Optimization of polyphenols extraction from pomegranate peels – drying, enzymatic pretreatment, extraction method, operating conditions

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Pomegranate (*Punica granatum* L.) is one of the oldest known edible fruit that contains the highest concentration of total polyphenols in comparison with other fruits studied. The main uses of pomegranates in food industries include fresh juice or pomegranate-based drinks. Since the juice yield of pomegranates is less half of the fruit weight, very large amounts of by-product wastes, such as peels, are formed every year. Pomegranate by-product wastes have been traditionally valorised as animal feed. Recently, a number of studies have proposed that some fruit or vegetable by-products could be a source of natural antioxidants. The antioxidant capacity of pomegranate is related to the presence of phenolic materials, especially elagic acid and punicalagin. These compounds that are mostly found in the fruit peels cause the antimutation, antiviral, antimicrobial, and antioxidant activity of different parts of pomegranate extracts.

Pomegranate peel phenolics can be extracted with various extraction methods. Shortcomings of existing extraction technologies, like increased consumption of energy, high extraction time, possible degradation of bioactive compounds, and high consumption of harmful chemicals, have forced the food and chemical industries to find new separation ‘‘green’’ techniques, which typically use less solvent and energy, such as ultrasound and microwave-assisted extraction. The main aim of the present research was to compare these new extraction techniques to propose an optimum method for isolation of priced compounds from pomegranate peels. For the ultrasound extraction, response surface methodology was used to study and optimize the effects of solvent type (methanol, ethanol, water, ethyl-acetate, 50% aqueous methanol), extraction temperature (25-45 ºC), solvent/solid ratio (10/1-50/1 mL/g), amplitude level (20-60%), and pulse duration/pulse interval ratio (5/15-2/1) on the yield of phenolics extraction. In the case of microwave-assisted extraction, solvent type (water, 50% and 70% aqueous ethanol, 50% and 70% aqueous methanol), solvent/solid ratio (10/1-50/1 mL/g), and microwave power (100-600 Watt) were the factors investigated. In both methods, the extracts were collected at determined time intervals and 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.

In addition, the effect of pomegranate peels moisture content on extraction yield was studied under the optimum extraction conditions. Two different drying treatments (air and solar drying) were performed and compared. Finally, another objective of the present work was to study the enhancement of the optimum extraction treatment by enzymatic pre-treatment using two different enzymes, cellulase and pectinase, under different operating conditions (enzyme concentration, 2-4% w/w; treatment time, 60-220 min; water/solid ratio, 2/1-6/1 mL/g).

Dehydration of pomegranate peels is the first step before extraction. Thus, another subject of this work is to study the drying behavior of this by-product and the kinetics of total phenolics degradation during the drying process. Drying (moisture vs time) data were obtained on slabs of pomegranate peels in an air dryer operated at 40-80 ºC. The effective diffusivity was determined using the simplified solution of the Fick’s second law and the method of slopes of the drying curve taking into account the effect of moisture content on diffusivity. The combined effect of moisture content and temperature on effective diffusivity was expressed by an empirical model. In addition, each moisture loss curve was fit to empirical simplified drying models.