

Design and Fabrication of Bio-Based Hydroquinone Functional Materials from *Citrus hystrix* Dc. for Antioxidant Performance Enhancement in nonpolar Systems

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Abstract

Hydroquinone is a polyphenolic compound widely used for its antioxidant properties. In this study, hydroquinone derivatives were synthesized *via* an aldol condensation reaction between 1,4-cyclohexanedione and citronellal, the latter being extracted from *Citrus hystrix* DC. leaves through steam distillation. The synthesis of compounds from natural substances enhances the value of natural products while reducing the reliance on synthetic chemicals. The reaction was carried out in pyridine using LiCl as a catalyst. The resulting hydroquinone derivatives were obtained as dark brown crystals with an R_f value of 0.42 (hexane:ethyl acetate:methanol, 7:2:1) and a melting point of 158–160 °C. Structural characterization by FT-IR spectroscopy revealed absorption bands at 3348 cm⁻¹ (O–H stretching), 1606 cm⁻¹ (C=C stretching of alkene), and 1453 and 1506 cm⁻¹ (aromatic C=C stretching). Further analysis by ¹H-NMR spectroscopy showed signals at δ 4.57 and 4.73 (s, 2H, aromatic OH), 6.63 (s, 1H), and 6.52 (dd, 2H) corresponding to aromatic protons, as well as 5.11 (t, 1H) attributed to a proton on the C=C bond. The antioxidant activity of the synthesized compounds was evaluated using ABTS cation radical and DPPH radical scavenging assays. The IC₅₀ values were determined spectrophotometrically and compared with the standard gallic acid. The results showed IC₅₀ values of 121.12 ppm and 77.06 ppm, respectively, which are higher than that of citronellal but lower than the gallic acid standard. Although the antioxidant activity of the synthesized compounds was lower than that of the standard, they are still suitable for applications in nonpolar systems, such as serving as antioxidants in biodiesel.

Keyword: antioxidant, citronellal, hydroquinone derivatives, *Citrus hystrix* DC.