

BAB V

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Berdasarkan penelitian yang telah dilakukan, dapat disimpulkan bahwa:

1. Pada koagulasi limbah cair sintetik merah, peningkatan dosis galaktomanan sebagai bahan pembantu koagulan meningkatkan persentase pengurangan zat warna dan volume *sludge* yang terbentuk. Semakin banyak dosis galaktomanan yang diberikan, semakin banyak pula rantai karbon galaktomanan yang dapat mendestabilisasi koloid melalui adsorpsi dengan pembentukan jembatan. Namun, terdapat titik kritis saat penambahan dosis galaktomanan tidak meningkatkan aktivitas koagulasi. Dosis terbaik yang diperoleh adalah 80 mg/L dengan pengurangan zat warna 42,6% dan volume *sludge* yang dihasilkan sebanyak 11 mL/L.
2. Variasi konsentrasi zat warna kongo merah pada proses koagulasi menghasilkan profil pengurangan zat warna dan volume *sludge* yang sama. Pengurangan zat warna dan volume *sludge* tertinggi diperoleh pada penggunaan konsentrasi zat warna yang paling rendah yaitu 20 ppm, karena sisi aktif koagulan tersedia lebih banyak untuk mengadsorpsi partikel zat warna. Jika dibandingkan dengan penggunaan koagulan FeCl₃ saja, penambahan galaktomanan ampas kopi berhasil meningkatkan persentase pengurangan zat warna dan volume *sludge* dari 68,8% dan 12,2 mL menjadi 88,9% dengan volume *sludge* 33 mL/L.

5.2 Saran

Saran yang dapat diberikan untuk penelitian selanjutnya adalah:

1. Perlu adanya analisis lebih lanjut untuk mengkonfirmasi senyawa galaktomanan hasil ekstrak ampas bubuk kopi, misalnya analisis *HPLC*.
2. Pemilihan kondisi yang lebih bervariasi diperlukan untuk mengetahui variabel yang mempengaruhi kinerja galaktomanan, misalnya seperti variasi pH.
3. Perubahan rentang percobaan koagulasi perlu diperkecil untuk memperoleh kondisi paling optimum dan hasil yang lebih valid.

DAFTAR PUSTAKA

- Ahmad, A., Anjum, F. M., Zahoor, T., Nawaz, H., & Ahmed, Z. (2010). Extraction and characterization of β -d-glucan from oat for industrial utilization. *International Journal of Biological Macromolecules*, 46(3), 304-309.
- Aktas T. S., M. Fujibayashi., C. Maruo., M. Nomura., dan O. Nishimura. 2012. *Influence of Velocity Gradient and Rapid Mixing Time on Flocs Formed by Polysilica Iron (PSI) And Polyaluminum Chloride (PACl)*. Taylor & Francis Publisher. London.
- Albuquerque, P. B. S., Barros, W., Santos, G. R. C., Correia, M. T. S., Mourão, P. A. S., Teixeira, J. A., & Carneiro-da-Cunha, M. G. 2014. *Characterization and rheological study of the galactomannan extracted from seeds of Cassia grandis*. *Carbohydrate Polymers*, 104, 127–134.
- Ali Tor; Yunus Cengeloglu (2006). *Removal of congo red from aqueous solution by adsorption onto acid activated red mud*. 138(2), 409–415.
- Al-Mamun, A. & Basir, A. T. A. 2006. *White popinac as potential phyto-coagulant to reduce turbidity of river water*. Asian Research Publishing Network (ARPN) Journal Vol. 11 No. 11 June 2016.
- Amokrane, A., Comel, C., Veron, J., 1997. Landfill leachates pretreatment by coagulation–flocculation. *Water Research* 31, 2775– 2782.
- Amuda, O.S., Amoo, I.A., 2007. Coagulation/flocculation process and sludge conditioning in beverage industrial wastewater treatment. *Journal of Hazardous Materialism* 141 (3), 778–783.
- Angraini, S., Pinem J. A., Saputra E. 2016. Pengaruh Kecepatan Pengadukan dan Tekanan Pemompaan pada Kombinasi Proses Koagulasi dan Membran Ultrafiltrasi dalam Pengolahan Limbah Cair Industri Karet. *Jom FTEKNIK* Volume 3 No.1 Februari 2016.
- Antoniou, E., Buitrago, C. F., Tsianou, M., & Alexandridis, P. (2010). *Solvent effects on polysaccharide conformation*. *Carbohydrate Polymers*, 79(2), 380–390.
- Ballesteros, L. F., Cerqueira, M. A., Teixeira, J., and Mussatto, S. I. 2015. *Characterization of polysaccharides extracted from spent coffee grounds by alkali pretreatment*. *Carbohydrate Polymers*, 127, 347-354.
- Binnie, C. & Kimber, M. 2013. *Basic Water Treatment*. ICE Publishing. London.
- Bolto, B., & Gregory, J. 2007. *Organic polyelectrolytes in water treatment*. *Water Res*, 41(11), 2301-2324.
- Bratby, J. 2006. *Coagulation and flocculation in water and wastewater treatment*, IWA publishing. London.

- Brian, B. dan John, G., 2007. Organic Polyelectrolytes in Water Treatment. *Water Research*, 15, pp. 2301-2324.
- Brummer, Y., Cui, W., & Wang, Q. 2003. *Extraction, purification and physicochemical characterization of fenugreek gum*. *Food Hydrocolloids*, 17(3), 229–236. Canada.
- Cai, W., Gu X., Tang J. 2007. *Extraction, purification, and characterization of the polysaccharides from Opuntia milpa alta*. *Carbohydrate Polymers* 71 (2008) 403–410.
- Campos-Vega R., Loarca-Pina G., Vergara-Castaneda H. A., Oomah B. D. 2015. *Spent Coffee Grounds: A Review on Current Research and Future Prospects*. *Food and Science Technology* 45 (24-36).
- Carliell, C., Barclay, S., Naidoo, N., Buckley, C., Mulholland, D. dan Senior, E. J. W. S. 1995. *Microbial decolourisation of a reactive azo dye under anaerobic conditions*. 21, 61-69.
- Cerqueira, M. A., Pinheiro, A. C., Souza, B. W. S., Lima, Á. M. P., Ribeiro, C., Miranda, C., Teixeira J. A., Moreira R. A., Coimbra M. A., Goncalves M. P., Vicente, A. A. 2009. *Extraction, purification and characterization of galactomannans from non-traditional sources*. *Carbohydrate Polymers*, 75(3), 408–414.
- Chaibakhsh, N., Ahmadi, N., & Zanjanchi, M. A. 2014. *Use of Plantago major L. as a Natural Coagulant for Optimized Decolorization of Dye-containing Wastewater*. *Industrial Crops and Products*, 61, 169–175.
- Chaiklahan R., Chirasuwan N., Triratana P., Loha V., Tia S., Bunnag B. 2013. *Polysaccharide Extraction from Spirulina sp. and its Antioxidant Capacity*. *International Journal of Biological Macromolecule* 58 73-78.
- Christie, R. 2014. *Colour chemistry*, Royal Society of Chemistry.
- Chua, Siong-Chin; Chong, Fai-Kait; Malek, M. A.; Ul Mustafa, Muhammad Raza; Ismail, Norli; Sujarwo, Wawan; Lim, Jun-Wei; Ho, Yeek-Chia (2020). *Optimized Use of Ferric Chloride and Sesbania Seed Gum (SSG) as Sustainable Coagulant Aid for Turbidity Reduction in Drinking Water Treatment*. *Sustainability*, 12(6), 2273.
- Cofield, E. 1950. *The Solvent Extraction of Oilseed: An Informational Survey*, Georgia Institute of Technology.
- Costa, C., Costa, J.-M., Desterke, C., Botterel, F., Cordonnier, C., & Bretagne, S. 2002. *Real-Time PCR Coupled with Automated DNA Extraction and Detection of Galactomannan Antigen in Serum by Enzyme-Linked Immunosorbent Assay for Diagnosis of Invasive Aspergillosis*. *Journal of Clinical Microbiology*, 40(6), 2224–2227.

- Cui, W., Mazza, G., Oomah, B. D., & Biliaderis, C. G. 1994. *Optimization of an Aqueous Extraction Process for Flaxseed Gum by Response Surface Methodology*. LWT – Journal of Food Science and Technology, 27(4), 363–369.
- Debnath, A.; Thapa, R.; Chattopadhyay, K. K.; Saha, B. (2015). *Spectroscopic Studies on Interaction of Congo Red with Ferric Chloride in Aqueous Medium for Wastewater Treatment*. Separation Science and Technology, 50(11), 1684–1688.
- Diniyah N., Maryanto, Nafi' A., Sulistia D., Subagio A. 2013. Ekstraksi dan Karakterisasi Polisakarida Larut Air dari Kulit Kopit Varieta Arabika (*Coffea Arabica*) dan Robusta (*Coffea Canephora*). Jurnal Teknologi Pertanian Vol. 14 No. 2 hal. 73-78.
- Eaton A. D., Greenberg A. E., Clesceri L. S. 1999. *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association, American Water Works Association, Water Environment Federation.
- Fatchiyah. 2018. Kajian Nutrigenomik dan Kesehatan: Nutrisi Berbasis Genomik dan Proteomik. Universitas Brawijaya Press. Indonesia.
- Faust, S. D., & Aly, O. M. 1998. *Chemistry of Water 2nd Edition*. United States: CRC Press.
- Fischer, A.J. & G.E. Symons. 1944. The determination of settleable sewage solids by weight. *Water Sewage Works* 91:37.
- Frank Woodard, P. D., P.E., 2001. *Industrial Waste Treatment Handbook*, United States of America, Butterworth Heinemann.
- Freitas, T. K. F. S., Almeida, C. A., Manholer, D. D., Geraldinho, H. C. L., De Souza, M. T. F. & Garcia, J. C. 2018. *Review of utilization plant-based coagulants as alternatives to textile wastewater treatment*. Detox Fashion. Springer. Singapore.
- Frid, P., Anisimov, S. V. dan Popvic, N. 2007a. *Congo red and protein aggregation in neurodegenerative diseases*. BRAIN RESEARCH REVIEWS 53, 135-160.
- Frid, P., Anisimov, S. V. dan Popvic, N. J. B. R. R. 2007b. *Congo red and protein aggregation in neurodegenerative diseases*. 53, 135-160.
- Garvasis, Julia; Prasad, Anupama R.; Shamsheera, K.O.; Jaseela, P.K.; Joseph, Abraham (2020). *Efficient removal of Congo red from aqueous solutions using phytogenic aluminum sulfate nano coagulant*. Materials Chemistry and Physics, 251(), 123040.
- Gebert, M. S., & Friend, D. R. 1998. *Purified Guar Galactomannan as an Improved Pharmaceutical Excipient*. Pharmaceutical Development and Technology, 3(3), 315–323.
- Gregory, P. 1990. Classification of dyes by chemical structure. *The Chemistry and Application of Dyes*. Springer.

- Guo, Qingbin, Ai L., Cui Steve W. 2018. *Methodology for Structural Analysis of Polysaccharides*. Springer. Switzerland.
- Hadayani L. W., Riwayati I., Ratnani R. D. 2015. Adsorpsi Pewarna Kongo merah Menggunakan Senyawa *Xanthat* Pulpa Kopi. *Jurnal Momentum*, Vol. 11, No. 1, April 2015, Hal. 19-23.
- Halimah S. N. 2016. Pembuatan dan Karakterisasi Serta Uji Adsorpsi Karbon Aktif Tempurung Kemiri (*Aleurites moluccana*) sebagai Terhadap Kongo merah. Tesis. Indonesia.
- Hamdaoui, O., and Chiha, M. 2006. *Removal of Methylene Blue from Aqueous Solution by Wheat Bran*. *Acta Chimica Slovenia*, 54(2), 407-418.
- Hassan, A., Ariffin, M., Tan, P. L., & Noor, Z. Z. 2009. *Coagulation and Flocculation Treatment of Wastewater in Textile Industry Using Chitosan*. *Journal of Chemical and Natural Resources Engineering*, 4(1), 43–53.
- Hawley. 1981. *Condensed Chemical Dictionary* 8 th edition. Van Nortrand Reinhold. New York.
- Hendrawati. 2016. The use of Moringa Oleifera Seed Powder as Coagulant to Improve the Quality of Wastewater and Ground Water. *Earth and Environmental Science*, 31, pp. 1755-1815.
- Himanshu Patel; R.T. Vashi (2012). *Removal of Congo Red dye from its aqueous solution using natural coagulants*. *Journal od Saudi Chemical Society* 16(2), 131–136.
- Howe, K. J., Crittenden, J. C., Hand, D. W., Trussell, R. R. & Tchobanoglous, G. 2012. *MWH's Water Treatment: Principles of Water Treatment*. John Wiley & Sons Inc. Singapore.
- Huang, X., Bo, X., Zhao, Y., Gao, B., Wang, Y., Sun, S., Yue, Q., Li, Q., 2014. *Effects of compound bioflocculant on coagulation performance and floc properties for dye removal*. *Bioresour. Technol.* 165, 116–121.
- Huang, X., Gao, B., Yue, Q., Zhang, Y., & Sun, S. (2015). *Compound bioflocculant used as a coagulation aid in synthetic dye wastewater treatment: The effect of solution pH*. *Separation and Purification Technology*, 154, 108–114.
- Huda T. dan Yulitaningtyas T. K. 2018. Kajian Adsorpsi *Methylene Blue* Menggunakan Selulosa Alang-Alang. *Ind. J. Chem. Anal.*, Vol. 01, No 01, 2018, pp. 09-19.
- Jadhav, M.V., Mahajan, Y.S., 2013. *A comparative study of natural coagulants in flocculation of local clay suspensions of varied turbidities*. *J. Civil Eng. Technol.* 1, 26–39.
- Jain, G., Khar, R. K. & Ahmad, F. J. 2013. *Theory and Practice of Physical Pharmacy-E-Book*, Elsevier Health Sciences.

- Jiang, J., Zhu, L., Zhang, W., & Sun, R. (2007). Characterization of galactomannan gum from fenugreek (*Trigonella foenum-graecum*) seeds and its rheological properties. *International Journal of Polymeric Materials*, 56(12), 1145-1154.
- Juliantari, N. P. D., Wrasati L. P., Wartini N. M. 2018. Karakteristik Ekstrak Ampas Kopi Bubuk Robusta (*Coffea canephora*) pada Perlakuan Konsentrasi Pelarut Etanol dan Suhu Maserasi. *Jurnal Rekayasa dan Manajemen Agroindustri* Vol. 6, No.3, 243-249.
- Khuluk, R. H. 2016. Pembuatan dan Karakterisasi Karbon Aktif dari Tempurung Kelapa (*Cocous nucifera L.*) sebagai Adsorben Zat Warna Kongo merah. Skripsi. Universitas Lampung. Indonesia.
- Kok, M.S., Hill, S.E., and Mitchell, J.R. 1999. *Viscosity of Galactomannan During High Temperature Processing, Influence of Degradation and Solubilisation*. *Food Hydrocoloids* 13 (1999) 535-542.
- Lesnichaya, M. V.; Aleksandrova, G. P.; Sukhov, B. G.; Rokhin, A. V. (2013). *Molecular-weight characteristics of galactomannan and carrageenan*. *Chemistry of Natural Compounds*, 49(3), 405–410.
- Lin, J.L., J.R. Pan., dan C. Huang. 2013. *Enhanced Particle Destabilization and Aggregation by Flash-mixing Coagulation for Drinking Water Treatment*. *Journal Separation and Purification Technology*, 115 (2013) 145-151.
- Lu, X., Chen, Z., Yang, X., 1999. Spectroscopic study of aluminium speciation in removing humic substances by Al coagulation. *Water Research* 33, 3271–3280
- M.I Aguilar; J Sáez; M Lloréns; A Soler; J.F Ortuño (2002). *Nutrient removal and sludge production in the coagulation–flocculation process.* , 36(11), 0–2919.
- Mahmoudabadi T. Z., Talebi P., Jalili M. 2019. *Removing Disperse Red 60 and Reactive Blue 19 Dyes Removal by Using Alcea rosea Root Mucilage as a Natural Coagulant*. *AMB Express*: 113 (2019).
- Manurung, R., R. Hasibuan, dan H. Irvan. 2004. Perombakan Zat Warna Azo Reaktif Secara Anaerob-Aerob. E-USU Repository Universitas Sumatra Utara.
- Marr, K. A., Laverdiere, M., Gugel, A., & Leisenring, W. 2005. *Antifungal Therapy Decreases Sensitivity of the Aspergillus Galactomannan Enzyme Immunoassay*. *Journal of Clinical Infectious Diseases*, 40(12), 1762–1769.
- Mathur, N.K., 2012, *Industrial Galactomannan Polysaccharides*. CRC Press Taylor & Francis Group, Boca Raton, Florida.
- McCleary B. V. and Matheson N. K. 1975. *Galactomannan Structure and β -Mannanase β -Mannosidase Activity in Germinating Legume Seeds*. *Journal Phymchemistry*. 1975. Vol. 14, pp. 11871-914.

- Merzouk B, Gourich B, Madani K, Vial C, Sekki A. 2012. *Removal of a Disperse red dye from synthetic wastewater by chemical coagulation and continuous electrocoagulation. A comparative study.* Desalination 272(1–3):246–253.
- Mishra, A., & Bajpai, M. (2005). *Flocculation behaviour of model textile wastewater treated with a food grade polysaccharide.* Journal of Hazardous Materials, 118(1-3), 213–217.
- Mishra, A., Srinivasan, R., & Dubey, R. 2002. *Flocculation of Textile Wastewater by Plantago psyllium Mucilage.* Macromolecular Materials and Engineering, 287(9), 592–596.
- Mishra, A., Yadav, A., Agarwal, M., & Bajpai, M. (2004). *Fenugreek mucilage for solid removal from tannery effluent.* Reactive and Functional Polymers, 59(1), 99–104.
- Nurwahyudi, R. 2006. Sintesis dan Karakterisasi Zeolit dari Abu Layang Batubara dengan Alkali Hidrotermal dan Aplikasinya sebagai Adsorben Ion Logam Fe(II) dan Zn(II) dalam Air. Tugas Akhir II. UNNES: Semarang.
- Oosterveld, A., Harmsen, J. S., Voragen, A. G. J., & Schols, H. A. 2003. *Extraction and characterization of polysaccharides from green and roasted Coffea arabica beans.* Carbohydrate Polymers, 52(3), 285–296.
- Pefferkorn, E. 2006. *Clay and oxide destabilization induced by mixedalum/macromolecular flocculation aids.* Advances in Colloid and Interface Science, 120, 33–45.
- Rachmawati S. W., Iswanto B., Winarni. 2009. Pengaruh pH pada Proses Koagulasi dengan Koagulan Aluminium Sulfat dan Ferri Klorida. JTL Vol. 5 No. 2 Des. 2009.
- Rashid, Farhat., Hussain, Sarfraz., & Ahmed, Zaheer. 2017. Extraction purification and characterization of galactomannan from fenugreek for industrial utilization. Journal *Carbohydrate Polymers.* Department of Home and Health Sciences, Allama Iqbal Open University (AIU), Pakistan.
- Rashmi Sanghi; Bani Bhattacharya; Vandana Singh (2007). *Seed gum polysaccharides and their grafted co-polymers for the effective coagulation of textile dye solutions.* 67(6), 495–502.
- Ravina, L. & Moramarco, N. J. Z.-M., INC. 1993. *Everything you want to know about Coagulation & Flocculation.* Zeta-meter Inc. 1-37.
- Reiss E. dan Lehmann P. F. 1979. *Galactomannan Antigenemia in Invasive Aspergillosis.* Journal of Infection and Immunity Vol. 25, No. 1.
- Riapanitra A., Setyaningtyas T., Riyani K. Penentuan Waktu Kontak dan pH Optimum Penyerapan Kongo merah Menggunakan Abu Sekam Padi. Chempublish Journal Vol 4 No 1 (2019) 19-29.

- Risdianto, Dian. 2007. Optimasi Proses Koagulasi Flokulasi untuk Pengolahan Air Limbah Industri Jamu (Studi Kasus PT Sido Muncul). Tesis. Universitas Diponegoro, Semarang. Indonesia.
- Sajjad Haydar; Javed Anwar Aziz (2009). *Coagulation–flocculation studies of tannery wastewater using combination of alum with cationic and anionic polymers.* , 168(2-3), 1035–1040.
- Samavati V. dan Manoochehrizade A. 2013. *Polysaccharide Extraction from Malva sylvestris and Its Anti-Oxidant Activity.* International Journal of Biological Macromolecules 60 (2013) 427– 436.
- Samavati, Vahid. 2013. *Polysaccharide extraction from Abelmoschus esculentus: Optimization by response surface methodology.* Carbohydrate Polymers, 95(1), 588–597.
- Sanghi R., Bani Bhattacharya; Vandana Singh (2007). Seed gum polysaccharides and their grafted co-polymers for the effective coagulation of textile dye solutions. 67(6), 495–502.
- Sanghi R., Bhattacharya B., Dixit A., Singh V. 2006. *Ipomoea dasysperma Seed Gum: An Effective Natural Coagulant for the Decolorization of Textile Dye Solutions.* Journal of Environmental Management 81 (2006) 36–41.
- Sanghi, R., Bhattacharya, B., & Singh, V. 2006. *Use of Cassia javahikai Sseed Gum and Gum-g-Polyacrylamide as Bahan pembantu koagulan for the Decolorization of Textile Dye Solutions.* Bioresource Technology, 97(10), 1259–1264.
- Sanja Papić; Natalija Koprivanac; Ana Lončarić Božić; Azra Meteš (2004). *Removal of some reactive dyes from synthetic wastewater by combined Al(III) coagulation/carbon adsorption process.* 62(3), 291–298.
- Saritha, V., K. Swetha Chowdhary and B.S.S.S. Harish Kumar. 2012. *Evaluation of Chitin as Natural Coagulant in Water Treatment.* Journal of Advanced Laboratory Research in Biology. e-ISSN 0976-7614.
- Senthilkumaar S., Varadarajan P. R., Porkodi K., Subbhuraam C. V. 2005. *Adsorption of Methylene Blue onto Jute Fiber Carbon: Kinetics and Equilibrium Studies.* Journal of Colloid and Interface Science 284 78–82.
- Shamnsejati S., Chaibakhsh N., Pendashteh A R., Hayeripour S. 2015. *Mucilaginous Seed of Ocimum basilicum as A Natural Coagulant for Textile Wastewater Treatment.* Industrial Crops and Products 69 (2015) 40–47.
- Sharma, B. R., and N. C. Dhuldhoya. 2008. *A Glimpse of Galactomannans,* Science Tech Entrepreneur.
- Sihombing R. 2014. Pengujian Sifat Antioksidan Galaktomanan yang Diekstraksi dari Ampas Kelapa. Tesis. Univeritas Sumatera Utara, Medan. Indonesia.

- Soebagio S. B., Soares J. S., Indraswati N., Kurniawan Y. 2014. Ekstraksi Polisakarida pada Biji tamarind (*Tamarindus Indica L*). Jurnal Ilmiah Volume 13 Nomor 02 November 2014.
- Srivastava, M., and Kapoor, V. P., 2005, *Seed Galactomannans: An Overview in Chemistry and Biodiversity*, Journal Vol. 2: 295-217.
- Suherman D. dan Sumawijaya N. 2013. Menghilangkan Warna dan Zat Organik Air Gambut dengan Metode Koagulasi-Flokulasi Suasana Basa. Jurnal Ris.Geo.Tam Vol. 23, No.2, (127-139).
- Suryadiputra, I.N.N. 1995. Pengantar Kuliah Pengolahan Air Limbah: Pengolahan Air Limbah dengan Metode Kimia (Koagulasi dan Flokulasi), Fakultas Perikanan, Institut Pertanian Bogor, Indonesia.
- Teh, C.Y., Wu, T.Y., Juan, J.C., 2014a. *Potential use of rice starch in coagulation–flocculation process of agro-industrial wastewater: treatment performance and flocs characterization*. Ecol. Eng. 71, 509–519.
- Torres L. G., Cadena, G., Carpinteyro-Urbin S., Corzo L. J. 2014. *New Galactomannans and Mucilages with Coagulant-Flocculant Activity for an Environment-Friendly Treatment of Wastewaters*. Jurnal Environmental Science.
- Treybal, R.E., 1981. *Mass Transfer Operation*, 3th ed., p.p. 34-37, 88, Mc Graw Hill International Editions, Singapore.
- Tzia, C. & Liadakis, G. 2003. *Extraction Optimization in Food Engineering*, CRC Press Taylor & Francis Group, Boca Raton, Florida.
- Ughini, F., Andrezza, I., Ganter, J. L. M., & Bresolin, T. M. 2004. *Evaluation of xanthan and highly substituted galactomannan from M. scabrella as a sustained release matrix*. International Journal of Pharmaceutics, 271(1-2), 197–205.
- Ulvskov, Peter. 2011. *Plant Polysaccharides, Biosynthesis, and Bioengineering; Annual Plant Reviews Volume 41*. Wiley-Blackwell Publishing. Denmark.
- Vijayaraghavan G., Sivakumar T., Kumar A. V. 2011. *Application of Plant Based Coagulants for Waste Water Treatment*. International Journal of Advanced Engineering Research and Studies E-ISSN2249– 8974.
- Xu, J., Yue, R.-Q., Liu, J., Ho, H.-M., Yi, T., Chen, H.-B., & Han, Q.-B. (2014). *Structural diversity requires individual optimization of ethanol concentration in polysaccharide precipitation*. International Journal of Biological Macromolecules, 67, 205–209.2014.03.036
- Yin, Chun-Yang. 2010. *Emerging usage of plant-based coagulants for water and wastewater treatment*. Journal of Process Biotechnology 45 1437-1444.

- Zafar M. S., Tausif M., Mohsin M., Ahmad S. W., Ziaulhaq M. 2015. *Potato Starch as a Coagulant for Dye Removal from Textile Wastewater*. Springer International Publishing. Switzerland.
- Zhang, Z.; Xia, S.; Zhao, J.; Zhang, J. 2010. Characterization and flocculation mechanism of high efficiency microbial flocculant TJ-F1 from *Proteus mirabilis*. *Colloids and Surfaces B: Biointerfaces* 2010, 75, 247–251.
- Zhao, S., Gao B., Yue Q., Wang Y., Li Q., Dong H., Yan H. 2014. *Study of Enteromorpha Polysaccharides as A New-style Bahan pembantu koagulan in Dye Wastewater Treatment*. *Carbohydrate Polymers* 103 179-186.