BAB V

KESIMPULAN

Furfural dapat diproduksi dari salah satu biomassa lignoselulosa yakni limbah tandan kosong kelapa sawit melalui beberapa tahapan: (1) proses pemecahan rantai karbon (penyederhanaan) untuk memperoleh hemiselulosa, (2) hidrolisa dan dehidrasi, serta (3) beberapa tahap pemurnian hingga didapatkan produk utama berupa furfural, serta produk samping yang meliputi asam levulinat, dan asam format. Produksi furfural ini ramah lingkungan karena dapat mengurangi pencemaran serta meningkatkan nilai guna limbah. Furfural dan turunannya dapat diaplikasikan dalam berbagai bidang terutama dalam bahan kimia dan bahan bakar (*biofuel*) yang digunakan dalam produksi obat-obatan, insektisida, polimer, perekat, resin, plastik, bahan kimia khusus, bahan bakar transportasi, aditif, pelumas, bensin, penghilang warna, dan lain sebagainya.

DAFTAR PUSTAKA

[1] H. L. P. Maryadi *et al.*, *" Peran Diplomasi dalam Mendukung Tujuan Pembangunan Berkelanjutan : Tinjauan terhadap Pengelolaan Industri Minyak Nabati ."* 2019.

[2] T. L. K. Yong, N. Mohamad, and N. N. M. Yusof, "Furfural Production from Oil Palm Biomass Using a Biomass-derived Supercritical Ethanol Solvent and Formic Acid Catalyst," *Procedia Eng.*, vol. 148, pp. 392–400, 2016, doi: 10.1016/j.proeng.2016.06.495.

[3] N. A. Abd Malek, "Furfural Separation From Palm Empty Fruit Bunch (PEFB) Using Solid Waste Catalyst (SWC)," no. June, 2015, [Online]. Available: http://umpir.ump.edu.my/id/eprint/12666/1/FKKSA - NURUL ARPAH ABD MALEK - CD 9577.pdf.

[4] J. P. Lange, E. Van Der Heide, J. Van Buijtenen, and R. Price, "Furfural-A promising platform for lignocellulosic biofuels," *ChemSusChem*, vol. 5, no. 1, pp. 150–166, 2012, doi: 10.1002/cssc.201100648.

[5] A. E. Eseyin and P. H. Steele, "An overview of the applications of furfural and its derivatives," *Int. J. Adv. Chem.*, vol. 3, no. 2, p. 42, 2015, doi: 10.14419/ijac.v3i2.5048.

[6] T. Werpy and G. Petersen, "Top Value Added Chemicals from Biomass Volume I," *Us Nrel*, p. Medium: ED; Size: 76 pp. pages, 2004, doi: 10.2172/15008859.

[7] D. M. Alonso, J. Q. Bond, and J. A. Dumesic, "Catalytic conversion of biomass to biofuels," *Green Chem.*, vol. 12, no. 9, pp. 1493–1513, 2010, doi: 10.1039/c004654j.

[8] J. Teng, H. Ma, F. Wang, L. Wang, and X. Li, "Catalytic Fractionation of Raw Biomass to Biochemicals and Organosolv Lignin in a Methyl Isobutyl Ketone/H2O Biphasic System," *ACS Sustain. Chem. Eng.*, vol. 4, no. 4, pp. 2020–2026, 2016, doi: 10.1021/acssuschemeng.5b01338.

[9] X. Li, P. Jia, and T. Wang, "Furfural: A Promising Platform Compound for Sustainable Production of C4 and C5 Chemicals," *ACS Catal.*, vol. 6, no. 11, pp. 7621–7640, 2016, doi: 10.1021/acscatal.6b01838.

[10] S. Dutta, S. De, B. Saha, and M. I. Alam, "Advances in conversion of hemicellulosic biomass to furfural and upgrading to biofuels," *Catal. Sci. Technol.*, vol. 2, no. 10, pp. 2025–2036, 2012, doi: 10.1039/c2cy20235b.

[11] P. Kumar, D. M. Barrett, M. J. Delwiche, and P. Stroeve, "Methods for pretreatment of lignocellulosic biomass for efficient hydrolysis and biofuel production," *Ind. Eng. Chem. Res.*, vol. 48, no. 8, pp. 3713–3729, 2009, doi: 10.1021/ie801542g.

[12] R. Mariscal, P. Maireles-Torres, M. Ojeda, I. Sádaba, and M. López Granados, "Furfural: A renewable and versatile platform molecule for the synthesis of chemicals and fuels," *Energy Environ. Sci.*, vol. 9, no. 4, pp. 1144–1189, 2016, doi: 10.1039/c5ee02666k.

[13] W. Yang and A. Sen, “One-Step catalytic transformation of carbohydrates and cellulosic biomass to 2,5-dimethyltetrahydrofuran for liquid Fuels,” *ChemSusChem*, vol. 3, no. 5, pp. 597–603, 2010, doi: 10.1002/cssc.200900285.

[14] W. Xu, Q. Xia, Y. Zhang, Y. Guo, Y. Wang, and G. Lu, “Effective production of octane from biomass derivatives under mild conditions,” *ChemSusChem*, vol. 4, no. 12, pp. 1758–1761, 2011, doi: 10.1002/cssc.201100361.

[15] N. R. Reed and E. S. C. Kwok, “Furfural,” *Encycl. Toxicol. Third Ed.*, vol. d, pp. 685–688, 2014, doi: 10.1016/B978-0-12-386454-3.00147-0.

[16] Z. W. Wang, C. J. Gong, and Y. C. He, “Improved biosynthesis of 5-hydroxymethyl-2-furancarboxylic acid and furoic acid from biomass-derived furans with high substrate tolerance of recombinant Escherichia coli HMFOMUT whole-cells,” *Bioresour. Technol.*, vol. 303, no. January, p. 122930, 2020, doi: 10.1016/j.biortech.2020.122930.

[17] S. Semikolenov, D. Ivanov, D. Babushkin, S. Malykhin, A. Kharitonov, and K. Dubkov, “Generation of methylene by the liquid phase oxidation of isobutene with nitrous oxide,” *Tetrahedron*, vol. 74, no. 27, pp. 3589–3595, 2018, doi: 10.1016/j.tet.2018.05.022.

[18] J. Wiantama, “The Utilization of Empty Fruit Bunches (EFB) from Palm Oil Mill Industry to Produce Levulinic Acid (LA) and Furfural using Self-Sustained Renewable Energy,” 2017.

[19] C. L. Yaws, *Yaws chemical properties handbook*. 1999.

[20] L. E. Brownell and E. H. Young, “Process Equipment Design Handbook(brownell).pdf.” .

[21] D. Q. Kern, *Process Heat Transfer*, vol. 14, no. 7–8. 1995.

[22] C. Geankoplis, “Transport Processes and Unit Operations Geankoplis.” .