



DAFTAR PUSTAKA

- Adil, M., Haider Abbasi, B., & Ul Haq, I. (2019). Red light controlled callus morphogenetic patterns and secondary metabolites production in *Withania somnifera* L. *Biotechnology Reports*, 24: e00380.
- Aeschbach, R., Löliger, J., Scott, B. C., Murcia, A., Butler, J., Halliwell, B., & Aruoma, O. I. (1994). Antioxidant actions of thymol, carvacrol, 6-gingerol, zingerone and hydroxytyrosol. *Food and Chemical Toxicology*, 32(1): 31–36.
- Aftab, T., Khan, M. M. A., da Silva, J. A. T., Idrees, M., & Naeem, M. (2011). Role of salicylic acid in promoting salt stress tolerance and enhanced artemisinin production in *Artemisia annua* L. *Journal of Plant Growth Regulation*, 30: 425–435.
- Aftab, T., Khan, M. M. A., Idrees, M., Naeem, M., & Moinuddin. (2010). Salicylic acid acts as potent enhancer of growth, photosynthesis and artemisinin production in *Artemisia annua* L. *Journal of Crop Science and Biotechnology*, 13: 183–188.
- Agoni, C., Olotu, F. A., Ramharack, P., & Soliman, M. E. (2020). Druggability and drug-likeness concepts in drug design: Are biomodelling and predictive tools having their say? *Journal of Molecular Modeling*, 26: 1–11.
- Amberg, A. (2013). In Silico Methods. In: Vogel, H. G., Maas, J., Hock, F. J., & Mayer, D. (eds) *Drug Discovery and Evaluation: Safety and Pharmacokinetic Assays*. Springer, Berlin.
- Ames-Sibin, A. P., Barizão, C. L., Castro-Ghizoni, C. V., Silva, F. M. S., Sá-Nakanishi, A. B., Bracht, L., Bersani-Amado, C. A., Marçal-Natali, M. R., Bracht, A., & Comar, J. F. (2018). β -Caryophyllene, the major constituent of copaiba oil, reduces systemic inflammation and oxidative stress in arthritic rats. *Journal of Cellular Biochemistry*, 119(12): 10262–10277.
- Andrusier, N., Mashiah, E., Nussinov, R., & Wolfson, H. J. (2008). Principles of flexible protein–protein docking. *Proteins: Structure, Function, and Bioinformatics*, 73: 271–289.
- Arab, M. M., Yadollahi, A., Shojaeiyan, A., & Shokri, S. (2014). Effects of nutrient media, different cytokinin types and their concentrations on in vitro multiplication of G×N15 (hybrid of almond×peach) vegetative rootstock. *Journal of Genetic Engineering and Biotechnology*, 12(2): 81–87.
- Arizuka, N., Murakami, T., & Suzuki, K. (2017). The effect of β -caryophyllene on nonalcoholic steatohepatitis. *Journal of Toxicologic Pathology*, 30(4): 263–273.
- Ashour, M., Wink, M., & Gershenson, J. (2010). Biochemistry of terpenoids: monoterpenes, sesquiterpenes and diterpenes. In: Wink, M. (ed) *Annual Plant Reviews: Biochemistry of Plant Secondary Metabolism*. Wiley, New York.



- Audain, E., Ramos, Y., Hermjakob, H., Flower, D. R., & Perez-Riverol, Y. (2016). Accurate estimation of isoelectric point of protein and peptide based on amino acid sequences. *Bioinformatics*, 32(6): 821–827.
- Aziz L. M. S., Chan, L. K., & Lim, B. P. (2006). Pertumbuhan dan akumulasi alkaloid dalam kalus dan suspensi sel *Eurycoma longifolia* Jack. *Jurnal Ilmiah Pertanian Kultura*, 41(1): 19–27.
- Azwin, Siregar, I. Z., & Supriyanto. (2006). Penggunaan BAP dan TDZ untuk perbanyak tanaman gaharu (*Aquilaria malaccensis* Lamk.). *Media Konservasi*, 11(3): 98–104.
- Bachmair, A., Finley, D., & Varshavsky, A. (1986). In vivo half-life of a protein is a function of its amino-terminal residue. *Science*, 234(4773): 179–186.
- Backman, T. W., Cao, Y., & Girke, T. (2011). ChemMine tools: an online service for analyzing and clustering small molecules. *Nucleic Acids Research*, 39: W486–W491.
- Baday, S. J. S. (2018). Plant tissue culture. *International Journal of Agriculture and Environmental Research*, 4(4): 977–990.
- Beckman, C. H. (2000). Phenolic-storing cells: keys to programmed cell death and periderm formation in wilt disease resistance and in general defence responses in plants?. *Physiological and Molecular Plant Pathology*, 57(3): 101–110.
- Bero, S. A., Muda, A. K., Choo, Y. H., Muda, N. A., & Pratama, S. F. (2017). Similarity measure for molecular structure: A brief review. *Journal of Physics: Conference Series*, 892: 012015.
- Bhardwaj, M., Sali, V. K., Mani, S., & Vasanthi, H. R. (2020). Neophytadiene from *Turbinaria ornata* suppresses LPS-induced inflammatory response in RAW 264.7 macrophages and sprague dawley rats. *Inflammation*, 43(3): 937–950.
- Bhatia, S. (2015). Plant Tissue Culture. In: Bhatia, S., Dahiya, R., Sharma, K., & Bera, T. (eds) *Modern Applications of Plant Biotechnology in Pharmaceutical Sciences*. Elsevier, Amsterdam.
- Bitew, M., Desalegn, T., Demissie, T. B., Belayneh, A., Endale, M., & Eswaramoorthy, R. (2021). Pharmacokinetics and drug-likeness of antidiabetic flavonoids: Molecular docking and DFT study. *PLoS One*, 16(12): e0260853.
- Block, R. & Lankes, C. (1996). Measures to prevent tissue browning of explants of the apple rootstock M9 during in vitro establishment. *Gartenbauwissenschaft*, 61(1): 11–17.
- Buraphaka, H. & Putalun, W. (2020). Stimulation of health-promoting triterpenoids accumulation in *Centella asiatica* (L.) Urban leaves triggered by postharvest application of methyl jasmonate and salicylic acid elicitors. *Industrial Crops and Products*, 146: 112171.



- Calderón, A. A., Zapata, J. M., Muñoz, R., Pedreño, M. A., & Barceló, A. R. (1993). Resveratrol production as a part of the hypersensitive-like response of grapevine cells to an elicitor from *Trichoderma viride*. *New Phytologist*, 124(3): 455–463.
- Cao, H., Pauff, J. M., & Hille, R. (2014). X-ray crystal structure of a xanthine oxidase complex with the flavonoid inhibitor quercetin. *Journal of Natural Products*, 77(7): 1693–1699.
- Cao, Y., Jiang, T., & Girke, T. (2008). A maximum common substructure-based algorithm for searching and predicting drug-like compounds. *Bioinformatics*, 24(13): i366–i374.
- Cassells, A. C. (2012). Pathogen and Biological Contamination Management in Plant Tissue Culture: Phytopathogens, Vitro Pathogens, and Vitro Pests. In: Loyola-Vargas V. M. & Ochoa-Alejo, N. (eds) *Plant Cell Culture Protocols, Methods in Molecular Biology*. Vol. 877. Springer, Berlin.
- Cassells, A. C. (2001). Contamination and its impact in tissue culture. *Acta Horticulturae*, (560): 353–359.
- Chen, X. & Reynolds, C. H. (2002). Performance of similarity measures in 2D fragment-based similarity searching: comparison of structural descriptors and similarity coefficients. *Journal of Chemical Information and Computer Sciences*, 42(6): 1407–1414.
- Choi, H. S., Song, H. S., Ukeda, H., & Sawamura, M. (2000). Radical-scavenging activities of citrus essential oils and their components: detection using 1,1-diphenyl-2-picrylhydrazyl. *Journal of Agricultural and Food Chemistry*, 48(9): 4156–4161.
- Choudhuri, S. (2014). Additional Bioinformatic Analyses Involving Protein Sequences. In: Choudhuri, S. (ed) *Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools*. Academic Press, Massachusetts.
- Conforti, F., Statti, G., Loizzo, M. R., Sacchetti, G., Poli, F., & Menichini, F. (2005). In vitro antioxidant effect and inhibition of alpha-amylase of two varieties of *Amaranthus caudatus* seeds. *Biological & Pharmaceutical Bulletin*, 28(6): 1098–1102.
- Dahham, S., Tabana, Y., Iqbal, M., Ahamed, M., Ezzat, M., Majid, A., & Majid, A. (2015). The anticancer, antioxidant and antimicrobial properties of the sesquiterpene β-caryophyllene from the essential oil of *Aquilaria crassna*. *Molecules*, 20(7): 11808–11829.
- Dalal, M. A., Sharma, B. B., & Rao, M. S. (1992). Studies on stock plant treatment and initiation culture mode in control of oxidative browning in in vitro cultures of grapevine. *Scientia Horticulturae*, 51(1–2): 35–41.
- Das, K. & Roychoudhury, A. (2014). Reactive oxygen species (ROS) and response of antioxidants as ROS-scavengers during environmental stress in plants. *Frontiers in Environmental Science*, 2(53): 1–13.



- Dasgupta, N., Chowdhury, P., & Das, S. (2015). Comparative adaptability assessment of two mangroves from Indian Sundarbans: some biochemical appearances. *Natural Science*, 7(12): 519–534.
- Delgado, C., Mendez-Callejas, G., & Celis, C. (2021). Caryophyllene oxide, the active compound isolated from leaves of *Hymenaea courbaril* L. (Fabaceae) with antiproliferative and apoptotic effects on PC-3 androgen-independent prostate cancer cell line. *Molecules*, 26(20): 6142.
- de Matos, C. K., Pereira, C. E. L., Balena, L., & Kawakami, J. (2020). Effect of agar concentration in culture medium on in vitro development of potato plant. *Research, Society and Development*, 9(7): 1–12.
- Dixon, R. A. & Paiva, N. L. (1995). Stress-induced phenylpropanoid metabolism. *The Plant Cell*, 7(7): 1085–1097.
- Du Preez, H. (2007). Squalene – antioxidant of the future?. *The South African Journal of Natural Medicine*, 33: 106–112.
- Ebrahimi, M., Farhadian, N., Amiri, A. R., Hataminia, F., Soflaei, S. S., & Karimi, M. (2022). Evaluating the efficacy of extracted squalene from seed oil in the form of microemulsion for the treatment of COVID-19: A clinical study. *Journal of Medical Virology*, 94(1): 119–130.
- Enroth, C., Eger, B. T., Okamoto, K., Nishino, T., Nishino, T., & Pai, E. F. (2000). Crystal structures of bovine milk xanthine dehydrogenase and xanthine oxidase: structure-based mechanism of conversion. *Proceedings of the National Academy of Sciences of the United States of America*, 97(20): 10723–10728.
- Evans, D. E., Coleman, J. O. D., & Kearns, A. (2003). *Plant Cell Culture*. BIOS Scientific Publishers, London.
- Fadillioglu, E., Kurcer, Z., Parlakpinar, H., Iraz, M., & Gursul, C. (2008). Melatonin treatment against remote organ injury induced by renal ischemia reperfusion injury in diabetes mellitus. *Archives of Pharmacal Research*, 31(6): 705–712.
- Fadlan, A. & Nusantoro, Y. R. (2020). Analisis sifat mirip obat, prediksi ADMET, dan penambatan molekular isatinil-2-aminobenzoilhidazon dan kompleks logam transisi Co(II), Ni(II), Cu(II), Zn(II) terhadap BCL2-XL. *Akta Kimia Indonesia*, 5(2): 114–126.
- Faqiha, A. F., Indrawijaya, Y. Y. A., Suryadinata, A., Amiruddin, M., & Mutiah, R. (2022). Potensi senyawa nitazoxanide dan arbidol sebagai antivirus SARS-CoV-2 terhadap reseptor NSP5 (7BQY dan 2GZ7) dan ACE2 (3D0G dan 1R4L). *Journal of Food and Pharmaceutical Sciences*, 10(1): 570–583.
- Fazili, M. A., Bashir, I., Ahmad, M., Yaqoob, U., & Geelani, S. N. (2022). In vitro strategies for the enhancement of secondary metabolite production in plants: a review. *Bulletin of the National Research Centre*, 46(1): 35.



- Ferrari, A. M., Wei, B. Q., Costantino, L., & Shoichet, B. K. (2004). Soft docking and multiple receptor conformations in virtual screening. *Journal of Medicinal Chemistry*, 47(21): 5076–5084.
- Ferreira, L. G., Dos Santos, R. N., Oliva, G., & Andricopulo, A. D. (2015). Molecular docking and structure-based drug design strategies. *Molecules*, 20: 13384–13421.
- Fink, R. C. & Scandalios, J. G. (2002). Molecular evolution and structure – function relationships of the superoxide dismutase gene families in angiosperms and their relationship to other eukaryotic and prokaryotic superoxide dismutases. *Archives of Biochemistry and Biophysics*, 399(1): 19–36.
- Francomano F., Caruso A., Barbarossa A., Fazio A., La Torre C., Ceramella J., Mallamaci R., Saturnino C., Iacopetta D., & Sinicropi M. S. (2019). β -caryophyllene: A sesquiterpene with countless biological properties. *Applied Sciences*, 9: 5420.
- Fridovich, I. (1995). Superoxide radical and superoxide dismutases. *Annual Review of Biochemistry*, 64: 97–112.
- Gadaleta, D., Vuković, K., Toma, C., Lavado, G. J., Karmaus, A. L., Mansouri, K., Kleinstreuer, N. C., Benfenati, E., & Roncaglioni, A. (2019). SAR and QSAR modeling of a large collection of LD₅₀ rat acute oral toxicity data. *Journal of Cheminformatics*, 11(1): 58.
- Gao, Y., Gesenberg, C., & Zheng, W. (2017). Oral Formulations for Preclinical Studies: Principle, Design, and Development Considerations. In: Qiu, Y., Chen, Y., Zhang, G. G. Z., Yu, L., & Mantri, R. V. (eds) *Developing Solid Oral Dosage Forms*. Elsevier, Amsterdam.
- Gasteiger, E., Hoogland, C., Gattiker, A., Duvaud, S., Wilkins, M. R., Appel, R. D., & Bairoch, A. (2005). Protein Identification and Analysis Tools on the ExPASy Server. In: Walker, J. M. (ed) *The Proteomics Protocols Handbook*. Humana Press.
- Gertsch, J., Leonti, M., Raduner, S., Racz, I., Chen, J.Z., Xie, X.Q., Altmann, K.H., Karsak, M., & Zimmer, A. (2008). Beta-caryophyllene is a dietary cannabinoid. *Proceedings of the National Academy of Sciences of the United States of America*, 105(26): 9099–9104.
- Ghalla, D. S., Shawky, E., Metwally, A. M., Celik, I., Ibrahim, R. S., & Mohyeldin, M. M. (2022). Integrated in silico–in vitro strategy for the discovery of potential xanthine oxidase inhibitors from Egyptian propolis and their synergistic effect with allopurinol and febuxostat. *Royal Society of Chemistry Advances*, 12(5): 2843–2872.
- Gill, S. C. & von Hippel, P. H. (1989). Calculation of protein extinction coefficients from amino acid sequence data. *Analytical Biochemistry*, 182(2): 319–326.
- Gonda, D. K., Bachmair, A., Wünnig, I., Tobias, J. W., Lane, W. S., & Varshavsky, A. (1989). Universality and structure of the N-end rule. *The Journal of Biological Chemistry*, 264(28): 16700–16712.



- Grogan, S. & Preuss, C. V. (2022). Pharmacokinetics. In: *StatPearls*. StatPearls Publishing.
- Hadi, S., Lestari, D., Dharmayani, N. K. T., Ratnasari, B. D., Ito, M., Yamada, I., & Mulyaningsih, T. (2020). Investigation of anticancer agents from the bark of *Gyrinops versteegii* (Gilg.) Domke from Lombok island. *Oriental Journal of Chemistry*, 36(6): 1037–1042.
- Halder, M., Sharkar, S., & Jha, S. (2019). Elicitation: A biotechnological tool for enhanced production of secondary metabolites in hairy root cultures. *Engineering Life Science*, 19(12): 880–895.
- Halliwell, B. (1995). How to characterize an antioxidant: an update. *Biochemical Society Symposium*, 61: 73–101.
- Halliwell, B. (2006). Reactive species and antioxidants. Redox biology is a fundamental theme of aerobic life. *Plant Physiology*, 141(2): 312–322.
- Hammami, S., Jmii, H., El Mokni, R., Khmiri, A., Faidi, K., Dhaouadi, H., El Aouni, M. H., Aouni, M., & Joshi, R. K. (2015). Essential oil composition, antioxidant, cytotoxic and antiviral activities of *Teucrium pseudochamaepitys* growing spontaneously in Tunisia. *Molecules*, 20(11): 20426–20433.
- Hariyati, M., Bachtiar, I., & Sedijani, P. (2016). Induksi kalus tanaman krisan (*Chrysanthemum morifolium*) dengan pemberian benzil amino purin (BAP) dan dichlorofenoksi acetil acid (2,4 D). *Jurnal Penelitian Pendidikan IPA*, 2(1): 89–96.
- Hasnain, A., Naqvi, S. A. H., Ayesha, S. I., Khalid, F., Ellahi, M., Iqbal, S., Hassan, M. Z., Abbas, A., Adamski, R., Markowska, D., Baazeem, A., Mustafa, G., Moustafa, M., Hasan, M. E., & Abdelhamid, M. M. A. (2022). Plants in vitro propagation with its applications in food, pharmaceuticals and cosmetic industries; current scenario and future approaches. *Frontiers in Plant Science*, 13: 1009395.
- Hayat, Q., Hayat, S., Irfan, M., & Ahmad, A. (2010). Effect of exogenous salicylic acid under changing environment: A review. *Environmental and Experimental Botany*, 68(1): 14–25.
- He, Y., Guo, X., Lu, R., Niu, B., Pasapula, V., Hou, P., Cai, F., Xu, Y., & Chen, F. (2009). Changes in morphology and biochemical indices in browning callus derived from *Jatropha curcas* hypocotyls. *Plant Cell Tissue Organ Culture*, 98: 11–17.
- Hendra, R., Ahmad, S., Oskoueian, E., Sukari, A., Shukor, M. Y. (2011). Antioxidant, anti-inflammatory and cytotoxicity of *Phaleria macrocarpa* (Boerl.) Scheff fruit. *BMC Complementary and Alternative Medicine*, 11: 110.
- Hollingsworth, S. A., & Karplus, P. A. (2010). A fresh look at the Ramachandran plot and the occurrence of standard structures in proteins. *Biomolecular Concepts*, 1(3–4): 271–283.



- Hopia, A. I., Huang, S.-W., Schwarz, K., German, J. B., & Frankel, E. N. (1996). Effect of different lipid systems on antioxidant activity of rosemary constituents carnosol and carnosic acid with and without α -tocopherol. *Journal of Agricultural and Food Chemistry*, 44(8): 2030–2036.
- Huang, S. Y. (2018). Comprehensive assessment of flexible-ligand docking algorithms: current effectiveness and challenges. *Briefings in Bioinformatics*, 19(5): 982–994.
- ITIS. (2011). *Gyrinops versteegii* (Gilg.) Domke. https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=845834#null. Diakses pada 20 Februari 2022.
- Jendele, L., Krivák, R., Skoda, P., Novotny, M., & Hoksza, D. (2019). PrankWeb: a web server for ligand binding site prediction and visualization. *Nucleic Acids Research*, 47(W1): W345–W349.
- Jones, A. M. & Saxena, P. K. (2013). Inhibition of phenylpropanoid biosynthesis in *Artemisia annua* L.: a novel approach to reduce oxidative browning in plant tissue culture. *PLoS One*, 8(10): e76802.
- Jung, J. I., Kim, E. J., Kwon, G. T., Jung, Y. J., Park, T., Kim, Y., Yu, R., Choi, M. S., Chun, H. S., Kwon, S. H., Her, S., Lee, K. W., & Park, J. H. (2015). β -Caryophyllene potently inhibits solid tumor growth and lymph node metastasis of B16F10 melanoma cells in high-fat diet-induced obese C57BL/6N mice. *Carcinogenesis*, 36(9): 1028–1039.
- Karakaya, S., Yilmaz, S. V., Özdemir, Ö., Koca, M. S., Pinar, N. M., Demirci, B., Yıldırım, K., Sytar, O., Turkez, H., & Baser, K. H. (2020). A caryophyllene oxide and other potential anticholinesterase and anticancer agent in *Salvia verticillata* subsp. *amasiaca* (Freyn & Bornm.) Bornm. (Lamiaceae). *Journal of Essential Oil Research*, 32: 512–525.
- Karuppusamy, S. (2009). A review on trends in production of secondary metabolites from higher plants by in vitro tissue, organ and cell cultures. *Journal of Medicinal Plants Research*, 3: 1222–1239.
- Kasote, D. M., Katyare, S. S., Hegde, M. V., & Bae, H. (2015). Significance of antioxidant potential of plants and its relevance to therapeutic applications. *International Journal of Biological Sciences*, 11(8): 982–991.
- Kim, M. T., Sedykh, A., Chakravarti, S. K., Saiakhov, R. D., & Zhu, H. (2014). Critical evaluation of human oral bioavailability for pharmaceutical drugs by using various cheminformatics approaches. *Pharmaceutical Research*, 31(4): 1002–1014.
- Kim, S. K. & Karadeniz, F. (2012). Biological Importance and Applications of Squalene and Squalane. In: Kim, S. K. (ed) *Advances in Food and Nutrition Research*. Vol. 65. Academic Press, Massachusetts.



- Klauke, A. L., Racz, I., Pradier, B., Markert, A., Zimmer, A. M., Gertsch, J., & Zimmer, A. (2014). The cannabinoid CB₂ receptor-selective phytocannabinoid beta-caryophyllene exerts analgesic effects in mouse models of inflammatory and neuropathic pain. *European Neuropsychopharmacology*, 24(4): 608–620.
- Kotomori, S. N. & Murashige, T. (1965). Some aspects of aseptic propagation of orchids. *American Orchid Society Bulletin*, 34: 484–489.
- Krivák, R. & Hoksza, D. (2018). P2Rank: machine learning based tool for rapid and accurate prediction of ligand binding sites from protein structure. *Journal of Cheminformatics*, 10(1): 39.
- Kumar, R., Sharma, A., & Varadwaj, P. K. (2011). A prediction model for oral bioavailability of drugs using physicochemical properties by support vector machine. *Journal of Natural Science, Biology, and Medicine*, 2(2): 168–173.
- Lagunin, A., Stepanchikova, A., Filimonov, D., & Poroikov, V. (2000). PASS: prediction of activity spectra for biologically active substances. *Bioinformatics*, 16: 747–748.
- Langhasova, L., Hanusova V., Rezek J., Stohanslova B., Ambroz M., Kralova V., Vanek, T., Lou, J. D., Yun, Z. L., Yang, J., & Skalova, L. (2014). Essential oil from *Myrica rubra* leaves inhibits cancer cell proliferation and induces apoptosis in several human intestinal lines. *Industrial Crops and Products*, 59(10): 20–26.
- Lexa, K. W. & Carlson, H. A. (2012). Protein flexibility in docking and surface mapping. *Quarterly Reviews of Biophysics*, 45(3): 301–343.
- Lindsey, C. W. (2014). Lipophilicity. In: Stolerman, I. P. & Price, L. H. (eds) *Encyclopedia of Psychopharmacology*. Springer, Berlin.
- Lipinski, C. A., Lombardo, F., Dominy, B. W., & Feeney, P. J. (2001). Experimental and computational approaches to estimate solubility and permeability in drug discovery and development settings. *Advanced Drug Delivery Reviews*, 46(1-3): 3–26.
- Liu, Y., Yang, X., Gan, J., Chen, S., Xiao, Z. X., & Cao, Y. (2022). CB-Dock2: improved protein-ligand blind docking by integrating cavity detection, docking and homologous template fitting. *Nucleic Acids Research*, 50(W1): W159–W164.
- Lizawati, L. (2012). Induksi kalus embriogenik dari eksplan tunas apikal tanaman jarak pagar (*Jatropha curcas* L.) dengan penggunaan 2,4-D dan TDZ. *Bioplantae*, 1(2): 75–77.
- Lozano-Grande, M. A., Gorinstein, S., Espitia-Rangel, E., Dávila-Ortiz, G., & Martínez-Ayala, L. (2018). Plant sources, extraction methods, and uses of squalene. *International Journal of Agronomy*, 2018(5): 1-13.
- Maleknia, S. D. & Adams, M. A. (2007). *Reactions of oxygen-containing terpenes with peptides and proteins*. Proceedings of the 4th International Peptide Symposium, Australian Peptide Association, Australia, pp. 334–335.



- Mardhiyetti, M., Syarif, Z., Jamarun, N., & Suliansyah, I. (2017). Pengaruh BAP (benzil adenin purin) dan NAA (naphthalene acetic acid) terhadap ekstrak tanaman turi (*Sesbania grandiflora*) dalam media multiplikasi in vitro. *Pastura*, 5(1): 35–38.
- Marisa, F. (2021). *Induksi Pembentukan Terpenoid pada Gaharu (Gyrinops versteegii (Gilg.) Domke) secara In Vitro* [Tesis, Universitas Gadjah Mada].
- Martin, Y. C., Kofron, J. L., & Traphagen, L. M. (2002). Do structurally similar molecules have similar biological activity?. *Journal of Medicinal Chemistry*, 45(19): 4350–4358.
- Masita, R., Nuringtyas, T. R., Wijayanti, N., & Hidayati, L. (2020). Antiviral activity of agarwood *Aquilaria malaccensis* Lamk. and *Gyrinops versteegii* (Gilg.) Domke leaves ethanolic against dengue serotype 3 virus in vitro. *AIP Conference Proceedings*, 2231: 040077.
- McVaugh, R. (1984). Compositae. In: Anderson, W. R. (ed) Flora Novo-Galiciano. *A Descriptive Account of the Vascular Plants of Western Mexico*. Vol. 12, University of Michigan Press, Ann Arbor.
- Medeiros, R., Passos, G. F., Vitor, C. E., Koepp, J., Mazzuco, T. L., Pianowski, L. F., Campos, M. M., & Calixto, J. B. (2007). Effect of two active compounds obtained from the essential oil of *Cordia verbenacea* on the acute inflammatory responses elicited by LPS in the rat paw. *British Journal of Pharmacology*, 151(5): 618–627.
- Mertens, H. D. & Gooley, P. R. (2005). Validating the use of database potentials in protein structure determination by NMR. *FEBS Letters*, 579(25): 5542–5548.
- Miller, L. R. & Murashige, T. (1976). Tissue culture propagation of tropical foliage plants. *In Vitro*, 12(12): 797–813.
- Misra, B. B. & Dey, S. (2013). Evaluation of in vivo anti-hyperglycemic and antioxidant potentials of α -santalol and sandalwood oil. *Phytomedicine*, 20(5): 409–416.
- Mohankumar, A., Kalaiselvi, D., Thiruppatti, G., Muthusaravanan, S., Nivitha, S., Levenson, C., Tawata, S., & Sundararaj, P. (2020). α - and β -santalols delay aging in *Caenorhabditis elegans* via preventing oxidative stress and protein aggregation. *ACS Omega*, 5(50): 32641–32654.
- Mohankumar, A., Shanmugam, G., Kalaiselvi, D., Levenson, C., Nivitha, S., Thiruppatti, G., & Sundararaj, P. (2018). East Indian sandalwood (*Santalum album* L.) oil confers neuroprotection and geroprotection in *Caenorhabditis elegans* via activating SKN-1/Nrf2 signaling pathway. *Royal Society of Chemistry Advances*, 8(59): 33753–33774.
- Morris, G. M., Huey, R., Lindstrom, W., Sanner, M. F., Belew, R. K., Goodsell, D. S., & Olson, A. J. (2009). AutoDock4 and AutoDockTools4: Automated docking with selective receptor flexibility. *Journal of Computational Chemistry*, 30(16): 2785–2791.



- Mulyaningsih, T. & Yamada, I. (2008). Notes on Some Species of Agarwood in Nusa Tenggara, Celebes and West Papua. In: *Natural Resource Management and Socio-Economic Transformation under the Decentralization in Indonesia: Toward Sulawesi Area Studies*. CSEAS. Kyoto University, Kyoto.
- Muna, P. I. (2023). *Profil Senyawa Terpenoid Kalus Gaharu Gyrinops versteegii (Gilg.) Domke Hasil Elisitasi Asam Salisilat dan Potensinya sebagai Inhibitor ACE-2* [Skripsi, Universitas Gadjah Mada].
- Munasinghe S. P., Somaratne, S., Weerakoon, S. R., & Ranasinghe, C. (2020). Prediction of chemical composition for callus production in *Gyrinops walla* Gaertner through machine learning. *Information Processing in Agriculture*, 7(4): 511–522.
- Munasinghe, S., Somaratne, S., Weerakoon, S., & Ranasinghe, C. (2021). Sustainable utilization of *Gyrinops walla* Gaertner: in vitro production of sesquiterpenes by chemical and biological elicitation. *Journal of Genetic Engineering and Biotechnology*, 19(1): 134.
- Muralikrishna, A. (1988). Development of micropropagation strategies in pomegranate, grape and guava cultivars. *Physiologia Plantarum*, 15: 473–497.
- Murkute, M., Patil, S., & Singh, S. K. (2004). In vitro regeneration in pomegranate cv. Ganesh from mature plant. *Indian Journal of Horticulture*, 61(3): 206–208.
- Naeem, M., Sadiq, Y., Jahan, A., Nabi, A., Aftab, T., & Khan, M. M. A. (2020). Salicylic acid restrains arsenic induced oxidative burst in two varieties of *Artemisia annua* L. by modulating antioxidant defence system and artemisinin production. *Ecotoxicology and Environmental Safety*, 202: 110851.
- Namdeo, A. G. (2007). Plant cell elicitation for production of secondary metabolites: A review. *Pharmacognosy Reviews*, 1(1): 69–79.
- Nasution, A. A., Siregar, U. J., & Miftahudin. (2019). Identification of chemical compounds in agarwood-producing species *Aquilaria malaccensis* and *Gyrinops versteegii*. *Journal of Forestry Research*, 31: 1371–1380.
- Newmark, H. L. (1999). Squalene, olive oil, and cancer risk. Review and hypothesis. *Annals of the New York Academy of Sciences*, 889: 193–203.
- Ningsih, I. Y. (2014). Pengaruh elisitor biotik dan abiotik pada produksi flavonoid melalui kultur jaringan tanaman. *Pharmacy*, 11(2): 117–131.
- Nugraha, R. Y. B., Faratisha, I. F. D., Mardhiyyah, K., Ariel, D. G., Putri, F. F., Nafisatuzzamrudah, Winarsih, S., Sardjono, T. W., & Fitri, L. E. 2020. Antimalarial properties of isoquinoline derivative from *Streptomyces hygroscopicus* subsp. *Hygroscopicus*: An in silico approach. *BioMed Research International*, 1–15.
- Nugroho, L. H. & Verpoorte, R. (2002). Secondary metabolism in tobacco. *Plant Cell, Tissue and Organ Culture*, 68: 105–125.



- Nugroho, L. H. (2017). *Struktur dan Produk Jaringan Sekretori Tumbuhan*. Gadjah Mada University Press, Yogyakarta.
- Nuringtyas, T. R., Isromarina, R., Septia, Y., Hidayati, L., Wijayanti, N., & Moeljopawiro, S. (2018). The antioxidant and cytotoxic activities of the chloroform extract of agarwood (*Gyrinops versteegii* (Gilg.) Domke) leaves on HeLa cell lines. *AIP Conference Proceedings*, 2002: 020067.
- Nurpratama, J. M. (2020). *Uji Toksisitas Ekstrak Metanol Daun Gaharu (*Gyrinops versteegii* (Gilg.) Domke) sebagai Upaya Pencarian Bahan Aktif Antikanker* [Skripsi, Universitas Mataram].
- Okudera, Y. & Ito, M. (2009). Production of agarwood fragrant constituents in *Aquilaria calli* and cell suspension cultures. *Plant Biotechnology*, 26(3): 307–315.
- Okugawa, H., Ueda, R., Matsumoto, K., Kawanishi, K., & Kato, A. (1995). Effect of α-santalol and β-santalol from sandalwood on the central nervous system in mice. *Phytomedicine*, 2(2): 119–126.
- Olugbami, J. O., Gbadegesin, M. A., & Odunola, O. A. (2014). In vitro evaluation of the antioxidant potential, phenolic and flavonoid contents of the stem bark ethanol extract of *Anogeissus leiocarpus*. *African Journal of Medicine and Medical Sciences*, 43(Suppl 1): 101–109.
- Pacher, P., Nivorozhkin, A., & Szabó, C. (2006). Therapeutic effects of xanthine oxidase inhibitors: renaissance half a century after the discovery of allopurinol. *Pharmacological Reviews*, 58(1): 87–114.
- Pan, Y., Li, L., Xiao, S., Chen, Z., Sarsaiya, S., Zhang, S., ShangGuan, Y., Liu, H., & Xu, D. (2020). Callus growth kinetics and accumulation of secondary metabolites of *Bletilla striata* Rchb.f. using a callus suspension culture. *PLoS One*, 15(2): e0220084.
- Papas, A. M. (1999). Diet and antioxidant status. *Food and Chemical Toxicology*, 37(9–10): 999–1007.
- Parwata, A., Manuaba, P., & Yasa, S. (2018). The potency of flavonoid compounds in water extract *Gyrinops versteegii* leaves as natural antioxidants sources. *Biomedical and Pharmacology Journal*, 11(3): 1501–1511.
- Paulpandi, M., Kannan, S., Thangam, R., Kaveri, K., Gunasekaran, P., & Rejeeth, C. (2012). In vitro anti-viral effect of β-santalol against influenza viral replication. *Phytomedicine*, 19(3–4): 231–235.
- Pham, D. M., Boussouira, B., Moyal, D., & Nguyen, Q. L. (2015). Oxidization of squalene, a human skin lipid: a new and reliable marker of environmental pollution studies. *International Journal of Cosmetic Science*, 37(4): 357–365.
- Pham-Huy, L. A., He, H., & Pham-Huy, C. (2008). Free radicals, antioxidants in disease and health. *International Journal of Biomedical Science*, 4(2): 89–96.
- Pichersky, E. & Raguso, R. A. (2016). Why do plants produce so many terpenoid compounds?. *New Phytologist*, 220(3): 692–702.



- Pieterse, C. M. & van Loon, L. C. (1999). Salicylic acid-independent plant defence pathways. *Trends in Plant Science*, 4(2): 52–58.
- Pollastri, M. P. (2010). Overview on the rule of five. *Current Protocols in Pharmacology*, 49: 9–12.
- Power, H., Wu, J., Turville, S., Aggarwal, A., Valtchev, P., Schindeler, A., & Dehghani, F. (2022). Virtual screening and in vitro validation of natural compound inhibitors against SARS-CoV-2 spike protein. *Bioorganic Chemistry*, 119: 105574.
- Price, G. & Patel, D. A. (2022). Drug Bioavailability. In: *StatPearls*. StatPearls Publishing.
- Purwianingsih, W., Febri, S., & Kusdianti. (2016). Formation flavonoid secondary metabolites in callus culture of *Chrysanthemum cinerariaefolium* as alternative provision medicine. *AIP Conference Proceedings*, 1708(1): 1–5.
- Pyrzynska, K. & Pekal, A. J. (2013). Application of free radical diphenylpicrylhydrazyl (DPPH) to estimate the antioxidant capacity of food samples. *Analytical Methods*, 5(17): 4288–4295.
- Rao, C. V., Newmark, H. L., & Reddy, B. S. (1998). Chemopreventive effect of squalene on colon cancer. *Carcinogenesis*, 19(2): 287–290.
- Richheimer, S. L., Bernart, M.W., King, G. A., Kent, M. C., & Bailey, D. T. (1996). Antioxidant activity of lipid soluble phenolic diterpenes from rosemary. *Journal of the American Oil Chemists' Society*, 73: 507–514.
- Rodriguez, E., Towers, G. H. N., & Mitchell, J. C. (1976). Biological activities of sesquiterpene lactones. *Phytochemistry*, 15(11): 1573–1580.
- Ruberto, G. & Baratta, M. T. (2000). Antioxidant activity of selected essential oil components in two lipid model systems. *Food Chemistry*, 69(2): 167–174.
- Sabeena, K. H. F., Anandan, R., Kumar, S. H., Shiny, K. S., Sankar, T. V., & Thankappan, T. K. (2004). Effect of squalene on tissue defense system in isoproterenol-induced myocardial infarction in rats. *Pharmacological Research*, 50(3): 231–236.
- Sabulal, B., Dan, M., J, A. J., Kurup, R., Pradeep, N. S., Valsamma, R. K., & George, V. (2006). Caryophyllene-rich rhizome oil of *Zingiber nimmonii* from South India: Chemical characterization and antimicrobial activity. *Phytochemistry*, 67(22): 2469–2473.
- Saikia, M., Shrivastava, K., Singh, S. S. (2013). Effect of culture media and growth hormones on callus induction in *Aquilaria malaccensis* Lam., a medically and commercially important tree species of north east India. *Asian Journal of Biological Sciences*, 6(2): 96–105.
- Sák, M., Dokupilová, I., Kaňuková, Š., Mrkvová, M., Mihálik, D., Hauptvogel, P., & Kraic, J. (2021). Biotic and abiotic elicitors of stilbenes production in *Vitis vinifera* L. cell culture. *Plants*, 10(3): 490.



- Santos-Sánchez, N. F., Salas-Coronado, R., Villanueva-Cañongo, C., & Hernández-Carlos, B. (2019). Antioxidant Compounds and Their Antioxidant Mechanism. In: Shalaby, E. A. (ed) *Antioxidants*. IntechOpen.
- Scandalios, J. G. (1997a). *Oxidative Stress and the Molecular Biology of Antioxidant Defenses*. Cold Spring Harbor Laboratory Press, New York.
- Scandalios, J. G. (1997b). Molecular genetics of superoxide dismutases. In: Scandalios, J. G. (ed) *Oxidative Stress and the Molecular Biology of Antioxidant Defenses*. Cold Spring Harbor Laboratory Press, New York.
- Scandalios, J. G. (2005). Oxidative stress: molecular perception and transduction of signals triggering antioxidant gene defenses. *Brazilian Journal of Medical and Biological Research*, 38(7): 995–1014.
- Scandalios, J. G., Guan, L., & Polidoros, A. N. (1997). Catalases in plants: Gene structure, properties, regulation, and expression. In: Scandalios, J. G. (ed) *Oxidative Stress and the Molecular Biology of Antioxidant Defenses*. Cold Spring Harbor Laboratory Press, New York.
- Schwarz, K., Ernst, H., & Ternes, W. (1996). Evaluation of antioxidant constituents of thyme. *Journal of the Science of Food and Agriculture*, 70(2): 217–223.
- Semprini, R., Martorana, A., Ragonese, M., & Motta, C. (2018). Observational clinical and nerve conduction study on effects of a nutraceutical combination on painful diabetic distal symmetric sensory-motor neuropathy in patients with diabetes type 1 and type 2. *Minerva Medica*, 109(5): 358–362.
- Setiawansyah, A. & Gemantari, B. M. (2022). Potential activity of caryophyllene derivatives as xanthine oxidase inhibitor: An in silico quantitative structure-activity relationship analysis. *Journal of Food and Pharmaceutical Sciences*, 10(3): 700–708.
- Setiawansyah, A., Reynaldi, M. A., Tjahjono, D. H., & Sukrasno, S. (2022). Molecular docking-based virtual screening of antidiabetic agents from songga (*Strychnos lucida* R.Br.): an Indonesian native plant. *Current Research on Biosciences and Biotechnology*, 3(2): 208–214.
- Shalaby, E. A. & Shanab, S. M. M. (2013). Antioxidant compounds, assays of determination and mode of action. *African Journal of Pharmacy and Pharmacology*, 7(10): 528–539.
- Sharma, M., Levenson, C., Clements, I., Castella, P., Gebauer, K., & Cox, M. E. (2017). East Indian Sandalwood Oil (EISO) alleviates inflammatory and proliferative pathologies of psoriasis. *Frontiers in Pharmacology*, 8: 125.
- Sharma, H. & Vashistha, B. D. (2015). Plant tissue culture: A biological tool for solving the problem of propagation of medicinally important woody plants - A review. *Advanced Research*, 3(2): 402–411.
- Singh, S., Baker, Q. B., & Singh, D. B. (2022). Molecular docking and molecular dynamics simulation. In: Singh, D. B. & Pathak, R. K. (eds) *Bioinformatics*, chap. 18: 291–304.



- Singh, S. K. & Khawale, R. N. (2006). Plantlet regeneration from nodal segments of pomegranate (*Punica granatum*) cv. Jyoti. *Plant Biotechnology and Its Applications in Tissue Culture* (Chapter 12, pp. 107–113).
- Singh, G., Marimuthu, P., de Heluani, C. S., & Catalan, C. A. (2006). Antioxidant and biocidal activities of *Carum nigrum* (seed) essential oil, oleoresin, and their selected components. *Journal of Agricultural and Food Chemistry*, 54(1): 174–181.
- Singh, P. & Patel, R. M. (2016). Factors affecting in vitro degree of browning and culture establishment of pomegranate. *African Journal of Plant Science*, 10(2): 43–49.
- Singh, T. P., Singh, R. K., & Malik, P. (2014). Analgesic and anti-inflammatory activities of *Annona squamosa* Linn bark. *Journal of Scientific and Innovative Research*, 3(1): 60–64.
- Singh, N. V., Singh, S. K., & Patel, V. B. (2011). In vitro culture establishment studies on pomegranate. *Indian Journal of Horticulture*, 68(3): 307–311.
- Šmelcerović, A., Tomović, K., Šmelcerović, Ž., Petronijević, Ž., Kocić, G., Tomašić, T., Jakopin, Ž., & Anderluh, M. (2017). Xanthine oxidase inhibitors beyond allopurinol and febuxostat; an overview and selection of potential leads based on in silico calculated physico-chemical properties, predicted pharmacokinetics and toxicity. *European Journal of Medicinal Chemistry*, 135: 491–516.
- Spanova, M. & Daum, G. (2011). Squalene - biochemistry, molecular biology, process biotechnology, and applications. *European Journal of Lipid Science and Technology*, 113(11): 1299–1320.
- Stank, A., Kokh, D. B., Fuller, J. C., & Wade, R. C. (2016). Protein binding pocket dynamics. *Accounts of Chemical Research*, 49(5): 809–815.
- Starkey, E. S. & Sammons, H. M. (2015). Practical pharmacokinetics: what do you really need to know?. *Archives of Disease in Childhood*, 100(1): 37–43.
- Stultz, C. M. & Karplus, M. (1999). MCSS functionality maps for a flexible protein. *Proteins*, 37(4): 512–529.
- Sukweenadhi, J., Yunita, O., Setiawan, F., Kartini, Siagian, M. T., Danduri, A. P., & Avanti, C. (2020). Antioxidant activity screening of seven Indonesian herbal extract. *Biodiversitas*, 21(5): 2062–2067.
- Sumarna, Y. (2002). *Budidaya Gaharu*. Penebar Swadaya, Depok.
- Sumitha, A., Devi, P. B., Hari, S., & Dhanasekaran, R. (2020). Covid-19 – In silico structure prediction and molecular docking studies with doxycycline and quinine. *Biomedical & Pharmacology Journal*, 13(3): 1185–1193.
- Sutomo, S. & Oktaviani, G. A. (2019). Eksplorasi lapangan jenis penghasil gaharu (*Gyrinops versteegii*) di Pulau Lombok Nusa Tenggara Barat. *ULIN: Jurnal Hutan Tropis*, 3: 64–69.



- Syaban, M. F. R., Faratisha, I. F. D., Yunita, K. C., Erwan, N. E., Kuriniawan, B. D., & Putra, G. F. A. (2022). Molecular docking and interaction analysis of propolis compounds against SARS-CoV-2 receptor. *Journal of Tropical Life Science*, 12(2): 219–230.
- Tang, W. & Newton, R. J. (2004). Increase of polyphenol oxidase and decrease of polyamines correlate with tissue browning in Virginia pine (*Pinus virginiana* Mill.). *Plant Science*, 167(3): 621–628.
- Tobias, J. W., Shrader, T. E., Rocap, G., & Varshavsky, A. (1991). The N-end rule in bacteria. *Science*, 254(5036): 1374–1377.
- Trichopoulou, A., Lagiou, P., Kuper, H., & Trichopoulos, D. (2000). Cancer and Mediterranean dietary traditions. *American Society of Preventive Oncology*, 9(9): 869–873.
- Tsujimoto, M. (1916). A highly unsaturated hydrocarbon in shark liver oil. *The Journal of Industrial and Engineering Chemistry*, 8(10): 889–896.
- Tung, Y. T., Chua, M. T., Wang, S. Y., & Chang, S. T. (2008). Anti-inflammation activities of essential oil and its constituents from indigenous cinnamon (*Cinnamomum osmophloeum*) twigs. *Bioresource Technology*, 99(9): 3908–3913.
- United Nations. (2011). *Globally harmonized system of classification and labelling of chemicals (GHS)*. Part 3. Health hazards. Chapter 3.1. Acute toxicity. United Nations Publications. p. 109.
- Verpoorte, R. (2000). Secondary Metabolism. In: Verpoorte, R. & Alfermann, A. W. (eds) *Metabolic Engineering of Plant Secondary Metabolism*. Kluwer Academic Publisher, Netherlands.
- Vinholes, J., Gonçalves, P., Martel, F., Coimbra, M. A., & Rocha, S. M. (2014). Assessment of the antioxidant and antiproliferative effects of sesquiterpenic compounds in in vitro Caco-2 cell models. *Food Chemistry*, 156: 204–211.
- Vijayasree, N. K., Udayasri, P., & Babu, R. (2010). Advancements in the production of secondary metabolites. *Journal of Natural Products*, 3: 112–123.
- Wahyuni, D. K., Huda, A., Faizah, S., Purnobasuki, H., & Wardojo, B. P. E. (2020). Effects of light, sucrose concentration and repetitive subculture on callus growth and medically important production in *Justicia gendarussa* Burm.f. *Biotechnology Reports*, 27: e00473.
- Walum E. (1998). Acute oral toxicity. *Environmental Health Perspectives*, 106 Suppl 2(Suppl 2): 497–503.
- Wardana, T. A. P. (2019). *Identifikasi Senyawa Aktif Anti Kanker Ekstrak dan Fraksi Daun Gaharu (*Gyrinops versteegii* (Gilg.) Domke) dengan LC-MS dan GC-MS [Skripsi, Universitas Gadjah Mada]*.



- Wardana, T. A. P., Nuringtyas, T. R., Wijayanti, N., & Hidayati, L. (2019). Phytochemical analysis of agarwood (*Gyrinops versteegii* (Gilg.) Domke) leaves extracts as anticancer using GC-MS. *AIP Conference Proceedings*, 2194: 020136.
- Xu, C. J., Sun, X. Z., Chen, D. Y., Lai, Y. Y., & Li, L. (2011). Cloning and characterization of peroxidase gene in *Phalaenopsis*. *Pakistan Journal of Botany*, 43(4): 2161–2167.
- Yamaguchi, Y., Matsumura, T., Ichida, K., Okamoto, K., & Nishino, T. (2007). Human xanthine oxidase changes its substrate specificity to aldehyde oxidase type upon mutation of amino acid residues in the active site: roles of active site residues in binding and activation of purine substrate. *Journal of Biochemistry*, 141(4): 513–524.
- Yuslianti, E. R. (2018). *Pengantar Radikal Bebas dan Antioksidan*. Deepublish Publisher, Yogyakarta.
- Zheng, G. Q., Kenney, P. M., & Lam, L. K. (1992). Sesquiterpenes from clove (*Eugenia caryophyllata*) as potential anticarcinogenic agents. *Journal of Natural Products*, 55(7): 999–1003.