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Fruit of Autumn Olive: A Rich Source of Lycopene

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Abstract. **Autumn olive (*Elaeagnus umbellata* Thunb.) has edible fruit with brilliant red or yellow pigmentation. An analysis of the pigment in fruit of five cultivars and six naturalized plants showed that the berries contain lycopene, α-cryptoxanthin, β-cryptoxanthin, β-carotene, lutein, phytoene, and phytofluene. The lycopene content per 100 g ranged from 15 to 54 mg in fresh fruit from the naturalized plants and from 17 to 48 mg in the four cultivars with red-pigmented fruit. A cultivar with yellow fruit had only 0.47 mg/100 g fresh fruit. In contrast, fresh tomato fruit, the major dietary source of lycopene, has a lycopene content per 100 g of ≈3 mg. This newly identified source of lycopene may provide an alternative to tomato as a dietary source of lycopene and related carotenoids.**

Autumn olive (Fig. 1), a shrub native to southern Europe and western and central Asia, was introduced to the United States around 1830 as an ornamental plant (Dirr, 1983). It is valued for its ability to prevent erosion, to fix nitrogen, and to attract wildlife (Zarger, 1980), and has been used to enhance certain types of agroforestry (Campbell and Dawson, 1989). Although the fruit is eaten in Asia (Parmar and Kaushal, 1982; Tanaka, 1976), there are only a few references to human consumption of autumn olive in the United States (Darrow and Yerkes, 1937; Reich, 1991). The abundant, sweet-tart fruit can be used for preserves, condiments, fruit rolls, juice, flavoring, and other food products.

The fruit of autumn olive is notable for its typical deep-red color. The identity of the pigment, to our knowledge, has not been reported, but it is insoluble in water or alcohol, suggesting that carotenoids rather than anthocyanins provide the color. We analyzed autumn olive fruit, both naturalized and cultivated, and found the fruit to be a particularly rich source of lycopene, a carotenoid widely believed to protect against myocardial infarction (Kohlmeier et al., 1997) and various forms of cancer (Clinton, 1998), including prostate cancer (Giovannucci et al., 1995).

Materials and Methods

In Fall 1999, ripe berries of five cultivars of autumn olive from Hidden Springs Nursery, Cookeville, Tenn., were shipped fresh, with fruit from each selection collected in a separate plastic bag, frozen upon receipt, and stored at –80 °C. One sample of each selection was extracted and analyzed.

Ripe berries of six selected naturalized plants were picked in Howard County, Md., also in Fall 1999, placed in individual plastic bags, frozen, and stored at –80 °C. One sample of each was extracted and analyzed.

The whole berries were treated by a procedure optimized for the extraction of carotenoids (Khachik et al., 1992). In brief, 5 g of fruit were mixed with 10 mL·g^{-1} tetrahydrofuran (THF) containing 0.05% butylated hydroxytoluene (BHT), 10% (by weight) magnesium carbonate, and 15% (by weight) celite, added to a precooled blender (Omni-Mixer; Omni International, Gainesville, Va.), and blended for 20 min on medium speed in an ice jacket. The mixture was filtered through Whatman No. 1 paper on a Büchner funnel and the solid material was re-extracted twice, yielding a residue devoid of pigments. The filtrates were combined and the volume reduced under vacuum on a rotary evaporator. The concentrate was dissolved in 25 mL methanol and partitioned into methylene chloride and saturated salt water in a separatory funnel; the organic layer was removed and the water layer washed with methylene chloride. The organic layers were dried over anhydrous sodium sulfate, filtered, and the volume reduced on a rotary evaporator to near dryness. The concentrate was dissolved and the volume brought to 100 mL with methylene chloride containing 0.01% BHT. To ensure accuracy of the measurements, four dilutions of each extract were analyzed and evaluated for linearity. The dilution factors were 1, 2, 25, and 50 for all extracts; values derived from the lesser dilutions were used to quantify carotenoids other than lycopene. Aliquots (0.4 mL) of each dilution were added to tubes containing the internal standard (0.4 mL β-apo-8´-carotenal), then dried under nitrogen. The residues were dissolved in 0.4 mL of high-performance liquid chromatography (HPLC) solvent (mobile phase) and 50 μL was injected onto a 5-μm reverse-phase C18 analytical column (Microsorb-MV; Varian Analytical Instruments, Walnut Creek, Calif.), 250 mm × 4.6 mm, protected by a 5-μm guard cartridge, 30

Fig. 1. Fruit of autumn olive.

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Table 1. Carotenoid content of fruit, on wet weight basis, from naturalized and cultivated plants of autumn olive.

	Lycopene	Lycopene	Lutein	α-Cryptoxanthin	β-Cryptoxanthin	α-Carotene	β-Carotene	Phytofluene	Phytoene	Total carotenoids
	%[z]	µg/100 g								
Naturalized plants:	82	38,232	156	2,921	4,374	46	384	103	650	46,866
range (n = 6)		15,090 –53,966	106–288	962–4432	1,658–6,603	31–68	230–599	49–174	338–867	
Cultivars:										
Delightful	82	29,682	67	2,379	3,590	14	172	77	391	36,372
Jewel	81	48,334	92	4,169	6,167	32	248	105	505	59,652
Brilliant Rose	72	29,591	49	3,976	7,003	5	103	108	521	41,356
Sweet ‘n’ Tart	72	17,874	56	2,306	4,068	6	29	80	394	24,813
Charlie’s Golden	12	471	101	52	96	22	382	172	2,596	3,892

[z]Lycopene as a percentage of total carotenoids.

mm × 4.6 mm. Carotenoids were eluted under isocratic conditions within 30 min at a flow rate of 0.80 $mL \cdot min^{-1}$ on a HPLC system with diode array detection (Hewlett Packard Series 1050, Palo Alto, Calif.). The mobile phase consisted of 65% acetonitrile, 25% methylene chloride, 10% methanol, 1 $g \cdot L^{-1}$ BHT, and 0.1 $mL \cdot L^{-1}$ of *N,N*-diisopropylethylamine (Aldrich Chemical Co., Milwaukee). Solvents were HPLC grade (Fisher Scientific, Pittsburgh) and used without further purification. The carotenoids were quantified following simultaneous detection at 450, 350, and 300 nm. Reference samples of carotenoids used for calibration of the HPLC system were isolated from natural sources or purchased from Sigma Chemical Co. (St. Louis). For each carotenoid of each sample, values from the individual dilutions were scaled to the original volume and averaged using only those dilutions that fell within the absorbance range of the calibrated standards. The precision and accuracy of the HPLC system was verified using Standard Reference Material 968b (National Institute of Standards and Technology, Gaithersburg, Md.).

Results and Discussion

Lycopene was the dominant carotenoid in fruit from both naturalized autumn olive and four of five cultivars of autumn olive assessed in this study (Table 1). In red-pigmented berries, lycopene accounted for 72% to 82% of the total carotenoids. The lycopene content per 100 g ranged from 15 to 54 mg in fresh fruit from the naturalized plants and from 18 to 48 mg in fruit from the four cultivars with red-pigmented fruit. An exception was ‘Charlie’s Golden’, an anomalous, yellow-pigmented cultivar, which was relatively low in total carotenoids. This cultivar contained only 0.47 mg of lycopene per 100 g fresh weight of fruit (12% of total carotenoids) but contained high concentrations of phytoene, a precursor of lycopene. Additionally, red-fruited types contained high levels of α- and β-cryptoxanthin. The β-cryptoxanthin content of these varieties was ≈10 times higher than the β-cryptoxanthin content of orange and tangerine (U.S. Dept. of Agriculture, Agricultural Research Service; and Univ. of Minnesota, Nutrition Coordinating Center, 1998), which are major sources of this carotenoid in the U.S. diet (Chug-Ahuja et al., 1993). Autumn olive fruit also contained small amounts of β-carotene, lutein, and phytofluene.

Tomato products are the dominant source of dietary lycopene in the United States, accounting for more than 80% of lycopene intake (Clinton, 1998). Watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai], guava (*Psidium guajava* L.), papaya (*Carica papaya* L.), and pink grapefruit (*Citrus ×paradisi* Macf.) are other sources of lycopene (Clinton, 1998; Mangels et al., 1993), but provide a relatively minor proportion of the intake. In contrast, other common dietary carotenoids, such as β-carotene and lutein, are found in a variety of fruits and vegetables.

Autumn olive fruit is similar to tomato in that both fruits are rich in lycopene and contain other carotenoids, including β-carotene, phytoene, and phytofluene, but lycopene concentrations of red autumn olive fruit (15 to 54 mg/100 g) are considerably higher than nutrient database values (U.S. Dept. of Agriculture, Agricultural Research Service; and Univ. of Minnesota, Nutrition Coordinating Center, 1998) for fresh tomato fruit (3 mg/100 g), and are similar to that of tomato paste (29 mg/100 g). Thus, if lycopene alone, or in synergy with other carotenoids, is responsible for the purported cancer prevention properties of tomato (Clinton, 1998), the autumn olive fruit, a new dietary source of lycopene and related carotenoids, may be worthy of clinical trials to assess its health benefits.

The carotenoid values from this study may not be representative for autumn olive fruit collectively. We analyzed a limited number of samples from narrow geographical areas. More comprehensive studies are needed to identify the variation in carotenoid content of autumn olive fruit not only by cultivar, but also under various environmental and growing conditions.

It is notable, however, that this fruit produces unusually high concentrations of lycopene, a carotenoid with potential for protection against some chronic diseases. If, in the future, autumn olive fruit is produced for human consumption, lycopene content could be enhanced by selecting cultivars that excel in lycopene synthesis and/or by hybridizing selected parent plants.

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