

REFERENCES

- Anwar, C. and Hardjosoedirdjo, W., 1994, The conversion of eugenol into more valuable substances, Universitas Gadjah Mada.
- Atanasov, A.G., Zotchev, S.B., Dirsch, V.M., International Natural Product Sciences Taskforce, and Supuran, C.T., 2021, Natural products in drug discovery: advances and opportunities., *Nat. Rev. Drug Discov.*, 20, 200–216.
- Balouiri, M., Sadiki, M., and Ibnsouda, S.K., 2016, Methods for in vitro evaluating antimicrobial activity: A review, *J. Pharm. Anal.*, 6, 71–79.
- Bendre, R.S., Rajput, J.D., Bagul, S.D., and Karandikar, P.S., 2016, Outlooks on Medicinal Properties of Eugenol and its Synthetic Derivatives, *Nat. Prod. Chem. Res.*, 04, 1–6.
- Borges, A., Ferreira, C., Saavedra, M.J., and Simões, M., 2013, Antibacterial activity and mode of action of ferulic and gallic acids against pathogenic bacteria, *Microb. Drug Resist.*, 19, 256–265.
- da Silva, F.F.M., Monte, F.J.Q., de Lemos, T.L.G., do Nascimento, P.G.G., de Medeiros Costa, A.K., and de Paiva, L.M.M., 2018, Eugenol derivatives: synthesis, characterization, and evaluation of antibacterial and antioxidant activities, *Chem. Cent. J.*, 12, 1–9.
- Dias, D.A., Urban, S., and Roessner, U., 2012, A Historical overview of natural products in drug discovery, *Metabolites*, 2, 303–336.
- Doron, S. and Gorbach, S.L., 2008, Bacterial Infections: Overview, *Int. Encycl. Public Heal.*, 273–282.
- Gupta, C. and Prakash, D., 2021, Comparative Study of the Antimicrobial Activity of Clove Oil and Clove Extract on Oral Pathogens, *Dent. – Open J.*, 7, 12–15.
- Handayani, R.S., Siahaan, S., and Herman, M.J., 2018, Antimicrobial Resistance and Its Control Policy Implementation in Hospital in Indonesia, *J. Penelit. dan Pengemb. Pelayanan Kesehat.*, 131–140.
- Haro-González, J.N., Castillo-Herrera, G.A., Martínez-Velázquez, M., and Espinosa-Andrews, H., 2021, Clove essential oil (*Syzygium aromaticum* l. myrtaceae): Extraction, chemical composition, food applications, and essential bioactivity for human health, *Molecules*, 26, .

- Haynes, W.M. CRC Handbook of Chemistry and Physics, 91st Editi. CRC Press Inc., Boca Raton, Florida.
- Hemaiswarya, S. and Doble, M., 2009, Synergistic interaction of eugenol with antibiotics against Gram negative bacteria, *Phytomedicine*, 16, 997–1005.
- Hudzicki, J., 2009, Kirby-Bauer Disk Diffusion Susceptibility Test Protocol, *Am. Soc. Microbiol.*, 1–13.
- Khalil, A.A., Rahman, U.U., Khan, M.R., Sahar, A., Mehmood, T., and Khan, M., 2017, Essential oil eugenol: Sources, extraction techniques and nutraceutical perspectives, *RSC Adv.*, 7, 32669–32681.
- Leboffe, M.J. and Pierce, B.E., 2011, A Photographic Atlas for the Microbiology Laboratory, 4th editio. Ferguson, D. (ed) Morton Publishing Company, Englewood, Colorado.
- Li, J.W.H. and Vederas, J.C., 2009, Drug discovery and natural products: End of an era or an endless frontier?, *Science (80-.)*, 325, 161–165.
- Listyo, A.B., Kusriani, D., and Fachriyah, E., 2018, Isolation of Ferulic Acid from Leaves of Mindi (*Melia azedarach* L.) and Its Antioxidant Activity Test, *JKPK (Jurnal Kim. dan Pendidik. Kim.)*, 3, 30.
- Marchese, A., Barbieri, R., Coppo, E., Orhan, I.E., Daglia, M., Nabavi, S.F., Izadi, M., Abdollahi, M., Nabavi, S.M., and Ajami, M., 2017, Antimicrobial activity of eugenol and essential oils containing eugenol: A mechanistic viewpoint, *Crit. Rev. Microbiol.*, 43, 668–689.
- Nankar, R., Prabhakar, P.K., and Doble, M., 2017, Hybrid drug combination: Combination of ferulic acid and metformin as anti-diabetic therapy, *Phytomedicine*, 37, 10–13.
- Nazzaro, F., Fratianni, F., De Martino, L., Coppola, R., and De Feo, V., 2013, Effect of essential oils on pathogenic bacteria, *Pharmaceuticals*, 6, 1451–1474.
- NCBI, 2022, Eugenol,. PubChem Compound Summary for CID 3314, Eugenol, *National Center for Biotechnology Information*. Accessed 6 December, 2022 . <https://pubchem.ncbi.nlm.nih.gov/compound/Eugenol>.
- Nurdjannah, N. and Bermawie, N., 2012, Cloves, *Handb. Herbs Spices Second Ed.*, 1, 197–215.

- Nurhasanah, S., Mardawati, E., and Herudiyanto, M., 2008, Pemisahan Eugenol Dari Minyak Cengkeh Dengan Cara Distilasi Fraksinasi, *Skripsi. Jur. Teknol. Ind.*, 1–14.
- Nurjanah, G.S., Cahyadi, A.I., and Windria, S., 2020, Escherichia Coli Resistance To Various Kinds of Antibiotics in Animals and Humans: a Literature Study, *Indones. Med. Veterinus*, 9, 970–983.
- Overhage, J., Steinbüchel, A., and Priefert, H., 2003, Highly Efficient Biotransformation of Eugenol to Ferulic Acid and Further Conversion to Vanillin in Recombinant Strains of Escherichia coli, *Appl. Environ. Microbiol.*, 69, 6569–6576.
- Pinto, S.M.L., Rivera, Y., Sandoval, L.V.H., Lizarazo, J.C., Rincón, J.J., and Méndez, L.Y.V., 2019, Semisynthetic eugenol derivatives as antifungal agents against dermatophytes of the genus Trichophyton, *J. Med. Microbiol.*, 68, 1109–1117.
- Prasetya, N.B.A., Ngadiwiyana, Ismiyarto, and Sarjono, P.R., 2019, Synthesis and study of antibacterial activity of polyeugenol, *IOP Conf. Ser. Mater. Sci. Eng.*, 509, 1–6.
- Sigma- Aldrich, 2023, IR Spectrum Table and Chart, *Merck*, Accessed 13 February, 2023.<https://www.sigmaaldrich.com/ID/en/technical-documents/technical-article/analytical-chemistry/photometry-and-reflectometry/ir-spectrum-table>.
- Sudarlin, S. and Haryadi, W., 2017, Polimerisasi Eugenol Minyak Daun Cengkeh Hasil Redistilasi, Ekstraksi, dan Fraksinasi Menggunakan Katalis Asam Sulfat Pekat, *J. Kim. Val.*, 3, 50–58.
- Tiwari, R. and Rana, C.S., 2015, Plant secondary metabolites, *Int. J. Eng. Res. Gen. Sci.*, 3, .
- Triana, D., Tafdilla, M.A., Antika, L.D., and Ernawati, T., 2019, Conversion Eugenol to Vanillin : Evaluation of Antimicrobial Activity, *Int. Summit Sci. Technol. Humanit.*, 594–602.
- Tulungen, F.R., 2019, Cengkeh Dan Manfaatnya Bagi Kesehatan Manusia Melalui Pendekatan Competitive Intelligence, *Biofarmasetikal Trop.*, 2, 158–169.
- Ulanowska, M. and Olas, B., 2021, Biological properties and prospects for the application of eugenol—a review, *Int. J. Mol. Sci.*, 22, 1–13.

- Wijayanti, E.D., Safitri, A., Siswanto, D., Triprisila, L.F., and Fatchiyah, F., 2021, Antimicrobial Activity of Ferulic Acid in Indonesian Purple Rice through Toll-like Receptor Signaling, *Makara J. Sci.*, 25, 247–257.
- Zduńska, K., Dana, A., Kolodziejczak, A., and Rotsztein, H., 2018, Antioxidant properties of ferulic acid and its possible application, *Skin Pharmacol. Physiol.*, 31, 332–336.
- Zhang, L.L., Zhang, L.F., Xu, J.G., and Hu, Q.P., 2017, Comparison study on antioxidant, DNA damage protective and antibacterial activities of eugenol and isoeugenol against several foodborne pathogens, *Food Nutr. Res.*, 61, .