



DAFTAR PUSTAKA

- Abaszadeh, M., Seifi, M., and Asadipour, A., 2015, Ultrasound Promotes One-Pot Synthesis of 1,4-Dihydropyridine and Imidazo[1,2-a]quinoline Derivatives, Catalyzed by ZnO Nanoparticles, *Res. Chem. Intermed.*, 41, 5229–5238.
- Aday, B., Yildiz, Y., Ulus, R., Eris, S., Sen, F., and Kaya, M., 2016, One-Pot, Efficient and Green Synthesis of Acridinedione Derivatives using Highly Monodisperse Platinum Nanoparticles Supported with Reduced Graphene Oxide, *New J. Chem.*, 40, 748–754.
- Alirezvani, Z., Dekamin, M.G., and Valiey, E., 2019, New Hydrogen-Bond-Enriched 1,3,5-Tris(2-hydroxyethyl) Isocyanurate Covalently Functionalized MCM-41: An Efficient and Recoverable Hybrid Catalyst for Convenient Synthesis of Acridinedione Derivatives, *ACS Omega*, 4, 20618–20633.
- Aqeel Ashraf, M., Liu, Z., Yang, Y., and Zhang, D., 2020, Magnetic Nanoparticles Supported Copper Catalysts: Synthesis of Heterocyclic Scaffolds, *Synth Commun*, 2885–2905.
- Argyle, M.D. and Bartholomew, C.H., 2015, Heterogeneous Catalyst Deactivation and Regeneration: A review, *Catalysts*, 5, 145–269.
- Azarifar, D., Badalkhani, O., and Abbasi, Y., 2016, Silica-Modified Magnetite Fe₃O₄ Nanoparticles Grafted with Sulfamic Acid Functional Groups: an Efficient Heterogeneous Catalyst for The Synthesis of 3,4-Dihydropyrimidin-2(1H)-one and Tetrahydrobenzo[b]pyran Derivatives, *J.Sulfur Chem.*, 37, 656–673.
- Bakherad, M., Bagherian, G., Mosayebi, F., Rezaeifard, A., and Keivanloo, A., 2022, Synthesis and UV-Visible Study of Polyhydroquinolines and 1,4-Dihydropyridines in Magnetized Distilled Water, *Polycycl Aromat Compd*, 42, 3501–3522.
- Balaji, G.L., Rajesh, K., Venkatesh, M., Sarveswari, S., and Vijayakumar, V., 2014, Ultrasound-Promoted Synthesis of Bi-, Tri- and Tetrapodal Polyhydroquinolines, 1,4-Dihydropyridines and The Corresponding Pyridines, *RSC Adv*, 4, 39–46.
- Bayramoğlu, D. and Özügür, M., 2021, Ultrasound-Assisted One-Pot Synthesis of 9-(Substituted heteroaryl) acridinedione Derivatives, *Düzce Üniversitesi Bilim ve Teknol. Derg.*, 1610–1620.
- Beiranvand, R. and Dekamin, M.G., 2021, Trimesic Acid-Functionalized Chitosan: A Novel And Ecient Multifunctional Organocatalyst For Green Synthesis of Polyhydroquinolines And Acridine diones Under Mild Conditions,,



- Bladen, C., Gündüz, M.G., Şimşek, R., Şafak, C., and Zamponi, G.W., 2014, Synthesis and Evaluation of 1,4-Dihydropyridine Derivatives with Calcium Channel Blocking Activity, *Pflugers Arch*, 466, 1355–1363.
- Brinkerhoff, R.C., Santa-Helena, E., Do Amaral, P.C., Cabrera, D.D.C., Ongarotto, R.F., De Oliveira, P.M., Da Ros Montes D’Oca, C., Neves Gonçalves, C.A., Maia Nery, L.E., and Montes D’Oca, M.G., 2019, Evaluation of The Antioxidant Activities of Fatty Polyhydroquinolines Synthesized by Hantzsch Multicomponent Reactions, *RSC Adv*, 9, 24688–24698.
- Crawford, D.E., 2017, Solvent-free sonochemistry: Sonochemical Organic Synthesis in The Absence of A Liquid Medium, *Beilstein J. Org. Chem.*, 13, 1850–1856.
- Dam, B., Nandi, S., and Pal, A.K., 2014, An Efficient “On-Water” Synthesis of 1,4-Dihydropyridines Using Fe₃O₄@SiO₂ Nanoparticles as A Reusable Catalyst, *Tetrahedron Lett*, 55, 5236–5240.
- Dangolani, S.K., Niknam, E., Shahraki, O., and Khalafi-Nezhad, A., 2021, Unexpected Dihydropyridinium Derivatives using A Multicomponent Reaction Containing Unprotected Amino Acids, *J Mol Struct*, 1245, .
- Dekamin, M.G., IlkhaniZadeh, S., Latifidoost, Z., Daemi, H., Karimi, Z., and Barikani, M., 2014, Alginic Acid: A Highly Efficient Renewable and Heterogeneous Bio-Polymeric Catalyst for One-Pot Synthesis of The Hantzsch 1,4-Dihydropyridines.
- Dömling, A., Wang, W., and Wang, K., 2012, Chemistry and Biology of Multicomponent Reactions, *Chem Rev*, 112, 3083–3135.
- Estévez, V., Villacampa, M., and Menéndez, J.C., 2010, Multicomponent Reactions for The Synthesis of Pyrroles, *Chem Soc Rev*, 39, 4402–4421.
- Fardood, S.T., Ramazani, A., and Moradi, S., 2017, Green Synthesis of Ni–Cu–Mg Ferrite Nanoparticles using Tragacanth Gum and Their Use as An Efficient Catalyst for The Synthesis of Polyhydroquinoline Derivatives, *J Solgel Sci Technol*, 82, 432–439.
- Ghafuri, H., Moradi, S., Ghanbari, N., Dogari, H., and Ghafori, M., 2022, Efficient and Green Synthesis of Acridinedione Derivatives Using Highly Fe₃O₄@Polyaniline-SO₃H as Efficient Heterogeneous Catalyst., MDPI AG, p. 23.
- Ghosh, S., Saikh, F., Das, J., and Pramanik, A.K., 2013, Hantzsch 1,4-Dihydropyridine Synthesis in Aqueous Ethanol by Visible Light, *Tetrahedron Lett*, 54, 58–62.



- Gilanizadeh, M. and Zeynizadeh, B., 2021, Synthesis of Acridinediones and Biscoumarins Using Fe₃O₄@SiO₂@Ni-Zn-Fe LDH as an Efficient Magnetically Recoverable Mesoporous Catalyst, *Polycycl Aromat Compd*, 41, 15–32.
- Girija, D.K. and Sudhamani, C., 2011, Cerium Oxide Nanoparticles-a Green, Reusable, and Highly Efficient Heterogeneous Catalyst for the Synthesis of Polyhydroquinolines Under Solvent-free Conditions Gut Metagenomics of *H. armigera* View project.,
- Hajjami, M. and Tahmasbi, B., 2015, Synthesis and Characterization of Glucosulfonic Acid Supported on Fe₃O₄ Nanoparticles as A Novel and Magnetically Recoverable Nanocatalyst and Its Application in The Synthesis of Polyhydroquinoline and 2,3-Dihydroquinazolin-4(1H)-one Derivatives, *RSC Adv*, 5, 59194–59203.
- Heusler, A., Fliege, J., Wagener, T., and Glorius, F., 2021, Substituted Dihydropyridine Synthesis by Dearomatization of Pyridines, *Angew. Chemie - Int. Ed.*, 60, 13793–13797.
- Kalaria, P.N., Satasia, S.P., and Raval, D.K., 2014, Synthesis, characterization and pharmacological screening of some novel 5-imidazopyrazole incorporated polyhydroquinoline derivatives, *Eur J Med Chem*, 78, 207–216.
- Kazemi, M. and Mohammadi, M., 2020, Magnetically Recoverable Catalysts: Catalysis in Synthesis of Polyhydroquinolines, *Appl Organomet Chem*, 34, .
- Khabazzadeh, H., Kermani, E.T., Afzali, D., Amiri, A., and Jalaladini, A., 2012, Efficient One-Pot Synthesis of Polyhydroquinoline Derivatives Using Cs 2.5H 0.5PW 12O 40 as A Heterogeneous and Reusable Catalyst in Molten Salt Media, *Arab. J. Chem.*, 5, 167–172.
- Kilbas, B., Ergen, S., and Cakici, D., 2019, Highly Efficient and Reusable Pd/Al(OH) Catalyzed Synthesis of Acridinedione Derivatives, *Curr Organocatal*, 6, 257–265.
- Kumar, R.S., Idhayadhulla, A., Abdul Nasser, A.J., and Selvin, J., 2011, Synthesis and Anticoagulant Activity of A New Series of 1,4-Dihydropyridine Derivatives, *Eur J Med Chem*, 46, 804–810.
- Liandi, A.R., Cahyana, A.H., Kusumah, A.J.F., Lupitasari, A., Alfariza, D.N., Nuraini, R., Sari, R.W., and Kusumasari, F.C., 2023, Recent Trends of spinel Ferrites (MFe₂O₄: Mn, Co, Ni, Cu, Zn) Applications as An Environmentally Friendly Catalyst in Multicomponent Reactions: A Review, *Case Stud. Chem. Environ. Eng.*, 7.



- Maleki, B., Atharifar, H., Reiser, O., and Sabbaghzadeh, R., 2021, Glutathione-Coated Magnetic Nanoparticles for One-Pot Synthesis of 1,4-Dihydropyridine Derivatives, *Polycycl Aromat Compd*, 41, 721–734.
- Mohammadi, H. and Shaterian, H.R., 2020, Ferric(III)Complex Supported on Superparamagnetic Fe₃O₄@SiO₂ as A Reusable Lewis Acid Catalyst: A New Highly Efficient Protocol for The Synthesis of Acridinedione and Spiroquinazolin-4(3H)-one Derivatives, *Res. Chem. Intermed.*, 46, 179–195.
- Nasr-Esfahani, M., Hoseini, S.J., Montazerozohori, M., Mehrabi, R., and Nasrabadi, H., 2014, Magnetic Fe₃O₄ Nanoparticles: Efficient and Recoverable Nanocatalyst for The Synthesis of Polyhydroquinolines and Hantzsch 1,4-Dihydropyridines Under Solvent-Free Conditions, *J Mol Catal A Chem*, 382, 99–105.
- Pagadala, R., Kasi, V., Shabalala, N.G., and Jonnalagadda, S.B., 2022, Ultrasound-Assisted Multicomponent Synthesis of Heterocycles in Water – A review, *Arab. J. Chem.*, 15, .
- Pourian, E., Javanshir, S., Dolatkahah, Z., Molaei, S., and Maleki, A., 2018, Ultrasonic-Assisted Preparation, Characterization, and Use of Novel Biocompatible Core/Shell Fe₃O₄@GA@Isinglass in the Synthesis of 1,4-Dihydropyridine and 4 H-Pyran Derivatives, *ACS Omega*, 3, 5012–5020.
- Ramish, S.M., Ghorbani-Choghamarani, A., and Mohammadi, M., 2022, Microporous Hierarchically Zn-MOF as An Efficient Catalyst for The Hantzsch Synthesis of Polyhydroquinolines, *Sci Rep*, 12, .
- Ruijter, E., Scheffelaar, R., and Orru, R.V.A., 2011, Multicomponent Reaction Design in The Quest for Molecular Complexity and Diversity, *Angew. Chemie - Int. Ed.*, 50, 6234–6246.
- Sakram, B., Sonyanaik, B., Ashok, K., and Rambabu, S., 2016, Polyhydroquinolines: 1-Sulfopyridinium Chloride Catalyzed An Efficient One-Pot Multicomponent Synthesis via Hantzsch Condensation Under Solvent-Free Conditions, *Res. Chem. Intermed.*, 42, 7651–7658.
- Saranya, S., Radhika, S., Afsina Abdulla, C.M., and Anilkumar, G., 2021, Ultrasound Irradiation in Heterocycle Synthesis: An Overview, *J Heterocycl Chem*, 58, 1570–1580.
- Sayahi, M.H., Afrouzandeh, Z., and Bahadorikhali, S., 2022, Cu(OAc)₂ Catalyzed Synthesis of Novel Chromeno [4,3-b]Pyrano[3,4-e]Pyridine-6,8-Dione Derivatives via a One-Pot Multicomponent Reaction in Water under Mild Reaction Conditions, *Polycycl Aromat Compd*, 42, 3391–3400.



- Schröder, F., Ojeda, M., Erdmann, N., Jacobs, J., Luque, R., Noël, T., Van Meervelt, L., Van Der Eycken, J., and Van Der Eycken, E. V., 2015, Supported Gold Nanoparticles as Efficient and Reusable Heterogeneous Catalyst for Cycloisomerization Reactions, *Green Chem.*, 17, 3314–3318.
- Sharma, D., Bandna, Reddy, C.B., Kumar, S., Shil, A.K., Guha, N.R., and Das, P., 2013, Microwave Assisted Solvent and Catalyst Free Method for Novel Classes of β-Enaminoester and Acridinedione Synthesis, *RSC Adv.*, 3, 10335–10340.
- Shelke, S.N., Bankar, S.R., Mhaske, G.R., Kadam, S.S., Murade, D.K., Bhorkade, S.B., Rathi, A.K., Bundaleski, N., Teodoro, O.M.N.D., Zboril, R., Varma, R.S., and Gawande, M.B., 2014, Iron Oxide-Supported Copper Oxide Nanoparticles (Nanocat-Fe-CuO): Magnetically Recyclable Catalysts for The Synthesis of Pyrazole Derivatives, 4-Methoxyaniline, and Ullmann-Type Condensation Reactions,. In, *ACS Sustain. Chem. Eng.*. American Chemical Society, pp. 1699–1706.
- Shiri, L., Heidari, L., and Kazemi, M., 2018, Magnetic Fe₃O₄ Nanoparticles Supported Imine/Thiophene-Nickel (II) Complex: A New and Highly Active Heterogeneous Catalyst for The Synthesis of Polyhydroquinolines and 2, 3-Dihydroquinazoline-4(1H)-ones, *Appl Organomet Chem.*, 32, .
- Sun, J., Zhou, S., Hou, P., Yang, Y., Weng, J., Li, X., and Li, M., 2007, Synthesis and Characterization of Biocompatible Fe₃O₄ nanoparticles, *J Biomed Mater Res A*, 80, 333–341.
- Taghavi, R. and Rostamnia, S., 2022, Four-Component Synthesis of Polyhydroquinolines via Unsymmetrical Hantzsch Reaction Employing Cu-IRMOF-3 as a Robust Heterogeneous Catalyst.
- Tamoradi, T., Ghadermazi, M., and Ghorbani-Choghamarani, A., 2018, Ni(II)-Adenine Complex Coated Fe₃O₄ Nanoparticles as High Reusable Nanocatalyst for The Synthesis of Polyhydroquinoline Derivatives and Oxidation Reactions, *Appl Organomet Chem.*, 32.
- Tanuraghaj, H.M. and Farahi, M., 2018, Preparation, Characterization and Catalytic Application of Nano-Fe₃O₄@SiO₂@(CH₂)₃OCO₂Na as A novel Basic Magnetic Nanocatalyst for The Synthesis of New Pyranocoumarin Derivatives, *RSC Adv.*, 8, 27818–27824.
- Vaitsis, C., Sourkouni, G., and Argirasis, C., 2020, Sonochemical Synthesis of MOFs,. In, *Met. Fram. Biomed. Appl.*, pp. 223–244.
- Wei, Y., Han, B., Hu, X., Lin, Y., Wang, X., and Deng, X., 2012, Synthesis of Fe₃O₄ Nanoparticles and Their Magnetic Properties,. In, *Procedia Eng.*, Elsevier Ltd, pp. 632–637.



UNIVERSITAS
GADJAH MADA

**STUDI SINTESIS TURUNAN SENYAWA 1,4-DIHIDROPIRIDIN TERKATALISIS Fe₃O₄-Cu MELALUI
REAKSI MULTIKOMPONEN
HANTZSCH DENGAN METODE SONOKIMIA**

Salsabila Oktaviani Hutomo Putri, Dr. Muhammad Idham Darussalam Mardjan, S.Si., M.Sc. dan Prof. Dra. Eko Sri Kurniati, S.Si., M.Sc.
Universitas Gadjah Mada, 2023 | Diunduh dari <http://etd.repository.ugm.ac.id/>

Xia, J.J. and Zhang, K.H., 2012, Synthesis of N-Substituted Acridinediones and Polyhydroquinoline Derivatives in Refluxing Water, *Molecules*, 17, 5339–5345.

Yoo, J.S., Laughlin, T.J., Krob, J.J., and Mohan, R.S., 2015, Bismuth(III) Bromide Catalyzed Synthesis of Polyhydroquinoline Derivatives via The Hantzsch Reaction, *Tetrahedron Lett*, 56, 4060–4062.

Zarnegar, Z., Safari, J., and Kafroudi, Z.M., 2015, Co₃O₄-CNT Nanocomposites: A Powerful, Reusable, and Stable Catalyst for Sonochemical Synthesis of Polyhydroquinolines, *New J. Chem.*, 39, 1445–1451.