

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Berdasarkan hasil pembahasan penelitian yang telah dilakukan dapat disimpulkan :

- a. Peningkatan konsentrasi NaOH dan waktu radiasi UV 254 nm masing-masing meningkatkan rendemen namun menurunkan indeks kristalinitas. Interaksi keduanya meningkatkan indeks kristalinitas namun menurunkan rendemen selulosa mikrokristalin eceng gondok.
- b. Prediksi konsentrasi NaOH sebesar 16,11% dan radiasi UV selama 119 menit mampu menghasilkan selulosa mikrokristalin yang optimum .

5.2 Saran

Berdasarkan hasil pembahasan penelitian yang telah dilakukan maka disarankan :

- a. Dilakukan verifikasi kondisi optimum konsentrasi NaOH dan radiasi UV untuk menghasilkan selulosa mikrokristalin yang optimum.
- b. Dilakukan karakterisasi lebih lanjut secara fisikokimia meliputi kompartibilitas dan kompresibilitas dari serbuk selulosa mikrokristalin eceng gondok.
- c. Dilakukan analisa lebih lanjut terhadap selulosa mikrokristalin menggunakan *solid state* NMR.

DAFTAR PUSTAKA

- Abdel-Fattah, A.F. and Abdel-Naby, M.A. 2012, Pretreatment and enzymic saccharification of water hyacinth cellulose, *Carbohydrate Polymers*, **87(3)**: 09–13.
- Aguiar, C. L. 2001, Biodegradation of the cellulose from sugarcane bagasse by fungal cellulase, *Ciencia y Tecnologia Alimentaria*, **3(2)**: 117–121.
- Alam, M.Z., Manchur, M.A. and Anwar, M.N. 2004, Isolation, purification, characterization of cellulolytic enzymes produced by the isolate *Streptomyces omiyaensis*, *Pakistan Journal of Biological Sciences*, **7(10)**: 1647-1653.
- Alatas, Z. and Lusiyanti, Y. 2001, Efek kesehatan radiasi non-pengion pada manusia, *Seminar Keselamatan, Kesehatan, dan Lingkungan*, Litbang Keselamatan Radiasi dan Biomedika Nuklir-BATAN, Bandung.
- Anm, M.R. and Khan, R.A. 2018, Influence of UV radiation on mechanical properties of PVC composites reinforced with pineapple fiber, *Journal of Textile Science & Engineering*, **8(1)**: 1–5.
- Ariputri, D.R. 2014, 'Identifikasi isolat bakteri penghasil enzim selulase dari limbah ampas tebu berdasarkan analisis homologi gen penyandi 16S rRna', *Skripsi*, Sarjana Farmasi, Universitas Katolik Widya Mandala Surabaya.
- Artati, E.K., Effendi, A. and Haryanto, T. 2009, Pengaruh konsentrasi larutan pemasak pada proses delignifikasi eceng gondok dengan proses organosolv, *Ekuilibrium* **8(1)**: 25–28.
- Azubuike, C.P. and Okhamafe A.O. 2012, Physicochemical, spectroscopic and thermal properties of microcrystalline cellulose derived from corn cobs, *International Journal of Recycling of Organic Waste in Agriculture*, **1(9)**: 01-07.
- Borjesson, M., Richardson, G. and Westman, G. 2015, UV radiation of cellulose fibers and acrylic acid modified cellulose fibers for improved stiffness in, *BioResources*, **10(2)**: 3056–3069.
- Brinchi, L. 2013, Production of nanocrystalline cellulose from lignocellulosic biomass, *Carbohydrate Polymer*, **94**: 154-159.
- Chalal, D.S. 1983, Growth characteristics of microorganisms in solid state fermentation for upgrading of protein values of lignocelluloses and

- cellulase production, *American Chemical Society*, **20**: 421–442.
- Chasanah, E., Dini, I.R. and Mubarik, N.R. 2013, Karakterisasi enzim selulase PMP 0126Y dari limbah pengolahan agar, *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan*, **8(2)**: 103-114.
- Christina, A.L. 2017, 'Karakterisasi selulosa mikrokristalin dari eceng gondok (*Eichhornia crassipes*) hasil hidrolisis enzim selulase dari *Bacillus subtilis* Strain SF01', *Skripsi*, Sarjana Farmasi, Universitas Katolik Widya Mandala Surabaya.
- David, G., Neufeldt, H., Berazneva, J. and Duby, S. 2015, Water hyacinth control in lake victoria: transforming an ecological catastrophe into economic, social, and environmental benefits, *The Institution of Chemical Engineers*, **3**:59-69.
- El-Sakhawy, M. and Hasan, M. 2017, Physical and mechanical properties of microcrystalline cellulose prepared from local agricultural residues, *Carbohydrate Polymers*, **67**: 1-10.
- Fajarpel, C.P.U. 2015, 'Karakterisasi Enzim Selulase dari Isolat Bakteri Selulolitik Asal Limbah Ampas Tebu', *Skripsi*, Sarjana Farmasi, Universitas Katolik Widya Mandala Surabaya.
- Fengel, D. and Wenger D. 1995, *Kimia Kayu, Reaksi, Ultrastruktur*, Diterjemahkan dari Bahasa Inggris oleh S. Hardono, UGM press, Yogyakarta.
- George, J., Ramana, K.V. and Bawa, A.S. 2010, Bacterial cellulose nanocrystal exhibiting high thermal stability and their polymer nanocomposites, *International Journal of Biological Macromolecules*, **48(1)**: 50-57.
- Gunam, I.B.W., Buda, K., Guna, I.M.Y.S. 2010, Pengaruh perlakuan delignifikasi dengan larutan NaOH dan konsentrasi substrat jerami padi terhadap produksi enzim selulase dari *Aspergillus niger* NRRL A-II, 264, *Jurnal Biologi*, **14(1)**: 55-61.
- Haafiz, M.K.M., Eichhorn, S.J., Hassan, A. and Jawaid, M. 2013, Isolation and characterization of microcrystalline cellulose from oil palm biomass residue, *Carbohydrate Polymers*, **93**: 628-634.
- Hames, D. and Hooper, N. 2005, *Biochemistry*, 3rd ed., Taylor & Francis Group, New York.

- Hadisoewignyo, L. and Fudholi, A. 2016, *Sediaan Solida*, Edisi Revisi, Pustaka pelajar, Yogyakarta.
- Halim, A. and Sulastri, E. 2002, Pembuatan mikrokristalin selulosa dari jerami padi (*Oryza sativa* Linn) dengan versi waktu hidrolisa, *Jurnal Sains dan Teknologi Farmasi*, **7(2)**: 80-87.
- Hartanti. 2010, 'Isolasi seleksi bakteri selulolitik termofilik dari kawah air panas gunung pancar Bogor', *Skripsi*, Sarjana Sains, Institut Pertanian Bogor.
- Hermiati, E., Mangunwidjaja, D., Sunarti, T.S. and Suparno, O. 2010, Pemanfaatan biomassa lignoselulosa ampas tebu untuk produksi bioetanol, *Jurnal Litbang Pertanian*, **29(4)**: 121–130.
- Ibrahim, M.M., El-Zawawy, W.K., Koschella, A. and Heinze, T. 2013, Cellulose and microcrystalline cellulose from rice straw and banana plant waste: preparation and characterization, *Cellulose*, **20(5)**: 3–16.
- Jung, C.H. and Wells, W.W. 1998, Spontaneous conversion of L-Dehydroascorbic acid to L-Ascorbic acid and L-Erythroascorbic acid, *Archives of Biochemistry and Biophysics*, **355(1)**: 9–14.
- Johar, N., Ahmad, I. and Dufresne, A. 2012, Extraction, preparation and characterization of cellulose fibres and nanocrystals from rice husk, *Industrial Crops and Products*, **37**: 93–99.
- Kennely, P.J. and Rodwell, V.W. 2009, Enzim: Mekanisme Kerja, dalam Murray, R.K., Granner, D.K. and Rodwell, V.W., *Biokimia Harper*, Diterjemahkan dari Bahasa Inggris oleh Brahm, Penerbit Buku Kedokteran EGC, Jakarta.
- Kroschwitz, J. 1990, *Polymer Characterization and Analysis*, John Wiley and Sons, Inc., Canada.
- Landin, M. 1993, Effect of batch variation and source of pulp on the properties of microcrystalline cellulose, *International Journal of Pharmaceutics*, **91(2–3)**: 133–41.
- Lehninger, A.L. 1993, *Dasar-dasar Biokimia, Jilid 1*, Diterjemahkan dari Bahasa Inggris oleh M. Thenawidjaja, Penerbit Erlangga, Surabaya.
- Lucas, R., McMichael, T., Smith, W. and Armstrong, B. 2006, Solar ultraviolet radiation: global burden of disease from solar ultraviolet radiation, *World Health Organization*, **55(13)**: 78.

- Lynd, L.R., Weimer, P.J., Zyl, W.H.V. and Isak, S. 2002, Microbial cellulose utilization: fundamentals and biotechnology, *Microbiology and Molecular Biology Reviews*, **66(2)**: 56–77.
- Mardiyati., Rizkiansyah, R.R., Steven., Basuki, A. and Suratman, R. 2016, Serat kapuk sebagai bahan baku pembuatan mikrokristalin selulosa, *Jurnal Sains Materi Indonesia*, **17(4)**:172-177.
- Masschelein, W.J and Rice, R.G. 2002, *Ultra violet Light in Water and Wastewater Sanitatioion*, Lewis Publisher, CRC Press, Florida.
- Meryandini, A. 2009, Isolasi bakteri selulolitik dan karakterisasi enzimnya, *Makara Sains*, **13(1)**: 33–38.
- Miller, G. L. 1959, Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugar, *Analytical Chemistry*, **31(3)**: 426-428.
- Moenandir, J. 1990, *Fisiologi Herbisida, Jilid II*, Rajawali Press, Jakarta.
- Nguyen, T. and Hanh, T. 2015, Habitat suitability of the invasive water hyacinth and its relation to water quality and macroinvertebrate diversity in a tropical reservoir, *Limnologia*, **52**: 67-74.
- Nurhajati, D.W. 1991, Pengaruh alkali pada pembuatan film pelapis ("coating film") menggunakan teknologi sinar ultraviolet, *Majalah Barang Kulit, Karet dan Plastik*, **6(10-11)**: 37-44.
- Ohwoavworhua, F.O. and Adelokun, T.A. 2009, Processing pharmaceutical grade microcrystalline cellulose from groundnut husk: extraction methods and characterization, *International Journal of Green Pharmacy* **3(2)**: 97.
- Pachua, L., Malsawmtluangi, C., Nath, N.K., Ramdinsangi, H., Vanlalpakawma, D.C. and Tripathi, S.K. 2013, Physicochemical and functional characterization of microcrystalline cellulose from bamboo (*Dendrocalamus longispatus*), *International Journal of PharmTech Research*, **5(4)**: 1561-1571.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R. 2001, *Introduction to Spectroscopy*, Nelson Education, Ltd, Canada.
- Perrin, D. D. and Dempsey, B. 1974, *Buffers for pH and Metal Ion Control*, Chapman and Hall Ltd, Springer Netherlands, London.
- Poedjiadi, A. and Supriyadi, T. 1994, *Dasar-dasar Biokimia*, UI-Press,

Jakarta.

Prescot, S.C and Dunn, G. 1981, *Industrial Microbiology*, Mc Graw-Hill Book Co. Ltd, New York.

Rahayu, A.G., Yahyani, Y. and Puspita, F. 2014, Uji aktivitas selulolitik dari tiga isolat bakteri bacillus sp. galur lokal riau, *Jurnal Online Mahasiswa FMIPA Universitas Riau*, **1(2)**: 19–27.

Rowe, R.C., Sheskey, P.J. and Quinn, M.E. 2009, *Handbook of Pharmaceutical Excipients*, 6th ed., The Pharmaceutical Press, London.

Shlieout, G., Arnold, K. and Muller, G. 2002, Powder and mechanical properties of microcrystalline cellulose with different degrees of polymerization, *AAPS PharmSciTech*, **3(2)**: 45–54.

Sholihati, A.M., Baharuddin, M. and Santi. 2015, Produksi dan uji aktivitas enzim selulase dari bakteri *Bacillus subtilis*, *Al Kimia*, **3(2)**:78-90.

Silva, R., Lago, E.S., Merheb, C.W., Macchione, M.M. and Gomes, E. 2005, Production of xylanase and CMCase on solid state fermentation in different residues by *Thermoascus aurantiacus* miehe, *Brazilian Journal of Microbiology*, **36(3)**: 35–41.

Stanbury, P.F., Whitaker, A. and Hall, S.J 1984, *Principles of Fermentation Technology*, 2nd ed, Butterworth-Heinemann, Hertfordshire.

Suratman, R., Steven., and Mardiyati. 2014, Pembuatan mikrokristalin selulosa rotan manau (*Calamus manan* sp.) serta karakterisasinya, *Jurnal Selulosa*, **4(2)**: 89-96.

Susanto, F. 2012, 'Skrining dan isolasi bakteri penghasil enzim selulase dari limbah tebu', *Skripsi*, Sarjana Farmasi, Universitas Katolik Widya Mandala Surabaya.

Suzuki, T. and Nakagami, H. 1999, Effect of crystallinity of microcrystalline cellulose on the compactability and dissolution of tablets, *European Journal of Pharmaceutics and Biopharmaceutics*, **47(3)**: 25–30.

Tanwijaya, L. 2016, 'Pengaruh penambahan ion logam Fe²⁺, Zn²⁺, Cu²⁺ dan ion NH⁴⁺ terhadap aktivitas ekstrak kasar enzim selulase dari *Bacillus subtilis* Strain SF01', *Skripsi*, Sarjana Farmasi, Universitas Katolik Widya Mandala Surabaya.

Thoorens, G. 2014, Microcrystalline cellulose, a direct compression binder

in a quality by design environment - A review, *International Journal of Pharmaceutics*, **473(1-2)**: 64–72.

Uchida, E., Uyama, Y. and Ikada, Y. 1990, A novel method for graft polymerization onto poly(ethylene terephthalate) film surface by UV irradiation without degassing, *Journal of Applied Polymer Science*, **41**: 677-687.

Villamagna, A. M. and Murphy, B.R. 2010, Ecological and socio-economic impacts of invasive water hyacinth (*Eichhornia crassipes*): A Review, *Freshwater Biology*, **55(2)**: 82–98.

Vora, R.S. and Shah, Y.D. 2015, Production of microcrystalline cellulose from corn husk and its evaluation as pharmaceutical excipient, *International Journal Research and Scientific Innovation*, **2(9)**: 69-74.

Wahyuningtyas, P., Argo, B.D. and Nugroho, W.A. 2013, Studi pembuatan enzim selulase dari mikrofungi *Trichoderma reesei* dengan substrat jerami padi sebagai katalis hidrolisis enzimatis pada produksi bioetanol, *Jurnal Bioproses Komoditas Tropis*, **1(1)**: 21-25.

Westermarck, S. 2000, 'Use of mercury porosimetry and nitrogen adsorption', *Disertasi*, University of Helsinki, Finland.

Wibisono, I. and Leonardo, H. 2012, Pembuatan pulp dari alang-alang, *Widya Tenik*, **10(1)**: 11–20.

Widia, I. and Wathoni, N. 2017, Review artikel selulosa mikrokristal : isolasi, karakterisasi, dan aplikasi dalam bidang farmasetik, *Farmaka*, **15(2)**: 27–43.

Yugatama, A., Maharani, L., Pratiwi, H. and Ikaditya, L. 2015, Uji karakteristik mikrokristalin selulosa dari nata e soya sebagai eksipien tablet, *Farmasains* **2(6)**: 69–74.