BAB V
KESIMPULAN

V.1 Kesimpulan

Ampas tebu telah dimanfaatkan sebagai sumber selulosa untuk pembuatan hidrojel. Asam sitrat dapat memsubtitusi ECH sebagai *crosslinker* untuk hidrojel selulosa. Hidrojel yang dihasilkan memiliki ketahanan mekanik yang lebih rendah dibandingkan dengan hidrojel epiklorohidrin. Rasio selulosa/asam sitrat/CMC 6/40/2 %b memberikan ketahanan mekanik hidrojel yang terbaik, dengan kedalaman penetrasi yang lebih kecil dibandingkan dengan rasio selulosa/asam sitrat yang lain yaitu 11,6 mm. Hidrojel yang diperoleh menunjukkan potensi untuk menghilakan zat warna metilen biru dari dalam air. Waktu adsorpsi untuk menyerap zat warna metilen biru adalah 2 jam. Kapasitas adsorpsi yang paling baik didapatkan pada suhu 70°C. Penurunan suhu menyebabkan penurunan kapasitas adsorpsi. Parameter termodinamika menunjukkan bahwa adsorpsi MB pada hidrojel terjadi secara spontan, endotermis dan ireversibel.

V.2 Saran

Penelitian untuk aplikasi hidrojel dalam pengolahan air limbah perlu dilakukan lebih lanjut. Melihat bahwa hidrojel yang dihasilkan tersusun dari senyawa organik, pH kemungkinan memiliki pengaruh yang cukup besar dalam disosiasi ion hidrogennya; dimana disosiasi ini akan berpengaruh pada proses adsorpsi. Oleh karena itu pengaruh pH dalam proses adsorpsi perlu dilakukan lebih lanjut. Selain itu, hidrojel yang berhasil disentesis dapat diaplikasikan dalam bidang agrikultur (*nutrient carrier dan soil conditioning*), biomedikal (*wound dressing dan tissue engineering*), dan *packaging*.

DAFTAR PUSTAKA

[1] Wen, X., Bao, D., Chen, M., Zhang, A., Liu, C., & Sun, R. (2015). Preparation of CMC/HEC Crosslinked Hydrogels for Drug Delivery. *Bioresources, 10,* 8339-8351.

[2] Ciolacu, D. E., & Suflet, D. M. (2018). Cellulose-Based Hydrogels for Medical/Pharmaceutical Applications. *Biomass as Renewable Raw Material to Obtain Bioproducts of High-Tech Value,* 401-439.

[3] Peng, Z., & Chen, F. (2010). Hydroxyethyl Cellulose-Based Hydrogels with Various Pore Sizes Prepared by Freeze-Drying. *Journal of Macromolecular Science, Part B: Physics, 50,* 340-349.

[4] Zhu, J., & Marchant, R. E. (2011). Design Properties of Hydrogel Tissue Engineering Scaffolds. *Expert Rev. Med. Devices, 8,* 607–626.

[5] Klemm, D., Philipp, B., Heinze, T., Heinze, U., & Wagenknecht, W. (1998). Comprehensive Cellulose Chemistry. Wiley-GH, D-69469 Weinheim (FRG).

[6] Ross, P., Mayer, R., & Benziman, M. (1991). Cellulose Biosynthesis and Function in Bacteria. *Microbiol. Rev, 55,* 5-58.

[7] Shen, X., Shamshina, J. L., Berton, P., Gurau, G., & Rogers, R. D. (2015). Hydrogels Based on Cellulose and Chitin: Fabrication, Properties, and Applications. *Green Chemistry,* 1-3.

[8] Devine, D., & Higginbotham, C. L. (2005). Synthesis and Characterization of Chemically Crosslinked N-vinyl Pyrrolidione (NVP) Based Hydrogels. *European Polymer Journal, 41,* 1272-1279.

[9] Rojas, J., & Azevedo, E. (2011). Functionalization and Crosslinking of Microcrystalline Cellulose in Aqueous Media: A Safe and

Economic Approach. *International Journal of Pharmaceutical Sciences Review and Research, 8,* 28-36.

[10] Demitri, C., Sole, R. D., Scalera, F., Sannino, A., Vasapollo, G., Maffezzoli, A., Ambrosio, L., & Nicolais, L. (2008). Novel Superabsorbent Cellulose-Based Hydrogels Crosslinked with Citric Acid. *Journal of Applied Polymer Science, 110,* 2453–2460

[11] Liu, Y., Li, L., Dong, G., Yang, Y., Zheng, C., & Yang, R. (2016). Preparation of Cellulose-Based Hydrogels and Their Characteristics for Cell Culture. *Cellulose Chemistry and Technology, 50,* 890-903.

[12] Gayakwad, B. P., Barhate, S. D., & Jain, M. S. (2017). Citric Acid Crosslinked Cellulose Based Hydrogel for Drug Delivery. *Asian J. Pharm, 7,* 247-255.

[13] Mali, K. K., Dhawale, S. C., Dias, R. J., Dhane, N. S., & Ghorpade, V. S. (2018). Citric Acid Crosslinked Carboxymethyl Cellulose-based Composite Hydrogel Films for Drug Delivery. *Indian Journal of Pharmaceutical Sciences, 80,* 657-667.

[14] Kralik, M. (2014). Adsorption, Chemisorption, and Catalysis. *Chemical Papers, 66,* 1625-1638.

[15] Simonin, J. P. (2016). On the Comparison of Pseudo-first Order and Pseudo-second Order Rate Laws in the Modeling of Adsorption Kinetics. *Chem. Eng. J, 300,* 254-263.

[16] Kim, S. A., Kannan, S. K., Lee, K. J., Park, Y. J., Shea, P. J., Lee, W. H., Kim, H. M. & Oh, B. T. (2013). Removal of Cu(II) from Aqueous Solution by a Zeolite-nanoscale Zero-valent Iron Composite. *Chemical Engineering Journal, 217,* 54-60.

[17] Zhou, Y., Fu, S., Liu, H., Yang, S., & Zhan, H. (2011). Removal of Methylene Blue Dyes From Wastewater Using Cellulose-Based

Superadsorbent Hydrogels. *Polymer Engineering and Science*, *51,* 2417-2442.

[18] Tan, I. A., Ahmad, A. L., & Hameed, B. (2007). Adsorption of Basic Dye on High Surface Area Activated Carbon Prepared from Coconut Husk: Equilibrium, Kinetic and Thermodynamic Studies. *Journal of Hazardous Materials, 154,* 337-346.

[19] Kaur, S., & Jindal, R. (2018). Synthesis of Interpenetrating Network Hydrogel from (Gum Copal alcohols-collagen)-copoly(acrylamide) and Acrylic Acid: Isotherms and Kinetics Study for Removal of Methylene Blue Dye from Aqueous Solution. *Materials Chemistry and Physics*, *220*, 75-86.

[20] Jeon, Y. S., Lei, J., & Kim, J. H. (2008). Dye Adsorption Characteristics of Alginate/polyaspartate Hydrogels. *Journal of Industrial and Engineering Chemistry*, *14*, 726-731.

[21] Hakam, A., Rahman, I. A., Jamil, M. S. S., Othaman, R., Amin, M. C. I. M., & Mat Lazim, A. (2015). Removal of Methylene Blue Dye in Aqueous Solution by Sorption on a Bacterial-g-Poly-(Acrylic Acid) Polymer Network Hydrogel. *Sains Malaysiana, 44,* 827-834.

[22] Wang, J., Meng, X., Yuan, Z., Tian, Y., Bai, Y & Jin, Z. (2017). Acrylated Composite Hydrogel Preparation and Adsorption Kinetics of Methylene Blue. *Molecules*, *22*, 1-12.

[23] Hernandez-Martíneza, A. R., Lujan-Montelongob, J. A., Silva-Cuevas, C., Mota-Moralesa, Josué D., Cortez-Valadezc, M., Álvaro de Jesus Ruíz-Baltazard., Cruze, M., & Jorge Herrera-Ordoneza. (2018). Swelling and Methylene Blue Adsorption of Poly (N,Ndimethylacrylamideco-2-hydroxyethyl methacrylate) Hydrogel. *Reactive and Functional Polymers*, *122,* 75-84.

[24] Paulino, A. T., Guilherme, M. R., Reis, A. V., Campese, G. M., Muniz, E. C., & Nozaki, J. (2006). Removal of Methylene Blue Dye from an Aqueous Media using Superabsorbent Hydrogel Supported on Modified Polysaccharide. *Journal of Colloid and Interface Science, 301*, 55-56.

[25] Fatmawati, A., Agustriyanto, R., Adhelia, C., Paulina, J., & Liasari, Y. (2013). Enzymatic Hydrolysis of Alkaline Pretreated Coconut Coir. *Bulletin of Chemical Reaction Engineering & Catalysis*, *8*, 34-39.

[26] Dewi, R. K., Zuhroh, S. T., & Zulaikha, S. (2018). Delignification Of Chandlenut Shell Waste With Alkali Pretreatment Method As An Alternative Fuel Feedstock. *International Journal Of Mechanical Engineering And Technology*, *(9)*, 271-278.

[27] Sjostrom, Eero. (1981). Wood Chemistry: Fundamentals and Applications, Academic Press Inc.

[28] Maryana, R., Ma'rifatun, D., Wheni, A. I., Satriyo, K.W., Rizal, W. A. (2014). Alkaline Pretreatment on Sugarcane Bagasse for Bioethanol Production. *Energy Procedia*, *47*, 250-254.

[29] Andrews., & C. M. (1989). Efficient ester cross-link finishing for formaldehyde-free durable press cotton fabrics. *American Dyestuff Reporter*, *78*, 15–23.

[30] Bansal, M., Chauhana, G . S., Kaushikb, A., & Sharma, A. (2016). Extraction and functionalization of bagasse cellulose nanofibres do Schiff-base based antimicrobial membranes. *International Journal of Biological Macromolecules*, 91, 887–894.

[31] Liu, L., Liu, D., Wang, M., Du, G., & Chen, J. (2007). Preparation and characterization of sponge-like composites by cross-linking

hyaluronic acid and carboxymethylcellulose sodium with adipic dihydrazide. *European Polymer Journal*, 43, 2672–2681.

[32] Adel, A. M., Abou-Youssef , H., El-Gendy. A. A ., & Nada, A. M. (2010). Carboxymethylated Cellulose Hydrogel; Sorption Behavior and Characterization. *Cellulose and Paper Department, National Research Centre*, 8(8), 244-256.

[33] Barbucci, R., Magnani, A., & Consumi, M. (2000). Swelling Behavior of Carboxymethylcellulose Hydrogels in Relation to Cross-Linking, pH, and Charge Density. *Macromolecules*, *33,* 7475-7480.

[34] Ghorai, S., Sarkar, A. K., Panda, A.B., Pal, S. (2013). Effective removal of Congo red dye from aqueous solution using modified xanthan gum/silica hybrid nanocomposite as adsorbent, *Bioresource Technol*, 144, 485-491.

[35] Arami, M., Limaee, N. Y., & Mahmoodi, N. M. (2006). Investigation on themadsorption capability of egg shell membrane towards model textile dyes. *Chemosphere, 65*, 1999–2008.

[36] Kumar, P. S., Ramalingam, S., Senthamarai, C., Niranjanaa, M., Vijayalakshmi, P., & Sivanesan, S. (2010). Adsorption of dye krom aqueous solution by cashewnut shell: studies on equilibriumisotherm, kinetics and thermodynamics of interactions. *Desalination*, *261*, 52–60.

[37] He, X., Male, K. B., Nesterenko, P. N., Brabazon, D., Paull, B., & Luong, J. H. T. (2013). Adsorption and Desorption of Methylene Blue on Porous Carbon Monoliths and Nanocrystalline Cellulose. *Appl. Mater. Interfaces, 5,* 8796-8806.

[38] Chen, L., Li, Y., Hu, S., Sun, J., Du, Q., Yang, X., Ji, Q., Wang, Z., Wang, D., & Xia, Y. (2016). Removal of methylene blue from water

by cellulose/graphene oxide fibres. *Journal Of Experimental Nanoscience*, 1156-1170.

[39] Tan, C. H. C., Sabar, S., & Hussin, M. H. (2018). Development of Immobilized Microcrystalline Cellulose as an Effective Adsorbent for Methylene Blue Dye Removal. *South African Journal of Chemical Engineering*.

[40] Annadurai, G., Juang, R. S., & Lee, D. J. (2002). Use of cellulose-based wastes for adsorption of 669 dyes from aqueous solutions. *J. Hazard Mater, 92,* 263 – 274.

[41] Hussin, M. H., Pohan, N. A., Garba, Z. N., Kassim, M. J., Rahim, A. A., Brosse, N., Yemloul, M., Fazita, M. R. N., & Haafiz, M. M. (2016). Physicochemical of microcrystalline cellulose from oil palm fronds as potential methylene blue adsorbents. *Int. J. Biol. Macromol. 92,* 11 – 19.

[42] Tan, K. B., Abdullah, A. Z., Horri, B. A & Salamatinia, B. (2016). Adsorption Mechanism of Microcrystalline Cellulose as Green Adsorbent for The Removal of Cationic Methylene Blue Dye. *Journal- Chemical Society of Pakistan, 38,* 651-664.

[43] Padmavathy, V. (2008). Biosorption of nickel(II) ions by baker's yeast: kinetic, thermodynamic and desorption studies. *Bioresour. Technol. 99*, 3100-3109.

[44] Ngah, W. S. W., & Hanafiah, M. (2008). Adsorption of copper on rubber (Hevea brasiliensis) leak powder: Kinetic, equilibrium, and thermodynamic studies, *Biochem. Eng. J, 39,* 521-530.