Synthesis of Quinoline Derivatives via the Friedländer Annulation Using a Sulfonic Acid Functionalized Liquid Acid as Dual Solvent-Catalyst

Nader Ghaffari Khaligh\textsuperscript{a,b}, Taraneh Mihankhah\textsuperscript{c}, and Mohd Rafie Johan\textsuperscript{b}

\textsuperscript{a}Professor Reza Research Institute, Education Guilan, Rasht, Iran; \textsuperscript{b}Nanotechnology and Catalysis Research Center, Institute of Postgraduate Studies University of Malaya, Kuala Lumpur, Malaysia; \textsuperscript{c}Environmental Research Laboratory, Department of Water and Environmental Engineering, School of Civil Engineering, Iran University of Science and Technology, Tehran, Iran

\textbf{ABSTRACT}
4-Imidazol-1-yl-butane-1-sulfonic acid (ImBu-SO\textsubscript{3}H) has been synthesized and completely characterized by FT-IR, one-dimensional NMR spectroscopy (\textsuperscript{1}H, \textsuperscript{13}C). The “plausible” alternative structures of ImBu-SO\textsubscript{3}H were discussed by NMR. The title liquid acid showed interesting dual solvent-catalytic property, which was studied experimentally in the synthesis of quinoline derivatives via the Friedländer annulation and provided good yield within short reaction time. ImBu-SO\textsubscript{3}H was successfully recycled by water extraction, instead of organic solvent extraction, with an average recovered yield of 82\% for five subsequent runs. The recycled liquid acid showed almost no loss of the catalytic activity even after five consecutive runs.

\textbf{INTRODUCTION}
Quinoline and its derivatives display numerous biological and pharmacological activities such as antimalarial, antibacterial, antifungal, antiviral, anti-HIV, anthelmintic, central nervous system (CNS) effect, cardiotonic, anti-convulsant, anti-inflammatory, antiproteozaal, antineoplastic, hypoglycemic, and analgesic.\textsuperscript{1} Quinoline and its analogs have been investigated in the inhibition of tyrosine kinases, proteasome, tubulin polymerization, topoisomerase, and DNA repair; also they are of developing an interest in the field of anticancer drugs to almost every branch of medicinal chemistry.\textsuperscript{2} A number of well-known protocols have been reported for the synthesis of quinoline ring, which can be well modified to prepare a variety of substituted quinolines, including Skraup,\textsuperscript{3} Doebner–von Miller,\textsuperscript{4} Friedländer,\textsuperscript{5} Pfitzinger,\textsuperscript{6} Cycloaddition reactions,\textsuperscript{7} Conrad–Limpach,\textsuperscript{8} and Combes.\textsuperscript{9}

The development of the environmentally benign synthesis routes has been strongly required due to the rising environmental concerns of conventional chemical processes. Four main approaches have widely been considered to synthesize compounds in a sustainable manner: use green solvents instead of an organic solvent; do the reaction under solvent-free conditions; load catalytic amounts of reagent instead of stoichiometric amounts, and use enzymes and organocatalysts.\textsuperscript{10} Several green approaches were reported for the synthesis of quinolones via Friedländer annulation in non-aqueous media and using ionic liquids.\textsuperscript{11,12}

\textbf{CONTACT} Nader Ghaffari Khaligh\textsuperscript{a} ngkhkhaligh@gmail.com Reza Research Institute, Education Guilan, Rasht, Iran. Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/gpol.

© 2018 Taylor & Francis Group, LLC