

Antimicrobial Potential of Pd(II) complexes bearing 1,1'- Bis(diphenylphosphino) ferrocene (dppf) Moiety

Abdul Afiq Nazmi Abdul Aziz^a, Shamsul Bahrin Gulam Ali^b, Khairil Anuar Jantan^{a,c*}

Structured Abstract

Background: Antimicrobial resistance (AMR) threatens worldwide health, including Malaysia. Health Minister Datuk Seri Dr. Dzulkefly Ahmad predicted 87,000 AMR deaths from 2020 to 2030 without appropriate treatments. AMR must be addressed to maintain public health and economic stability. Pd(II) complexes exhibit structural adaptability that enables them to disrupt microbial functions, mimic essential metal ions, and induce oxidative stress, positioning them as promising candidates for addressing resistant infections. This research evaluates the efficacy of Pd(II) complexes with dppf ligand against human pathogenic microorganisms.

Methods: PdI₂(dppe) was synthesised through the reaction of (Ph₄P)₂[Pd₂I₆] with dppe in acetone at ambient conditions. The resultant compounds were meticulously characterised by FT-IR, ¹H and ³¹P NMR spectroscopy. Elemental and TGA analysis additionally validated their chemical composition. The antibacterial efficacy was evaluated by the Kirby-Bauer Disc Diffusion Susceptibility Test, in accordance with the protocols set forth by the Clinical and Laboratory Standards Institute (CLSI). The assessment focused on both Gram-positive bacterial strains (*Bacillus subtilis*, *Bacillus cereus*, and *Staphylococcus aureus*) and the Gram-negative strain *Escherichia coli*. The antimicrobial efficacy was evaluated at different concentrations, using chloramphenicol as the reference standard.

Results: A precipitate of brownish-red PdI₂(dppf) was formed. The formation of the complex was validated by the ³¹P{¹H} NMR spectrum at 24.3 ppm, while the presence of dppf ligands was distinctly identified in the ¹H NMR spectrum via ferrocenyl resonances at 4.14 and 4.35 ppm. The purity was further confirmed through IR spectroscopy, elemental analysis, and TGA evaluation. The initial antimicrobial evaluation indicated that PdI₂(dppf) exhibited moderate activity against the tested gram-positive bacterial strains (6 and 13 mm) compared to chloramphenicol (30 to 38 mm). A consistent zone of inhibition was observed at elevated concentrations, suggesting a non-dose-dependent response. No inhibition zone was detected against the Gram-negative *E. coli* strains.

Conclusion: PdI₂(dppf) was effectively synthesised and characterized. Initial antimicrobial assays indicate its promise as an antibacterial agent, necessitating additional research on its biological applications and toxicity profile.

Keywords: Palladium complex, dppe, antimicrobial activity

*Correspondence: khairil0323@uitm.edu.my

^a School of Chemistry & Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia

^b Faculty of Health Sciences, Bertam Campus, Universiti Teknologi MARA, 13200 Kepala Batas, Penang Malaysia

^c Multifunctional Nanoporous Material Research Group (MULNA), Universiti Teknologi MARA, Shah Alam, Malaysia