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Extraction of Bioactive Secondary Metabolites from Citrus Maxima Peel Via Pressurized Hot Water Extractor for the Synthesis of Iron Oxide Nanoparticles

Abstract

Using bioactive secondary metabolites (BSM) from Citrus maxima peel extract, this work investigated a green method of synthesizing magnetite iron oxide (Fe_3O_4) nanoparticles (NPs). The BSM acts as a reducing cum stabilizing agent in the process. The optimization of the BSM parameters were conducted through response surface methodology (RSM). The optimal condition obtained in this study for pressurized hot water extractor (PHWE) extraction was temperature of 94.96 °C, solvent-to-solid ratio of 29.7 ml/g and extraction time of 27.6 min. BSM Yield of 49.31 % could be obtained based on this condition. The formation of Fe_3O_4 NPs were detected using the FTIR analysis with the absorption peaks observed at around 590 and 580 cm^{-1}. X-ray diffraction results matched standard magnetite Fe3O4 patterns with planes at (220), (311), (400), (511) and (440). Field emission scanning electron microscopy (FESEM) results showed that the magnetite Fe_3O_4 NPs synthesized in this study predominantly appeared in spherical shape. The extraction process's kinetics were examined using various empirical models, including the Elovich's model, Peleg's model, Power law and parabolic diffusion model. All applied models were found to be well fitted with the measured data from experiment, with R^2 values exceeding 0.9. Notably, the Peleg's model exhibited the highest R^2, the smallest RMSD, and the least significant p-values, indicating its superior performance.

Keywords

Bioactive secondary metabolites; Extraction; Fruit peels; Magnetite iron oxide nanoparticles