Green Synthesis of Potent Antimicrobial 1,2,4-Triazolo [1,5-a] pyrimidine Derivatives using Indian Gooseberry (Phyllanthus Emblica) Extract as a Natural Catalyst

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Abstract:

Antimicrobial resistance (AMR) poses a critical global health challenge, necessitating the development of novel therapeutic agents. In alignment with the principles of green chemistry, this study presents an eco-conscious synthesis of 25 novel 1,2,4-triazolo[1,5-a]pyrimidine derivatives catalyzed by Indian gooseberry (Phyllanthus Emblica) fruit extract. Rich in organic acids and polyphenolic compounds, gooseberry juice acts as an environmentally sustainable catalyst, enabling a one-pot, solvent-free synthetic route. This method not only reduces environmental impact but also enhances the reaction's efficiency, achieving high yields in significantly less time compared to conventional methods. The synthesized compounds were rigorously evaluated for their antimicrobial activity against a spectrum of clinically relevant microorganisms, including Chromobacterium violaceum, Klebsiella pneumoniae, Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Candida albicans, Cryptococcus neoformans, and Aspergillus niger. Additionally, cytotoxicity assessments were performed on HEK-293 cells, ensuring the biocompatibility of the compounds. Notably, compounds B-1, B-6, B-7, B-14, and B-15 demonstrated potent antimicrobial activity, low cytotoxicity, and high cell viability, highlighting their potential for further pharmaceutical development. This research underscores the importance of sustainable synthesis in antimicrobial drug discovery, offering a green alternative to traditional synthetic methods while addressing the pressing issue of AMR. By integrating natural catalysts and solvent-free processes, this study contributes to a more sustainable future in pharmaceutical innovation.