

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

1. Fungi endofit dapat diisolasi dari tanaman daun jeruk kalamansi (*Citrus microcarpa*) dan diperoleh 4 macam.
2. Perbedaan waktu sterilisasi natrium hipoklorit mempengaruhi hasil isolasi, untuk waktu sterilisasi selama 5 menit tidak mampu mengisolasi fungi endofit dari daun jeruk kalamansi sedangkan waktu sterilisasi 3 menit mampu mengisolasi isolasi fungi endofit daun jeruk kalamansi
3. Keempat macam fungi endofit yang didapat pada isolasi daun jeruk kalamansi diperoleh dua macam fungi endofit yaitu JK1 dan JK4 yang memiliki aktivitas antibakteri terhadap bakteri *Salmonella typhi* dengan rata-rata rasio Daerah Hambatan Pertumbuhan (DHP) sebesar 1,29 dan 1,27.
4. Karakterisasi fungi endofit daun jeruk kalamansi dari makroskopis, mikroskopis dan uji biokimia diduga fungi endofit JK1 termasuk dalam genus *Aspergillus*, JK3 termasuk dalam genus *Mortierella*, JK4 termasuk dalam genus *Oidiodendron*, dan JK6 termasuk dalam genus *Mucor*.

5.2 Saran

1. Mengeksplor jenis fungi endofit lain yang mungkin belum didapat saat isolasi.
2. Mengeksplor aktivitas lain seperti aktivitas farmakologi.
3. Uji aktivitas antibakteri dilakukan terhadap bakteri lain.

DAFTAR PUSTAKA

- Abouamama, S., Anis, B., Abir, S., Maroua, H. and Sirine, B. 2023, Amylolytic and antibacterial activity of filamentous fungi isolated from the rhizosphere of different plants grown in the Tamanghasset region, *Heliyon*, **9(3)**: 1-7.
- Afzal, I., Shinwari, Z.K., Sikandar, S. and Shahzad, S. 2019, Plant beneficial endophytic bacteria: mechanisms, diversity, host range and genetic determinants, *Microbiological Research*, **221**: 36–49.
- Chebotar, V.K., Malfanova, N.V., Shcherbakov, A.V., Ahtemova, G.A., Borisov, A.Y., Lugtenberg, B. and Tikhonovich, I.A. 2015, Endophytic bacteria in microbial preparations that improve plant development, *Applied Biochemistry and Microbiology*, **51(3)**: 271–277.
- Compan, S., Clément, C. and Sessitsch, A. 2010, Plant growth-promoting bacteria in the rhizo- and endosphere of plants: their role, colonization, mechanisms involved and prospects for utilization, *Soil Biology and Biochemistry*, **42(5)**: 669–678.
- Elfina, D., Martina, A., dan Roza, R.M. 2014, ‘Isolasi dan karakterisasi fungi endofit dari kulit buah manggis (*Garcinia mangostana L.*) sebagai antimikroba terhadap *Candida albicans*, *Staphylococcus aureus* dan *Escherichia coli*’, Skripsi, Sarjana Sains, Universitas Riau.
- Elnekave, E., Hong, S.L., Lim, S., Johnson, T.J., Perez, A. and Alvarez, J. 2020, Comparing serotyping with whole-genome sequencing for subtyping of non-typhoidal *Salmonella enterica*: a large-scale analysis of 37 serotypes with a public health impact in the USA, *Microbial Genomics*, **6(9)**: 1-13.
- Gangathraprabhu, B., Kannan, S., Santhanam, G., Suryadevara, N. and Maruthamuthu, M. 2020, A review on the origin of multidrug-resistant *Salmonella* and perspective of tailored phoP gene towards avirulence, *Microbial Pathogenesis*, **147**: 104-352.
- Gauld, J.S., Olgemoeller, F., Heinz, E., Nkhata, R., Bilima, S., Wailan, A.M., Kennedy, N., Mallewa, J., Gordon, M.A., Read, J.M., Heyderman, R.S., Thomson, N.R., Diggle, P.J. and Feasey, N.A. 2021, Spatial and genomic data to characterize endemic typhoid transmission, *Clinical Infectious Diseases*, **71(11)**: 1993-2000.

- Gauld, J.S., Bilima, S., Diggle, P.J., Feasey, N.A. and Read, J.M. 2022, Rainfall anomalies and typhoid fever in Blantyre Malawi, *Epidemiology and Infection*, **150**: 122.
- Hardoim, P.R., van Overbeek, L.S. and Elsas, J.D. van 2008, Properties of bacterial endophytes and their proposed role in plant growth, *Trends in Microbiology*, **16(10)**: 463–471.
- Hastuti, U.S., Nugraheni, F.S.A., dan Al Asna, P.M. 2017, Identifikasi dan penentuan indeks hidrolisis protein pada bakteri proteolitik dari tanah mangrove di Margomulyo, Balikpapan, *Proceeding Biology Education Conference*, **14(1)**: 265–270.
- Horowidi, C., Sinay, H., Lusian Karuwal, R. and Parinussa, L. 2021, Struktur sel sekresi daun jeruk kalamansi (*Citrus microcarpa bunge*) di pulau Ambon, *Buletin Anatomi dan Fisiologi*, **6(2)**: 138–145.
- Imara, F. 2020, *Salmonella typhi* bakteri penyebab demam tifoid, *Prosiding seminar nasional biologi di era pandemi COVID-19 Gowa*, **6(1)**: 1–5.
- Kawai, Y., Baba, T., Yoshida, M., Agravante, Josephine U. and Del Carmen, Dormita R. 2018, Effects of benzyladenine and light on post-harvest calamondin (*Citrofortunella microcarpa*) fruit color and quality, *The Horticulture Journal*, **87(3)**: 324–328.
- Liu, T., Li, P., Ou, Z., Feng, Y., Wang, B., Yu, T., Zhu, Y. and Yu, L. 2025, Insights into the special physiology of *Mortierella alpina* cultured by agar supported solid state fermentation in enhancing arachidonic acid enriched lipid production, *Scientific Reports*, **15(1)**: 1–10.
- Masurekar, P. 2009, *Antibiotic Production*, Elsevier eBooks, pp 174–190.
- McGinnis, M. 2000, ‘*Mucor species*’, *Doctor Fungus*, diakses pada 6 Mei 2025, <https://drfungus.org/knowledge-base/mucor-species/>.
- Muteeb, G., Rehman, M.T., Shahwan, M. and Aatif, M. 2023, Origin of antibiotics and antibiotic resistance, and their impacts on drug development: a narrative review, *Pharmaceuticals*, **16(11)**: 1615.
- Rosas-Vega, F.E., Pozzan, R., Martínez-Burgos, W.J., Junior, A., Beatriz, P., Ramos-Neyra, L.C., Dudeque, G.S., Bittencourt, G.A., Gabriela, Porto, L. and Soccil, C.R. 2025, Enzymes produced by the genus *Aspergillus* integrated into the biofuels industry using sustainable raw materials, *Fermentation*, **11(2)**: 62–62.

- Simatupang, E.G.H., Wardana, K.D.P.K. and Ivanka, D. 2023, Epidemiologi dan resistensi antibiotik *Salmonella typhi* dan *paratyphi a* pada kasus demam tifoid di jakarta, *Jurnal Ilmu Psikologi dan Kesehatan*, **2(2)**: 173-184.
- Oktasila, D.O. and Handayani, D. 2019, Uji aktivitas antibakteri daun jeruk kalamansi (*Citrofortunella microcarpa*) terhadap bakteri *Staphylococcus aureus* dan *Escherichia coli*, *Jurnal Pendidikan dan Ilmu Kimia*, **3(2)**: 158–169.
- Pebriani, D. 2016, ‘Tinjauan ekonomi islam terhadap sistem jual beli jeruk kalamansi di Kelurahan Padang Serai Kota Bengkulu’, *Skripsi*, IAIN, Bengkulu.
- Quah, S.R. 2008, International encyclopedia of public health, *Academic Press*, **3**: 204-211.
- Steenis, V. 2008, *Flora*, PT. Pradnya Paramita, Jakarta.
- Ulya, N.N., Fitri, I. and Widyawati, D.I. 2020, Gambaran makroskopis dan mikroskopis bakteri *Salmonella typhi* dan *Salmonella paratyphi* pada penderita demam tifoid, *Jurnal Sintesis*, **1(2)**: 40-46.
- Venkatachalam, K., Charoenphun, N., Srean, P., Yuvanatemiya, V., Pipatpanukul, C., Pakkechai, K., Paramethanuwat, T. and Wongsa, J. 2023, Phytochemicals, bioactive properties and commercial potential of calamondin (*Citrofortunella microcarpa*) fruits, *Molecules*, **28(8)**: 3401.
- Watannabe, T. 2002, *Pictorial atlas of soil and seed fungi: morphologies of cultured fungi and key to species second edition*, CRC Press, Taylor and Francis Group, USA.
- Wen, J., Okyere, S.K., Wang, S., Wang, J., Xie, L., Ran, Y. and Hu, Y. 2022, Endophytic fungi: an effective alternative source of plant-derived bioactive compounds for pharmacological studies, *Journal of Fungi*, **8(2)**: 205.
- White, J.F., Kingsley, K.L., Zhang, Q., Verma, R., Obi, N., Dvinskikh, S., Elmore, M.T., Verma, S.K., Gond, S.K. and Kowalski, K.P. 2019, Endophytic microbes and their potential applications in crop management, *Pest Management Science*, **75(10)**: 2558–2565.