual capacity, brain cognitive function, obesity, ulcer protection, cardiovascular risk, and cancer prevention. Improvement of visual capacity has been attributed to anthocyanins, **but** only one human study has indicated an apparent improvement of nocturnal vision in myopia subjects after repetitive high doses of a purified anthocyanoside oligomer, **whereas** a previous study failed to find any effect of high doses of bilberry capsules on night vision in young males with good vision. Several animal studies have shown that anthocyanins and berry extracts can increase the cognitive performance, and protect the brain function by reducing oxidative ischemic damage and enhancing memory. Diabetes and obesity can also be prevented in animals fed anthocyanins by decreasing blood sugar levels, or reducing body weight gain and adipose tissue. **Also**, chokeberry has been reported to have a gastroprotective effect on ethanol-induced gastric hemorrhagic lesions, and to inhibit *Helicobacter pylori* growth.

The prevention of the development of cardiovascular diseases by dietary anthocyanins has been thoroughly studied. Numerous *in vitro* studies have described possible mechanisms of action for anthocyanidins in the cardiovascular system. **Although** a lot has been learnt from these studies, results must be interpreted with caution given the limitations of the *in vitro* experimental conditions. A few *in vivo* animal experiments have confirmed some of the cardiovascular protective effects. The consumption of anthocyanins has been associated to some improvement of diverse cardiovascular risk markers. In dietary-induced hyperlipidemic rats, the intake of chokeberry juice reduced the levels of total plasma cholesterol and of LDL-cholesterol. An anthocyanin-rich extract from black rice also decreased serum levels of triglycerides, total cholesterol and LDL-cholesterol. Some other recent findings, **however**, do not support some of these protective effects. An anthocyanin-rich extract from blackcurrant was found to increase plasma LDL-cholesterol in rabbits.

Few controlled human dietary interventions have investigated the anticholesterolemic and antioxidant effects of anthocyanins or anthocyanin-rich berries, and data are still scarce and inconclusive. In a group of healthy volunteers, a daily intake of a mixed berry juice for a 4-week period led to a decrease in oxidative cell damage. **However**, another study in healthy volunteers consuming blackcurrant juice or an anthocyanin drink (from blackcurrant) for 3 weeks showed no effect on DNA damage markers. Other recent studies have looked at effects in groups under stress conditions (physical work or smokers) or groups with enhanced risk. In this context, **it** has been reported that the intake of blackcurrant capsules improved muscle fatigue in healthy volunteers after repeated typing work. Daily consumption of chokeberry juice by rowers performing regular physical exercise limited induced oxidative damage, and enhanced endogenous antioxidant defence systems. In addition, **it** has been shown very recently that a standardized herbal product from *Hibiscus sabdariffa*, containing high levels of anthocyanins, significantly decreased blood pressure in hypertensive patients.

The chemopreventive properties of dietary polyphenols and specifically of anthocyanins, are a lot more complicated to demonstrate, and much of the evidence accumulated so far is based mostly on *in vitro* studies and animal cancer models. A chemopreventive role of berries or derived extracts has **also** been shown in animal models, in particular in models of gastrointestinal cancer. The consumption of anthocyanins from bilberry reduced the number of intestinal adenomas in a mouse model. In rats, berries have been shown to decrease the number of induced oesophageal tumours, and to inhibit multiple biomarkers of induced colon cancer.