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DAFTAR PUSTAKA

Abubakar, A. R., & Haque, M. (2020). Preparation of Medicinal Plants: Basic Extraction and Fractionation Procedures for Experimental Purposes. *Journal of Pharmacy and Bioallied Sciences*, *12*(1), 1–10. https://doi.org/10.4103/jpbs.JPBS_175_19

Adam, D. H. (2024). Skrinning Fitokimia, Kandungan Flavonoid Total dan Uji Aktivitas Antioksidan Ekstrak Kayu Balakka (*Phyllanthus emblica* L.). *Jurnal Kimia Unand*, *13*(2), 18–23. https://doi.org/10.25077/jku.13.2.18-23.2024

Afdal, M., Kasim, A., Alimon, A. R., & Abdullah, N. (2023). Investigation of The Antioxidant Activity of Cinnamon Bark Extracted with Different Solvents. *Jurnal Ilmiah Ilmu-Ilmu Peternakan*, *26*(1), 68–79. https://doi.org/10.22437/jiiip.v26i1.24368

Agustinisari, I., Nasori, A. S., Rahayu, E., Pongtuluran, O. B., Atmaji, P., Hernani, Harimurti, N., Yuliani, S., Rosyidin, A. K., & Batubara, I. (2026). Potential Phytochemical Compounds in Massoi Bark Extracted Using The Soxhlet Method. *IOP Conference Series: Earth and Environmental Science*, *1584*(1), 012103. https://doi.org/10.1088/1755-1315/1584/1/012103

Ajuziogu, G. C., Ugwu, L. U., & Ojua, E. O. (2019). Termicidal properties of wood extractive partitions as a prospective eco-friendly wood preservatives. *Journal of the Indian Academy of Wood Science*, *16*(1), 67–72. https://doi.org/10.1007/s13196-019-00238-9

Alara, O. R., Abdurahman, N. H., & Ukaegbu, C. I. (2018). Soxhlet Extraction of Phenolic Compounds from *Vernonia cinerea* Leaves and its Antioxidant Activity. *Journal of Applied Research on Medicinal and Aromatic Plants*, *11*, 12–17. https://doi.org/10.1016/j.jarmap.2018.07.003

Alvarez-Rivera, G., Bueno, M., Ballesteros-Vivas, D., Mendiola, J. A., & Ibañez, E. (2019). Pressurized Liquid Extraction. *Liquid-Phase Extraction*. Elsevier. https://doi.org/10.1016/B978-0-12-816911-7.00013-X

Ames, B. N., Shigenaga, M. K., & Hagen, T. M. (1993). Oxidants, antioxidants, and the degenerative diseases of aging (cancer/mutation/endogenous DNA adducts/oxygen radicals). *Proc. Natl. Acad. Sci. USA* (Vol. 90). https://www.pnas.org

Ariani, S. R. D., & Lestari, T. (2025). Chemical Components of Essential Oils from Woods of *Cinnamomum burmanii* (Ness) BL, *Santalum album* Linn., and *Cryptocarya massoia* (Oken) Kosterm and Their Application as Antibacterial Additives in Transparent Herbal Soaps. *HAYATI Journal of Biosciences*, *32*(3), 632–641. https://doi.org/10.4308/hjb.32.3.632-641

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Arisandi, R., Lukmandaru, G., Sawitri, Sunarti, S., & Nirsatmanto, A. (2025). Characterization of Wood Extractives and Antioxidant Activity in Acacia Hybrid (*Acacia mangium* × *Acacia auriculiformis*) Grown in Wonogiri, Indonesia. *Journal of the Korean Wood Science and Technology*, *53*(5), 480–500. https://doi.org/10.5658/WOOD.2025.53.5.480

Azmir, J., Zaidul, I. S. M., Rahman, M. M., Sharif, K. M., Mohamed, A., Sahena, F., Jahurul, M. H. A., Ghafoor, K., Norulaini, N. A. N., & Omar, A. K. M. (2013). Techniques for Extraction of Bioactive Compounds from Plant Materials: A review. *Journal of Food Engineering*, *117*(4), 426–436. https://doi.org/10.1016/j.jfoodeng.2013.01.014

Baliyan, S., Mukherjee, R., Priyadarshini, A., Vibhuti, A., Gupta, A., Pandey, R. P., & Chang, C. M. (2022). Determination of Antioxidants by DPPH Radical Scavenging Activity and Quantitative Phytochemical Analysis of *Ficus religiosa*. *Molecules*, *27*(4). https://doi.org/10.3390/molecules27041326

Barros, M. E. S. B., Freitas, J. C. R., Oliveira, J. M., Da Cruz, C. H. B., Da Silva, P. B. N., De Araújo, L. C. C., Militão, G. C. G., Da Silva, T. G., Oliveira, R. A., & Menezes, P. H. (2014). Synthesis and Evaluation of (-)-Massoialactone and Analogues as Potential Anticancer and Anti-inflammatory agents. *European Journal of Medicinal Chemistry*, *76*, 291–300. https://doi.org/10.1016/j.ejmech.2014.02.013

Boudet, A. M. (2007). Evolution and Current Status of Research in Phenolic Compounds. *Phytochemistry*, *68*, 2711-2735. https://doi.org/10.1016/j.phytochem.2007.06.012

Boussahel, S., Speciale, A., Dahamna, S., Amar, Y., Bonaccorsi, I., Cacciola, F., Cimino, F., Donato, P., Ferlazzo, G., Harzallah, D., & Cristani, M. (2015). Flavonoid Profile, Antioxidant and Cytotoxic Activity of Different Extracts from Algerian *Rhamnus alaternus* L. bark. *Pharmacognosy Magazine*, *11*(42), 102–109. https://doi.org/10.4103/0973-1296.157707

Breil, C., Vian, M. A., Zemb, T., Kunz, W., & Chemat, F. (2017). "Bligh and Dyer" and Folch methods for Solid–Liquid–Liquid Extraction of Lipids from Microorganisms. Comprehension of Solvatation Mechanisms and Towards Substitution with Alternative Solvents. *International Journal of Molecular Sciences*, *18*(4). https://doi.org/10.3390/ijms18040708

Bustanussalam, Susilo, H., & Nurhidayati, E. (2015). Identifikasi Senyawa dan Uji Aktivitas Ekstrak Etil Asetat Kulit Kayu Massoi (*Cryptocarpa massoy*). *Jurnal Ilmiah Farmasi*, *4*(2). https://doir.org/10.33751/jf.v4i2.187

Candra, L. M. M., Andayani, Y., & Wirasisya, D. G. (2021). Pengaruh Metode Ekstraksi Terhadap Kandungan Fenolik Total dan Flavonoid Total Pada

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Ekstrak Etanol Buncis (*Phaseolus vulgaris* L.). *Jurnal Pijar MIPA*, *16*(3), 397–405. https://doi.org/10.29303/jpm.v16i3.2308

Chatepa, L. E. C., Mwamatope, B., Chikowe, I., & Masamba, K. G. (2024). Effects of solvent Extraction on The Phytoconstituents and In Vitro Antioxidant Activity Properties of Leaf Extracts of The Two Selected Medicinal Plants from Malawi. *BMC Complementary Medicine and Therapies*, *24*(1). https://doi.org/10.1186/s12906-024-04619-7

Chaves, J. O., de Souza, M. C., da Silva, L. C., Lachos-Perez, D., Torres-Mayanga, P. C., Machado, A. P. da F., Forster-Carneiro, T., Vázquez-Espinosa, M., González-de-Peredo, A. V., Barbero, G. F., & Rostagno, M. A. (2020). Extraction of Flavonoids From Natural Sources Using Modern Techniques. *Frontiers in Chemistry*, *8*. https://doi.org/10.3389/fchem.2020.507887

Cicilia, M., Purwanjani, W., & Kenanga Sari, G. (2024). Pengaruh Jenis Pelarut Terhadap Aktivitas Antioksidan Ekstrak Daun Alpukat (*Persea americana Mill*). *Jurnal Farmasi IKIFA*, *3*(3), 94–106.

Dai, J., & Mumper, R. J. (2010). Plant phenolics: Extraction, analysis and Their Antioxidant and Anticancer Properties. *Molecules*, *15*(10). https://doi.org/10.3390/molecules15107313

D'Archivio, M., Filesi, C., Benedetto, R. Di, Gargiulo, R., Giovannini, C., & Masella, R. (2007). Polyphenols, Dietary Sources and Bioavailability. *Annali dell Istituto Superiore di Sanita*, *43*, 348–361.

Daryono, E. D., Pursitta, A. T., & Isnaini, A. (2014). Ekstraksi Minyak Atsiri pada Tanaman Kemangi dengan Pelarut N-Heksana. *Jurnal Teknik Kimia*, *9*(1), 1–7. https://doi.org/ 10.33005/jurnal_tekkim.v9i1.720

Dirar, A. I., Alsaadi, D. H. M., Wada, M., Mohamed, M. A., Watanabe, T., & Devkota, H. P. (2019). Effects of Extraction Solvents on Total Phenolic and Flavonoid Contents and Biological Activities of Extracts from Sudanese Medicinal Plants. *South African Journal of Botany*, *120*, 261–267. https://doi.org/10.1016/j.sajb.2018.07.003

Do, Q. D., Angkawijaya, A. E., Tran-Nguyen, P. L., Huynh, L. H., Soetaredjo, F. E., Ismadji, S., & Ju, Y.-H. (2014). Effect of Extraction Solvent on Total Phenol Content, Total Flavonoid Content, and Antioxidant Activity of *Limnophila aromatica*. *Journal of Food and Drug Analysis*, *22*(3), 296–302. https://doi.org/10.1016/j.jfda.2013.11.001

Dotulong, V., Wonggo, D., & Montolalau, L. A. D. Y. (2018). Phytochemical Content, Total Phenols, and Antioxidant Activity of Mangrove (*Sonneratia alba*) Young Leaf Through Different Extraction Methods and Solvents.

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
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International Journal of ChemTech Research, *11*(11), 356–363. https://doi.org/10.20902/ijctr.2018.111140

Dumanauw, J. F. (1982). *Mengenal Kayu*. PT Gramedia.

Dzięcioł, M., Wala, K., Wróblewska, A., & Janda-Milczarek, K. (2024). The Effect of the Extraction Conditions on the Antioxidant Activity and Bioactive Compounds Content in Ethanolic Extracts of *Scutellaria baicalensis* Root. *Molecules*, *29*(17). https://doi.org/10.3390/molecules29174153

Engelhardt, L., Pöhnl, T., & Neugart, S. (2021). Interactions of Ascorbic acid, 5-Caffeoylquinic acid, and Quercetin-3-rutinoside in the Presence and Absence of Iron during Thermal Processing and the Influence on Antioxidant Activity. *Molecules*, *26*(24), 1–19. https://doi.org/10.3390/molecules26247698

Faisal, H., Ligo, A., & Nasution, R. H. (2025). Perbandingan Aktivitas Antioksidan Ekstrak Etanol, Etil Asetat, dan n-Heksan Daun Kayu Manis Hutan (*Cinnamomum iners*) dengan Metode ABTS dan DPPH. *Jurnal Siti Rufaidah*, *3*(4), 310–326. https://doi.org/10.57214/jasira.v3i4.271

Fengel, D., & Wegener, G. (1984). *Wood: Chemistry, Ultrastructure, Reactions*. Walter de Gruyter & Co. Berlin.

Fernández-Agulló, A., Freire, M. S., & González-Álvarez, J. (2015). Effect of the extraction technique on the recovery of bioactive compounds from eucalyptus (*Eucalyptus globulus*) wood industrial wastes. *Industrial Crops and Products*, *64*, 105–113. https://doi.org/10.1016/j.indcrop.2014.11.031

Ferreira, J. P. A., Miranda, I., Sousa, V. B., & Pereira, H. (2018). Chemical Composition of Barks from *Quercus faginea* Trees and Characterization of Their Lipophilic and Polar Extracts. *PLoS ONE*, *13*(5). https://doi.org/10.1371/journal.pone.0197135

Gori, A., Boucherle, B., Rey, A., Rome, M., Fuzzati, N., & Peuchmaur, M. (2021). Development of an Innovative Maceration Technique to Optimize Extraction and Phase Partition of Natural Products. *Fitoterapia*, *148*. https://doi.org/10.1016/j.fitote.2020.104798

Graf, M., & Stappen, I. (2022). Beyond the Bark: An Overview of the Chemistry and Biological Activities of Selected Bark Essential Oils. *Molecules*, *27*(21). https://doi.org/10.3390/molecules27217295

Gulcin, İ., & Alwasel, S. H. (2023). DPPH Radical Scavenging Assay. *Processes*, *11*(8). https://doi.org/10.3390/pr11082248

Hananti, R. S., Hidayat, S., & Yanti, L. (2012). Uji Aktivitas Antidiabetes Ekstrak Etanol Kulit Kayu Manis (*Cinnamomum Burmanii Nees* Ex.Bl.) dibandingkan dengan Glibenklamid pada Mencit Jantan Galur Swiss Webster dengan

UNIVERSITAS
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Metode Toleransi Glukosa. *Indonesian Journal of Pharmaceutical Science and Technology*, *1*(1), 13-21. https://doi.org/10.4108/eai.11-10-2022.2325484

Handa, S. S., Khanuja, S. P. S., Longo, G., & Rakesh, D. D. (2008). Extraction Technologies for Medicinal and Aromatic Plants. *International Centre for Science and High Technology*.

Hegemur, S. H., Sayuti Pono, W., Nugroho, B., & Mahmud. (2023). Tata Niaga, Nilai Ekonomi dan Kualitas Kulit Kayu Masohi di Kabupaten Fakfak Provinsi Papua Barat. *Median : Jurnal Ilmu Ilmu Eksakta*, *16*(2), 121–133. https://doi.org/10.33506/md.v16i2.3591

Hertiani, T., Yuswanto, A., Pratiwi, S. U. T., & Mashar, H. M. (2018). Effect of Massoia (*Massoia aromatica* Becc.) Bark on the Phagocytic Activity of Wistar Rat Macrophages. *Scientia Pharmaceutica*, *86*(2), 1–7. https://doi.org/10.3390/scipharm86020019

Hogg, J. S., Lohmann, D. H., & Russell, K. E. (1961). The Kinetics Of Reaction Of 2,2-Diphenyl-1-Picrylhydrazyl with Phenols1. *Canadian Journal of Chemistry*, *39*(8), 1588-1594. https://doi.org/10.1139/v61-202

Hutapea, F. J., Kuswandi, R., & Asmoro, J. P. (2020). Potensi dan Sebaran Masoi (*Cryptocarya massoy*) di Kabupaten Teluk Bintuni dan Kabupaten Kaimana. *Penelitian Kehutanan*, *4*(1), 57–70. https://doi.org/10.20886/jpkf.2020.4.1.57-70

Jain, D., Meena, M., Janmeda, P., Seth, C. S., & Arora, J. (2024). Analysis of Quantitative Phytochemical Content and Antioxidant Activity of Leaf, Stem, and Bark of *Gymnosporia senegalensis* (Lam.) Loes. *Plants*, *13*(11). https://doi.org/10.3390/plants13111425

Jovanović, A. A., Đorđević, V. B., Zdunić, G. M., Pljevljakušić, D. S., Šavikin, K. P., Gođevac, D. M., & Bugarski, B. M. (2017). Optimization of the Extraction Process of Polyphenols from *Thymus serpyllum* L. Herb using Maceration, heat- and Ultrasound-assisted Techniques. *Separation and Purification Technology*, *179*, 369–380. https://doi.org/10.1016/j.seppur.2017.01.055

Jusman, J., & Syamsuddin, S. (2025). Natural Antioxidant Potential of *Cassia siamea* Flowers: Influence of Solvents on Phytochemicals and Activity. *Jurnal Sains Farmasi & Klinis*, *12*(2), 119–127. https://doi.org/10.25077/jsfk.12.2.119-127.2025

Ka, M. H., Choi, E. H., Chun, H. S., & Lee, K. G. (2005). Antioxidative Activity of Volatile Extracts Isolated from *Angelica tenuissimae* Roots, Peppermint Leaves, Pine Needles, and Sweet Flag Leaves. *Journal of Agricultural and Food Chemistry*, *53*(10), 4124–4129. https://doi.org/10.1021/jf047932x

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Karonen, M., Hämäläinen, M., Nieminen, R., Klika, K. D., Loponen, J., Ovcharenko, V. V., Moilanen, E., & Pihlaja, K. (2004). Phenolic Extractives from the Bark of *Pinus sylvestris L.* and Their Effects on Inflammatory Mediators Nitric Oxide and Prostaglandin E 2. *Journal of Agricultural and Food Chemistry*, *52*(25), 7532–7540. https://doi.org/10.1021/jf048948q

Khoddami, A., Wilkes, M. A., & Roberts, T. H. (2013). Techniques for Analysis of Plant Phenolic Compounds. *Molecules*, *18*(2), 2328-2375. https://doi.org/10.3390/molecules18022328

Lama-Muñoz, A., & Contreras, M. del M. (2022). Extraction Systems and Analytical Techniques for Food Phenolic Compounds: A Review. *Foods*, *11*(22). https://doi.org/10.3390/foods11223671

Leite, C., & Pereira, H. (2017). Review of Cork-containing barks. *Frontiers in Materials*, *3*. https://doi.org/10.3389/fmats.2016.00063

Li, J. (2020). *A Systematic Testing Strategy In Performing A Successful Chemical Characterization At Medtronic-How Industry May Be Performing Chemical Characterization Differently Than FDA Preferences and Why*. Medtronic.

Li, X. J., Guo, J., Xu, Y. P., Li, S. Y., Li, N., & Liu, Q. Y. (2025). Effects of Heat Reflux Extraction on The Content, Antioxidant, and Immune Activity of Polyphenols and Flavonoids From Hempseed Threshing Residues. *PLoS ONE*, *20*(5 May), 1–17. https://doi.org/10.1371/journal.pone.0322134

Luanmansar. (2012). *Hubungan Diameter Pohon Terhadap Produksi Kulit Masoi (Cryptocarya massoia) Pada Hutan Lindung Tanggaromi Kabupaten Kaimana*. Universitas Papua.

Luksta, I., & Spalvins, K. (2023). Methods for Extraction of Bioactive Compounds from Products: A Review. *Environmental and Climate Technologies*, *27*(1), 422–437. https://doi.org/10.2478/rtuect-2023-0031

Mancini, L. T., Ramalho, F. M. G., Trugiho, P. F., & Hein, P. R. G. (2019). Green Synthesis of Silver Nanoparticles (Ag-nps) from *Olea dioica* roxb., Leaf Extracts and its Biological Activity. *Biogeosciences and Forestry*, *14*(4), 18–25. https://doi.org/10.3832/IFOR3472-013

Martawijaya, A. (1996). *Atlas Kayu Indonesia Jilid II*. Badan Penelitian dan Pengembangan Kehutanan.

Martín, M. Á., & Ramos, S. (2021). Impact of dietary flavanols on microbiota, Immunity and Inflammation in Metabolic Diseases. *Nutrients*, *13*(3), 1–24. https://doi.org/10.3390/nu13030850

Maryuni, A. E., Nurhairi, & Sawias, O. B. W. (2020). Aktivitas Antibakteri dan Fitokimia Kulit Kayu *Cryptocarya massoy* Asal Distrik Web, Keerom, Papua.

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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AVOGADRO: Jurnal Kimia, *4*(2), 117-124. https://doi.org/10.31957/.v4i2.1990

Mcgowan, J. C., Powell, T., & Raw, R. (1959). The Rates of Reaction of DPPH with Certain Amines and Phenols. *Journal of the Chemical Society*, *58*, 3103-3110. https://doi.org/10.1039/JR9590003103

Mendes, S. A., Boas, V., Pedro, S., Pinho, A., Amorim, M. O., Ferreira, S., & Fernandes, L. (2017). *Studies on the Solubility of Phenolic Compounds*. Repositório Institucional da Universidade Tecnológica Federal do Paraná.

Miranda, I., Lima, L., Quilhó, T., Knapic, S., & Pereira, H. (2016). The Bark of *Eucalyptus sideroxylon* as a Source of Phenolic Extracts with Anti-oxidant Properties. *Industrial Crops and Products*, *82*, 81–87. https://doi.org/10.1016/j.indcrop.2015.12.003

Mohammedi, H., Idjeri-Mecherara, S., Menaceur, F., & Hassani, A. (2019). The Effect of Solvents and Extraction Procedure on The Recovery of Phenolic Compounds and The Antioxidant Capacity of *Algerian Bassia muricata L*. extracts. *Chemistry Journal of Moldova*, *14*(2), 79–89. https://doi.org/10.19261/cjm.2019.637

Moldoveanu, S. C., & David, V. (2019). Derivatization Methods in GC and GC/MS. In *Gas Chromatography-Derivatization, Sample Preparation, Application*. IntechOpen. https://doi.org/10.5772/intechopen.81954

Moomin, A., Russell, W. R., Knott, R. M., Scobbie, L., Mensah, K. B., Adu-Gyamfi, P. K. T., & Duthie, S. J. (2023). Season, Storage and Extraction Method Impact on the Phytochemical Profile of Terminalia Ivorensis. *BMC Plant Biology*, *23*. https://doi.org/10.21203/rs.3.rs-2418949/v1

Nakamura, Y., Tsuji, S., & Tonogai, Y. (2003). Analysis of Proanthocyanidins in Grape Seed Extracts, Health Foods and Grape Seed Oils. *Journal of Health Science*, *49*(1), 45–54. https://doi.org/10.1248/jhs.49.45

Nascimento, M. S., Santana, A. L. B. D., Maranhão, L. S., Oliveira, & Bieber, L. (2013). *Phenolic Extractives and Natural Resistance of Wood*. InTech. https://doi.org/10.5772/56358

Natasya, E., Daulay, A. S., Ridwanro, & Rahayu, Y. P. (2023). Penetapan Kadar Flavonoid Total Ekstrak Kayu Raru (*Cotylelobium lanceolatum Craib*) Berdasarkan Perbedaan Konsentrasi Etanol dengan Metode Spektrofotometri Uv-Vis. *Journal of Pharmaceutical and Sciences*, *6*(4), 1804–1810. https://www.journal-jps.com

Natasya, S. A., Nasution, M. P., Nasution, H. M., & Yuniarti, R. (2025). Determination of Total Flavonoid Content of Ethanol Extract and Ethyl

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Acetate Fraction of Avocado Seed (*Persea americana Mill*) by Visible Spectrofotometry Methods. *Indonesian Journal of Science and Pharmacy*, *2*(3), 120–125. https://doi.org/10.63763/ijsp.v2i3.98

Nisca, A., & Tanase, C. (2025). Approaches to Extracting Bioactive Compounds from Bark of Various Plants. *Plants*, *14*(18). https://doi.org/10.3390/plants14182929

Noli, Z. A., Nurainas, Rozen, N., Pujani, V., Hany, I. P., & Fajrisani, S. (2024). *Mengenal Massoia (Cryptocarya massoy (Oken) Kosterm) Tanaman Penghasil Minyak Atsiri Asli Papua* (Z. A. Noli, Ed.). Deepublish Digital.

Nursamsiar, N., Marwati, M., & Nur, S. (2023). The Effect of Extraction Method on Flavonoid Content and Antioxidant Activity of Red Betel and Green Betel Extracts. *Tropical Journal of Natural Product Research*, *7*(8), 3620–3625. https://doi.org/10.26538/tjnpr/v7i8.7

Pratama, F., & Sugiharto, A. (2024). Uji Efektivitas Pelarut Ekstraksi Flavonoid dari Akar Kayu Bajakah dengan Variabel Pelarut Etanol, Etil Asetat, dan Metanol. *Simposium Nasional RAPI XXIII*, 34–38.

Patil, M. C., & M, G. (2026). Phytochemical Screening and GC-MS Profiling of the Methanolic Fraction of *Cryptocarya Wightiana* Thw. *International Journal of Multidisciplinary Research*, *8*(2), 1–15. https://doi.org/10.36948/ijfmr.2026.v08i02.72515

Paula, V. B., Sousa-Dias, M. L., Seixas, N. L., Combarros-Fuertes, P., Estevinho, L. M., & Dias, L. G. (2024). Phenolic Class Analysis in Honey: Comparison of Classical and Single UV Spectrum Methodologies. *Processes*, *12*(10). https://doi.org/10.3390/pr12102297

Pawar, S. S., & Dasgupta, D. (2018). Quantification of Phenolic Content from Stem-Bark and Root of *Hugonia mystax* Linn. using RP-HPLC. *Journal of King Saud University - Science*, *30*(3), 293–300. https://doi.org/10.1016/j.jksus.2016.09.002

Peiris, D. S. H. S., Fernando, D. T. K., Senadeera, S. P. N. N., & Ranaweera, C. B. (2023). Phytochemical Screening for Medicinal Plants: Guide for Extraction Methods. *Asian Plant Research Journal*, *11*(4), 13–34. https://doi.org/10.9734/aprj/2023/v11i4216

Pękal, A., & Pyrzynska, K. (2014). Evaluation of Aluminium Complexation Reaction for Flavonoid Content Assay. *Food Analytical Methods*, *7*(9), 1776–1782. https://doi.org/10.1007/s12161-014-9814-x

Pérez, M., Dominguez-López, I., & Lamuela-Raventós, R. M. (2023). The Chemistry Behind the Folin-Ciocalteu Method for the Estimation of

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

(Poly)phenol Content in Food: Total Phenolic Intake in a Mediterranean Dietary Pattern. *Journal of Agricultural and Food Chemistry*, *71*(46), 17543–17553. https://doi.org/10.1021/acs.jafc.3c04022

Pietarinen, S. P., Willför, S. M., Ahotupa, M. O., Hemming, J. E., & Holmbom, B. R. (2006). Knotwood and Bark Extracts: Strong antioxidants from waste materialsM. *Journal of Wood Science*, *52*(5), 436–444. https://doi.org/10.1007/s10086-005-0780-1

Platzer, M., Kiese, S., Tybussek, T., Herfellner, T., Schneider, F., Schweiggert-Weisz, U., & Eisner, P. (2022). Radical Scavenging Mechanisms of Phenolic Compounds: A Quantitative Structure-Property Relationship (QSPR) Study. *Frontiers in Nutrition*, *9*, 1–12. https://doi.org/10.3389/fnut.2022.882458

Prasetyorini, Utami, N. F., Yulianita, Novitasari, N., & Fitriyani, W. (2021). Potensi Ekstrak Refluks Kulit Batang Kayu Manis (*Cinnamomum burmannii*) Sebagai Antijamur *Candida albicans* dan *Candida tropicalis*. *Jurnal Ilmiah Farmasi*, *11*(2), 164–178. https://doi.org/10.33751/jf.v11i2.2272

Rali, T., Wossa, S. W., & Leach, D. N. (2007). Comparative Chemical Analysis of the Essential Oil Constituents in the Bark, Heartwood and Fruits of *Cryptocarya massoy* (Oken) *Kosterm*. (Lauraceae) from Papua New Guinea. *Molecules*, *12*(2), 149-154. https://doi.org/10.3390/12020149

Ramadhan, R., & Sari, A. A. (2020). Pengaruh Metode Ekstraksi Terhadap Kadar Flavonoid Total dan Aktivitas Antioksidan Tanaman Kenop (*Gomphrena globosa*). *Journal of Pharmaceutical Sciences*, *8*(4), 2356–2361. https://doi.org/10.36490/journal-jps.com

Ramayani, S. L., Nugraheni, D. H., Robertin, A., & Wicaksono, E. (2021). Pengaruh Metode Ekstraksi Terhadap Kadar Total Fenolik dan Kadar Total Flavonoid Daun Talas (*Colocasia esculenta* L.). *Journal of Pharmacy*, *10*(1), 11–16. https://doi.org/10.37013/jf.v10i1.115

Ramos, S. (2008). Cancer Chemoprevention and Chemotherapy: Dietary Polyphenols and Signalling Pathways. *Molecular Nutrition and Food Research*, *52*(5), 507–526. https://doi.org/10.1002/mnfr.200700326

Rijoice, M., & Saragih, H. (2022). Mengekstrak Senyawa Bioaktif yang Terkandung pada Kulit Kayu Manis dan Mengidentifikasinya dengan Teknik *Gas Chromatography-Mass Spectroscopy* (GC-MS). *Jurnal Biologi dan Pembelajarannya*, *9*, 12–26. https://ojs.unpkediri.ac.id/index.php/biologi

Rohmah, J., Saidi, I. A., Rini, C. S., Masyitha, D. A., Ramadhani, D. N., & Wulandari, H. P. (2020). Aktivitas Antioksidan Ekstrak Etanol, Etil Asetat, dan n-Heksana Batang Turi Putih (*Sesbania grandiflora* (L.) Pers.)dengan

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Metode DPPH (1,1-Diphenyl-2-picrylhydrazyl). *Jurnal Kimia Riset*, *5*(1), 67–85. https://doi.org/10.20473/jkr.v5i1.20900

Rosalia, R., Setyaningsih, D., Ahda, A., Aziz, S., Lulu Luthfiah, S., Dwi Apriani, V., Tantia Dinita, S., Dewi, Y., & Oktaviani Malik, M. (2022). Studi Fitokimia dan Aktivitas Farmakologi dari Kulit Batang Mesoyi (*Massoia aromatica Becc*.). *Jurnal Ilmiah Farmasi*, *2*(2), 10-18. https://doi.org/10.36805/jbf.v2i2.382

Rowell, R. M. (2013). *Handbook of Wood Chemistry and Wood Composites*. CRC Press.

Royal Botanic Gardens, K. (2023, April 10). *Cryptocarya massoy*. Plants of The World Online.

Rudiana, T., Nurbayti, S., Ashari, T. H., Zhorif, S. A., & Suryani, N. (2023). Comparison of Maceration and Soxhletation Methods on the Antioxidant Activity of the *Bouea macrophylla* Griff Plant. *Jurnal Kimia Valensi*, *9*(2), 244–252. https://doi.org/10.15408/jkv.v9i2.35239

Rudiana, T., Suryani, N., & Anwar, H. (2021). Aktivitas Antioksidan dan Identifikasi Senyawa Metabolit Sekunder dari Ekstrak Batang Dahu (*Dracontomelon dao*). *Jurnal Kimia dan Terapannya*, *5*(1), 8–12. https://doi.org/10.17977/um0260v5i12021p008

Rumbrawer, Y., Siallagan, J., & Maryuni, A. E. (2021). Uji Kualitatif Fitokimia Tumbuhan Kayu Massoy (*Cryptocarya Massoia Oken Kostermans*) Berasal dari Kabupaten Keerom Papua Menggunakan Metode Ekstraksi Maserasi. *AVOGADRO Jurnal Kimia*, *5*(1), 9–19. https://doi.org/10.31957/.v5i1.2007

Sa'adah, S. N. (2024). Penentuan Kadar Total Fenol dan Flavonoid pada Ekstrak Kayu Manis (*Cinnamomum burmannii*). *Maliki Interdisciplinary Journal*, *2*, 1470–1483. http://urj.uin-malang.ac.id/index.php/mij/index

Saitis, I., Muslihin, A. M., Hardia, L., Budiyanto, A. B., Rossardy, D., Watora, W., Fadli, J. C., & Fitrianti, A. (2026). The Effect of Different Extraction Methods on the Total Flavonoid and Alkaloid Content of Red Fruit Stalk (*Pandanus conoideus* L.). *Journal of Pharmaceutical Sciences*, *9*(2), 2111–2123. https://doi.org/10.36490/journal-jps.com

Salamah, N., & Widyasari, E. (2015). Aktivitas Antioksidan Ekstrak Metanol Daun Kelengkeng (*Euphoria longan* (L) Steud.) dengan Metode Penangkapan Radikal 2,2'-difenil-1-pikrilhidrazil. *Pharmaciana*, *5*, 25–34. https://doi.org/10.12928/pharmaciana.v5i1.2283

Sangkal, A., Djamal, J. M., & Supardi, R. H. (2025). Identification of Bioactive Compounds from Cocoa Fruit Skin (*Theobroma Cacao* L.) with Variations in

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Solvent Polarity Properties. *International Journal of Health Science*, *5*, 356–362. https://doi.org/10.55606/ijhs.v5i2.5676

Santoso, A., & Abdurachman, A. (2016). Karakteristik Ekstrak Kulit Kayu Mahoni Sebagai Bahan Perekat Kayu. *Jurnal Penelitian Hasil Hutan*, *34*(4), 269–284. https://doi.org/10.20886/jphh.2016.34.4.269-284

Sari, B. L., Rurianti, W., & Simanjuntak, P. (2015). Toksisitas, Aktivitas Antioksidan dan Antibakteri Ekstrak Air Kulit Kayu Massoi (*Cryptocarpa massoy* (*Lauraceae*)). *Fitofarmaka*, *4*(1), 18–26. https://doi.org/10.33751/jf.v4i1.183

Sasnita, M., Daulay, A. S., Ridwanto, R., & Nasution, H. M. (2023). Effect of Extraction Methodon Yellow Wood Rendement and Phenolic Content (*Arcangelisia flava* (L.) Merr) UV-Vis Spectrophotometry Extract of Ethanol. *Indonesian Journal of Science and Pharmacy*, *1*(1), 31–45. https://doi.org/10.63763/ijsp.v1i1.25

Satrianegara, F., Tahar, N., Rukmana, R., Rauf, A., Rahmi, Putri, S. S., & Hamzah, N. (2024). The Effect of Various Extraction Methods and Solvents on the Phytochemical Contents and Antioxidant Capacities of Safflower Florets (*Carthamus Tinctorius* L.) from South Sulawesi. *Trends in Sciences*, *21*(7). https://doi.org/10.48048/tis.2024.7576

Shraim, A. M., Ahmed, T. A., Rahman, M. M., & Hijji, Y. M. (2021). Determination of Total Flavonoid Content by Aluminum Chloride Assay: A critical evaluation. *LWT*, *150*. https://doi.org/10.1016/j.lwt.2021.111932

Sillero, L., Prado, R., Andrés, M. A., & Labidi, J. (2019). Characterisation of Bark of Six Species from Mixed Atlantic Forest. *Industrial Crops and Products*, *137*, 276–284. https://doi.org/10.1016/j.indcrop.2019.05.033

Singla, R. K., Dubey, A. K., Garg, A., Sharma, R. K., Fiorino, M., Ameen, S. M., Haddad, M. A., & Al-Hiary, M. (2019). Natural Polyphenols: Chemical classification, Definition of Classes, Subcategories, and Structures. *Journal of AOAC International*, *102*(5), 1397–1400. https://doi.org/10.5740/jaoacint.19-0133

Slaček, G., Kotnik, P., Osmić, A., Postružnik, V., Knez, Ž., Finšgar, M., & Knez Marevci, M. (2023). The Extraction Process, Separation, and Identification of Curcuminoids from Turmeric *Curcuma longa*. *Foods*, *12*(21). https://doi.org/10.3390/foods12214000

Stalikas, C. D. (2007). Extraction, Separation, and Detection Methods for pPhenolic Acids and Flavonoids. *Journal of Separation Science*, *30*(18), 3268–3295. https://doi.org/10.1002/jssc.200700261

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Suardiana, I. K., Putra, A. A. G. R. Y., & Sari, P. M. N. A. (2025). Effect of Extraction Methods on Total Flavonoid Content and Antioxidant Activity Potential of Ethanol Extracts of Galing-galing Leaves (*Cayratia trifolia* (L.) Domin). *Journal of Pharmaceutical Science and Application*, *7*(1), 12–20. https://doi.org/10.24843/jpsa.2025.v07.i01.p02

Sultana, B., Anwar, F., & Ashraf, M. (2009). Effect of Extraction Solvent/Technique on the Antioxidant Activity of Selected Medicinal Plant Extracts. *Molecules*, *14*(6), 2167–2180. https://doi.org/10.3390/molecules14062167

Sun, W., & Shahrajabian, M. H. (2023). Therapeutic Potential of Phenolic Compounds in Medicinal Plants—Natural Health Products for Human Health. *Molecules*, *28*(4). https://doi.org/10.3390/molecules28041845

Syukur, M., Prahasiwi, M. S., Nurkhasanah, Yuliani, S., Purwaningsih, Y., & Indriyanti, E. (2023). Profiling of Active Compounds of Extract Ethanol, n-Hexane, Ethyl Acetate and Fraction Ethanol of Star Anise (*Illicium verum* Hook. f.) and Determination of Total Flavonoids, Total Phenolics and Their Potential as Antioxidants. *Science and Technology Indonesia*, *8*(2), 219–226. https://doi.org/10.26554/sti.2023.8.2.219-226

Tourabi, M., Faiz, K., Ezzouggari, R., Louasté, B., Merzouki, M., Dauelbait, M., Bourhia, M., Almaary, K. S., Siddique, F., Lyoussi, B., & Derwich, E. (2025). Optimization of extraction process and solvent polarities to enhance the recovery of phytochemical compounds, nutritional content, and biofunctional properties of *Mentha longifolia* L. extracts. *Bioresources and Bioprocessing*, *12*(1). https://doi.org/10.1186/s40643-025-00859-8

Triantoro, R. G. N., & Susanti, C. M. E. (2007). Kandungan Bahan Aktif Kayu Kulilawang (*Cinnamomum culilawane* Bl.) dan Masoi (*Cryptocaria massoia*). *Jurnal Ilmu dan Teknologi Kayu Tropis*, *5*(2).

Triyanti, S. B., Lestari, F. P., Fitriana, P. A. N., Rostiana, H. R., Silalahi, D. D., Syalsabina, T. D., Putri, R. Y., & Saputra, I. S. (2025). Pengaruh Metode Ekstraksi Maserasi, Sonikasi, dan Sokletasi Terhadap Nilai Rendemen Sampel Kulit Buah Naga (*Hylocereus polyrhizus*). *Jurnal Sains Dan Edukasi Sains*, *8*(1), 71–78. https://doi.org/10.24246/juses.v8i1p71-78

Tsao, R. (2010). Chemistry and biochemistry of dietary polyphenols. *Nutrients*, *2*(12), 1231–1246. https://doi.org/10.3390/nu2121231

Tuturop, A., Nugroho, J. D., & Hendri. (2022). Pengetahuan Lokal Berbasis Masyarakat Adat untuk Pengelolaan Tanaman Masohi: Pembelajaran dari Distrik Teluk Patipi Kabupaten Fak-Fak. *Cassowary*, *5*(1), 1–10. https://doi.org/10.30862/casssowary.cs.v5.i1.113

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Usman, H., Jalaluddin, M. N., Harlim, T., Hakim, E. H., Achmad, S. A., Syah, Y. M., Latip, J., & Said, I. M. (2006). Senyawa Kalkon Baru Bersifat Anti-Bakteri dari Tumbuhan *Cryptocarya Costata (*Lauraceae*)*. *Berkala MIPA*, 16(1), 37-40. https://journal.ugm.ac.id/bimipa/article/view/13899

Utami, N. F., Syarif, R. M., Irawan, C. S., & Ramadhani, S. (2025). Analysis of Solvent Concentration Effect and Extraction Method on The Total Phenolic of *Syzygium myrtifolium Walp*. Leaf Extract. *Pharmacognosy Journal , 17*(4), 461–469. https://doi.org/10.5530/pj.2025.17.59

Verep, D., Ates, S., & Karaogul, E. (2023). A Review of Extraction Methods for Obtaining Bioactive Compounds in Plant-Based Raw Materials. *Bartın Orman Fakültesi Dergisi*, *25*(3), 492–513. https://doi.org/10.24011/barofd.1303285

Wahyuningsih, S., Sari, N. I., Wahid, H., & Azima, A. (2026). Perbandingan Metode Ekstraksi terhadap Kadar Flavonoid dan Aktivitas Antioksidan Ekstrak Etanol Daun Pulai (*Alstonia scholaris*) dengan Metode 2,2-difenil-1-pikrilhidrazil (DPPH). *Sinteza*, *6*(1), 52–61. https://doi.org/10.29408/sinteza.v6i1.31992

Westphal, E., & Jansen, P. C. M. (1989). *Plant resources of South-East Asia*. Pudoc.

Widiyastuti, Y., M. Sholikhah, I. Y., & Haryanti, S. (2018). Cytotoxic Activities of Methanolic and Chloroform Extract of *Cryptocarya Massoy* (Oken) Kosterm. Bark on MCF-7 Human Breast Cancer Cell Line. *Health Science Journal of Indonesia*, *9*(1), 57–62. https://doi.org/10.22435/hsji.v9i1.482

Wijaya, H., Jubaidah, S., Program,), Farmasi, S., Tinggi, S., & Samarinda, I. K. (2022). Perbandingan Metode Ekstraksi Maserasi dan Sokhletasi terhadap Rendemen Ekstrak Batang Turi (*Sesbania grandiflora* L.). *Indonesian Journal of Pharmacy and Natural Product*, *5*(1), 1-11. https://doi.org/10.35473/ijpnp.v5i1.1469

Wulandari, F. T., & Sarjan, M. (2024). Peran Hasil Hutan Bukan Kayu dalam Mewujudkan Keberlanjutan Sumberdaya Hutan di Indonesia: Suatu Kajian Aksiologi Ilmu. *Hutan Tropika*, *19*(2), 404–413. https://doi.org/10.36873/jht.v19i2.17611

Xie, J., & Schaich, K. M. (2014). Re-evaluation of the 2,2-diphenyl-1-picrylhydrazyl free radical (DPPH) assay for antioxidant activity. *Journal of Agricultural and Food Chemistry*, *62*(19), 4251–4260. https://doi.org/10.1021/jf500180u

Xuan Cuong, D., Xuan Hoan, N., Huu Dong, D., Thi Minh Thuy, L., Van Thanh, N., Thai Ha, H., Thi Thanh Tuyen, D., & Xuan Chinh, D. (2020). *Tannins: Extraction from Plants*. InTech. https://doi.org/10.5772/intechopen.86040

UNIVERSITAS
GADJAH MADA
**Kadar Ekstraktif dan Aktivitas Antioksidan Kulit Kayu Masohi (Cryptocarya massoy) di Hutan Alam PT
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Arnaya Khairi Rapul Hanisi, Sigit Sunarta; Rizki Arisandi
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Yan, K., Cheng, X. J., Bian, G. L., Gao, Y. X., & Li, D. Q. (2022). The Influence of Different Extraction Techniques on the Chemical Profile and Biological Properties of *Oroxylum indicum*: Multifunctional Aspects for Potential Pharmaceutical Applications. *Evidence-Based Complementary and Alternative Medicine*, *2022*, 1–17. https://doi.org/10.1155/2022/8975320

Yeny, I., Narendra, B. H., & Nuroniah, H. S. (2018). Potensi Pengembangan Masoyi (*Cryptocarya massoy* (Oken) Kosterm) di Wilayah UPTD KPH Unit V Boalemo Berdasarkan Kesiapan Masyarakat dan Tingkat kesesuaian Lahan. *Jurnal Penelitian Hutan Tanaman*, *15*(2), 125–145. https://doi.org/10.20886/jpht.2018.15.2.125-145

Zheng, Y. Z., Zhou, Y., Liang, Q., Chen, D. F., Guo, R., & Lai, R. C. (2016). Hydrogen-bonding Interactions between Apigenin and Ethanol/Water: A Theoretical Study. *Scientific Reports*, *6*. https://doi.org/10.1038/srep34647