A comparative study on different extraction techniques to recover polyphenols from winery waste

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Around 80% of the world grape production is estimated to be processed into wines resulting in the accumulation of great amounts of grape pomace. Statistical data regarding grape pomace amounts are lacking. Thus, data reported in literature may only be regarded as rough estimates, ranging from 5 to 7 million tons to 14.5 million tons solely in Europe. However, given the aforementioned production quantities and considering must yields of around 80%, pomace amounts are safely assumed to exceed 10 million tons per year. Even though grape pomace offers the potential for recovering a wide range of high-value products, such as ethanol, tartrate, malate, citric acid, grape seed oil, hydrocolloids, and dietary fiber, it has long been disposed of in the form of soil conditioner or for producing compost, since it is neither applicable in animal production due to poor digestibility. Furthermore, large amounts of pomace are accumulated within a comparatively short harvest period and, due to its high moisture content, this by-product is prone to rapid microbial spoilage. Consequently, grape pomace needs to be either processed immediately or transformed into stable dehydrated products. However, the drying process and storage of the dried material go along with significant losses of valuable components, especially of phenolic compounds. In recent decades, however, grape pomace has been recognized as a valuable source of phenolic compounds, which are poorly extracted from the skins and seeds upon vinification.

Maceration is the most commonly used procedure for leaching phenolic compounds from grapes and residues from them, where the solid sample is stirred with a suitable liquid for long times. However, the different treatments to which grape pomace is subjected suggest the possibility of using auxiliary energies to enhance the leaching efficiency of strongly retained compounds. In this sense, the leaching step can be assisted by auxiliary energies such as microwaves or ultrasound. The main aim of the present research was to compare the present and traditional extraction techniques to propose an optimum method for isolation of priced compounds from grape pomace.

Two present extraction techniques (microwave-assisted extraction, MAE and ultrasound-assisted extraction, UAE) have been selected and used in comparison with conventional maceration extraction, CME, using overall quantitation methods. 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 2, 5, 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.

In addition, the effect of grape pomace 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 procedure 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).

Grape pomace extracts obtained according to the aforementioned processes may be used as functional components of enriched foods both to color the products with anthocyanins and to supplement with biofunctional plant metabolites.