Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Al-Obaidi, J. R., Mohd-Yusuf, Y., Razali, N., Jayapalan, J. J., Tey, C. C., Md-Noh, N., ... & Hashim, O. H. (2014). Identification of proteins of altered abundance in oil palm infected with Ganoderma boninense. *International journal of molecular sciences*, *15*(3), 5175-5192.

Alviodinasyari, R., Martina, A., & Lestari, W. (2015). Pengendalian Ganoderma Boninense oleh Trichoderma Sp. Sbj8 pada Kecambah dan Bibit Kelapa Sawit (Elaeis Guineensis Jacq.) di Tanah Gambut. *Jom Fmipa*, 2(1).

Andrade, C. M., Tinoco, M. L. P., Rieth, A. F., Maia, F. C. O., & Aragão, F. J. L. (2016). Host-induced gene silencing in the necrotrophic fungal pathogen Sclerotinia sclerotiorum. *Plant Pathology*, 65(4), 626–632. https://doi.org/10.1111/ppa.12447

Anothai, J., & Chairin, T. (2020). Soil physicochemical properties closely associated with fungal enzymes and plant defense enzymes in Ganoderma-infected oil palm orchards. *Plant and Soil*, 456(1–2), 99–112. https://doi.org/10.1007/s11104-020-04705-y

Azmi, A. N. N., Bejo, S. K., Jahari, M., Muharam, F. M., Yule, I., & Husin, N. A. (2020). Early detection of *ganoderma boninense* in oil palm

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

seedlings using support vector machines. *Remote Sensing*, 12(23), 1–21. https://doi.org/10.3390/rs12233920

Beernink, B. M., Amanat, N., Li, V. H., Manchur, C. L., Whyard, S., & Belmonte, M. F. (2024). SIGS vs. HIGS: opportunities and challenges of RNAi pest and pathogen control strategies. *In Canadian Journal of Plant Pathology* 46(6), pp. 675–689). Taylor and Francis Ltd. https://doi.org/10.1080/07060661.2024.2392610

Beijen, E. P. W., van Maanen, M. H., Marian, I. M., Klusener, J. X., van Roosmalen, E., Herman, K. C., Koster, M. C., & Ohm, R. A. (2024). Transcriptomics reveals the regulation of the immune system of the mushroom-forming fungus Schizophyllum commune during interaction with four competitors. *Microbiological Research*, 289. https://doi.org/10.1016/j.micres.2024.127929

Bharudin, I., Ab Wahab, A. F. F., Abd Samad, M. A., Xin Yie, N., Zairun, M. A., Abu Bakar, F. D., & Abdul Murad, A. M. (2022). Review Update on the Life Cycle, Plant–Microbe Interaction, Genomics, Detection and Control Strategies of the Oil Palm Pathogen *Ganoderma boninense*. *In Biology*, 11(2). MDPI. https://doi.org/10.3390/biology11020251

Burlacu, A., Israel-Roming, F., & Cornea, C. P. (2018). Depolymerization of kraft lignin with laccase and peroxidase: A review. *Sci. Bull. Ser. F Biotechnol*, *22*, 172-179.

Bustin, S. A., Benes, V., Garson, J. A., Hellemans, J., Huggett, J., Kubista, M., Mueller, R., Nolan, T., Pfaffl, M. W., Shipley, G. L., Vandesompele,

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

J., & Wittwer, C. T. (2009). The MIQE guidelines: Minimum information for publication of quantitative real-time PCR experiments. *Clinical Chemistry*, 55(4), 611–622. https://doi.org/10.1373/clinchem.2008.112797

Canacuán Melo, F. Y., Suárez Anaya, Y. K., Rey Valenzuela, V. E., Morales Osorio, J. G., & Arango Isaza, R. E. (2025). RNA-mediated gene silencing can reduce azole resistance, growth and pathogenicity in Pseudocercospora fijiensis. *PLoS One*, *20*(6), e0325057.

Capriotti, L., Molesini, B., Pandolfini, T., Jin, H., Baraldi, E., Cecchin, M., ... & Sabbadini, S. (2024). RNA interference-based strategies to control Botrytis cinerea infection in cultivated strawberry. *Plant cell reports*, 43(8), 201.

Chellappan, P., Xia, J., Zhou, X., Gao, S., Zhang, X., Coutino, G., Vazquez, F., Zhang, W., & Jin, H. (2010). siRNAs from miRNA sites mediate DNA methylation of target genes. *Nucleic Acids Research,* 38(20), 6883–6894. https://doi.org/10.1093/nar/gkq590

Chen, C., Imran, M., Feng, X., Shen, X., & Sun, Z. (2025). Spray-induced gene silencing for crop protection: recent advances and emerging trends. *Frontiers in Plant Science*, *16*, 1527944.

Chong, K. P., Abdullah, S., & Ng, T. L. (2013). Molecular fingerprint of Ganoderma spp. from Sabah, Malaysia. *Int. J. Agric. Biol*, 15, 1112–1118. http://www.fspublishers.org

UNIVERSITAS
GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Chow, Y. Y., & Ting, A. S. Y. (2019). Influence of fungal infection on plant tissues: FTIR detects compositional changes to plant cell walls. *Fungal Ecology*, 37, 38–47. https://doi.org/10.1016/j.funeco.2018.10.004

Dhillon, B., Hamelin, R. C., & Rollins, J. A. (2021). Transcriptional profile of oil palm pathogen, Ganoderma boninense, reveals activation of lignin degradation machinery and possible evasion of host immune response. *BMC Genomics*, 22(1). https://doi.org/10.1186/s12864-021-07644-9

Ding, S. W. (2023). Transgene Silencing, RNA Interference, and the Antiviral Defense Mechanism Directed by Small Interfering RNAs. *In Phytopathology*, 113(4). 616–625). American Phytopathological Society. https://doi.org/10.1094/PHYTO-10-22-0358-IA

Eisenman, H. C., & Casadevall, A. (2012). Synthesis and assembly of fungal melanin. *In Applied Microbiology and Biotechnology* 93(3), pp. 931–940). https://doi.org/10.1007/s00253-011-3777-2

Fakhr, E., Zare, F., & Teimoori-Toolabi, L. (2016). Precise and efficient siRNA design: A key point in competent gene silencing. In Cancer Gene Therapy, 23(4) pp. 73–82). *Nature Publishing Group*. https://doi.org/10.1038/cgt.2016.4

Fan, S., Zhou, Y., Zhu, N., Meng, Q., Zhao, Y., Xu, J., Tang, Y., Dai, S., & Yuan, X. (2024). Exogenous Application of dsRNA—Inducing Silencing of the Fusarium oxysporum Tup1 Gene and Reducing Its Virulence.

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

International Journal of Molecular Sciences, 25(19). https://doi.org/10.3390/ijms251910286

Forster, H., & Shuai, B. (2020). Exogenous siRNAs against chitin synthase gene suppress the growth of the pathogenic fungus Macrophomina phaseolina. *Mycologia*, 699–710. https://doi.org/10.1080/00275514.2020.1753467

Ganapathy, D., Siddiqui, Y., Ahmad, K., Adzmi, F., & Ling, K. L. (2021). Alterations in mycelial morphology and flow cytometry assessment of membrane integrity of ganoderma boninense stressed by phenolic compounds. *Biology*, 10(9). https://doi.org/10.3390/biology10090930

Goh, K. M., Ganeson, M., & Supramaniam, C. V. (2014). Infection potential of vegetative incompatible Ganoderma boninense isolates with known ligninolytic enzyme production. *African Journal of Biotechnology*, 13(9), 1056–1066. https://doi.org/10.5897/ajb2013.13409

Govender, N., Mui-Yun, W., & Paterson, R. R. M. (2020). Opportunities for New-Generation Ganoderma boninense Biotechnology. In Grand Challenges in Biology and Biotechnology (pp. 477–500). *Springer Science and Business Media B.V.* https://doi.org/10.1007/978-3-030-29541-7_17

Guo, X. Y., Li, Y., Fan, J., Xiong, H., Xu, F. X., Shi, J., Shi, Y., Zhao, J. Q., Wang, Y. F., Cao, X. L., & Wang, W. M. (2019). Host-induced gene silencing of Moap1 confers broad-spectrum resistance to

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Magnaporthe oryzae. *Frontiers in Plant Science*, 10. https://doi.org/10.3389/fpls.2019.00433

Hardini, P. A., Prakoso, A. B., Medina, S., Baskara, G., Wandri, R., Asmono, D., Suwandi, S., Subandiyah, S., & Muslim, A. (2025). Identification and Pathogenicity of Ganoderma Causing Basal Stem Rot in Oil Palm in South Sumatra. *International Journal of Agriculture and Biology*, 34(06), 340614–340614. https://doi.org/10.17957/ijab/15.2414

Ho, P. Y., Namasivayam, P., Sundram, S., & Ho, C. L. (2020). Expression of genes encoding manganese peroxidase and laccase of ganoderma boninense in response to nitrogen sources, hydrogen peroxide and phytohormones. *Genes*, 11(11), 1–15. https://doi.org/10.3390/genes11111263

Höfle, L., Biedenkopf, D., Werner, B. T., Shrestha, A., Jelonek, L., & Koch, A. (2020). Study on the efficiency of dsRNAs with increasing length in RNA-based silencing of the Fusarium CYP51 genes. *RNA Biology*, 17(4), 463–473. https://doi.org/10.1080/15476286.2019.1700033

Hofrichter, M. (2002). Review: Lignin conversion by manganese peroxidase (MnP). *In Enzyme and Microbial Technology*, 30(4) 454–466. https://doi.org/10.1016/S0141-0229(01)00528-2

Husin, N. A., Khairunniza-Bejo, S., Abdullah, A. F., Kassim, M. S., Ahmad, D., & Aziz, M. H. (2020). Classification of basal stem rot disease in oil

UNIVERSITAS
GADJAH MADA
**Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro**
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

palm plantations using terrestrial laser scanning data and machine learning. *Agronomy*, *10*(11), 1624.

Iwakawa, H. O., & Tomari, Y. (2022). Life of RISC: Formation, action, and degradation of RNA-induced silencing complex. *Molecular cell*, *82*(1), 30-43.

Järvinen, J., Taskila, S., Isomäki, R., & Ojamo, H. (2012). Screening of white-rot fungi manganese peroxidases: A comparison between the specific activities of the enzyme from different native producers. *AMB Express*, 2(1). https://doi.org/10.1186/2191-0855-2-62

Karimi, H., & Innes, R. W. (2022). Molecular mechanisms underlying host-induced gene silencing. *The Plant Cell*, *34*(9), 3183-3199.

Karlen, Y., McNair, A., Perseguers, S., Mazza, C., & Mermod, N. (2007). Statistical significance of quantitative PCR. *BMC Bioinformatics*, 8. https://doi.org/10.1186/1471-2105-8-131

Khalil, H. P. S., Siti Alwani, M., Ridzuan, R., Kamarudin, H., & Khairul, A. (2008). Chemical composition, morphological characteristics, and cell wall structure of Malaysian oil palm fibers. *Polymer-Plastics Technology and Engineering*, *47*(3), 273-280.

Khoo, Y. W., & Chong, K. P. (2023). Ganoderma boninense: general characteristics of pathogenicity and methods of control. *In Frontiers in Plant Science* (14). Frontiers Media SA. https://doi.org/10.3389/fpls.2023.1156869

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Koch, A., Biedenkopf, D., Furch, A., Weber, L., Rossbach, O., Abdellatef, E., Linicus, L., Johannsmeier, J., Jelonek, L., Goesmann, A., Cardoza, V., McMillan, J., Mentzel, T., & Kogel, K. H. (2016). An RNAi-Based Control of Fusarium graminearum Infections Through Spraying of Long dsRNAs Involves a Plant Passage and Is Controlled by the Fungal Silencing Machinery. *PLoS Pathogens*, 12(10). https://doi.org/10.1371/journal.ppat.1005901

Koetsier, G., & Cantor, E. (2019). A practical guide to analyzing nucleic acid concentration and purity with microvolume spectrophotometers. *New England Biolabs Inc*, *1*(8).

Kumar, A., & Arora, P. K. (2022). Biotechnological applications of manganese peroxidases for sustainable management. *Frontiers in Environmental Science*, *10*, 875157.

Kuo, Y. W., & Falk, B. W. (2020). RNA interference approaches for plant disease control. In BioTechniques, 69(6), pp. 469–477). *Future Science Ltd.* https://doi.org/10.2144/btn-2020-0098

Lax, C., Tahiri, G., Patiño-Medina, J. A., Cánovas-Márquez, J. T., Pérez-Ruiz, J. A., Osorio-Concepción, M., Navarro, E., & Calo, S. (2020). The evolutionary significance of rnai in the fungal kingdom. *In International Journal of Molecular Sciences*, 21(24), pp. 1–22. MDPI AG. https://doi.org/10.3390/ijms21249348

Li, X., & Fu, H. (2020). Fungal spore aerosolization at different positions of a growing colony blown by airflow. *Aerosol and Air Quality*

UNIVERSITAS
GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Research, 20(12), 2826–2833. https://doi.org/10.4209/aaqr.2020.09.0565

Lim, F.-H., Fakhrana, I. N., Rasid, O. A., Idris, A. S., Parveez, G. K. A., Ho, C.-L., & Shaharuddin, N. A. (2014). Isolation And Selection of Reference Genes For Ganoderma Boninense Gene Expression Study Using Quantitative Real-Time Pcr (Qpcr). *Journal of Oil Palm Research*, 26, 170–181.

Liu, Q., Luo, L., & Zheng, L. (2018). Lignins: Biosynthesis and biological functions in plants. *In International Journal of Molecular Sciences*, 19(2). MDPI AG. https://doi.org/10.3390/ijms19020335

Lück, S., Kreszies, T., Strickert, M., Schweizer, P., Kuhlmann, M., & Douchkov, D. (2019). siRNA-Finder (si-Fi) Software for RNAi-Target Design and Off-Target Prediction. *Frontiers in Plant Science*, 10. https://doi.org/10.3389/fpls.2019.01023

Malarvizhi, K. (2014). Phylogenetic relationships of Ganoderma species based on mitochondrial and nuclear dna sequences from tamil nadu, india. In *Proceedings of 8th International Conference on Mushroom Biology and Mushroom Products* (p. 113).

Mih, A. M., & Kinge, T. R. (2015). Ecology of Basal Stem Rot Disease of Oil Palm (Elaeis guineensis Jacq.) in Cameroon. *American Journal of Agriculture and Forestry*, 5, 208–215.

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Mueth, N. A., Ramachandran, S. R., & Hulbert, S. H. (2015). Small RNAs from the wheat stripe rust fungus (Puccinia striiformis f.sp. tritici). *BMC Genomics*, 16(1). https://doi.org/10.1186/s12864-015-1895-4

Murphy, D. J., Goggin, K., & Paterson, R. R. M. (2021). Oil palm in the 2020s and beyond: challenges and solutions. In CABI Agriculture and Bioscience, 2(1). *BioMed Central Ltd.* https://doi.org/10.1186/s43170-021-00058-3

Naher, L., Yusuf, U. K., Ismail, A., Tan, S. G., & Mondal, M. M. (2013). Ecological status of'Ganoderma'and basal stem rot disease of oil palms (*Elaeis guineensis* Jacq.). *Australian Journal of Crop Science*, *7*(11), 1723-1727.

Nicolás, F. E., & Garre, V. (2017). RNA interference in fungi: retention and loss. *The Fungal Kingdom*, 657-671.

Ong, C. E., Ahmad, R., Goh, Y. K., Azizan, K. A., Baharum, S. N., & Goh, K. J. (2021). Growth modulation and metabolic responses of Ganoderma boninense to salicylic acid stress. *Plos one*, *16*(12), e0262029.

Othman, F. N., Azizi, N., Mohd-Zim, N. A., Ping, L. Y., & Sulaiman, S. (2022). In silico Genome-Wide Computational Profiling of Non-Coding RNA in Oil Palm Elaeis guineensis and its Pathogen Ganoderma boninense. *Malaysian Applied Biology*, 51(5), 271–280. https://doi.org/10.55230/mabjournal.v51i5.2343

Pazdernik, N. J., Brookman-Amissah, N., Packer, H., Prediger, E., Sabel, J., Gunstream, S., Hellemans, J., Lewis, L., Menezes, A., Owens, B.,

UNIVERSITAS
GADJAH MADA
**Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro**
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Rose, S., Rouw, S., Sander, R., & Vandesompele, J. (2020). IDT_Real-time qPCR guide Part 1—assay design 1(1).

Pilotti, C. A., Gorea, E. A., & Bonneau, L. (2018). Basidiospores as sources of inoculum in the spread of Ganoderma boninense in oil palm plantations in Papua New Guinea. *Plant Pathology*, 67(9), 1841–1849. https://doi.org/10.1111/ppa.12915

Pilotti, C. A., Sanderson, F. R., Aitken, E. A. B., & Armstrong, W. (2004). Morphological variation and host range of two *Ganoderma* species from Papua New Guinea. In Mycopathologia (Vol. 158).

Priwiratama, H., Prasetyo, A. E., & Susanto, A. (2020). Incidence of basal stem rot disease of oil palm in converted planting areas and control treatments. *IOP Conference Series: Earth and Environmental Science*, 468(1). https://doi.org/10.1088/1755-1315/468/1/012036

Pusat Data dan Sistem Informasi Pertanian. (2023). *Analisis Kinerja Perdagangan Komoditas Kelapa Sawit Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderal Kementerian Pertanian 2023*. Jakarta: Kementerian Pertanian.

Pusat Data dan Sistem Informasi Pertanian. (2024). *Outlook Kelapa Sawit Tahun 2024*. Jakarta: Kementerian Pertanian.

Rafiei, V., Vélëz, H., & Tzelepis, G. (2021). The role of glycoside hydrolases in phytopathogenic fungi and oomycetes virulence. *In International Journal of Molecular Sciences*, 22(17). https://doi.org/10.3390/ijms22179359

UNIVERSITAS
GADJAH MADA
**Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro**
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Rakib, M. R. M., Bong, C.-F. J., Khairulmazmi, A., & Idris, A. S. (2014). Genetic and Morphological Diversity of Ganoderma Species Isolated from Infected Oil Palms (Elaeis guineensis). *International Journal of Agriculture & Biology*, 16(4), 1814–9596. http://www.fspublishers.org

Ramzi, A. B., Me, M. L. C., Ruslan, U. S., Baharum, S. N., & Muhammad, N. A. N. (2019). Insight into plant cell wall degradation and pathogenesis of Ganoderma boninense via comparative genome analysis. *PeerJ*, *7*, e8065.

Ray, P., Sahu, D., Aminedi, R., & Chandran, D. (2022). Concepts and considerations for enhancing RNAi efficiency in phytopathogenic fungi for RNAi-based crop protection using nanocarrier-mediated dsRNA delivery systems. *Frontiers in fungal biology*, *3*, 977502.

Rees, R. W., Flood, J., Hasan, Y., Potter, U., & Cooper, R. M. (2009). Basal stem rot of oil palm (Elaeis guineensis); Mode of root infection and lower stem invasion by Ganoderma boninense. *Plant Pathology*, 58(5), 982–989. https://doi.org/10.1111/j.1365-3059.2009.02100.x

Rosa, C., Kuo, Y. W., Wuriyanghan, H., & Falk, B. W. (2018). RNA interference mechanisms and applications in plant pathology. *Annual review of phytopathology*, *56*(1), 581-610.

Rose, L. E., Overdijk, E. J. R., & van Damme, M. (2019). Small RNA molecules and their role in plant disease. In European Journal of Plant

UNIVERSITAS
GADJAH MADA
**Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro**
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Pathology, 153(1). *Springer Netherlands*. https://doi.org/10.1007/s10658-018-01614-w

Said, F. M., Hamid, N. F., Razali, M. A. A., & Daud, N. F. S. (2021). Lignocellulosic of oil palm biomass to chemical product via fermentation. *In Elaeis guineensis*. IntechOpen.

Schlee, M., Hornung, V., & Hartmann, G. (2006). siRNA and isRNA: two edges of one sword. *In Molecular Therapy,* 14(4), pp. 463–470). https://doi.org/10.1016/j.ymthe.2006.06.001

Schoch, C. L., Seifert, K. A., Huhndorf, S., Robert, V., Spouge, J. L., Levesque, C. A., Chen, W., Bolchacova, E., Voigt, K., Crous, P. W., Miller, A. N., Wingfield, M. J., Aime, M. C., An, K. D., Bai, F. Y., Barreto, R. W., Begerow, D., Bergeron, M. J., Blackwell, M., … Schindel, D. (2012). Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. *Proceedings of the National Academy of Sciences of the United States of America*, 109(16), 6241–6246. https://doi.org/10.1073/pnas.1117018109

Schuetz, M., Benske, A., Smith, R. A., Watanabe, Y., Tobimatsu, Y., Ralph, J., Demura, T., Ellis, B., & Samuels, A. L. (2014). Laccases direct lignification in the discrete secondary cell wall domains of protoxylem. *Plant Physiology*, 166(2), 798–807. https://doi.org/10.1104/pp.114.245597

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Smagghe, G. (2025). RNA Interference in Fungal Plant Pathogens: What Do We Know from Botrytis cinerea with Research Hotspots and Gaps, and What Are the Future Directions?. *Journal of Fungi*, *11*(7), 498.

Susanto, A., Prasetyo, A. E., Priwiratama, H., & Wening, S. (2014). Aktivitas Enzim Ligninolitik Ganoderma Isolat Tanaman Kelapa Sawit Indonesia. *J. Pen. Kelapa Sawit*, 22(1), 20–28.

Trapnell, C., & Salzberg, S. L. (2009). How to map billions of short reads onto genomes. *Nature biotechnology*, *27*(5), 455-457.

Ui-Tei, K., Naito, Y., Nishi, K., Juni, A., & Saigo, K. (2008). Thermodynamic stability and Watson–Crick base pairing in the seed duplex are major determinants of the efficiency of the siRNA-based off-target effect. *Nucleic acids research*, *36*(22), 7100-7109.

Ui-Tei, K., Naito, Y., Takahashi, F., Haraguchi, T., Ohki-Hamazaki, H., Juni, A., Ueda, R., & Saigo, K. (2004). Guidelines for the selection of highly effective siRNA sequences for mammalian and chick RNA interference. *Nucleic Acids Research*, 32(3), 936–948. https://doi.org/10.1093/nar/gkh247

Utomo, C., Tanjung, Z. A., Aditama, R., Pratomo, A. D. M., Buana, R. F. N., Putra, H. S. G., Tryono, R., & Liwang, T. (2024). Whole-genome sequencing of Ganoderma boninense, the causal agent of basal stem rot disease in oil palm, via combined short- and long-read sequencing. *Scientific Reports*, 14(1). https://doi.org/10.1038/s41598-024-60713-3

UNIVERSITAS GADJAH MADA
Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk Pangkal Batang Tanaman Sawit Secara In Vitro
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

WA, E., & GM, D. (2022). The precious Ganoderma mushroom and plant diseases. *J Microbiol Biotechnol*, *7*(4), 000241.

Wada, F. H., Pertiwi, A., Hasiolan, M. I. S., Lestari, S., Sudipa, I. G. I., Patalatu, J. S., ... & Rahman, A. (2024). *Buku ajar metodologi penelitian*. Jambi : PT. Sonpedia Publishing Indonesia.

Werner, B. T., Gaffar, F. Y., Schuemann, J., Biedenkopf, D., & Koch, A. M. (2020). RNA-Spray-Mediated Silencing of Fusarium graminearum AGO and DCL Genes Improve Barley Disease Resistance. *Frontiers in Plant Science*, 11. https://doi.org/10.3389/fpls.2020.00476

Xiong, Q., & Zhang, Y. (2023). Small RNA modifications: regulatory molecules and potential applications. *Journal of Hematology & Oncology*, *16*(1), 64.

Xu, H., Guo, M. Y., Gao, Y. H., Bai, X. H., & Zhou, X. W. (2017). Expression and characteristics of manganese peroxidase from Ganoderma lucidum in Pichia pastoris and its application in the degradation of four dyes and phenol. *BMC Biotechnology*, 17(1). https://doi.org/10.1186/s12896-017-0338-5

Zakaria, L. (2023). Basal stem rot of oil palm: The pathogen, disease incidence, and control methods. *Plant Disease*, *107*(3), 603-615.

Zhao, Q., & Dixon, R. A. (2011). Transcriptional networks for lignin biosynthesis: more complex than we thought? *Trends in Plant Science*, 16(4).

Zhou, X. W., Cong, W. R., Su, K. Q., & Zhang, Y. M. (2013). Ligninolytic enzymes from Ganoderma spp: Current status and potential applications. *In*

UNIVERSITAS
GADJAH MADA
**Aplikasi Small RNA Target Gen Manganese Peroxidase (MnP) Ganoderma Boninense Penyebab Penyakit Busuk
Pangkal Batang Tanaman Sawit Secara In Vitro**
Muhammad Ilham Sadikin, Prof. Ir. Siti Subandiyah, M.Agr.Sc., Ph.D.; Prof. Ani Widiastuti, S.P., M.P., Ph.D.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Critical Reviews in Microbiology 39(4), pp. 416–426). https://doi.org/10.3109/1040841X.2012.722606