An integrated process for utilization of unused chokeberries

P. Tzatsi, D. Fotiou, D. Karipoglou, E.G. Stampinas, A.M. Goula

Department of Food Science and Technology, School of Agriculture, Forestry and Natural Environment, Aristotle University, 541 24 Thessaloniki, Greece
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Presenting author email: tpinelop@agro.auth.gr, athgou@agro.auth.gr

Aronia melanocarpa berries (black chokeberries) are one of the richest plant sources of phenolic compounds. Different beneficial effects on health have been reported for black chokeberries and their extracts, such as prevention and treatment of cardiovascular diseases and colon cancer, antidiabetes, and antimutagenic effects. This may principally be due to the antioxidant activity exhibited by phenolic species in these berries and their extracts (Galvan D'Alessandro *et al*, 2014). Applications for food preservation are also possible, since natural polyphenols enable to limit lipids degradation.

Although *A. melanocarpa* berries have a good value of edible use, it could be unfavorable for direct consumption because of its heavy astringent taste. The overproduction and non-marketable products lead to unusued fruits that are becoming "waste". Plant wastes are growing rapidly providing new raw materials both in scientific and industrial areas. Plant waste can be a significant source of valuable compounds, such as bioactive molecules useful in the preparation of dietary supplements or nutraceuticals, food ingredients, pharmaceuticals, and cosmetic products. Research for valorization of agricultural waste and by-products has increased during the last decade; however, it has been focused mainly on the waste of the major horticultural products, such as citrus fruits, grapes, raspberries, pomegranates, and apples, while numerous other vegetables, fruits and berry species, including chokeberry, remain underexplored.

Extraction is the first and important step in isolation and purification of bioactive components from plant material. Various extraction techniques can be applied for polyphenol recovery from plants, and generally these techniques can be divided into traditional and modern ones. The traditional extraction methods include maceration, maceration assisted with stirring, and Soxhlet extraction. In recent years, new techniques have been used for the extraction of bioactive compounds, including ultrasound-assisted and microwave-assisted extraction. Extraction efficiency is influenced by several factors such as type and concentration of solvent, solid–solvent ratio, time, temperature, pH, etc. However, in the most studies the influence of a single factor has been explained while the interactions between the factors have not been examined thoroughly.

Many studies have reported extraction of polyphenols from different plant material, but literature data concerning optimization of polyphenol extraction from chokeberry is scarce. Only optimization of ultrasound-assisted extraction of polyphenols from chokeberry by-products has been studied previously (Galvan D'Alessandro *et al*, 2012; Ramic´ *et al*, 2015). Considering that phenolic molecules possesses beneficial effects on human health, and the industry set up demands for reduction of production costs, it is worthwhile to investigate the optimal conditions for the efficient extraction of chokeberry polyphenols.

In the present study, the effects of different factors on the extraction efficiency of polyphenols from dried chokeberry fruit were analyzed in order to optimize the experimental procedure using ultrasound-assisted and microwave-assisted method. In ultrasound-assisted extraction, extraction temperature (20–60 °C), solvent type (0–100% aqueous ethanol), amplitude level (20–60%), and solvent/solid ratio (8–24 mL/g) were the factors investigated with respect to extraction yield. In the case of microwave extraction, the effects of solvent type (0–100% aqueous ethanol), solvent/solid ratio (8–24 mL/g), and microwave power (100–600 Watt) were studied using a response surface methodology. In both methods, the extracts were collected at time intervals of 1, 2, 3, 4, 5, 6, 10, 20, and 30 min. Second-order kinetic models were successfully developed for describing the mechanism of ultrasound and microwave extraction under different processing parameters. The optimum extraction method and operating conditions were determined.

However, it is desirable to produce a dry powder from this aqueous extract since powder is easier to handle and has a longer shelf life than an aqueous extract. Faridi Esfanjani and Jafari (2016) reported that incorporation of pure phenolics in foods is restricted by many reasons: fast release, low solubility, low permeation, low bioavailability, and easily destruction against environment stresses. Among the existing stabilization methods, encapsulation is an interesting means. The most common encapsulation method is the spray drying technique. Spray drying is relatively low-cost, flexible, and leads to the production of high quality and stable particles, making this technique the most used in the food industry.

The aim of this work is to optimize the spray drying encapsulation of pomegranate peel phenolic extract. More specifically, the effects of various parameters, namely wall to core material ratio (2.3–9.0 g/g), drying air inlet temperature (150–190 ^{o}C), and drying air flow rate (17.5–22.8 m^3/h) on encapsulation efficiency and yield were investigated. The main physicochemical properties of the obtained microcapsules, such as moisture content, bulk density, solubility, hygroscopicity, particle morphology, and release behavior in water, were also studied. The obtained dried extract may be used as a functional component of enriched foods to supplement with biofunctional plant metabolites.

References

Faridi Esfanjani, A., & Jafari, S.M. (2016). Biopolymer nano-particles and natural nano-carriers for nano-encapsulation of phenolic compounds. *Colloids and Surfaces B: Biointerfaces*, 146, 532–543.

Galvan D'Alessandro, L., Kriaa, K., Nikov, I., & Dimitrov, K. (2012). Ultrasound assisted extraction of polyphenols from black chokeberry. *Separation and Purification Technology*, *93*, 42–47.

Galván D'Alessandro, L., Dimitrov, K., Vauchel, P., & Nikov, I. (2014). Kinetics of ultrasound assisted extraction of anthocyanins from *Aronia melanocarpa* (black chokeberry) wastes. *Chemical Engineering Research and Design*, *92*, 1818–1826.

Ramić, M., Vidović, S., Zeković, Z., Vladić, J., Cvejin, A., & Pavlić, B. (2015). Modeling and optimization of ultrasound-assisted extraction of polyphenolic compounds from *Aronia melanocarpa* by-products from filter-tea factory. *Ultrasonics Sonochemistry*, *23*, 360–368.