

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Kesimpulan yang dapat diambil dari penelitian ini adalah:

1. Fungi endofit dapat diisolasi dari daun afrika (*Vernonia amygdalina*), diperoleh 3 macam fungi endofit.
2. Ketiga macam fungi endofit yang diisolasi dari daun afrika (*Vernonia amygdalina*) tidak memiliki aktivitas antibakteri terhadap *Pseudomonas aeruginosa* dan *Staphylococcus aureus*.
3. Isolat 1 dari fungi endofit yang diperoleh memiliki enzim amilase, gelatinase, kasease, dan lipase. Makroskopis tipe koloninya adalah koloni filamen, sifat permukaan koloninya seperti kapas, warna koloninya putih dengan spora berwarna oranye, pada pengamatan mikroskopis ditemukan adanya konidia berbentuk elipsoid panjang serta konidiofor. Diduga berasal dari genus *Fusarium*. Isolat 2 memiliki enzim lipase, dengan ciri makroskopis sifat permukaan koloninya seperti lilin, tipe koloni ragi, warna koloni kuning dan *opaque*. Hasil pengamatan mikroskopis ditemukan zoospora, diduga berasal dari genus *Pythium*. Isolat 3 memiliki enzim amilase, gelatinase, kasease, dan lipase. Makroskopis tipe koloninya adalah koloni filamen, sifat permukaan koloni seperti beludru, warna koloninya hijau keabu-abuan dengan bagian tepi berwarna putih. Hasil pengamatan mikroskopisnya ditemukan konidiospora tunggal atau bercabang serta konidia berbentuk *spindle* yang di dalamnya terdapat 4-5 dinding melintang dan 1-2 dinding memanjang. diduga berasal dari genus *Alternaria*.

5.2 **Saran**

Saran terhadap penelitian terkait yang akan dilakukan selanjutnya adalah sebagai berikut:

1. Perlu dilakukannya standarisasi terkait proses sterilisasi permukaan terhadap daun dengan morfologi yang tipis.
2. Perlu dilakukannya skrining fitokimia pada fungi endofit untuk melihat apakah fungi endofit yang tidak memiliki aktivitas antibakteri memiliki metabolit sekunder atau tidak.

DAFTAR PUSTAKA

- Abe, J.P., Inaba, S., Orihara, T., Kobayashi, H., Shigemori, A., Yamada, A. 2009, *Introduction to the World of Fungi*, Mycological Society of Japan, Higashi-Hiroshima, Jepang.
- Adekunle, A.A. and Odukoya, K.A. 2006, Antifungal Activities of Ethanol and Aqueous Crude Extracts of Four Nigerian Chewing Sticks, *Ethnobotanical Leaflets*, **10**: 24-40.
- Adetunji, C.O., Olaniyi, O.O., Ogunkunle, A.T.J., 2013, Bacterial Activity of Crude Extracts of *Vernonia amygdalina* on Clinical Isolates, *Journal of Microbiology and Antimicrobials*, **5(6)**: 60-64.
- Adisasmito, A.W., Tumbelaka. A.R., 2006, Penggunaan Antibiotik Khususnya pada Infeksi Bakteri Gram Negatif di ICU Anak RSAB Harapan Kita, *Sari Pediatri*, **8(2)**: 127-134.
- Afandhi, A., Choliq, F.A., Anggrilika H., Tarno, H. 2018, Distribution of the Endophytic Fungi in Apple Leaves, *Agrivita Journal of Agricultural Science*, **40(1)**: 91-100.
- Aryal, S. 2015. 'Cetrimide Agar-Composition, Principle, Uses, Preparation and Colony Morphology'. diakses pada 20 Februari 2019, <https://microbiologyinfo.com/cetrimide-agar-composition-principle-uses-preparation-and-colony-morphology/>.
- Ayunda, R. 2015, 'Isolasi, Seleksi, dan Uji Aktivitas Antibakteri dari Kapang Endofit Daun Parijoto (*Medinilla speciosa*) terhadap *Staphylococcus aureus*, *Bacillus subtilis*, *Eschericia coli*, dan *Shigella dysenteriae*', *Skripsi*, Fakultas Farmasi, Universitas Islam Negeri Syarif Hidayatullah Jakarta.
- Banna, M.Z.A., Hartati, 2017, Isolasi dan Uji Antagonistik Bakteri Endofit dan Rizosfer Bambu Asal Tana Toraja terhadap Jamur Patogen Tanaman, *Jurnal Dinamika*, **8(2)**: 20-30.

- Binomar, M., Qumaizi, K.I., Al Shaqha, W.M., Khan, F.I., Bobbitt, K., Anwer, R. 2015, Screening of Different Soil Sources of New York City for Antimicrobial Activity against Methicillin-Resistant *Staphylococcus aureus* (MRSA), *Journal of Pure and Applied Microbiology*, **9(2)**: 77-86.
- Brooks, G.F., Carroll, K.C., Butel, J.S., Morse, S.A., Mietzner, T.A. (eds). 2010, *Jawetz, Melnick, and Adelberg's Medical Microbiology*, McGraw-Hill Companies, New York.
- Brunton, L.L., Parker, K.L. 2008, *Goodman & Gilman's Manual of Pharmacology and Therapeutics*, MCGraw-Hill Companies, New York.
- Carol, K.C. 2013, 'Pseudomonads, Acinetobacters, and Uncommon Gram-Negative Bacteria' in Jawetz, Melnick and Adelberg's, *Medical Microbiology*, 26th ed., The McGraw-Hill, New York, pp 245-251.
- Castillo, U., Streobel, G.A., Ford, E.J., Hess, W.M., Porter, H., and Jensen, J.B. 2002, Munumbicins, wide-spectrum antibiotics produced by *Streptomyces* NRRL 30562, endophytic on *Kennedia nigricans*. diakses pada 22 Agustus 2018, <https://www.ncbi.nlm.nih.gov/pubmed/12213914>.
- Centers for Disease Control and Prevention, 2018, 'Antibiotic/ Antimicrobial Resistance (AR/ AMR)', diakses pada 9 Agustus 2018, <https://www.cdc.gov/drugresistance/index.html>.
- Deck, D.H., Winston, L.G. 2014, 'Sulfonamides, Trimethoprim, and Quinolones', in Katzung, B., Masters, S.B. and Trevor, A.J., *Basic and Clinical Pharmacology*, 12th ed, McGraw-Hill Companies, New York.
- DeMarco, C.E., Lerner, S.A. 2009, 'Mechanisms of Action of Antimicrobial Agents', in Goldman. E. and Green. L.H., *Practical Handbook of Microbiology*, 2nd ed, CRC Press Taylor and Francis Group, Florida, pp 132-141.
- Departemen Kesehatan RI. 2016, 'Mari Bersama Atasi Resistensi Antimikroba (AMR)' diakses pada 15 Agustus 2018, <http://www.depkes.go.id/article/print/16060800002/mari-bersama-atasi-resistensi-antimikroba-amr-.html>.

- Fernandes, G. W., Oki, Y., Sanchez-Azofeifa, A., Faccion, G., Amaro-Arruda, H. C. 2011, Hail Impact on Leaves and Endophytes of the Endemic Threatened *Coccoloba cereifera* (Polygonaceae). *Plant Ecology*, **212**(10), pp 1687–1697.
- Gandjar, I., Sjamsuridzal, W., Oetari, A. 2007, *Mikologi Dasar dan Terapan*, Yayasan Buku Obor, Jakarta.
- Govan, J.R.W. 2007, ‘Pseudomonads and non-fermenters: Opportunist infection; cystic fibrosis; melioidosis’, in Greenwood, D., Slack, R., Peutherer, and J., Barer, M., *Medical Microbiology*, 7th ed., Churchill Livingstone Elsevier, Edinburg, pp 293-298.
- Grubben, G.J.H., Denton O.A. (eds). 2004, *Vegetables*, Backhuys Publishers, Wageningen.
- Handayani, D., Rivai, H., Hutabarat, M., Rasyid R. 2017, Antibacterial Activity of Endophytic Fungi Isolated from Mangrove Plant *Sonneratia griffithii* Kurz, *Journal of Applied Pharmaceutical Science*, **7**(04):209-212.
- Hanin, N.N.F. dan Pratiwi, R. 2017, Kandungan Fenolik, Flavonoid dan Aktivitas Antioksidan Ekstrak Daun Paku Laut (*Acrostichum aureum* L.) Fertil dan Steril, *Journal of Tropical Biodiversity and Biotechnology*, **2**: 51-56.
- Harley, J.P., Prescott, L.M. 2002, *Laboratory Exercise in Microbiology*, 5th ed, McGraw-Hill Companies, New York.
- Harrigan, W.F., McCance, M.E. 2014, *Laboratory Methods in Microbiology*, Academic Press, Cambridge, Massachusetts.
- Harti, A.S., Kusumawati, H.N., Estuningsih, 2012, Perbandingan Uji Aktivitas Anti Bakteri Chitooligosakarida terhadap *Eschericia coli* ATCC 225922, *Staphylococcus aureus* ATCC 25923 dan *Salmonella typhi* secara *in vitro*, *Biomedika*, **4**(2): 18-25.
- Hilarino, M. P. A., Silveira, F. A. de O. e, Oki, Y., Rodrigues, L., Santos, J. C., Corrêa Junior, A., Rosa, C.A., 2011, Distribution of the Endophytic Fungi Community in Leaves of *Bauhinia brevipes* (Fabaceae), *Acta Botanica Brasilica*, **25**(4): 815–821.

- Humphreys, H. 2007, 'Staphylococcus: Skin infection; osteomyelitis; food poisoning; foreign body infection; MRSA', in Greenwood, D., Slack, R., Peutherer, and J., Barer, M., *Medical Microbiology*, 7th ed., Churchill Livingstone Elsevier, Edinburg, pp 172-175.
- Indijah, S.W., Fajri, P. 2016, *Farmakologi*, Pusdik SDM Kesehatan, Jakarta.
- Jeffrey, L.S.H., Son.R. dan Tosiah, S. 2008, Preliminary Screening of Endophytic Fungi Isolated from Medicinal Plants at MARDI Sessang, Sarawak for their Bioactivity, *J. Trop. Agric. And Fd. Sc.*, **36(1)**: 121-126.
- Johnson, M., Odetunde, S.K., Olufunmilayo, L.A., 2015, Phytochemical Analysis, In Vitro Evaluation of Antioxidant and Antimicrobial Activity of Methanolic Leaf Extract of *Vernonia amygdalina* (Bitter Leaf) againts *Staphylococcus aureus* and *Pseudomonas aeruginosa*, *International Journals of Current Microbiology and Applied Sciences*, **4(5)**: 411-426.
- Kemka-Evans, C.I., Okoli, B., Nwachukwu, C.U. 2014, Epidermal Studies of Three Species of *Vernonia* Schreb, in Southern Nigeria, *Biodiversitas*, **15(2)**: 137-141.
- Khan, A.L., Shahzad, R., Al-Harrasi, A. Dan Lee, I.J. 2017, 'Endophytic Microbes: A Resource for Producing Extracellular Enzymes', in Maheshwari, D.K. and Annapurna, K., *Endophytes: Crop Productivity and Protection*, Volume 2, Springer International Publishing, Switzerland, pp 94-102.
- Khiralla, A. 2015, 'Phytochemical study, cytotoxic and antibacterial potentialities of endophytic fungi from medicinal plants from Sudan', *Skripsi*, Fakultas Ilmu Pengetahuan dan Teknik, Universitas de Lorraine, Vandoeuvre-lès-Nancy, Prancis.
- Krajaejun, T., Rujirawat, T., Kanpanleuk, T., Santanirand, P., Yingyong, W., Kumsang, Y. dan Patumcharoenpol, P. 2018, 'Biochemical and Genetic Analyses of the Oomycete *Pythium insidiosum* Provide New Insight into Clinical Identification and Urease-Based Evolution of Metabolism-Related Traits', diakses pada 16 Maret 2019, <https://www.ncbi.nlm.nih.gov/pubmed/29888122>.

- Kumala, S. 2014, *Mikroba Endofit, Pemanfaatan Mikroba Endofit dalam Bidang Farmasi*, ISFI Penerbitan, Jakarta.
- Kumar, S. 2012, *Textbook of Microbiology*, Jaypee Brothers Medical Publisher (P) Ltd, New Delhi.
- Kwon, H.W., Yoon, J.H., Kim, S.H., Hong, S.B., Cheon, Y. Dan Ko. S.J. 2007, Detection of Extracellular Enzymes Activities in Various *Fusarium* spp., *Mycobiology*, **35(3)**: 162-165.
- Lewis, K., Whipps, J.M. and Cooke, R.C. 1994, 'Mechanism of Biological Disease Control with Special Reference to the Case Study of *Pythium oligandrum* as an Antagonist', in Whipps, J.M. and Lumsden, R.D., *Biotechnology of Fungi for Improving Plant Growth*, Antony Rowe Ltd, Wiltshire, pp 191-210.
- López-González, R. C., Gómez-Cornelio, S., De la Rosa-García, S. C., Garrido, E., Oropeza-Mariano, O., Heil, M., Partida-Martínez, L. P. 2017, The Age of Lima Bean Leaves Influences the Richness and Diversity of the Endophytic Fungal Community, but Not the Antagonistic Effect of Endophytes Against *Colletotrichum lindemuthianum*. *Fungal Ecology*, **26**: 1-10.
- Miftachul, H. 2008, 'Isolasi Jamur Endofit dari Daun Sirih (*Piper betle* L.) sebagai Antimikroba terhadap *Eschericia coli*, *Staphylococcus aureus*, dan *Candida albicans*', *Skripsi*, Fakultas Sains dan Teknologi, Unviersitas Islam Negeri Malang.
- Murwani, S., Qosimah, D., Amri, I.A., 2017, *Penyakit Bakterial pada Ternak Hewan Besar dan Unggas*, UB Press, Malang.
- Noverita, Fitria, D., Sinaga, E. 2009, Isolasi dan Uji Aktivitas Antibakteri Jamur Endofit dari Daun dan Rimpang *Zingiber ottensii* Val., *Jurnal Farmasi Indonesia*, **4(4)**: 171-176.
- Nwachukwu, E.O. and Umerchuruba, C.L. 2001, Antifungal Activities of Some Leaf Extracts on Seed-borne Fungi of Africal Yam Bean Seeds, Seed Germination and Seedling Emergence, *Journal Appl. Sci. Environ. Mgt*, **5(1)**: 29-32.

- Ofori, D.A., Anjarwalla, P., Jamnadass, R., Stevenson, P.C., Smith, P. 2013, 'Pesticidal Plant Leaflet: *Vernonia amygdalina* Del.', diakses pada 5 September 2018, <https://www.researchgate.net/publication/262487061>.
- Okezie, U.M., Eze, P.M., Okoye F.B.C., Ikegbunam, M.N., Ugwu, M.C., Esimone, C.O. 2017, Biologically Active Metabolites of an Endophytic Fungus Isolated from *Vernonia amygdalina*, *African Journal of Pharmaceutical Research and Development*, **9(1)**: 24-26.
- Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., Anthony, S. 2009. 'Agroforestry. Database: a Tree Reference and Selection Guide Vol. 4'. diakses pada 9 September 2018, <http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp>.
- Pai, G dan Chandra, M. 2018, Antimicrobial Activity of Endophytic Fungi Isolated from Ethnomedicinal Plant *Phyllanthus reticulatus* Poir, *International Journal of Engineering Science Invention (IJESI)*, **7(1)**: 40-46.
- Palleroni, N.J. 2009, 'The Genus *Pseudomonas*', in Goldman. E. and Green. L.H., *Practical Handbook of Microbiology*, 2nd ed, CRC Press Taylor and Francis Group, Florida, pp 231-241.
- Pangestika, N.W. 2017, 'Hubungan antara Tingkat Pendidikan dan Pengetahuan terhadap Rasionalitas Penggunaan Antibiotik pada Kader PKK di 17 Kecamatan Wilayah Kabupaten Banyumas', *Skripsi*, Fakultas Farmasi, Universitas Muhammadiyah Purwokerto.
- Peraturan Kementerian Kesehatan Republik Indonesia, 2011, Pedoman Umum Penggunaan Antibiotik, Jakarta: Kementerian Kesehatan Republik Indonesia.
- Pulungan, A.S., Tumangger, D.E. 2018, Isolasi dan Karakterisasi Bakteri Endofit Penghasil Enzim Katalase dari Daun Buasbuas (*Premna pubescens* Blume), *Jurnal Biologi Lingkungan, Industri, Kesehatan*, **5(1)**: 72-79.

- Radji, M. 2005, Peranan Bioteknologi dan Mikroba Endofit dalam Pengembangan Obat Herbal, *Majalah Ilmu Kefarmasian*, **II(3)**: 113-120.
- Raini, M. 2016, Antibiotik Golongan Fluorokuinolon: Manfaat dan Kerugian, *Media Litbangkes*, **26(3)**: 163-174.
- Sachin, N., Manjunatha, B.L., Ravikanth, G., Suryanarayanan, T.S., Ganeshiah, K.N. and Shaanker, R.U. 2013, Do endophytic fungi possess pathway genes for plant secondary metabolites?, *Current Science*, **104(2)**: 178-182.
- Schneewind, O., Misiakas, D. 2009, 'Staphylococcus aureus and Related Staphylococci', in Goldman. E. and Green. L.H., *Practical Handbook of Microbiology*, 2nd ed, CRC Press Taylor and Francis Group, Florida, pp 275-288.
- Shofiyani, A dan Hajoeningtjas, O.D. 2010, Pengaruh Sterilan dan Waktu Perendaman pada Eksplan Daun Kencur (*Kaemferia galanga* L.) untuk Meningkatkan Keberhasilan Kultur Kalus, *Agritech*, **XII(1)**: 11-29.
- Shokrollahi, A dan Firoozbakht, F. 2016, Determination of the Acidity Constants of Neutral Red and Bromocresol Green by Solution Scanometric Method and Comparison with Spectrophotometric Result, *Beni-suef University Journal of Basic and Applied Sciences*, **5**: 13-20.
- Soedarto, 2016, *Infeksi Nosokomial di Rumah Sakit*, Sagung Seto, Jakarta.
- Stone, J.K., Bacon, C.W., White, J.F. 2000, 'An Overview of Endophytic Microbes: Endophytism Defined', in Bacon, C.W. and White, J.F., *Microbial Endophytes*, Marcel Dekker, New York, pp 3-6.
- Strobel, G dan Daisy, B. 2003, Bioprospecting for Microbial Endophytes and Their Natural Products, *Microbiology and Molecular Biology Reviews*, **67(4)**: 491-502.
- Strobel, G.A. 2018, The Emerge of Endophytic Microbes and Their Biological Promise, *Journal of Fungi*, **4(57)**: 1-19.

- Sunitha, V.H., Devi, D.N. dan Srinivas, C. 2013, Extracellular Enzymatic Activity of Endophytic Fungal Strains Isolated from Medicinal Plants, *World Journal of Agricultural Sciences*, **9(1)**: 1-9.
- Suryati, S., Dwisari, D., Fridhani, R., 2016, Pengaruh Ekstrak Etanol Daun *Vernonia amygdalina* Del. Terhadap Kadar Kreatinin Serum Mencit Putih Jantan, *Jurnal Sains Farmasi dan Klinis*, **3(1)**: 79-83.
- Suwarto, S. 2014, Penyakit Tropik dan Infeksi pada Abad 21: Apakah Masih Relevan?, *Jurnal Penyakit Dalam Indonesia*, **1(2)**: 77-78.
- Talaro, K.P., Talaro, A. 2002, *Foundations in Microbiology*, The McGraw-Hill Companies, New York.
- Tan, R.X dan Zou, W.X. 2001, Endophytes:a rich sources of functional metabolites, *National Product Reports*, **18**: 448-459.
- Todar, K. 2012. ‘Todar’s Online Textbook of Bacteriology’. diakses pada 12 September 2018, <http://textbookofbacteriology.net/staph.html>.
- Udayakumar, R dan Begum, V.H., 2002, Antimicrobial Studies of some Selected Medicinal Plants, *Ancient Science of Life*, **21(4)**: 230-239.
- Unkovic N., Dimkic, I., Stupar, M., Stankovic, S., Vukojevic, J. dan Grbic, M.L. 2018, Biodegradative potential of fungal isolates from Sacral Ambient: *In vitro* study as risk assessment implication for the conservation of wall paintings, *PLOS Pathogens Antifungal Immunity*, **13(1)**: 1-16.
- Wanger, A. 2009, ‘Antibiotic Susceptibility Testing’, in Goldman. E. and Green. L.H., *Practical Handbook of Microbiology*, 2nd ed, CRC Press Taylor and Francis Group, Florida, pp 149-157.
- Watanabe, T., 2002, *Soil and Seed Fungi, Pictorial Atlas of Soil and Seed Fungi. Morphologies of Cultured Fungi and Key to Species*, 2nd ed, CRC Press, Florida.
- World Health Organization, 2018, ‘The Top 10 Causes of Death’, diakses pada 9 Agustus 2018, <http://www.who.int/mediacentre/factsheets/fs310/en/index2.html>.

- Yeap, S.K., Ho, W.Y., Beh, B.K., Liang, W.S., Ky, H., Yousr, A.H.N., Alitheen, N.B. 2010, *Vernonia amygdalina*, an Ethnoveterinary and Ethnomedical Used Green Vegetable with Multiple Bioactivities, *Journal of Medical Plants Research*, **4(25)**: 2787-2807.
- Zanette, A.R., Ferreiro, L., Alves, S.H., Jesus, F.P.K., Lautert, C., Spanemberg, A. Dan Santurio, J.M. 2012, Enzymatic Variability among Brazilian *Pythium insidiosum* isolates, *Rev Iberoamericana de Micologia*, **30(4)**: 264-266.