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Catalytic activity of green synthesized iron-palladium bimetallic nanoparticles on Sonogashira and Stille cross-coupling reactions

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Catalytic applications of plant extract mediated green synthesized bimetallic NPs have attracted significant interest as an eco-friendly method. The Sonogashira and Stille carbon-carbon cross-coupling reactions are widely used in the synthesis of complex organic molecules. The objective of this research was to investigate the catalytic activity of Fe-Pd bimetallic nanoparticles, synthesized using banana leaf extract of *Musa Paradisiaca*, on Sonogashira and Stille cross-coupling reactions. Banana leaf extract (BLE) was prepared by boiling fresh banana leaves (50 g) in deionized water (150 mL) for 30 minutes. The UV-Vis spectrum of the BLE showed peaks at 200-270 nm range and 350 nm, which correspond to the polyphenolic compounds that can act as reducing, capping and stabilizing agents during nanoparticle synthesis. PdCl₂ (0.050 M) and Fe₂O₃ (0.0028 M) were used as precursors to synthesize the bimetallic nanoparticles. Synthesized Fe-Pd nanoparticles were characterized by X-ray diffraction. Reflections at 39.82^o, 46.31^o and 67.65^o are well indexed to the (111), (200), and (220) planes of crystalline palladium. The powder X-ray diffraction study confirmed the crystal structure of zero-valent Pd. The synthesized Fe-Pd nanoparticles showed magnetic properties which is an important feature for catalytic reusability. The catalytic activity of synthesized Fe-Pd NPs was studied in Sonogashira and Stille C-C cross-coupling reactions. The optimum reaction conditions for Sonogashira C-C cross-coupling reaction of bromobenzene and phenylacetylene were found out to be 0.63% Fe-Pd nanoparticles (with respect to bromobenzene) in water (solvent) using K₂CO₃ (2 mmol) as a base at 60 °C for 30 min. The purified product, diphenyl acetylene was isolated in 47% yield. Stille cross-coupling reaction was carried out using Fe-Pd NPs (2% w/w, relative to bromobenzene) as the catalyst and K₂CO₃ (2.0 mmol) as the base at 80 °C in water for 1 h. The Stille cross-coupling reaction of bromobenzene with tributylphenylstannane yielded pure biphenyl in 87%. It can be concluded that Fe-Pd bimetallic NPs synthesized using banana leaf extract can be applied as a catalyst on Sonogashira and Stille cross-coupling reactions.

Keywords: Fe-Pd nanoparticles, green synthesis, banana leaf extract, C-C cross coupling reactions

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