DAFTAR PUSTAKA

Abbott, A.P., Boothby D., Capper, G., Davies, D.L., Rasheed, R.K., 2004. Deep Eutectic Solvents Formed Between Choline Chloride and Carboxylic Acid: Versatile Alternatives to Ionic Liquids. *Journal of The American Chemical Society*. 126 (29), 9142-9147. https:// doi. org/ 10. 1021/ ja048 266j.

Abubakar, A., Suberu, H.A., Bello, I.M., Abdulkadir, R., Daudu,O.A., Lateef, A.A., 2013. Effect of pH On Mycelial Growth and Sporulation of Aspergillus parasiticus. *J.Plant Sci*. 1, 64-67.

Adnan, H. & Porse, H.,1987. Culture of Eucheuma cottonii and Eucheuma spinosum in Indonesia. *Twelfth International Seaweed Symposium*. 41, 355–358.

Aga, A., Coh, CC., 2013. Cellulosic Ethanol Production Using A Yeast Consortium Displaying A Minicellulosome and β-glucosidase. *Microb Cell Fact*. 12, 14.

Agrawal, K., Bhardwaj, N., Kumar, B., Chaturvedi, V., Verma, P., 2019. Process Optimization, Purification and Characterization of Alkaline Stable White Laccasse From Myrothecium verrucaria ITCC-8447 and Its Application In Delignification of Agroresidues. *Int. J. Biol. Macromol*. 125, 1042-1055.

Alio, M.A., Tugui, O.C., Vial, C., Pons, A., 2019. Microwave-Assisted Organosolv Pretreatment of A Sawmill Mixed Feedstock For Bioethanol Production in A Wood Biorefinery. *Bioresource Technology*. 276, 170-176. https:// doi. org/ 10. 1016/j. biort ech. 2018. 12. 078.

Alvira, P., Tomas-Pejo, E., Ballesteros, M.J., Negro, M.J., 2010. Pretreatment Technologies For An Efficient Bioethanol Production Process Based On Enzymatic Hydrolysis: A Review. *Bioresource Technology*. 101, 4851-4861. https://doi.org/10.1016/j. biortech.2009.11.093.

Anwar, Z., Gulfraz, M., Irshad, M., 2014. Agro-Industrial Lignocellulosic Biomass A Key to Unlock The Future Bio-Energy: A Brief Review. *Journal of Radiation Research and Applied Sciences*. 7(2), 163-173.

Arfarita, N., Imai, T., Kanno, A., Yarimizu, T., Xiaofeng, S., Jie, W., Higuchi, T., Akada, R. 2013. The Potential Use of *Trichoderma viride* Strain FRP3 in Biodegradation of The Herbicide Glyphosate. *Biotechnology and Biotechnological Equipment*. 27(1), 3518-3521.

H., Abdullah N., Umi, K.M.S., Shirai, Y., Hassan, M.A., 06. Production and Characterization of Cellulase by

Bacillus pumilus EB3. *International Journal of Engineering and Technology*. 3, 47-53.

Assadad, L. 2009. Pemanfaatan Limbah Industri Karaginan Untuk Menghasilkan Produk Bernilai Tambah. *Squalen*. 4(3), 93-98.

Badan Pusat Statistik, (2021). Hasil Survei Komoditas Perikanan Potensi 2021 Seri-I Profil Rumah Tangga Usaha Budidaya Rumput Laut.

Balan, V., Da Costa Sousa, L., Chundawat, S.P.S., Marshall, D., Sharma, L.N., Chambliss, C.K., Dale, B.E., 2009. Enzymatic Digestibility and Pretreatmet Degradation Products of AFEX-Treated Hardwoods (*Populus nigra*). *Biotechnology Progress*. 25, 365-375.

Bhardwaj, N., Kumar, B., Verma, P., 2019. A Detailed Overview of Xylanases: An Emerging Biomolecule for Current and Future Prospective. *Bioresources and Bioprocessing*. 6(40), 1-36.

Binod, P., Sindhu, R., Janu, K.U., Pandey, A. 2019. Hydrolysis of Cellulosic and Hemicellulosic Biomass. *Biomass, Biofuels, Biochemicals: Biofuels: Alternative Feedstocks and Conversion Processes for The Production of Liquid and Gaseous Biofuels*, 447-460. https://doi.org/10.1016/B978-0-12-816856-1.00019-1

Bixler, H.J., Johondro, K.D. 2000. P*hilippine Natural Grade or Semi Refines Carrageenan*. In: Phillips. G.O., and Williams, P.A. (eds). Handbooks of Hydrocolloids. CRC Press. Cambridge England.

Borines, M. G., De Leon, R. L., McHenry, M. P., (2011). Bioethanol production from farming non-food macroalgae in Pacific island nations: Chemical constituents, bioethanol yields, and prospective species in the Philippines. *Renewable and Sustainable Energy Reviews*. *15*(9), 4432–4435. https://doi.org/10.1016/j.rser.2011.07.109.

Carillo-Reyes, J., Barragan-Trinidad, M., Buitron, G., 2016. Biological Pretreatment of Microalgal Biomass for Gaseous Biofuel Production and The Potential Use of Rumen Microorganisms: A Review. *Algal Res*. 19, 341-351.

Chandra, R.P., Bura, R., Mabee, W.E., Berlin, A., Pan, X., Saddler, J.N., 2007. Substrate Pretreatment: The Key To Effective Enzymatic Hydrolysis of Lignocellulosics. Adv. *Biochem Eng Biotechnol*. 108, 67-93.

[illegible] W.Y., Sankaran, R., Show, P.L., Ibrahim, T.N.B.T., Chew, [illegible]., Culaba, A., Chang, J.S., 2020. Pretreatment Methods [illegible] Lignocellulosics Biofeuels Production: Current Advances, [illegible]llenges and Future Prospects. *Biofuel Research Journal*. [illegible], 1115-1127. DOI: 10.18331/BRJ2020.7.1.4.

Da Costa Sousa, L., Jin, M., Chundawat, S.P.S., Bokade, V., Tang, X., Azarpira, A. et al., 2016. Next-Generation Ammonia Pretreatment Enhances Cellulosic Biofuel Production. Energy Enviromental Science. 9 (4), 1215-1223. https://doi.org/10.1039/C5EE03051J.

Dashtban, M., Maki, M., Leung, KT., Mao, C., Qin, W., 2010. Cellulase Activities in Biomass Conversion: Measurement Methods and Comparison. *Crit Rev Biotechnol*. 30(4), 302-309.

Den, W., Sharma, V.K., Lee, M., Nadadur, G., Varma, R.S., 2018. Lignocellulocis Biomass Transformations Via Greener Oxidative Pretreatment Processes: Access to Energy and Value Added Chemicals. *Front Chem*. 6, 1-23.

DKPSULSEL. (2021). *Laporan Statistik Perikanan Sulawesi Selatan 2020*.

Fadillah, N., Taufan, Wi. L., Aska, M. S., (2018). Production of Bioethanol From *Kappaphycus alvarezii* Algae by Using Pichia kudriavzevii Yeast. *International Journal of Applied Biology*. *2*(1), 47–54. https://doi.org/10.20956/ijab.v2i1.4391.

Fithriani, D., Sari, R.N., Sedayu, B.B., 2007. Ekstraksi Selulosa Dari Limbah Pembuatan Karaginan. *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan*. 2(2), 91-97.

Fonseca, L. M., Parreiras, L. S., Murakami, M. T., (2020). Rational engineering of the Trichoderma reesei RUT-C30 strain into an industrially relevant platform for cellulase production. *Biotechnology for Biofuels*. *13*(1), 1–15.

Frisvad, J. C., Lars, L.H.M., Thomas, O.L., Ravi, K., Jose, A., (2018). Safety of the fungal workhorses of industrial biotechnology : update on the mycotoxin and secondary metabolite potential of *Aspergillus niger*, *Aspergillus oryzae*, and *Trichoderma reesei*. *Appl Microbiol Biotechnol*. 102, 9481–9515.

Gao, Z., Duong, V., Le Thi, HY., Katsuhiko, A., Shuichi, H., Ryuichiro, K. 2012. The Production of β-glucosidases by *Fusarium proliferatum* NBRC109045 Isolated From Vietnamese Forest. *AMB Express*. 2(1), 49.

Gaur, R., Tiwari, S., 2015. Isolation, Production, Purification and Characterization of An Organic-Solvent-Thermostable Alkalophilic Cellulase From *Bacillus vallismortis* RG-07. *BMC Biotechnology*. 15(1), 1-12.

. S., and Lee, K. T., (2010). A visionary and conceptual roalgae-based third-generation bioethanol (TGB) efinery in Sabah, Malaysia as an underlay for renewable sustainable development. *Renewable and Sustainable*

Energy Reviews. *14*(2), 842–848. https://doi.org/10.1016/j.rser.2009.10.001

Guerrero, R. D., (2001). *Farming of Carrageenophytes in the Philippines: A Success Story of Red Seaweeds Cultivation*. APAARI.

Gupta, P., Samant, K., Sahu, A., 2012. Isolation of Cellulose-Degrading Bacteria and Determination of Their Cellulolytic Potential. *International Journal of Microbiology*.

Gusakov, A. V., (2011). Alternatives to Trichoderma reesei in biofuel production. *Trends in Biotechnology*. *29*(9), 419–425. https://doi.org/10.1016/j.tibtech.2011.04.004

Hahn-Hagerdal, B., Galbe, M., Gorwa-Grauslund, MF., Liden, G., Zacchi, G., 2006. Bio-Ethanol-The Fuel of Tomorrow From The Residues of Today. *Trends in Biotechnology*. 24(12), 549-556.

Handoko, T., Suhandjaja, G., Muljana, H., (2012). Hidrolisis serat selulosa dalam buah bintaro sebagai bahan baku bioetanol. *Jurnal Teknik Kimia Indonesia*. *11*(1), 26. https://doi.org/10.5614/jtki.2012.11.1.4.

Harmsen, P., Huijgen, W., Bermudez, L., Bakker, R., 2010. Literature Review of Physical and Chemical Pretreatment Processes for Lignocellulosic Biomass.

Haque, M.A., Barman, D.N., Kang, T.H., Kim, M.K., Kim, J., Kim, H., Yun, H.D., 2012. Effect of Dilute Alkali On Structural Features and Enzymatic Hydrolysis Of Barley Straw (*Hordeum vulgare*) at Boiling Temperature With Low Residence Time. *J. Microbiol Biotechnol*. 22(12), 1681-1691.

Havukainen, S., Pujol-Giménez, J., Valkonen, M., Westerholm-Parvinen, A., Hediger, M. A., Landowski, C. P., (2021). Electrophysiological characterization of a diverse group of sugar transporters from Trichoderma reesei. *Scientific Reports*. *11*(1), 14678. https://doi.org/10.1038/s41598-021-93552-7.

Hadayati, S., Zulferiyenni., Ulfa, M., Wisnu, S., Sutopo, H., 2021. Effect of Glycerol Concentration and Carboxy Methyl Cellulose on Biodegradable Film Characteristics of Seaweed Waste. *Heliyon*. 7,1-8.

Hill, J., Nelson, E., Tilman, D., Polasky, S., Tiffany, D., 2006. Enviromental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels. *Proceedings of The National Academy of Sciences*. 103(30), 11206-11210.

[illegible] S. J., Aasen, I. M., Østgaard, K., (2000). Production of ethanol from mannitol by *Zymobacter palmae. Journal of Industrial Microbiology and Biotechnology*. *24*(1), 51–57. https://doi.org/10.1038/sj.jim.2900771.

Hu, Z.H., Wang, G., Yu, H.Q., 2004. Short Communication: Anaerobic Degradation of Cellulose by Rumen Microorganisms at Various pH Values. *Biochemical Engineering Journal.* 21, 59-62.

Kazemi, M., 2020. Based On Magnetic Nanoparticles: Gold Reusable Nanomagnetic Catalysts In Organic Synthesis. An International Journal For Rapid Communication of Synthetic Organic Chemistry. 50 (14), 2079-2094. https:// doi. org/ 10. 1080/ 00397 911. 2020. 17250 58.

Kim, S.W., Hong, C.H., Jeon, S.W., Shin, H.J., 2015. High-yield Production of Biosugars From *Gracilaria verrucosa* by Acid and Enzymatic Hydrolysis Processes. *Bioresour.Technol*. 196, 634-641.https://doi.org/10.1016/j.biortech.2015.08.016.

KKP. (2020). *Kementerian kelautan dan perikanan tahun 2020*.

Kosanovic, D., Potocnik, I., Vukojevic, J., Stajic, M., Rekanovic, E., Stepanovic, M., Todorovic, B., 2015. Fungicide Sensitivity of *Trichoderma* sp. from *Agaricus bisporus* Farms in Serbia. *Journal of Enviromental Science and Health- Part B Pesticides, Food Contaminants, and Agricultural Wastes*. 50(8), 607-613.

Kostylev, M., Wilson, D., 2012. Synergistic Interactions in Cellulose Hydrolysis. *Biofuels*. 3(1), 61-70.

Kuglarz, M., Alvarado-Morales, M., Dabkowska, K., Angelidaki, I., 2018. Integrated Production of Cellulosic Bioethanol and Succinic Acid FromRapeseed Straw After Dilute-Acid Pretreatment. *Bioresource Technology*. 265, 191-199. https://doi.org/10.1016/j.biortech.2018.05.099.

Kumar, B., Bhardwaj, N., Alam., Agrawal, K., Prasad, H., Verma, P., 2018. Production, Purification and Characterization of An Acid/Alkali and Thermo Tolerant Cellulase From Schizophyllum commune NAIMCC-F-03379 and Its Application in Hydrolysis of Lignocellulosic Wastes. *AMB Express*. 8, 1-16.

Kumar B., Bhardwaj, N., Agrawal, K., Chaturvedi, V., Verma P., 2020. Current Perspective on Pretreatment Technologies Using Lignocellulosic Biomass: An Emerging Biorefinery Concept. *Fuel Processing Technology*. 199, 1-24. https://doi.org/10.1016/j.fuproc.2019.106244.

Kumar, R., Singh, S., Singh OV., 2008. Bioconversion of Lignocellulosic Biomass: Biochemical and Molecular Perspectives. *Journal of Industrial Microbiology & echnology*. 35(5), 377-391.

R., Strezov, V., Weldekidan, H., He, J., Singh, S., Kan, T., tjerdi, B., 2020. Lignocellulose Biomass Pyrolysis For Oil Productions: A Review of Biomass Pretreatment

Methods For Production of Drop-In Fuels. *Renewable and Sustainable Energy Reviews*. 123, 1-31. https://doi.org/10.1016/j.rser.2020.109763.

Lambertz, C., Garvey, M., Klinger, J., Heesei, D., Klose, H., Fischer, R., 2014. Commandeur U: Challenges and Advances in The Heterologous Expression of Cellulolytic Enzymes: A Review. Biotechnology For Biofuels. 7(1), 135.

Lee, J., 1997. Biological Conversion of Lignocellulosic Biomass to Ethanol. *Journal of Biotechnology*. 56(1), 1-24.

Li, Y., Liu, C., Fengwu, B., Xinqing, Z., 2016. Overproduction of Cellulase by Trichoderma reesei RUT C30 Through Batch-Feeding of Synthesized Low-Cost Sugar Mixture. *Bioresource Technology*. 216, 503-510.

Lodha, A., Pawar, S., Virendra, R., 2020. Optimised Cellulase Production From Fungal Co-Culture of Trichoderma reesei NCIM 1186 and Penicillium citrinum NCIM 768 Under Solid State Fermentation. *Journal of Enviromental Chemical Engineering*. 8, 1-6.

Lorenci, W.A., Dalmas, N.C.J., De Souza, Porto, Vandenberghe, L., De Carvalho, N.D.P. et al., 2020. Lignocellulosic Biomass: Acid and Alkaline Pretreatments and Their Effects on Biomass Recalcitrance-Conventional Processing and Recent Advances. *Bioresour Technol*. 304.

Lynd, L. R., Weimer, P. J., Van Zyl, W. H., Pretorius, I. S., (2002). Microbial cellulose utilization: fundamentals and biotechnology. *Microbiology and Molecular Biology Reviews*. *66*(3), 506–577.

Maki, M., Leung, KT., Qin, W., 2009. The Prospects of Cellulase-Producing Bacteria for The Bioconversion of Lignocellulosic Biomass. I*nternasional Journal of Biological Sciences*. 5, 500-516.

Mankar, A.R., Ashish, P., Arindam, M. K.K.P., 2021. Pretreatment of Lignocellulosic Biomass: A Review on Recent Advances. *Bioresource Technology*. 334, 1-12.

Martinez-Patino, J.C., Lu-Chau, T.A., Gullon, B., Ruiz, E., Romero, I., Castro, E., Lema, J.M., 2018. Application of A Combined Fungal and Diluted Acid Pretreatment On Olive Tree Biomass. *Ind. Crop. Prod.* 121, 10-17. https://doi.org/10.1016/j.indcrop.2018.04.078.

Megawati. 2015. *Bioetanol Generasi Kedua*, Yogyakarta: Graha Ilmu.

M. D. N., Hong, Y.-K., Jeong, G.T., (2012). Comparison sulfuric and hydrochloric acids as catalysts in hydrolysis of paphycus alvarezii (cottonii). *Bioprocess and Biosystems ineering*. *35*(1), 123–128.

Meinita, M. D. N., Hong, Y.-K., Jeong, G.-T. (2012). Detoxification of acidic catalyzed hydrolysate of Kappaphycus alvarezii (cottonii). *Bioprocess and Biosystems Engineering*. *35*(1), 93–98.

Meinita, M. D. N., Kang, J.-Y., Jeong, G.-T., Koo, H. M., Park, S. M., Hong, Y.-K., (2012). Bioethanol production from the acid hydrolysate of the carrageenophyte Kappaphycus alvarezii (cottonii). *Journal of Applied Phycology*. *24*(4), 857–862.

Meinita, M. D. N., Marhaeni, B., Jeong, G.-T., Hong, Y.K., (2019). Sequential acid and enzymatic hydrolysis of carrageenan solid waste for bioethanol production: a biorefinery approach. *Journal of Applied Phycology*. *31*(4), 2507–2515. https://doi.org/10.1007/s10811-019-1755-8.

Meinita, M. D. N., Marhaeni, B., Winanto, T., Jeong, G.-T., Khan, M. N. A., Hong, Y.-K., (2013). Comparison of agarophytes (Gelidium, Gracilaria, and Gracilariopsis) as potential resources for bioethanol production. *Journal of Applied Phycology*. *25*(6), 1957–1961.

Mirmohamadsadeghi, S., Chen, Z., Wan, C., 2016. Reducing Biomass Recalcitrance Via Mild Sodium Carbonate Pretreatment. *Bioresource Technology*. 209, 386-390. https://doi.org/10.1016/j.biortech.2016.02.096.

Mishra, P.K., & Khan, F.N., 2015. Effect pf Different Growth Media and Physical Factors on Biomass Production of *Trichoderma viride*. 8(2), 11-17.

Moon, R.J., Martini, A., Naim, J., Simonsen, J., Youngblood, J., 2011. Cellulose Nanomaterials Review: Structure, Properties and Nanocomposites. *Chemical Society Reviews.* 40(7), 3941-3994.

Mosier, N., Wyman, C., Dale, B., Elander, R., Lee, Y.Y., Holtzapple, M., Ladisch, M., 2005. Features of Promising Technologies For Pretreatment of Lignocellulosic Biomass. *Bioresource Technology*. 96, 673-686.

Muhaimin, M, B., Wulan, F., Arfan, S., (2018). Reaction Kinetics In Conversion Process of Pineapple Leaves Into Glucose. *Reaktor*. 18(3). 155-159.

Mussatto, SI., Teixeira, J., 2010. Lignocellulose As Raw Material in Fermentation Processes. *Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology (Mendez-Vilas, A, Ed)*. 2, 897-907.

V., Nielsen, F., Bernhard, S., Bernd, N., 2019. The ence of Feedstock Characteristics on Enzyme luction in *Trichoderma reesei:* A Review on Productivity, e Regulation and Secretion Profiles. *Biotechnology for uels*. 12(238). 1-12.

Nurfadillah., Taufan, W.L., Muhammad, S.A., Sulfahri. 2018. Production of Bioethanol From Kappaphycus alvarezii Algae by Using Pichia kudriavzevii. *International Journal of Applied Biology*. 2(1). 47-54.

Prasad, S., Malav, M.K., Kumar, S., Singh, A., Pant, D., Radhakrishnan, S., 2018. Enhancement of Bioethanol Production Potential of Wheat Straw By Reducing Furfural and 5-hydroxymethyfurfural (HMF). *Bioresour Technol Rep*. 4, 50-56.

Rani, R., Indian, S., Scienc, I., 2005. Microbial Cellulases-Production, Applications and Challenges. *J. Sci. Ind. Res*. 64, 832-844.

Rezania, S., Oryani, B., Cho, J., Talaiekhozani, A., Sabbagh, F., Hashemi, B., Rupani, P.F., Mohammadi, A.A., 2020. Different Pretreatment Technologies of Lignocellulosic Biomass for Bioethanol Production: An Overview. Energy. 199, 1-13. https://doi.org/10.1016/j.energy.2020.117457.

Romano, R.T., Zhang, R., Teter, S., McGarvey, J.A., 2009. The Effect of Enzyme Addition on Anaerobic Digestion of Jose Tall Wheat Grass. *Bioresource Technology*. 100, 4564-4571.

Roni Nugraha, Nurjannah, T. N., (2019). *Fisiologi, Formasi, dan Degradasi Metabolit Hasil Perairan*. IPB Press, Bogor. Retrieved from https://books.google.co.id/books?id=LxMSEAAAQBAJ.

Rouches, E., Herpoel-Gimbert, I., Steyer, J.P., Bernet, N., Carrere, H., 2016. Improvement of Anaerobic Degradation by White-Rot Fungi Pretreatment of Lignocellulosic Biomass: A Review. *Renewable Sustainable Energy. Rov*. 59, 179-198.

Safaria , S., Idiawati, N., Marlisa, T. 2013. Efektivitas Campuran Enzim Selulase dari Aspergillus niger dan Trichoderma reesei dalam Menghidrolisis Substrat Sabut Kelapa. *JKK*. 2(1), 46-51.

Santos, C.C., De Souza, W., Sant Anna, C., Brienzo, M., 2018. Elephant Grass Leaves Have Lower Recalcitrance to Acid Pretreatment Than Stems With Higher Potential For Ethanol Production. *Industrial Crops and Products*. 111, 193-200. https://doi.org/10.1016/j.indcrop.2017.10.013.

Sawit, M. H., (2001). Industri Gula Nasional Di Persimpangan Jalan: Mampu Bertahan Atau Tersingkir. *Jurnal Ekonomi Dan Bisnis Indonesia*. *16*(2), 111–121.

RC., Adhikari, DK., Goyal, HB., 2009. Biomass-Based rgy Fuel Through Biochemical Routes: A Review. *ewable and Sustainable Energy Reviews* . 13(1), 167-

M., (2022). Trichoderma reesei. *Trends in Microbiology*.

30(4), 403-404.

Seftian, D., Antonius, F., Faizal, M., (2012). Pembuatan Etanol Dari Kulit Pisang Menggunakan Metode Hidrolisis Enzimatik dan Fermentasi. *Jurnal Teknik Kimia*. *18*(1), 10–16.

Seo, JK., Park, TS., Kwon, IH., Piao, MY., Lee, CH., Ha, JK., 2013. Characterization of Cellulolytic and Xylanolytic Enzymes of *Bacillus licheniformis* JK7 Isolated From The Rumen of A Native Korean Goat. *Asian Australas J Anim Sci*. 26(1), 50-58.

Shahzadi, T., Mehmood, S., Irshad, M., Anwar, Z., Afroz, A., Zeeshan, N., Rashid, U., Sughra, K., 2014. Advances in Lignocellulosic Biotechnology: A Brief Review On Lignocellulosic Biomass and Cellulases. *Advances in Bioscience and Biotechnology*.

Shi, Y., Yan, X., Li, Q., Wang, X., Xie, S., Chai, L., Yuan, J., et al., 2017. Directed Bioconversion of Krfat Lignin to Polyhydroxyalkanoare by *Cupriavidus basilensis* B-8 Without Any Pretreatment. *Process Biochem*. 52, 238-242.

Sindhu, R., Binod, P., Pandey, A., 2016. Biological Pretreatment of Lignocellulosic Biomass- An Overview. Bioresource Technology. 199, 76-82

Sinha, A., Singh, R., Rao,S. G., Verma, A., 2018. Comprehensive Evaluation of Trichoderma harzianum and Trichoderma viride On Different Culture Media and At Different Temperature and pH. *The Pharma Innovation Journal*. 7(2), 193-195

Sreeja-Raju, A., Christoper, M., Prajeesh, KV., Rajasree, KP., Digambar, V.G., Meena, S., et al., 2020. Penicillium janthinellum NCIM1366 Shows Improved Biomass Hydrolysis and A Larger Number of CAZymes With Higher Induction Levels Over Trichoderma reesei RUT-C30. *Biotechnol Biofuels*. 13(196), 1-15. https://doi.org/10.1186/s13068-020-01830-9

Sukumaran, RK., Singhania, RR., Pandey, A., 2005. Microbial Cellulases-Production, Applications and Challenges. *Journal of Scientific and Industrial Research*. 64(11), 832.

Sulfahri, Mushlihah, S., Husain, D. R., Langford, A., Tassakka, A. C. M. A. R., (2020). Fungal pretreatment as a sustainable and low cost option for bioethanol production from marine algae. *Journal of Cleaner Production*, *265*, 121763. https://doi.org/10.1016/j.jclepro.2020.121763.

., Cheng, J., 2002. Hydrolysis of Lignocellulosic Materials Ethanol Production: A Review. *Bioresource Technology*. 1), 1-11.

i, F., Laureano-Perez, L., Alizadeh, H., Dale, B.E., 2005.

Optimization of The Ammonia Fiber Exploxion (AFEX) Treatment Parameters For Enzymatic Hydrolysis of Corn Stover. *Bioresource Technology*. 96 (18), 2014-1018. https://doi.org/10.1016/j.biortech.2005.01.016.

Tiwari, P., Misra, B., Sangwan, NS., 2013. β-Glucosidases From The Fungus *Trichoderma*: An Efficient Cellulase Machinery in Biotechnological Applications. *BioMed Research International.*

Travaini, R., Barrado, E., Bolado-Rodriguez, S., 2016. Effect of Ozonolysis Pretreatment Parameters On The Sugar Release, Ozone Consumption and Ethanol Production From Sugarcane Bagasse. Bioresource Technology. 214, 150-158.

Uppugundla, N., Da Costa Sousa, L., Chundawat, S.P.S., Yu, X., Simmons, B., Singh, S. et al., 2014. A Comparative Study Of Ethanol Production Using Dilute Acid, Ionic Liquid and AFEX™ Pretreated Corn Stover. *Biotechnology For Biofuels*. 7, 1-14.

Yan, X., Wang, Z., Zhang, K., Si, M., Liu, M., Chai, L., Liu, X., Shi, Y., 2017. Bacteria Dilute Acid Pretreatment of Lignocellulosic Biomass. *Bioresource Technology*. 245, 419-425.

Veluchamy, C., Kalamdhad, A.S., Gilroyed, B.H., 2018. Advanced Pretreatment Strategies for Bioenergy Production From Biomass and Biowaste. Handb Environ Mater. 1-19.

Wahidah, T. H., Dewi, M., Talitha, W., Pramesti, D., 2022. Pengaruh Faktor Lingkungan Terhadap Pertumbuhan Trichoderma spp. dan Aktivitas Enzim Amilase dan Xilanase. *Life Science*. 11(2), 108-119.

Wan, C., Li, Y., 2012. Fungal Pretreatment of Lignocellulosic Biomass. *Biotechnology Adv*. 30, 1447-1457.

Wald, S., Wike, C.R., Blanch, H.W., 2010. Kinetics of The Enzymatic Hydrolysis of Cellulose. *Biotechnology & Bioengineering*. 26(3), 221-230.

Wekridhany, 2012. Pengaruh Rasio Selulosa / NaOH pada Tahap Alkalinisasi Terhadap Produksi Natrium. *Prosiding SNSMAIP III-2012*. Universitas Bandar Lampung, Lampung. 407-411.

Widodo, P., Chairul, S., Reni, Y., 2015. Produksi Bioetanol Dari Nira Nipah Skala 50 Liter dengan Penambahan Tween 80 dan Ergosterol Pada Proses Fermentasi Menggunakan Saccharomyces cerevisiae. *JOM Teknik*. 2(2). 1-8. -

Wingren, A., Galbe, M., Zacchi, G., 2003. Techno-economic ...uation of Producing Ethanol from Softwood: Comparison ... SSF and SHF and Identification of Bottlenecks. ...*echnology Progress*. 19(4), 1109-1117.

..., Hu,X., Chen, H., Zhou, Y., Wang, D., 2019. Advances in ...hanced Volatile Fatty Acid Production From Anaerobic

Fermentation of Waste Activated Sludge. *Sci.Total Environ*. 694, 133741. https:// doi. org/ 10. 1016/j. scito tenv.

Yustin, D., Angelia, D.R., Yusafir, H., Paulina, T., 2005. Analisis Potensi Limbah Cair Hasil Pengolahan Rumput Laut Sebagai Pupuk Buatan. *Marina Chimica Acta*. 6(1), 2-8.

Zaenab, St., Kasmiati., Sulfahri., Asmi, C,M, A,R,T, 2020. Biosugar Production From *Kappaphycus alvarezii* by Hydrolysis Method Using Fungi *Trichoderma harzianum.* International Journal of Environment, Agriculture and Biotechnology. 5(4), 865-869.

Zaenab, S., Tassakka, A. C. M. A. R., Sulfahri, Kasmiati, 2020. Utilization of Double Fungal Treatment by *Trichoderma harzianum* and *Saccharomycopsis fibuligera* to produce biosugar from red seaweed *Kappaphycus alvarezii*. *IOP Conference Series: Earth and Environmental Science*. IOP Publishing, pp. 1-6. https://doi.org/10.1088/1755-1315/575/1/012015.

Zakaria, M.R., Fujimoto, S., Hirata, S., Hassan, M.A., 2014. Ball Milling Pretreatment of Oil Palm Biomass For Enhancing Enzymatic Hydrolysis. *Appl. Biochem. Biotechnol*. 173, 1778-1789.

Zhao, C., Ding, W., Cheng, C., Shao, Q., 2014. Effects of Compositional Changes of AFEX-treated and H-AFEX-treated Corn Stover on Enzymatic Digestibility. *Bioresour. Technol*. 155, 34-40.

Zhang, H., Han, L., Dong, H., 2021. An insight to pretreatment, enzyme adsorption and enzymatic hydrolysis of lignocellulosic biomass: Experimental and modeling studies. *Renewable and Sustainable Energy Reviews*. *140*(12), 110758. https://doi.org/10.1016/j.rser.2021.110758

Zhang, K., and Feng, H., 2010. Fermentation potentials of Zymomonas mobilis and its application in ethanol production from low-cost raw sweet potato. *African Journal of Biotechnology*. *9*(37), 6122–6128.

Zhang, Q., De Oliveira, V.K., Royer, S., Jerome, F., 2012. Deep Eutectic Solvents: Syntheses, Properties and Applications. Chemical Society Reviews. 41 (21), 7108-7146. https:// doi. org/ 10. 1039/ c2cs3 5178a.

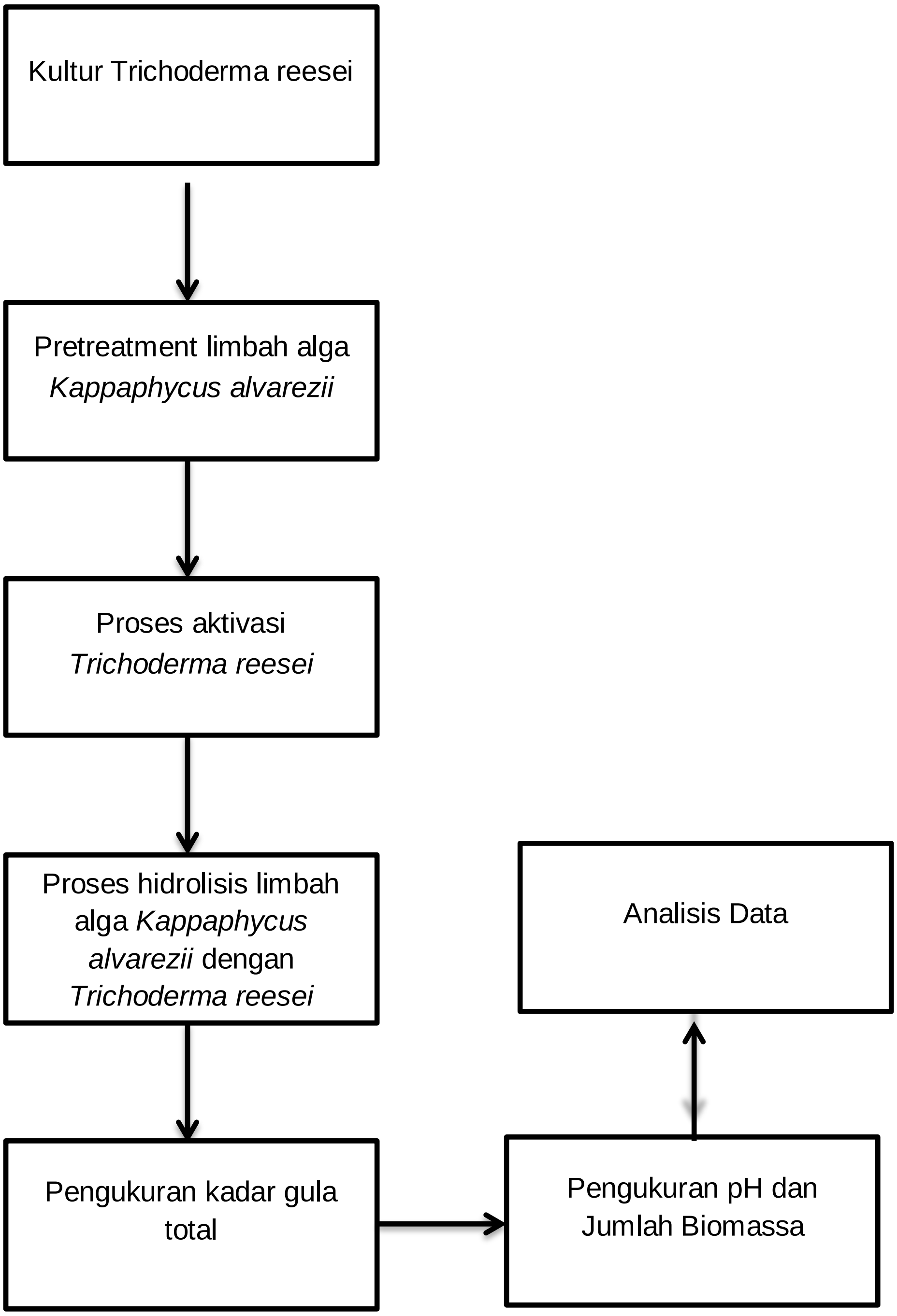
Zhang X-Z, Zhang Y-HP. 2013. Cellulases: Characteristics, Sources, Production, and Applications In: Yang, ST, El-Enhasy H, Thongchul N (eds) Bioprocess-ing Technologies Biorefinery for Sustainable Production of Fuels, Chemicals Polymers, Wiley, Inc., Haboken. 131-146.

M., Yan, B., Wong, J.W.C., Zhang, Y., 2018. Enhanced tile Fatty Acids Production From Anaerobic

Fermentatiton on Food Waste: A Mini-Review Focusing on Acidogenic Metabolic Pathways. *Biores.Technol.* 248, 68-78.

LAMPIRAN

Lampiran 1. Skema Kerja



Lampiran 2. Hasil uji statistik kadar gula total pada konsentrasi substrat 2.5%

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	5.581	<0.0001	****	Yes	
Row Factor	89.18	<0.0001	****	Yes	
Column Factor	3.689	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.1421	6	0.02369	F (6, 24) = 14.41	P<0.0001
Row Factor	2.271	3	0.7570	F (3, 24) = 460.4	P<0.0001
Column Factor	0.09396	2	0.04698	F (2, 24) = 28.57	P<0.0001
Residual	0.03947	24	0.001644		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 3. Hasil uji statistik kadar gula total pada konsentrasi substrat 5%

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	2.180	<0.0001	****	Yes	
Row Factor	92.18	<0.0001	****	Yes	
Column Factor	4.760	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.03024	6	0.005041	F (6, 24) = 9.862	P<0.0001
Row Factor	1.279	3	0.4262	F (3, 24) = 833.9	P<0.0001
Column Factor	0.06602	2	0.03301	F (2, 24) = 64.59	P<0.0001
Residual	0.01227	24	0.0005111		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 4. Hasil uji statistik kadar gula total pada konsentrasi substrat 7.5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	2.449	<0.0001	****	Yes	
Row Factor	94.48	<0.0001	****	Yes	
Column Factor	2.266	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.02274	6	0.003790	F (6, 24) = 12.18	P<0.0001
Row Factor	0.8773	3	0.2924	F (3, 24) = 939.9	P<0.0001
Column Factor	0.02104	2	0.01052	F (2, 24) = 33.81	P<0.0001
Residual	0.007467	24	0.0003111		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 5. Hasil uji statistik kadar gula total pada konsentrasi substrat 10%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	4.377	<0.0001	****	Yes	
Row Factor	87.94	<0.0001	****	Yes	
Column Factor	7.250	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.04643	6	0.007738	F (6, 24) = 40.37	P<0.0001
Row Factor	0.9328	3	0.3109	F (3, 24) = 1622	P<0.0001
Column Factor	0.07691	2	0.03845	F (2, 24) = 200.6	P<0.0001
Residual	0.004600	24	0.0001917		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 6. Hasil uji statistik pH pada konsentrasi substrat 2.5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	17.33	0.0013	**	Yes	
Row Factor	68.79	<0.0001	****	Yes	
Column Factor	0.7826	0.4981	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.01563	6	0.002605	F (6, 24) = 5.298	P=0.0013
Row Factor	0.06202	3	0.02067	F (3, 24) = 42.05	P<0.0001
Column Factor	0.0007056	2	0.0003528	F (2, 24) = 0.7175	P=0.4981
Residual	0.01180	24	0.0004917		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 7. Hasil uji statistik pH pada konsentrasi substrat 5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	2.416	0.2848	ns	No	
Row Factor	89.38	<0.0001	****	Yes	
Column Factor	0.9024	0.2469	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.004061	6	0.0006769	F (6, 24) = 1.324	P=0.2848
Row Factor	0.1502	3	0.05008	F (3, 24) = 97.98	P<0.0001
Column Factor	0.001517	2	0.0007583	F (2, 24) = 1.484	P=0.2469
Residual	0.01227	24	0.0005111		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 8. Hasil uji statistik pH pada konsentrasi substrat 7.5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	1.481	0.5443	ns	No	
Row Factor	91.29	<0.0001	****	Yes	
Column Factor	0.2675	0.6362	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.003444	6	0.0005741	F (6, 24) = 0.8505	P=0.5443
Row Factor	0.2123	3	0.07077	F (3, 24) = 104.8	P<0.0001
Column Factor	0.0006222	2	0.0003111	F (2, 24) = 0.4609	P=0.6362
Residual	0.01620	24	0.0006750		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 9. Hasil uji statistik pH pada konsentrasi substrat 10%

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	0.9434	0.8397	ns	No	
Row Factor	90.52	<0.0001	****	Yes	
Column Factor	0.09650	0.8724	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.002661	6	0.0004435	F (6, 24) = 0.4472	P=0.8397
Row Factor	0.2554	3	0.08512	F (3, 24) = 85.83	P<0.0001
Column Factor	0.0002722	2	0.0001361	F (2, 24) = 0.1373	P=0.8724
Residual	0.02380	24	0.0009917		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 10. Hasil uji statistik jumlah biomassa pada konsentrasi substrat 2.5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	0.2833	0.0022	**	Yes	
Row Factor	99.20	<0.0001	****	Yes	
Column Factor	0.2866	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.02001	6	0.003334	F (6, 24) = 4.860	P=0.0022
Row Factor	7.004	3	2.335	F (3, 24) = 3403	P<0.0001
Column Factor	0.02024	2	0.01012	F (2, 24) = 14.75	P<0.0001
Residual	0.01647	24	0.0006861		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 11. Hasil uji statistik jumlah biomassa pada konsentrasi substrat 5%

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	0.1093	0.0016	**	Yes	
Row Factor	99.69	<0.0001	****	Yes	
Column Factor	0.1209	<0.0001	****	Yes	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.006361	6	0.001060	F (6, 24) = 5.158	P=0.0016
Row Factor	5.804	3	1.935	F (3, 24) = 9411	P<0.0001
Column Factor	0.007039	2	0.003519	F (2, 24) = 17.12	P<0.0001
Residual	0.004933	24	0.0002056		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 12. Hasil uji statistik jumlah biomassa pada konsentrasi substrat 7.5%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	0.4872	0.0292	*	Yes	
Row Factor	98.78	<0.0001	****	Yes	
Column Factor	0.05780	0.3734	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.009039	6	0.001506	F (6, 24) = 2.885	P=0.0292
Row Factor	1.833	3	0.6108	F (3, 24) = 1170	P<0.0001
Column Factor	0.001072	2	0.0005361	F (2, 24) = 1.027	P=0.3734
Residual	0.01253	24	0.0005222		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 13. Hasil uji statistik jumlah biomassa pada konsentrasi substrat 10%.

Two-way ANOVA	Ordinary				
Alpha	0.05				
Source of Variation	**% of total variation**	**P value**	**P value summary**	**Significant?**	
Interaction	0.2091	0.1849	ns	No	
Row Factor	99.14	<0.0001	****	Yes	
Column Factor	0.1295	0.0683	ns	No	
ANOVA table	**SS**	**DF**	**MS**	**F (DFn, DFd)**	**P value**
Interaction	0.003267	6	0.0005444	F (6, 24) = 1.620	P=0.1849
Row Factor	1.549	3	0.5162	F (3, 24) = 1536	P<0.0001
Column Factor	0.002022	2	0.001011	F (2, 24) = 3.008	P=0.0683
Residual	0.008067	24	0.0003361		
Data summary					
Number of columns (Column Factor	3				
Number of rows (Row Factor)	4				
Number of values	36				

Lampiran 14. Prosedur kerja

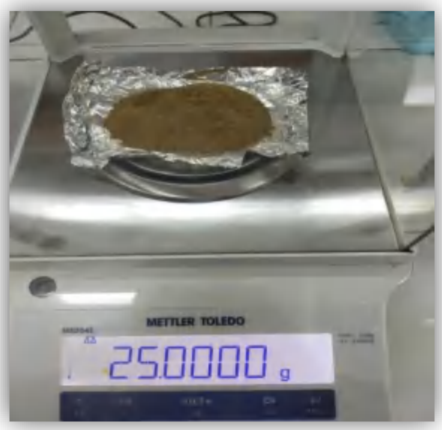
Limbah alga *Kappaphycus alvarezii*

Pencucian limbah alga *Kappaphycus alvarezii*

Limbah alga yang telah dibersihkan

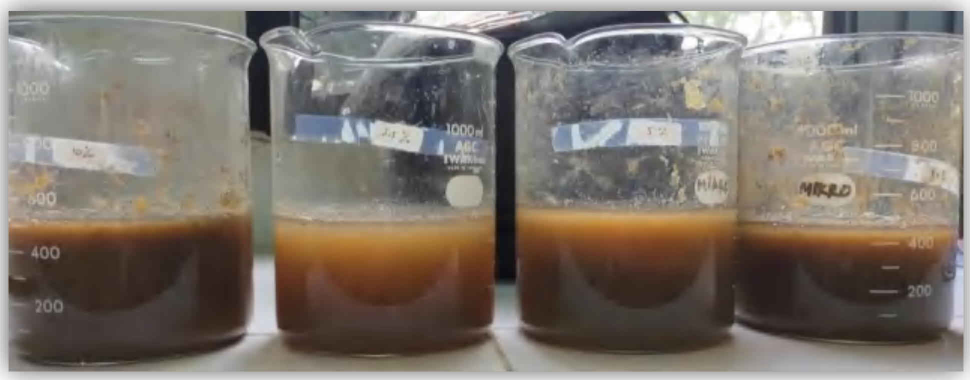
Limbah alga *Kappaphycus alvarezii* dikeringkan dengan menggunakan oven

ses penghancuran dan pengayakan limbah alga *Kappaphycus alvarezii* dengan ayakan 40 mesh



Proses penimbangan beberapa konsentrasi tepung limbah alga *Kappaphycus alvarezii*

Proses pemanasan tepung limbah alga *K. alvarezii* menggunakan *water batch* selama 2 jam pada suhu 100°C



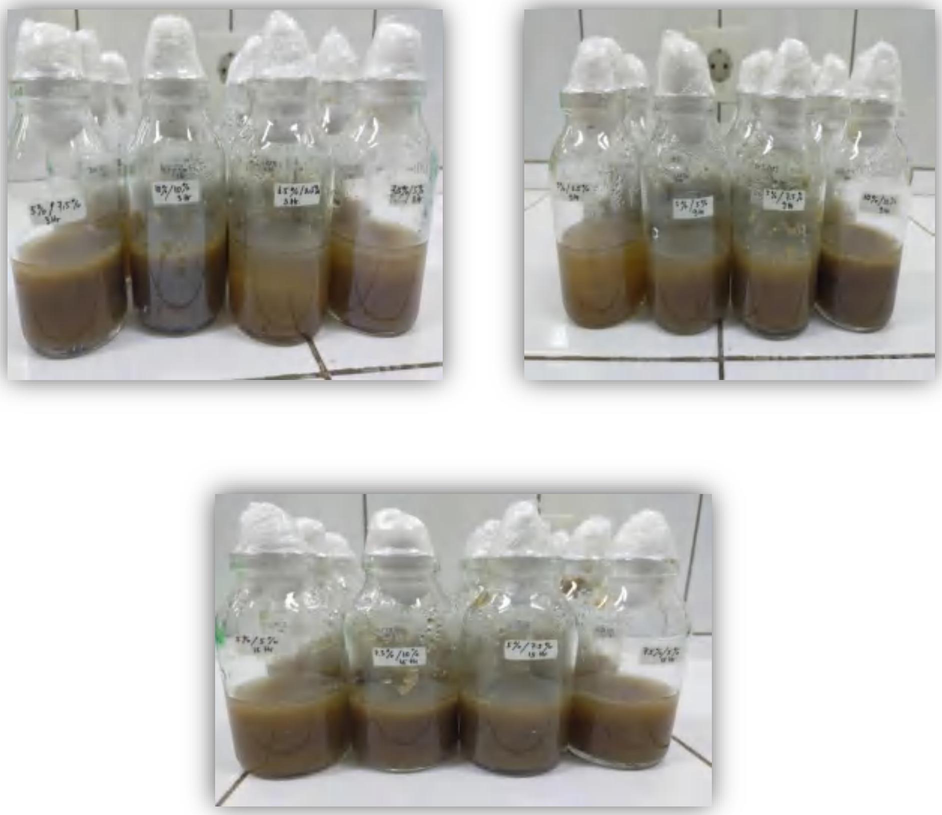
Hasil proses pemanasan tepung limbah alga

bah alga yang telah dipanasakan dimasukkan ke dalam botol fermentor

Proses sterilisasi substrat limbah alga menggunakan autoclave

Proses aktivasi isolat *T. reesei* dengan aquades steril

Proses inokulasi *T. reseei* kedalam botol fermentor yang berisi substrat limbah alga



sis (Inkubasi) selama 3 hari, 9 hari dan 15 hari pada suhu ± 30°C (suhu ruang)

Proses sentrifugasi larutan substrat limbah alga

Pengukuran kadar glukosa

Pengukuran Biomassa

RIWAYAT HIDUP

Nama lengkap penulis adalah Kurnia Kadir, kelahiran 28 Juli 1997 di Kabupaten Takalar, Provinsi Sulawesi Selatan. Alamat di Bontolabbua, Kelurahan Barombong, Kecamatan Tamalate, Kota Makassar, Sulawesi Selatan. Penulis beragama Islam dan merupakan anak pertama dari tiga bersaudara dari pasangan Bapak H. Abd. Kadir Mustafa dan Ibu Norma Jafri dengan 2 orang adik kandung diantaranya adalah Fatimah Azzahra dan Sulaiman.

Penulis mengawali karir pendidikan pada jenjang sekolah dasar pada tahun 2003-2009 di SD Negeri Bontomanai. K, jenjang sekolah lanjut tingkat pertama pada tahun 2009-2012 di SMP Negeri 1 Pallangga, jenjang sekolah lanjut tingkatbatas pada tahun 2012-2015 di SMK Pratidina Makassar, dan ke tingkat strata satu pada tahun 2016-2021 dan meraih gelar Sarjana Sains (S.Si.) pada jurusan Biologi, Fakultas Sains dan Teknologi, Universitas Islam Negeri Alauddin Makassar, serta saat ini penulis dalam tahap penyelesaian studi akhir pada jenjang magister untuk gelar Magister Sains (M.Si.) pada Program Studi Magister Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Hasanuddin.

Penulis mengawali karir sebagai seorang tenaga pendidik di Yayasan Cobig Islamic School pada bulan Juli tahun 2023.

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