Total Carotenoid, Flavonoid and Phenolic Compounds Concentration in Willowleaf Cotoneaster (*Cotoneaster Salicifolius* Franch.) Fruits

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Abstract

Willofleaf cotoneaster (*Cotoneaster salicifolius* Franch.) is a low, prostrate shrub, grown in Romania as an ornamental plant. Its fruits are small, ovoid pomes. Fruit tissues were analyzed for total carotenoid content (through acetone extraction and spectrophotometry), flavonoid content (methanol extraction and spectrophotometry) and total concentration of phenolic and polyphenolic compounds (methanol extraction and spectrophotometric Folin-Ciocâlteu method). *C. salicifolius* fruits analyzed contained an average of 311.50 mg/kg DW carotenoids (heat-dried fruits – only 100.25 mg/kg). Average flavonoid concentration was 9,777.62 mg/kg in fresh frozen fruits and 4,574 mg/kg in dried ones. 25,056.09 mg/kg GAE was the average concentration of total phenolics in fresh fruits, while dry fruit powder contained 5,271 mg/kg GAE. These concentrations of bioactive compounds are comparable, or even have a higher than in pomes belonging to related species, including domestic cultivars of rowanberry (*Sorbus* sp.), wild *Sorbus* species, firethorns (*Pyracantha* sp.), or other studied cotoneasters. This shows a significant potential for these pomes, requiring further investigation. However, heat-drying was found to be an unsuitable processing method for these fruits, since it led to a 53.22-78.94% decrease in bioactive compounds concentrations.

Keywords: Cotoneaster salicifolius, fruits, carotenoids, flavonoids, phenolic compounds

Introduction

Cotoneaster salicifolius Franch. (common name: willowleaf cotoneaster or cranberry cotoneaster), belongs to the Rosaceae family, Amygdaloideae subfamily, Maleae tribe and is a common ornamental shrub.

An evergreen, or (rarely) semi-evergreen small to medium size low shrub, with extensively spreading branches, reddish to gray brown branchlets, elliptic to lanceolate glossy leaves (4-

8.5 cm long), with entire margins and acute apex. White flowers are grouped in dense corymbs. Fruits are scarlet, subglobose to ovoid pomes, with 2-3 pyrenes each, ripening in September-October.

It is native to mountain areas, open slopes and mixed forests in Southern China, but grown worldwide as an ornamental plant (groundcover). It tolerates a wide variety of soils (except for those with water excess), while it is susceptible to some bacterial diseases and insect attack. With proper maintenance, it is able to thrive in urban habitats (Lu & Brach, 2003). In Romania, it is grown in parks and gardens, 'Parkteppich' and 'Repens' being the most popular cultivars (Fig. 1).

Fig.1. *Cotoneaster salicifolius* Franch.

There are no known other uses for *C. salicifolius*, however other related species are used in Asian traditional medicine, for treating bronchitis, gastritis, various infections and vascular illnesses (Liu et al., 2018).

The purpose of this research was to determine the concentration of some key phytochemical classes in fresh and heat-dried fruits of *C. salicifolius*.

Carotenoids (carotenes, lycopene, lutein, zeaxanthin among others) are common pigments in plant leaves, flowers and fruits. They represent the basis for melanin and retinol synthesis, being important for skin and eye health. Some have antitumoral properties (Eldahshan & Singab, 2013).

There are various types of phenolic and polyphenolic compounds, with protective function against pathogens and insects (Kivrak & Kivrak, 2014). Among them are flavonoids, phenolic acids, tannins, with radical scavenging, reducing and lipid oxidation inhibiting activity, thus potent antioxidants (Zymonė et al., 2018).

Among low-mass phenolics, flavonoids have antiviral, antibacterial, antifungal, antiproliferative, antitumoral and anti-inflammatory properties (Kivrak & Kivrak, 2014).

Material and Methods

Pomes were collected from several *C. salicifolius* individuals in public gardens from Constanța, Romania, in November 2018. All individuals found belonged to the 'Repens' cultivar.

Fruit pyrenes (kernels) were extracted and the fruit pulp was ground using an electrical grinder. Part of the pulp was frozen at -20°C, prior to analysis, while the rest was oven-dried at 80°C (over 72 hours).

Both fresh frozen tissue and dry one were analyzed for determining carotenoid, flavonoid and phenolic compounds concentrations (triplicate samples each).

For carotenoids, 0.1 g frozen/dry fruit pulp were ground in 10 mL acetone (80%) and filtered. Spectrophotometric absorbance was read against a blank, using a S106 WPA spectrophotometer, at 470, 647 and 663 nm (Miazek, 2011). Overall carotenoid concentration was estimated according to Lichtenthaler & Buschmann, 2001.

For flavonoids, 1 g fruit pulp was ground with 5 mL methanol and filtered. 0.5 mL of the extract was mixed with 4 mL distilled water and 8 mL methanol. Spectrophotometric absorbance was determined at 340 nm, and concentration calculated according to Szabo et al., 2012.

Total concentration of phenolic compounds was determined via a spectrophotometric Folin-Ciocâlteu method. 0.1 g pulp was ground with 10 mL methanol. 1 mL of extract was mixed with 5 mL 10% Folin-Ciocâlteu reagent and 4 mL 7.5% sodium bicarbonate. After 30 minutes, absorbance was read at 765 nm (Siddiqui et al., 2017; Stanković, 2011).

Concentrations were expressed as mg/kg DW, respectively mg/kg gallic acid equivalent DW (GAE; for phenolics, after proper calibration).

Results and Discussions

Fig. 2 shows carotenoid content in fresh frozen and dry fruits. Fig. 3 and 4 show flavonoid and total phenolic compounds concentrations.

With a 19% dry biomass percentage, the average total carotenoid concentration in fresh frozen pomes was 311.50 mg/kg DW (271.31-346.04 mg/kg in individual samples), while in dry ones only 100.25 mg/kg (92.34-114.26 mg/kg; Fig. 2).

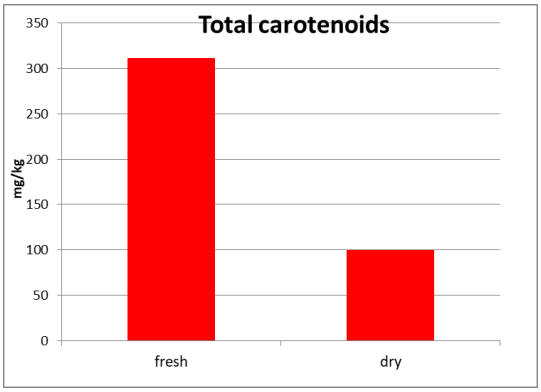

Fig.2. Total carotenoid concentration in fresh and dry *Cotoneaster salicifolius* fruits (average values; mg/kg DW).

While literature offers few data on carotenoid content in *Cotoneaster* fruits, useful comparison can be drawn with related *Pyracantha* species, with over 65 mg/kg total carotenoids in *P. angustifolia* (Zechmeister & Schroeder, 1942), and over 22 mg/kg in *P. crenulata* (a valuable medicinal species growing in the Himalayas; Pal et al., 2013).

Sorbus is another related genus (it includes rowans and service-trees), in the Maleae tribe, subject of a detailed that found a total carotenoid concentration of 39-2,659 mg/kg, in various domestic varieties (Zymonė et al., 2018).

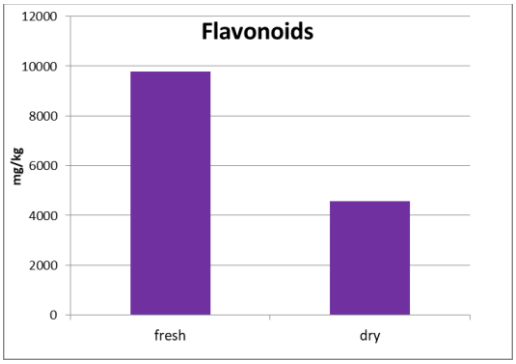

Fig.3. Total flavonoid concentration in fresh and dry *Cotoneaster salicifolius* fruits (average values; mg/kg DW).

Fresh *C. salicifolius* fruits contained, on average, 9,777.62 mg/kg DW of flavonoids (5,307.85-15,225.17 mg/kg), while in dry fruit powder, the concentration dropped to 4,574 mg/kg (4,167-4,910 mg/kg; Fig. 3). For comparison, another creeping cotoneaster species, *C. horizontalis* fruits contains around 6,800 mg/kg (Mohamed et al., 2012), while *C. multiflorus* contains 53,700 mg/kg (Liu et al., 2018).

Sorbus species pomes contain 435-37,000 mg/kg, with high variations due to species, cultivar, geographical and pedological factors (Majić et al., 2015; Zymonė et al., 2018).

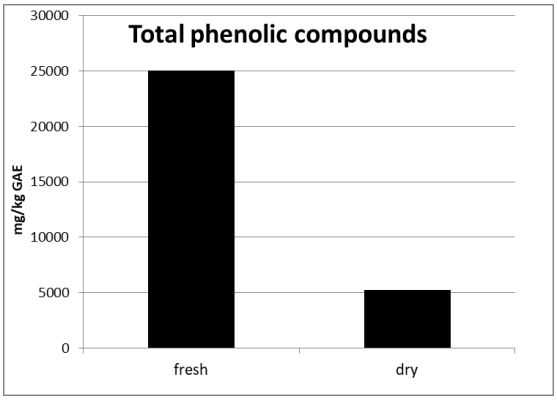

Fig.4. Concentration of total phenolic compounds in in fresh and dry *Cotoneaster salicifolius* fruits (average values; mg/kg GAE DW).

Fresh *C. salicifolius* pomes contained an average of 25,029.09 mg/kg GAE total phenolic compounds (DW; 23,056.09-27,199.39 mg/kg), while in dry fruit powder, the amount dropped to 5,271 mg/kg GAE (4,690-5,730 mg/kg; Fig. 4).

These concentrations are between those found in pomes of *C. horizontalis* (14,000 mg/kg GAE; Mohamed et al., 2012) and *C. multiflorus* (38,600 mg/kg GAE; Liu et al., 2018).

Among related genera, *Pyracantha crenulata* pomes contain 7,430 mg/kg phenolic and polyphenolic compounds (Pal et al., 2013). *S. domestica* fruits contain over 10,000 mg/kg (Majić et al., 2015) and *S. torminalis*, 19,150 mg/kg (Hasbal et al., 2015). Various domestic *Sorbus* sp. cultivars were found to contain 362-8,142 mg/kg GAE phenolics (Zymonė et al., 2018). Wild varieties of *Sorbus* contain 2,218-9,843 mg/kg GAE phenolics in their fruits (Raudonis et al., 2014).

Heat-drying of *C. salicifolius* fruits led to a 67.81% decrease in carotenoids, 53.22% decrease in flavonoids and a 78.94% loss of total phenolics. Thus, the decrease in biocative compounds concentration was a signficant one, higher than the one normal occuring in freeze-drying of various fruits (10-50% for phenolics; Shofian et al., 2011).

Conclusion

Having an average concentration of 311.50 mg/kg total carotenoids, 9,777.62 mg/kg flavonoids and 25,029.09 mg/kg total phenolic snd polyphenolic compounds in their pulp tissues, *C. salicifolius* fruits are comparable, or even have a higher content of bioactive compounds, than pomes belonging to related species, including domestic cultivars of rowanberry (*Sorbus* sp.), wild *Sorbus* species, firethorns (including the medicinal plant *Pyracantha crenulata*), or other studied cotoneasters.

This show a significant potential for these pomes, requiring further investigation.

However, heat-drying was found to be an unsuitable processing method for these fruits, since it led to a 53.22-78.94% decrease in bioactive compounds concentrations.

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