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Alkali-catalyzed Organosolv Treatment for Wheat Straw Harnessing as a Bioresource of Hydroxycinnamate Antioxidants

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Abstract

Biowaste treatment and valorisation are key elements in strategies pertaining to higher sustainability and bioeconomy consolidation. In this direction, the search for low-cost and abundant bioresources, as well as the development of eco-friendly technologies for effective recovery of high value-added substances are imminent. In this framework, the examination presented herein aimed at developing a benign alkali-catalysed organosolv treatment for efficacious recovery of antioxidant hydroxycinnamates from wheat straw (WS), which is a widespread agricultural residue, rich in lignocellulosic material. After an initial screening, 20% (v/v) 1-propanol was selected as the most efficient solvent, and a following trial indicated 1.5% sodium hydroxide as the most appropriate catalyst concentration. Using this system (20% 1propanol/1.5% sodium hydroxide), WS treatment was investigated by carrying out polyphenol recovery kinetics, estimating the effect of severity and performing treatment optimisation with response surface methodology. It was shown that the yield in total polyphenols and the ferric-reducing power of the extracts produced were highly correlated with treatment severity, but the antiradical activity was less so. Under optimised conditions, the treatment afforded a total polyphenol yield of 30.0±1.7 mg ferulic acid equivalents g-1 dry WS mass, at 300 min and 80 °C. Analysis of the extracts obtained under optimised conditions with liquid chromatography-tandem mass spectrometry revealed the instrumental role of the alkali catalyst in liberating major bound hydroxycinnamates, namely p-coumaric acid and ferulic acid. The corresponding yields of these two compounds were 4.01 and 2.55 mg g-1 dry WS mass, suggesting WS as a promising source of high value-added phytochemicals, with a significant prospect in food, pharmaceutical and cosmetics industry. It is proposed that such advancements would further demonstrate the significant potential of WS as an exceptionally rich lignocellulosic bioresource, while these technologies may constitute key components of integrated biomass utilisation strategies, aimed at bioproduct development within an overarching biorefinery framework.

Keywords: antioxidants, p-coumaric acid, ferulic acid, lignin, polyphenols, wheat straw