ARTICLES

Oxygen Radical Absorbing Capacity of Anthocyanins

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Anthocyanins are natural colorants belonging to the flavonoid family. They are widely distributed among flowers, fruits, and vegetables. Using the automated oxygen radical absorbance capacity (ORAC) assay developed in our laboratory, we determined the antioxidant capacity of 14 anthocyanins including the aglycons delphinidin, cyanindin, pelargonidin, malvidin, peonidin, and their derivatives with different sugar linkages. Among these anthocyanins, kuromanin (cyanidin-3-glucoside) had the highest ORAC activity, which was 3.5 times stronger than Trolox (vitamin E analogue), while pelargonin had the lowest antioxidant activity but was still as potent as Trolox. Different patterns of hydroxylation and glycosylation in anthocyanins appear to modulate their antioxidant properties. Therefore, in addition to their colorful characteristics, anthocyanins possess potent antioxidant properties.

Keywords: *Anthocyanins; flavonoids; colorants; ORAC; antioxidant; peroxyl radical*

INTRODUCTION

Anthocyanins are natural colorants belonging to the flavonoid family. They are widely distributed among flowers, fruits (particularly in berries), and vegetables and are responsible for the bright colors such as orange, red, and blue (Tables 1 and 2). They play a definite role in attracting animals in pollination and seed dispersal. They may also have a role in the mechanism of plant resistance to insect attack (Strack and Wray, 1993). The anthocyanins are glycosides and acylglycosides of anthocyanidins. Some common anthocyanidins with different hydroxyl or methoxyl substitutions in their basic structure, flavylium (2-phenylbenzopyrilium), are shown in Figure 1. There are over 250 naturally occurring anthocyanins (Strack and Wray, 1993), and all are *O*-glycosylated with different sugar substitutes (Francis, 1989). The most prevalent sugars substituted on the aglycon (anthocyanidins) in order of occurrence in nature are glucose, rhamnose, xylose, galactose, arabinose, and fructose. The common anthocyanins are either 3- or 3,5-glycosylated. When the number of sugar residues is higher than three, they may be attached to the basic molecule with alternating sugar and acyl linkages (Francis, 1989).

The daily intake of anthocyanins in humans has been estimated to be as much as 180−215 mg/day in the U.S. (Kühnau, 1976) due to their widespread distribution and occurrence in fruits and vegetables (Table 2). Despite the relatively high potential intake in humans, the physiological impact of the anthocyanins is not well studied. Nevertheless, anthocyanins have been shown to have some positive therapeutic effects including in

Table 1. Color and Distribution of Major Anthocyanidins in Some Common Fruits and Vegetables

compd	color[a]	fruits and vegetables[a]
delphinidin	bluish red	Concord grape, blueberry, bilberry, black currant
cyanidin	orange red	strawberry, blackberry, rhubarb, black currant, cherry, red cabbage, bilberry, cranberry, elderberry, Concord grape, corn, plum, raspberry, red onion
pelargonidin	orange	strawberry, corn
malvidin	bluish red	grape, blueberry, bilberry
peonidin	red	cherry, cranberry, sweet potato, plum

[a] Sources: Francis (1989); Timberlake and Harry (1988); Strack and Wray (1993); Terahara et al. (1994).

the treatment of diabetic retinopathy (Scharrer and Ober, 1981), in fibrocystic disease of the breast in human (Leonardi, 1993), and on vision (Politzer, 1977; Timberlake and Henry, 1988). A commercial extract of *Vaccinium myrtillus* (bilberry), called *V. myrtillus* anthocyanin (VMA), containing largely glycosides of delphinidin and cyanidin (Baj et al., 1983) has been used to treat various microcirculation diseases resulting from capillary fragility (Mian et al., 1977; Timberlake and Henry, 1988) and has been used to maintain normal vascular permeability (Robert et al., 1977; Miskulin et al., 1980; Detre et al., 1986). VMA also prevents cholesterol-induced atherosclerosis in the rabbit (Kadar et al., 1979). Anthocyanins may also have other potential physiologic effects as antineoplastic agents (Kamei et al., 1995), radiation-protective agents (Minkova et al., 1990; Akhmadieva et al., 1993), vasotonic agents (Colantuoni et al., 1991), vasoprotective and antiinflammatory agents (Lietti et al., 1976), chemoprotective agents against platinum toxicity in anticancer therapy (Karaivanova et al., 1990), and hepatoprotective agents against carbon tetrachloride damage (Mitcheva et al., 1993), and possibly other effects due to their diverse actions on various enzymes and metabolic process (Carpenter et al., 1967; Wheeler et al., 1967; Ferrell et al., 1979; Gibb

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