Valorization of peach (*Prunus persica* L.) by-products using green methods

S. Christaki, N. Solomakou, A. Kyriakoudi, K. Kaderides, A.M. Goula, I. Mourtzinos

Department of Food Science and Technology, School of Agriculture, Forestry and Natural Environment, Aristotle University, 541 24 Thessaloniki, Greece

Presenting author email: stamchri@agro.auth.gr

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Peach (*Prunus persica*) is a "stone fruit" which belongs to the *Rosaceae* family, originating from China. It is considered the third most important deciduous tree fruit worldwide, ranking after apples and pears. It constitutes a naturally rich source of vitamins, minerals, carotenoids and phenolic compounds such as chlorogenic and neochlorogenic acids, catechin, epicatechin, cyanidin and quercetin derivatives (Bento *et al* 2020; Liu *et al* 2015). Peaches are categorized, depending on the adherence of flesh to the stone, as free-stone, mainly consumed fresh, or as clingstone, which have industrial applications. Many products can be processed from clingstone fruit, like juice, jelly or canned, jam, frozen, dried peaches. Preparation of raw material before processing involves removal of peels and kernels, which are later disposed as wastes. Peach peels and kernels are the major by-products of the peaches industry, resulting in disposal costs and waste environmental problems. In the case of peels, known also as epicarp, they contain much higher concentrations of bioactive components compared to the mesocarp. Specifically, according to Chang *et al* (2000), peach peels contain 2-2.5 times higher concentrations of phenolic compounds and carotenoids in comparison to the flesh of the fruit, a finding that has been observed by a number of researchers. This phenomenon can be especially observed in the outer skin layer, as phenolic compounds probably contribute to the protection of the fruit from environmental stresses and microbial threats (Stojanovic *et al* 2016). Consequently, peach peels should be considered a material with significant potential as a nutritional source. On the other hand, peach kernels, known as the pit or endocarp, range between 3 and 8% of the total fresh fruit mass and are mainly composed of unsaturated fatty acids (40-50%), proteins (15-45%), and fibers (4-8%). The main fatty acids found in peach kernel oil are oleic acid and linoleic acid (Wu *et al* 2011). The high concentration of phenolic components and fatty acids suggest that peach kernels could be considered a great source of value-added components for food, cosmetic, and nutraceutical industries.

In this view, a holistic approach for peach waste management towards the recovery of bioactive compounds, is proposed. Traditionally for this purpose, conventional maceration extraction (CME) utilizing organic solvents is used, although such procedures are time, solvent, and energy consuming. Thus, the focus of the research community has turned on the development of novel environmentally friendly extraction techniques, that minimize solvent and energy consumption, with a concomitant reduced duration and increased extraction yield. Specifically, in the present study, ultrasound-assisted extraction (UAE) was used for the recovery of phenolic compounds from peach peels. Response surface methodology (RSM) was employed to optimize the extraction parameters, namely, the duration (min), the percentage of ethanol (%), the solvent/solid ratio as well as the pulse duration/pulse interval ratio. The sample temperature was kept below 30 ^{o}C with the aid of an ice bath. The optimum extraction conditions were then compared with CME. In addition, an enzymatic pre-treatment was also employed in order to increase the phenolics extraction yield. In this case, the examined parameters were the pre-treatment duration (60-240 min), the type of enzyme (cellulose:pectinase) (0-100% pectinase), the enzyme concentration (2-4% w/w), and the ratio of solution/solid waste, which ranged between 2/1 and 6/1 mL/g.

Regarding the extraction of oil from the peach stones, UAE was also employed and the extraction parameters, namely the extraction temperature (20-65 ^{o}C), the amplitude level (30-60%), and the hexane/solid waste ratio (8/1 and 24/1 mL/g) were optimized. The pulse duration/pulse interval ratio was kept constant. The optimum extraction conditions were then compared with the CME results.

Findings of the present study seem promising towards the holistic exploitation of peach industry by-products as well as their future applications as natural additives (e.g. antioxidants) to functional products, with the simultaneous reduction of environmental threat.

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