

DAFTAR PUSTAKA

- Abd Hamid, S. B., Chowdhury, Z. Z., & Karim, M. Z. (2014). Catalytic extraction of microcrystalline cellulose (MCC) from *Elaeis guineensis* using central composite design (CCD). *BioResources*, 9(4), 7403–7426. <https://doi.org/10.15376/biores.9.4.7403-7426>
- Abdullah, M. A., Nazir, M. S., Raza, M. R., Wahjoedi, B. A., & Yussof, A. W. (2016). Autoclave and ultra-sonication treatments of oil palm empty fruit bunch fibers for cellulose extraction and its polypropylene composite properties. *Journal of Cleaner Production*, 126, 686–697. <https://doi.org/10.1016/j.jclepro.2016.03.107>
- Abdullah, N. A., Sainorudin, M. H., Rani, M. S. A., Mohammad, M., Kadir, N. H. A., & Asim, N. (2021). Structure and thermal properties of microcrystalline cellulose extracted from coconut husk fiber. *Polimery/Polymers*, 66(3), 187–192. <https://doi.org/10.14314/POLIMERY.2021.3.4>
- Abik, F., Palasingh, C., Bhattarai, M., Leivers, S., Ström, A., Westereng, B., Mikkonen, K. S., & Nypelö, T. (2023). Potential of Wood Hemicelluloses and Their Derivates as Food Ingredients. *Journal of Agricultural and Food Chemistry*, 71(6), 2667–2683. <https://doi.org/10.1021/acs.jafc.2c06449>
- Abu Bakar, N. F., Abd Rahman, N., Mahadi, M. B., Mohd Zuki, S. A., Mohd Amin, K. N., Wahab, M. Z., & Wuled Lenggoro, I. (2021). Nanocellulose from oil palm mesocarp fiber using hydrothermal treatment with low concentration of oxalic acid. *Materials Today: Proceedings*, xxxx, 9–14. <https://doi.org/10.1016/j.matpr.2021.09.357>
- Adel, A. M., & Nada, A. M. (2010). *Carboxymethylated Cellulose Hydrogel ; Sorption Behavior and Characterization*. 8(8), 244–256.
- Adi, S. H., & Heryani, N. (2019). Sintesis Dan Optimasi Hidrogel Berbasis Sodium Carboxymethyl Cellulose Dan Chitosan Cellulose and Chitosan-Based Hydrogel Using. *Jurnal Widyariset*, 5(1), 1–10.
- Adinugraha, M. P., Marseno, D. W., & Haryadi. (2005). Synthesis and characterization of sodium carboxymethylcellulose from cavendish banana pseudo stem (*Musa cavendishii* LAMBERT). *Carbohydrate Polymers*, 62(2), 164–169. <https://doi.org/10.1016/j.carbpol.2005.07.019>
- Aghaei, Z., Emadzadeh, B., Ghorani, B., & Kadkhodae, R. (2018). Cellulose Acetate Nanofibres Containing Alizarin as a Halochromic Sensor for the Qualitative Assessment of Rainbow Trout Fish Spoilage. *Food and Bioprocess Technology*, 11(5), 1087–1095. <https://doi.org/10.1007/s11947-017-2046-5>
- Ahmad, Z., Rozaizan, N. N., Rahman, R., Mohamad, A. F., & Wan Ismail, W. I. N. (2016). Isolation and characterization of microcrystalline cellulose (MCC) from rice husk (RH). *MATEC Web of Conferences*, 47, 1–6. <https://doi.org/10.1051/mateconf/20164705013>
- Ahmed, E. M. (2013). Hydrogel : Preparation , characterization , and applications. *JOURNAL OF ADVANCED RESEARCH*.

<https://doi.org/10.1016/j.jare.2013.07.006>

Akalin, G. O. (2018). *Preparation and Characterization of Nanoporous Sodium Carboxymethyl Cellulose Hydrogel Beads*. 2018.

Alizadeh-Sani, M., Mohammadian, E., Rhim, J. W., & Jafari, S. M. (2020a). pH-sensitive (halochromic) smart packaging films based on natural food colorants for the monitoring of food quality and safety. *Trends in Food Science and Technology*, 105(September), 93–144. <https://doi.org/10.1016/j.tifs.2020.08.014>

Alizadeh-Sani, M., Mohammadian, E., Rhim, J. W., & Jafari, S. M. (2020b). pH-sensitive (halochromic) smart packaging films based on natural food colorants for the monitoring of food quality and safety. *Trends in Food Science and Technology*, 105(January), 93–144. <https://doi.org/10.1016/j.tifs.2020.08.014>

Alizadeh-Sani, M., Tavassoli, M., McClements, D. J., & Hamishehkar, H. (2021). Multifunctional halochromic packaging materials: Saffron petal anthocyanin loaded-chitosan nanofiber/methyl cellulose matrices. *Food Hydrocolloids*, 111, 106237. <https://doi.org/10.1016/j.foodhyd.2020.106237>

Almlöf, H., Kreutz, B., Jardeby, K., & Germgård, U. (2012). The influence of extended mercerization on some properties of carboxymethyl cellulose (CMC). *Holzforschung*, 66(1), 21–27. <https://doi.org/10.1515/HF.2011.131>

Alonso, G. J., Rivera, J. L. R. A., Mendoza, A. M. M., & Mendez, M. L. H. (2007). Effect of temperature and pH on swelling behavior of hydroxyethyl cellulose-acrylamide hydrogel. *E-Polymers*, 150, 1–9.

Alves, V., Costa, N., Hilliou, L., & Larotonda, F. (2006). *Design of biodegradable composite films for food packaging*. 199(September), 331–333. <https://doi.org/10.1016/j.desal.2006.03.078>

Ambjörnsson, H. A., Schenzel, K., & Germgård, U. (2013). Carboxymethyl cellulose produced at different mercerization conditions and characterized by nir ft raman spectroscopy in combination with multivariate analytical methods. *BioResources*, 8(2), 1918–1932. <https://doi.org/10.15376/biores.8.2.1918-1932>

Arafa, A. A., Nada, A. A., Ibrahim, A. Y., Zahran, M. K., & Hakeim, O. A. (2021). Greener therapeutic pH-sensing wound dressing based on Curcuma Longa and cellulose hydrogel. *European Polymer Journal*, 159(September), 110744. <https://doi.org/10.1016/j.eurpolymj.2021.110744>

Ardiyansyah, Apriliyanti, M. W., Wahyono, A., Fatoni, M., Poerwanto, B., & Suryaningsih, W. (2018). The Potency of betacyanins extract from a peel of dragon fruits as a source of colourimetric indicator to develop intelligent packaging for fish freshness monitoring. *IOP Conference Series: Earth and Environmental Science*, 207(1). <https://doi.org/10.1088/1755-1315/207/1/012038>

Awan, I. Z., Tanchoux, N., Quignard, F., Albonetti, S., Cavani, F., & Di Renzo, F. (2019). Heterogeneous Catalysis as a Tool for Production of Aromatic Compounds from Lignin. *Studies in Surface Science and Catalysis*, 178, 257–

275. <https://doi.org/10.1016/B978-0-444-64127-4.00013-6>

- Azeredo, H. M. C., Morrugares-carmona, R., Wellner, N., Cross, K., Bajka, B., & Waldron, K. W. (2016). Development of pectin films with pomegranate juice and citric acid. *Food Chemistry*, *198*, 101–106. <https://doi.org/10.1016/j.foodchem.2015.10.117>
- Azeredo, H. M. C., Rosa, M. F., & Mattoso, L. H. C. (2016). Nanocellulose in bio-based food packaging applications. *Industrial Crops & Products*, 1–8. <https://doi.org/10.1016/j.indcrop.2016.03.013>
- Azubuiké, C. P., & 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*(1), 106–115. <https://doi.org/10.1186/2251-7715-1-9>
- Babinszki, B., Jakab, E., Terjék, V., Sebestyén, Z., Várhegyi, G., May, Z., Mahakhant, A., Attanatho, L., Suemanotham, A., Thanmongkhon, Y., & Czégény, Z. (2021). Thermal decomposition of biomass wastes derived from palm oil production. *Journal of Analytical and Applied Pyrolysis*, *155*(February), 1–11. <https://doi.org/10.1016/j.jaap.2021.105069>
- Bajwa, D. S., Pourhashem, G., Ullah, A. H., & Bajwa, S. G. (2019). A concise review of current lignin production, applications, products and their environment impact. *Industrial Crops and Products*, *139*(February). <https://doi.org/10.1016/j.indcrop.2019.111526>
- Bandyopadhyay, S., Saha, N., Zandraa, O., Pummerova, M., & Saha, P. (2020). Essential oil based PVP-CMC-BC-GG functional hydrogel sachet for ‘ Cheese ’: Its shelf life confirmed with anthocyanin (isolated from red cabbage) bio stickers. *Foods*, *9*(307), 1–20. <https://doi.org/doi:10.3390/foods9030307>
- Bao, D., Chen, M., Wang, H., Wang, J., Liu, C., & Sun, R. (2014). Preparation and characterization of double crosslinked hydrogel films from carboxymethylchitosan and carboxymethylcellulose. *Carbohydrate Polymers*, *110*, 113–120. <https://doi.org/10.1016/j.carbpol.2014.03.095>
- Barbucci, R., Magnani, A., & Consumi, M. (2000). Swelling behavior of carboxymethylcellulose hydrogels in relation to cross-linking, pH, and charge density. *Macromolecules*, *33*(20), 7475–7480. <https://doi.org/10.1021/ma0007029>
- Batista, R. A., Judith, P., Espitia, P., Souza, J. De, Quintans, S., Machado, M., Ângelo, M., António, J., & Cordeiro, J. (2019). Hydrogel as an alternative structure for food packaging systems. *Carbohydrate Polymers*, *205*(October 2018), 106–116. <https://doi.org/10.1016/j.carbpol.2018.10.006>
- Bertella, S., & Luterbacher, J. S. (2020). Lignin Functionalization for the Production of Novel Materials. *Trends in Chemistry*, *2*(5), 440–453. <https://doi.org/10.1016/j.trechm.2020.03.001>
- Bhattacharyya, D., Singhal, R. S., & Kulkarni, P. R. (1995). A comparative account of conditions for synthesis of sodium carboxymethyl starch from corn and amaranth starch. *Carbohydrate Polymers*, *27*(4), 247–253.

[https://doi.org/10.1016/0144-8617\(95\)00083-6](https://doi.org/10.1016/0144-8617(95)00083-6)

- Bhattacharyya, S., Guillot, S., Dabboue, H., Tranchant, J. F., & Salvetat, J. P. (2008). Carbon nanotubes as structural nanofibers for hyaluronic acid hydrogel scaffolds. *Biomacromolecules*, 9(2), 505–509. <https://doi.org/10.1021/bm7009976>
- Biby, G., Hanna, M., & Miladinov, V. (2001). *Production of Microcrystalline Cellulose by Reactive Extrusion* (US 6228213 B1).
- Biji, K. B., Ravishankar, C. N., Mohan, C. O., & Srinivasa Gopal, T. K. (2015). Smart packaging systems for food applications: a review. *Journal of Food Science and Technology*, 52(10), 6125–6135. <https://doi.org/10.1007/s13197-015-1766-7>
- Bodbodak, S., & Rafiee, Z. (2016). Recent trends in active packaging in fruits and vegetables. In *Eco-Friendly Technology for Postharvest Produce Quality*. Elsevier Inc. <https://doi.org/10.1016/B978-0-12-804313-4.00003-7>
- Bonetti, L., De Nardo, L., & Farè, S. (2020). Thermo-Responsive Methylcellulose Hydrogels: From Design to Applications as Smart Biomaterials. *Tissue Engineering Part B: Reviews*, 1–94. <https://doi.org/10.1089/ten.teb.2020.0202>
- Bono, A., Ying, P. H., Yan, F. Y., Muei, C. L., Sarbatly, R., & Krishnaiah, D. (2009). Synthesis and characterization of carboxymethyl cellulose from palm kernel cake. *Advances in Natural and Applied Sciences*, 3(1), 5–11.
- BPS. (2024). Luas Tanaman Perkebunan Menurut Provinsi (Ribu Hektar), 2023. In *Statistik Pertanian, Kehutanan, Perikanan*. <https://www.bps.go.id/id/statistics-table/2/MTMxIzI=/luas-tanaman-perkebunan-menurut-provinsi--ribu-hektar-.html>
- Buwalda, S. J., Boere, K. W. M., Dijkstra, P. J., Feijen, J., Vermonden, T., & Hennink, W. E. (2014). Hydrogels in a historical perspective: From simple networks to smart materials. *Journal of Controlled Release*. <https://doi.org/10.1016/j.jconrel.2014.03.052>
- Cagnin, C., & Simões, B. M. (2020). *Hydrogels of starch / carboxymethyl cellulose crosslinked with sodium trimetaphosphate via reactive extrusion*. May, 1–12. <https://doi.org/10.1002/app.50194>
- Cai, J., & Zhang, L. (2005). *Rapid Dissolution of Cellulose in LiOH / Urea and NaOH / Urea Aqueous Solutions*. 11–15. <https://doi.org/10.1002/mabi.200400222>
- Castellan, A., & Grelier, S. (2016). Color and Color Reversion of Cellulosic and Lignocellulosic Fibers. *Lignocellulosic Fibers and Wood Handbook: Renewable Materials for Today's Environment*, 531–551. <https://doi.org/10.1002/9781118773727.ch21>
- Chabrat, E., Abdillahi, H., Rouilly, A., & Rigal, L. (2012). Influence of citric acid and water on thermoplastic wheat flour / poly (lactic acid) blends . I : Thermal , mechanical and morphological properties. *Industrial Crops & Products*, 37(1), 238–246. <https://doi.org/10.1016/j.indcrop.2011.11.034>

- Chan, A. W., Whitney, R. A., & Neufeld, R. J. (2009). *Semisynthesis of a Controlled Stimuli-Responsive Alginate Hydrogel*. 609–616.
- Chang, C., Duan, B., Cai, J., & Zhang, L. (2010). Superabsorbent hydrogels based on cellulose for smart swelling and controllable delivery. *European Polymer Journal*, 46(1), 92–100. <https://doi.org/10.1016/j.eurpolymj.2009.04.033>
- Chang, C., & Zhang, L. (2011). Cellulose-based hydrogels: Present status and application prospects. *Carbohydrate Polymers*, 84(1), 40–53. <https://doi.org/10.1016/j.carbpol.2010.12.023>
- Chang, S. H. (2014). ScienceDirect An overview of empty fruit bunch from oil palm as feedstock for bio-oil production. *Biomass and Bioenergy*, 62, 174–181. <https://doi.org/10.1016/j.biombioe.2014.01.002>
- Charpentier, D., Mocanu, G., Carpov, A., Chapelle, S., Merle, L., & Muller, G. (1997). New hydrophobically modified carboxymethylcellulose derivatives. *Carbohydrate Polymers*, 33(2–3), 177–186. [https://doi.org/10.1016/S0144-8617\(97\)00031-3](https://doi.org/10.1016/S0144-8617(97)00031-3)
- Chayavanich, K., Thiraphibundet, P., & Imyim, A. (2020). Biocompatible film sensors containing red radish extract for meat spoilage observation. *Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy*, 226, 117601. <https://doi.org/10.1016/j.saa.2019.117601>
- Chen, D., Lawton, D., Thompson, M. R., & Liu, Q. (2012a). Biocomposites reinforced with cellulose nanocrystals derived from potato peel waste. *Carbohydrate Polymers*, 90(1), 709–716. <https://doi.org/10.1016/j.carbpol.2012.06.002>
- Chen, D., Lawton, D., Thompson, M. R., & Liu, Q. (2012b). Biocomposites reinforced with cellulose nanocrystals derived from potato peel waste. *Carbohydrate Polymers*, 90(1), 709–716. <https://doi.org/10.1016/j.carbpol.2012.06.002>
- Chen, H., & Fan, M. (2008). Novel thermally sensitive pH-dependent chitosan/carboxymethyl cellulose hydrogels. *Journal of Bioactive and Compatible Polymers*, 23(1), 38–48. <https://doi.org/10.1177/0883911507085070>
- Chen, H., Yan, X., Feng, Q., Zhao, P., Xu, X., Ng, D. H. L., & Bian, L. (2017). Citric Acid/Cysteine-Modified Cellulose-Based Materials: Green Preparation and Their Applications in Anticounterfeiting, Chemical Sensing, and UV Shielding. *ACS Sustainable Chemistry and Engineering*, 5(12), 11387–11394. <https://doi.org/10.1021/acssuschemeng.7b02473>
- Chen, W., Yu, H., Liu, Y., Chen, P., Zhang, M., & Hai, Y. (2011). Individualization of cellulose nanofibers from wood using high-intensity ultrasonication combined with chemical pretreatments. *Carbohydrate Polymers*, 83(4), 1804–1811. <https://doi.org/10.1016/j.carbpol.2010.10.040>
- Cherian, B. M., Pothan, L. A., Nguyen-Chung, T., Mennig, G., Kottaisamy, M., & Thomas, S. (2008). A novel method for the synthesis of cellulose nanofibril whiskers from banana fibers and characterization. *Journal of Agricultural and*

- Food Chemistry*, 56(14), 5617–5627. <https://doi.org/10.1021/jf8003674>
- Ching, Y. C., & Ng, T. S. (2014). Effect of preparation conditions on cellulose from oil palm empty fruit bunch fiber. *BioResources*, 9(4), 6373–6385. <https://doi.org/10.15376/biores.9.4.6373-6385>
- Chio, C., Sain, M., & Qin, W. (2019). Lignin utilization: A review of lignin depolymerization from various aspects. *Renewable and Sustainable Energy Reviews*, 107(March), 232–249. <https://doi.org/10.1016/j.rser.2019.03.008>
- Choi, I., Lee, J. Y., Lacroix, M., & Han, J. (2017). Intelligent pH indicator film composed of agar/potato starch and anthocyanin extracts from purple sweet potato. *Food Chemistry*, 218, 122–128. <https://doi.org/10.1016/j.foodchem.2016.09.050>
- Chuayjuljit, S., Su-uthai, S., & Charuchinda, S. (2010). *Waste Management & Research*. 28(1), 109–117. <https://doi.org/10.1177/0734242X09339324>
- Ciolacu, D., Ciolacu, F., & Popa, V. I. (2011). Amorphous cellulose - Structure and characterization. *Cellulose Chemistry and Technology*, 45(1–2), 13–21.
- Croisier, F., & Jérôme, C. (2013). Chitosan-based biomaterials for tissue engineering. *European Polymer Journal*, 49(4), 780–792. <https://doi.org/10.1016/j.eurpolymj.2012.12.009>
- Cui, X., Honda, T., Asoh, T. A., & Uyama, H. (2020). Cellulose modified by citric acid reinforced polypropylene resin as fillers. *Carbohydrate Polymers*, 230, 115662. <https://doi.org/10.1016/j.carbpol.2019.115662>
- Cumming, M. H., Leonard, A. R., LeCorre-Bordes, D. S., & Hofman, K. (2018). Intra-fibrillar citric acid crosslinking of marine collagen electrospun nanofibres. *International Journal of Biological Macromolecules*, 114, 874–881. <https://doi.org/10.1016/j.ijbiomac.2018.03.180>
- Da Silva Neuro, S. M., Dragunski, D. C., Rubira, A. F., & Muniz, E. C. (2000). Miscibility of PVC/PEO blends by viscosimetric, microscopic and thermal analyses. *European Polymer Journal*, 36(3), 583–589. [https://doi.org/10.1016/S0014-3057\(99\)00082-8](https://doi.org/10.1016/S0014-3057(99)00082-8)
- Dacrory, S., Abou-Yousef, H., Abou-Zeid, R. E., Kamel, S., Abdel-Aziz, M. S., & Elbadry, M. (2018). Preparation and characterization of eco-friendly carboxymethyl cellulose antimicrobial nanocomposite hydrogels. *Journal of Renewable Materials*, 6(5), 536–547. <https://doi.org/10.7569/JRM.2017.634190>
- Dash, M., Chiellini, F., Ottenbrite, R. M., & Chiellini, E. (2011). Chitosan - A versatile semi-synthetic polymer in biomedical applications. *Progress in Polymer Science (Oxford)*, 36(8), 981–1014. <https://doi.org/10.1016/j.progpolymsci.2011.02.001>
- Dash, R., Foston, M., & Ragauskas, A. J. (2013). Improving the mechanical and thermal properties of gelatin hydrogels cross-linked by cellulose nanowhiskers. *Carbohydrate Polymers*, 91(2), 638–645. <https://doi.org/10.1016/j.carbpol.2012.08.080>

- De Souza Lima, M. M., & Borsali, R. (2004). Rodlike cellulose microcrystals: Structure, properties, and applications. *Macromolecular Rapid Communications*, 25(7), 771–787. <https://doi.org/10.1002/marc.200300268>
- Delbecq, F., Wang, Y., Muralidhara, A., El Ouardi, K. E., Marlair, G., & Len, C. (2018). Hydrolysis of hemicellulose and derivatives-a review of recent advances in the production of furfural. *Frontiers in Chemistry*, 6(MAY). <https://doi.org/10.3389/fchem.2018.00146>
- Demitri, C., De Benedictis, V. M., Madaghiele, M., Corcione, C. E., & Maffezzoli, A. (2016). Nanostructured active chitosan-based films for food packaging applications: Effect of graphene stacks on mechanical properties. *Measurement: Journal of the International Measurement Confederation*, 90, 418–423. <https://doi.org/10.1016/j.measurement.2016.05.012>
- Demitri, C., Scalera, F., Madaghiele, M., Sannino, A., & Maffezzoli, A. (2013). Potential of cellulose-based superabsorbent hydrogels as water reservoir in agriculture. *International Journal of Polymer Science*, 2013. <https://doi.org/10.1155/2013/435073>
- Dharmalingam, K., & Anandalakshmi, R. (2019a). Fabrication, characterization and drug loading efficiency of citric acid crosslinked NaCMC-HPMC hydrogel films for wound healing drug delivery applications. *International Journal of Biological Macromolecules*, 134, 815–829. <https://doi.org/10.1016/j.ijbiomac.2019.05.027>
- Dharmalingam, K., & Anandalakshmi, R. (2019b). Fabrication, characterization and drug loading efficiency of citric acid crosslinked NaCMC-HPMC hydrogel films for wound healing drug delivery applications. *International Journal of Biological Macromolecules*, 134, 815–829. <https://doi.org/10.1016/j.ijbiomac.2019.05.027>
- Doelker, E. (1993). Comparative Compaction Properties of Various Microcrystalline Cellulose Types and Generic Products. *DRUG DEVELOPMENT AND INDUSTRIAL PHARMACY*, 19, 2399–2471.
- Dong, H., Ling, Z., Zhang, X., Zhang, X., Ramaswamy, S., & Xu, F. (2020). Smart colorimetric sensing films with high mechanical strength and hydrophobic properties for visual monitoring of shrimp and pork freshness. *Sensors and Actuators, B: Chemical*, 309, 127752. <https://doi.org/10.1016/j.snb.2020.127752>
- Dormanns, J. W., Schuermann, J., Müssig, J., Duchemin, B. J. C., & Staiger, M. P. (2016). Solvent infusion processing of all-cellulose composite laminates using an aqueous NaOH/urea solvent system. *Composites Part A: Applied Science and Manufacturing*, 82, 130–140. <https://doi.org/10.1016/j.compositesa.2015.12.002>
- DRITSAS, S., VIJAY, Y., HALIM, S., TEO, R., SANANDIYA, N., & FERNANDEZ, J. G. (2020). Cellulosic Biocomposites for Sustainable Manufacturing. *Fabricate* 2020, d, 74–81. <https://doi.org/10.2307/j.ctv13xpsvw.14>
- Duan, M., Yu, S., Sun, J., Jiang, H., Zhao, J., Tong, C., Hu, Y., Pang, J., & Wu, C.

- (2021). Development and characterization of electrospun nanofibers based on pullulan/chitin nanofibers containing curcumin and anthocyanins for active-intelligent food packaging. *International Journal of Biological Macromolecules*, 187(June), 332–340. <https://doi.org/10.1016/j.ijbiomac.2021.07.140>
- Dudnyk, I., Janeček, E. R., Vaucher-Joset, J., & Stellacci, F. (2018). Edible sensors for meat and seafood freshness. *Sensors and Actuators, B: Chemical*, 259, 1108–1112. <https://doi.org/10.1016/j.snb.2017.12.057>
- Ebrahimi Tirtashi, F., Moradi, M., Tajik, H., Forough, M., Ezati, P., & Kuswandi, B. (2019). Cellulose/chitosan pH-responsive indicator incorporated with carrot anthocyanins for intelligent food packaging. *International Journal of Biological Macromolecules*, 136, 920–926. <https://doi.org/10.1016/j.ijbiomac.2019.06.148>
- Edison, Diharmi, A., & Sari, E. D. (2019). Karakteristik selulosa mikrokristalin dari rumput laut merah *Eucheuma cottonii*. *Indonesian Fisheries Processing Journal*, 22(3), 483-489. <https://doi.org/10.17844/jphpi.v22i3.28946>
- El-Sakhawy, M., & Hassan, M. L. (2007). Physical and mechanical properties of microcrystalline cellulose prepared from agricultural residues. *Carbohydrate Polymers*, 67(1), 1–10. <https://doi.org/10.1016/j.carbpol.2006.04.009>
- Elgharbawy, A. A., Alam, M. Z., Moniruzzaman, M., & Goto, M. (2016). Ionic liquid pretreatment as emerging approaches for enhanced enzymatic hydrolysis of lignocellulosic biomass. In *Biochemical Engineering Journal* (Vol. 109). Elsevier B.V. <https://doi.org/10.1016/j.bej.2016.01.021>
- Eliyanti, N., & Othman, A. (2021). *Preparation and Characterization of Palm-based Sodium Carboxymethyl Cellulose for Application in Food Additive*. 11(5), 13053–13063.
- Emeje, M., Ekpo, M., Olayemi, O., Isimi, C., & Buraghoin, A. (2020). Physicochemical and drug release properties of microcrystalline cellulose derived from *Musa balbisiana*. *Polimeros*, 30(1), 1–6. <https://doi.org/10.1590/0104-1428.07418>
- Evans, S. K., Wesley, O. N., Nathan, O., & Moloto, M. J. (2019). Chemically purified cellulose and its nanocrystals from sugarcane baggase: isolation and characterization. *Heliyon*, 5(10), e02635. <https://doi.org/10.1016/j.heliyon.2019.e02635>
- Ezati, P., & Rhim, J. W. (2020a). pH-responsive chitosan-based film incorporated with alizarin for intelligent packaging applications. *Food Hydrocolloids*, 102, 105629. <https://doi.org/10.1016/j.foodhyd.2019.105629>
- Ezati, P., & Rhim, J. W. (2020b). pH-responsive pectin-based multifunctional films incorporated with curcumin and sulfur nanoparticles. *Carbohydrate Polymers*, 230, 115638. <https://doi.org/10.1016/j.carbpol.2019.115638>
- Ezati, P., Tajik, H., Moradi, M., & Molaei, R. (2019). Intelligent pH-sensitive indicator based on starch-cellulose and alizarin dye to track freshness of rainbow trout fillet. *International Journal of Biological Macromolecules*, 132,

157–165. <https://doi.org/10.1016/j.ijbiomac.2019.03.173>

Fahma, F., Iwamoto, S., Hori, N., Iwata, T., & Takemura, A. (2011). Effect of pre-acid-hydrolysis treatment on morphology and properties of cellulose nanowhiskers from coconut husk. *Cellulose*, *18*(2), 443–450. <https://doi.org/10.1007/s10570-010-9480-0>

Farhat, W., Venditti, R. A., Hubbe, M., Taha, M., Becquart, F., & Ayoub, A. (2017). A Review of Water-Resistant Hemicellulose-Based Materials: Processing and Applications. *ChemSusChem*, *10*(2), 305–323. <https://doi.org/10.1002/cssc.201601047>

Faris, S. I., A, A. Z. M., & Jawaid, M. (2018). Effect of microcrystalline cellulose on the strength of oil palm empty fruit bunch paper Effect of microcrystalline cellulose on the strength of oil palm empty fruit bunch paper. *IOP Conf. Series: Materials Science and Engineering*, *368*(2018 012042), 1–12. <https://doi.org/10.1088/1757-899X/368/1/012042>

Fei, B., Wach, R. A., Mitomo, H., Yoshii, F., & Kume, T. (2000). Hydrogel of biodegradable cellulose derivatives. I. Radiation-induced crosslinking of CMC. *Journal of Applied Polymer Science*, *78*(2), 278–283. [https://doi.org/10.1002/1097-4628\(20001010\)78:2<278::AID-APP60>3.0.CO;2-9](https://doi.org/10.1002/1097-4628(20001010)78:2<278::AID-APP60>3.0.CO;2-9)

Fekete, T., Borsa, J., Takács, E., & Wojnárovits, L. (2017). Synthesis of carboxymethylcellulose/starch superabsorbent hydrogels by gamma-irradiation. *Chemistry Central Journal*, *11*(1), 1–10. <https://doi.org/10.1186/s13065-017-0273-5>

Fernández, A., Soriano, E., López-Carballo, G., Picouet, P., Lloret, E., Gavara, R., & Hernández-Muñoz, P. (2009). Preservation of aseptic conditions in absorbent pads by using silver nanotechnology. *Food Research International*, *42*(8), 1105–1112. <https://doi.org/10.1016/j.foodres.2009.05.009>

Ferrer, A., Filpponen, I., Rodríguez, A., Laine, J., & Rojas, O. J. (2012). Valorization of residual Empty Palm Fruit Bunch Fibers (EPFBF) by microfluidization: Production of nanofibrillated cellulose and EPFBF nanopaper. *Bioresource Technology*, *125*, 249–255. <https://doi.org/10.1016/j.biortech.2012.08.108>

Fitriana, R., Imawan, C., Listyarini, A., & Sholihah, W. (2017). A green label for acetic acid detection based on chitosan and purple sweet potatoes extract. *Proceedings - 2017 International Seminar on Sensor, Instrumentation, Measurement and Metrology: Innovation for the Advancement and Competitiveness of the Nation, ISSIMM 2017, 2017-Janua*, 129–132. <https://doi.org/10.1109/ISSIMM.2017.8124276>

Foo, M. L., Ooi, C. W., Tan, K. W., & Chew, I. M. L. (2020). A Step Closer to Sustainable Industrial Production: Tailor the Properties of Nanocrystalline Cellulose from Oil Palm Empty Fruit Bunch. *Journal of Environmental Chemical Engineering*, *8*(5), 104058. <https://doi.org/10.1016/j.jece.2020.104058>

Foo, M. L., Ooi, C. W., Tan, K. W., & Chew, I. M. L. (2022). Preparation of black

- cumin seed oil Pickering nanoemulsion with enhanced stability and antioxidant potential using nanocrystalline cellulose from oil palm empty fruit bunch. *Chemosphere*, 287(P2), 132108. <https://doi.org/10.1016/j.chemosphere.2021.132108>
- Foo, M. L., Tan, C. R., Lim, P. D., Ooi, C. W., Tan, K. W., & Chew, I. M. L. (2019a). Surface-modified nanocrystalline cellulose from oil palm empty fruit bunch for effective binding of curcumin. *International Journal of Biological Macromolecules*, 138, 1064–1071. <https://doi.org/10.1016/j.ijbiomac.2019.07.035>
- Foo, M. L., Tan, C. R., Lim, P. D., Ooi, C. W., Tan, K. W., & Chew, I. M. L. (2019b). Surface-modified nanocrystalline cellulose from oil palm empty fruit bunch for effective binding of curcumin. *International Journal of Biological Macromolecules*, 138, 1064–1071. <https://doi.org/10.1016/j.ijbiomac.2019.07.035>
- Fouad, H., Kian, L. K., Jawaid, M., Alotaibi, M. D., Alothman, O. Y., & Hashem, M. (2020). Characterization of microcrystalline cellulose isolated from conocarpus fiber. *Polymers*, 12(12), 1–11. <https://doi.org/10.3390/polym12122926>
- French, A. D. (2017). Glucose, not cellobiose, is the repeating unit of cellulose and why that is important. *Cellulose*, 24(11), 4605–4609. <https://doi.org/10.1007/s10570-017-1450-3>
- Fuente-Hernandez, A., Corcos, P.-O., Beauchet, R., & Lavoie, J.-M. (2013). Biofuels and Co-Products Out of Hemicelluloses. *Liquid, Gaseous and Solid Biofuels - Conversion Techniques*, 3–46. <https://doi.org/10.5772/52645>
- Galvão, M. T. E. L., Moura, D. B., Barretto, A. C. S., & Pollonio, M. A. R. (2014). Effects of micronized sodium chloride on the sensory profile and consumer acceptance of turkey ham with reduced sodium content. *Food Science and Technology*, 34(1), 189–194. <https://doi.org/10.1590/S0101-20612014005000009>
- Gan, S., Lin, W., Zou, Y., Xu, B., Zhang, X., Zhao, J., & Rong, J. (2020). Nano-hydroxyapatite enhanced double network hydrogels with excellent mechanical properties for potential application in cartilage repair. *Carbohydrate Polymers*, 229. <https://doi.org/10.1016/j.carbpol.2019.115523>
- Gan, S., Zakaria, S., Chia, C. H., Chen, R. S., Ellis, A. V., & Kaco, H. (2017). Highly porous regenerated cellulose hydrogel and aerogel prepared from hydrothermal synthesized cellulose carbamate. *PLoS ONE*, 12(3), 1–13. <https://doi.org/10.1371/journal.pone.0173743>
- GAPKI. (2024). *Produksi CPO Tahun 2023*. <https://news.majalahhortus.com/gapki-catat-produksi-cpo-2023-naik-715-persen-jadi-5007-juta-ton/>
- Garcia-nunez, J. A., Ramirez-contreras, N. E., Tatiana, D., Silva-lora, E., Stuart, C., Stockle, C., & Garcia-perez, M. (2016). Resources , Conservation and Recycling Evolution of palm oil mills into bio-refineries : Literature review on current and potential uses of residual biomass and effluents. *“Resources*, 345

Conservation & Recycling, 110, 99–114.
<https://doi.org/10.1016/j.resconrec.2016.03.022>

- Garvey, C. J., Parker, I. H., & Simon, G. P. (2005). On the interpretation of X-ray diffraction powder patterns in terms of the nanostructure of cellulose I fibres. *Macromolecular Chemistry and Physics*, 206(15), 1568–1575. <https://doi.org/10.1002/macp.200500008>
- Gellerstedt, G., Pettersson, M., Lindfors, E. L., & Robert, D. (1995). Reactions of Lignin in Chlorine Dioxide Bleaching of Kraft Pulps. *Research on Chemical Intermediates*, 21(3), 441–456. <https://doi.org/10.1163/156856795X00350>
- Glasser, W. G. (2019). About Making Lignin Great Again—Some Lessons From the Past. *Frontiers in Chemistry*, 7(August), 1–17. <https://doi.org/10.3389/fchem.2019.00565>
- Golasz, L. B., Silva, J. Da, & Botelho Da Silva, S. (2013). Film with anthocyanins as an indicator of chilled pork deterioration Filme com antocianinas como indicador da deterioração de carne suína refrigerada. *Ciênc. Tecnol. Aliment*, 2012, 155–162.
- Guerrero, P., Muxika, A., Zarandona, I., & de la Caba, K. (2019). Crosslinking of chitosan films processed by compression molding. *Carbohydrate Polymers*, 206, 820–826. <https://doi.org/10.1016/j.carbpol.2018.11.064>
- Guo, X., Dong, X., Zou, G., Gao, H., & Zhai, W. (2023). Strong and tough fibrous hydrogels reinforced by multiscale hierarchical structures with multimechanisms. *Science Advances*, 9(2), 1–11. <https://doi.org/10.1126/sciadv.adf7075>
- Gusrianto, P., Zulharmita, Z., & Rivai, H. (2011). Preparasi dan karakterisasi mikrokristalin selulosa dari limbah serbuk kayu penggergajian. *Jurnal Sains Dan Teknologi Farmasi*, 16(2), 180–188.
- Gutierrez-macias, P., Lourdes, M. De, Jesus, H. De, & Barragan-huerta, B. E. (2017). *AGRO-INDUSTRIAL WASTE*. June.
- Haafiz, M. K. M., Eichhorn, S. J., Hassan, A., & Jawaid, M. (2013). Isolation and characterization of microcrystalline cellulose from oil palm biomass residue. *Carbohydrate Polymers*, 93(2), 628–634. <https://doi.org/10.1016/j.carbpol.2013.01.035>
- Habibi, Y., Lucia, L. A., & Rojas, O. J. (2010). Cellulose nanocrystals: Chemistry, self-assembly, and applications. *Chemical Reviews*, 110(6), 3479–3500. <https://doi.org/10.1021/cr900339w>
- Haleem, N., Arshad, M., Shahid, M., & Tahir, M. A. (2014). Synthesis of carboxymethyl cellulose from waste of cotton ginning industry. *Carbohydrate Polymers*, 113, 249–255. <https://doi.org/10.1016/J.CARBPOL.2014.07.023>
- Hambali, E., & Rivai, M. (2017). The Potential of Palm Oil Waste Biomass in Indonesia in 2020 and 2030. *IOP Conference Series: Earth and Environmental Science*, 65(1), 1–9. <https://doi.org/10.1088/1755-1315/65/1/012050>
- Haque, I., Paddar, K., Matin, M., & Yasmin, S. (2024). Heliyon Development of

- eco-friendly biofilms by utilizing microcrystalline cellulose extract from banana pseudo-stem. *Heliyon*, 10(7), e29070. <https://doi.org/10.1016/j.heliyon.2024.e29070>
- Hasan, A. M. A., & Abdel-Raouf, M. E.-S. (2019). *Cellulose-Based Superabsorbent Hydrogels*. 245–267. https://doi.org/10.1007/978-3-319-77830-3_11
- Hashem, M., Sharaf, S., El-hady, M. M. A., & Hebeish, A. (2013). Synthesis and characterization of novel carboxymethylcellulose hydrogels and. *Carbohydrate Polymers*, 95(1), 421–427. <https://doi.org/10.1016/j.carbpol.2013.03.013>
- Heinze, T., Koschella, A., Kull, A. H., Klohr, E., & Koch, W. (2000). *Effective preparation of cellulose derivatives in a new simple cellulose solvent*. 631, 627–631.
- Hennink, W. E., & van Nostrum, C. F. (2012). Novel crosslinking methods to design hydrogels. *Advanced Drug Delivery Reviews*, 64(SUPPL.), 223–236. <https://doi.org/10.1016/j.addr.2012.09.009>
- Henrique, M. A., Flauzino Neto, W. P., Silvério, H. A., Martins, D. F., Gurgel, L. V. A., Barud, H. da S., Morais, L. C. de, & Pasquini, D. (2015). Kinetic study of the thermal decomposition of cellulose nanocrystals with different polymorphs, cellulose I and II, extracted from different sources and using different types of acids. *Industrial Crops and Products*, 76, 128–140. <https://doi.org/10.1016/j.indcrop.2015.06.048>
- Hong, S. I., & Park, W. S. (2000). Use of color indicators as an active packaging system for evaluating kimchi fermentation. *Journal of Food Engineering*, 46(1), 67–72. [https://doi.org/10.1016/S0308-8146\(00\)00141-2](https://doi.org/10.1016/S0308-8146(00)00141-2)
- Hu, L., Du, M., & Zhang, J. (2018). Hemicellulose-Based Hydrogels Present Status and Application Prospects: A Brief Review. *Open Journal of Forestry*, 08(01), 15–28. <https://doi.org/10.4236/ojf.2018.81002>
- Hu, Y., Hu, S., Zhang, S., Dong, S., Hu, J., Kang, L., & Yang, X. (2021). A double-layer hydrogel based on alginate-carboxymethyl cellulose and synthetic polymer as sustained drug delivery system. *Scientific Reports*, 11(1), 1–14. <https://doi.org/10.1038/s41598-021-88503-1>
- Huang, C. M. Y., Chia, P. X., Lim, C. S. S., Nai, J. Q., Ding, D. Y., Seow, P. B., Wong, C. W., & Chan, E. W. C. (2017). Synthesis and characterisation of carboxymethyl cellulose from various agricultural wastes. *Cellulose Chemistry and Technology*, 51(7–8), 665–672.
- Huang, L. Z., Ma, M. G., Ji, X. X., Choi, S. E., & Si, C. (2021). Recent Developments and Applications of Hemicellulose From Wheat Straw: A Review. *Frontiers in Bioengineering and Biotechnology*, 9(June), 1–14. <https://doi.org/10.3389/fbioe.2021.690773>
- Huang, S., Xiong, Y., Zou, Y., Dong, Q., Ding, F., Liu, X., & Li, H. (2019). A novel colorimetric indicator based on agar incorporated with *Arnebia euchroma* root extracts for monitoring fish freshness. *Food Hydrocolloids*, 90, 198–205.

<https://doi.org/10.1016/j.foodhyd.2018.12.009>

- Huang, X., Xie, F., & Xiong, X. (2018). Surface-modified microcrystalline cellulose for reinforcement of chitosan film. *Carbohydrate Polymers*, 201(8), 367–373. <https://doi.org/10.1016/j.carbpol.2018.08.085>
- Iindra, A., & Dhake, J. D. (2008). Microcrystalline cellulose from bagasse and rice straw. *Indian Journal of Chemical Technology*, 15(5), 497–499. <https://doi.org/Corpus ID: 97689248>
- Ismail, F., Othman, N. E. A., Wahab, N. A., Hamid, F. A., & Aziz, A. A. (2021). Preparation of Microcrystalline Cellulose from Oil Palm Empty Fruit Bunch Fibre Using Steam-Assisted Acid Hydrolysis. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 81(1), 88–98. <https://doi.org/10.37934/arfmts.81.1.8898>
- Jahan, M. S., Saeed, A., He, Z., & Ni, Y. (2011). Jute as raw material for the preparation of microcrystalline cellulose. *Cellulose*, 18(2), 451–459. <https://doi.org/10.1007/s10570-010-9481-z>
- Jamróz, E., Kulawik, P., Guzik, P., & Duda, I. (2019). The verification of intelligent properties of furcellaran films with plant extracts on the stored fresh Atlantic mackerel during storage at 2 °C. *Food Hydrocolloids*, 97(April), 105211. <https://doi.org/10.1016/j.foodhyd.2019.105211>
- Kancı Bozoğlan, B., Duman, O., & Tunç, S. (2021). Smart antifungal thermosensitive chitosan/carboxymethylcellulose/scleroglucan/montmorillonite nanocomposite hydrogels for onychomycosis treatment. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 610(September 2020). <https://doi.org/10.1016/j.colsurfa.2020.125600>
- Karagoz, P., Khiawjan, S., Marques, M. P. C., Santzouk, S., Bugg, T. D. H., & Lye, G. J. (2023). Pharmaceutical applications of lignin-derived chemicals and lignin-based materials: linking lignin source and processing with clinical indication. *Biomass Conversion and Biorefinery*. <https://doi.org/10.1007/s13399-023-03745-5>
- Karagöz, S., Bhaskar, T., Muto, A., & Sakata, Y. (2006). Hydrothermal upgrading of biomass: Effect of K₂CO₃ concentration and biomass/water ratio on products distribution. *Bioresource Technology*, 97(1), 90–98. <https://doi.org/10.1016/j.biortech.2005.02.051>
- Kargarzadeh, H., Ahmad, I., Abdullah, I., Dufresne, A., Zainudin, S. Y., & Sheltami, R. M. (2012). Effects of hydrolysis conditions on the morphology, crystallinity, and thermal stability of cellulose nanocrystals extracted from kenaf bast fibers. *Cellulose*, 19(3), 855–866. <https://doi.org/10.1007/s10570-012-9684-6>
- Karthäuser, J., Biziks, V., Mai, C., & Militz, H. (2021). Lignin and lignin-derived compounds for wood applications—A review. *Molecules*, 26(9). <https://doi.org/10.3390/molecules26092533>
- Khalid, M., Ratnam, C. T., Chuah, T. G., Ali, S., & Choong, T. S. Y. (2008).

- Comparative study of polypropylene composites reinforced with oil palm empty fruit bunch fiber and oil palm derived cellulose. *Materials and Design*, 29(1), 173–178. <https://doi.org/10.1016/j.matdes.2006.11.002>
- Khalil, H. P. S. A., Davoudpour, Y., Islam, N., Mustapha, A., Sudesh, K., Dungani, R., & Jawaid, M. (2014). Production and modification of nanofibrillated cellulose using various mechanical processes: A review. *Carbohydrate Polymers*, 99, 649–665. <https://doi.org/10.1016/j.carbpol.2013.08.069>
- Khoo, H. E., Azlan, A., Tang, S. T., & Lim, S. M. (2017). Anthocyanidins and anthocyanins : colored pigments as food , pharmaceutical ingredients , and the potential health benefits. *Food & Nutrition Research*, 61(1), 1–21. <https://doi.org/10.1080/16546628.2017.1361779>
- Kim, J. S., Lee, Y. Y., & Kim, T. H. (2016). A review on alkaline pretreatment technology for bioconversion of lignocellulosic biomass. *Bioresource Technology*, 199, 42–48. <https://doi.org/10.1016/j.biortech.2015.08.085>
- Kim, T. H. (2013). Pretreatment of Lignocellulosic Biomass. *Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals, and Polymers*, 91–110. <https://doi.org/10.1002/9781118642047.ch6>
- Kipdiah, S., Hubeis, M., & Suharjo, B. (2013). Strategi Rantai Pasok Sayuran Organik Berbasis Petani di Kecamatan Pangalengan, Kabupaten Bandung (Farmer-Based Organic Vegetable Supply Chain Strategy in Pangalengan District, Bandung Regency). *MANAJEMEN IKM: Jurnal Manajemen Pengembangan Industri Kecil Menengah*, 8(2), 99–114. <http://journal.ipb.ac.id/index.php/jurnalmpi/article/view/7248>
- Kleemann, C., Zink, J., Selmer, I., Smirnova, I., & Kulozik, U. (2020). Effect of ethanol on the textural properties of whey protein and egg white protein hydrogels during water-ethanol solvent exchange. *Molecules*, 25(19), 1–14. <https://doi.org/10.3390/molecules25194417>
- Klemm, D., Heublein, B., Fink, H. P., & Bohn, A. (2005). Cellulose: Fascinating biopolymer and sustainable raw material. *Angewandte Chemie - International Edition*, 44(22), 3358–3393. <https://doi.org/10.1002/anie.200460587>
- Klunklin, W., Jantanasakulwong, K., Phimolsiripol, Y., Leksawasdi, N., Seesuriyachan, P., Chaiyaso, T., Insomphun, C., Phongthai, S., Jantrawut, P., Sommano, S. R., Punyodom, W., Reungsang, A., Ngo, T. M. P., & Rachtanapun, P. (2021). Synthesis, characterization, and application of carboxymethyl cellulose from asparagus stalk end. *Polymers*, 13(1), 1–15. <https://doi.org/10.3390/polym13010081>
- Kolpak, F. J., Weih, M., & Blackwell, J. (1978). Mercerization of cellulose: 1. Determination of the structure of Mercerized cotton. *Polymer*, 19(2), 123–131. [https://doi.org/10.1016/0032-3861\(78\)90027-7](https://doi.org/10.1016/0032-3861(78)90027-7)
- Koneru, A., Dharmalingam, K., & Anandalakshmi, R. (2020). Cellulose based nanocomposite hydrogel films consisting of sodium carboxymethylcellulose–grapefruit seed extract nanoparticles for potential wound healing applications. *International Journal of Biological Macromolecules*, 148, 833–842. <https://doi.org/10.1016/j.ijbiomac.2020.01.018>

- Kretschmer, B., Smith, C., Watkins, E., Allen, B., Buckwell, A., Desbarats, J., & Kieve, D. (2013). Technology options for recycling agricultural, forestry and food wastes and residues for sustainable bioenergy and biomaterials. Report for the European Parliament, STOA, as part of the study 'Technology Options for Feeding 10 Billion People.' In *Institute for European Environmental Policy (IEEP)*.
- Krstic, M., Maksimovic, Z., Ibric, S., Bakic, T., Prodanovic, J., & Razic, S. (2018). Lignocellulosic biomass as a source of microcrystalline cellulose - Chemical and technological characterization and future perspectives. *Cellulose Chemistry and Technology*, 52(7–8), 577–588.
- Kumar, A., Behl, T., & Chadha, S. (2020). Synthesis of physically crosslinked PVA/Chitosan loaded silver nanoparticles hydrogels with tunable mechanical properties and antibacterial effects. *International Journal of Biological Macromolecules*, 149, 1262–1274. <https://doi.org/10.1016/j.ijbiomac.2020.02.048>
- Kundu, D., & Banerjee, T. (2020a). Development of microcrystalline cellulose based hydrogels for the in vitro delivery of Cephalexin. *Heliyon*, 6(1), e03027. <https://doi.org/10.1016/j.heliyon.2019.e03027>
- Kundu, D., & Banerjee, T. (2020b). Heliyon Development of microcrystalline cellulose based hydrogels for the in vitro delivery of Cephalexin. *Heliyon*, 6(May 2019), e03027. <https://doi.org/10.1016/j.heliyon.2019.e03027>
- Kunusa, W. R., Iyabu, H., Taufik, M., & Botutihe, D. N. (2018). Characterization and analysis of the molecular weight of corn corbs microcrystalline cellulose (MCC) fiber using mass-spectrometry methods. *IOP Conference Series: Journal of Physics*, 1040, 012015 1-9. <https://doi.org/doi:10.1088/1742-6596/1040/1/012015>
- Lai, D. S., Osman, A. F., Adnan, S. A., Ibrahim, I., Alrashdi, A. A., Nabil, M., Salimi, A., & Ul-hamid, A. (2021). On the use of OPEFB-derived microcrystalline cellulose and nano-bentonite for development of thermoplastic starch hybrid bio-composites with improved performance. *Polimers*, 13(897), 1–22. <https://doi.org/10.3390/polym13060897>
- Lai, J., Ye, X., Liu, J., Wang, C., Li, J., Wang, X., Ma, M., & Wang, M. (2021). 4D printing of highly printable and shape morphing hydrogels composed of alginate and methylcellulose. *Materials and Design*, 205, 109699. <https://doi.org/10.1016/j.matdes.2021.109699>
- Langan, P., Nishiyama, Y., & Chanzy, H. (2001). X-ray structure of mercerized cellulose II at 1 Å resolution. *Biomacromolecules*, 2(2), 410–416. <https://doi.org/10.1021/bm005612q>
- Li, R., Fei, J., Cai, Y., Li, Y., Feng, J., & Yao, J. (2009). Cellulose whiskers extracted from mulberry: A novel biomass production. *Carbohydrate Polymers*, 76(1), 94–99. <https://doi.org/10.1016/j.carbpol.2008.09.034>
- Liang, T., Sun, G., Cao, L., Li, J., & Wang, L. (2019). A pH and NH₃ sensing intelligent film based on *Artemisia sphaerocephala* Krasch. gum and red cabbage anthocyanins anchored by carboxymethyl cellulose sodium added as

- a host complex. *Food Hydrocolloids*, 87, 858–868.
<https://doi.org/10.1016/j.foodhyd.2018.08.028>
- Lien, S. M., Li, W. Te, & Huang, T. J. (2008). Genipin-crosslinked gelatin scaffolds for articular cartilage tissue engineering with a novel crosslinking method. *Materials Science and Engineering C*, 28(1), 36–43.
<https://doi.org/10.1016/j.msec.2006.12.015>
- Liu, B., Xu, H., Zhao, H., Liu, W., Zhao, L., & Li, Y. (2017). Preparation and characterization of intelligent starch/PVA films for simultaneous colorimetric indication and antimicrobial activity for food packaging applications. *Carbohydrate Polymers*, 157, 842–849.
<https://doi.org/10.1016/j.carbpol.2016.10.067>
- Liu, G., Li, W., Chen, L., Zhang, X., Niu, D., Chen, Y., Yuan, S., Bei, Y., & Zhu, Q. (2020). Molecular dynamics studies on the aggregating behaviors of cellulose molecules in NaOH/urea aqueous solution. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 594(December 2019), 124663.
<https://doi.org/10.1016/j.colsurfa.2020.124663>
- Liu, J., Wang, H., Wang, P., Guo, M., Jiang, S., Li, X., & Jiang, S. (2018). Films based on κ -carrageenan incorporated with curcumin for freshness monitoring. *Food Hydrocolloids*, 83, 134–142.
<https://doi.org/10.1016/j.foodhyd.2018.05.012>
- Liu, Y. J., Fu, L. H., Liu, S., Meng, L. Y., Li, Y. Y., & Ma, M. G. (2016). Synthetic self-assembled homogeneous network hydrogels with high mechanical and recoverable properties for tissue replacement. *Journal of Materials Chemistry B*, 4(28), 4847–4854. <https://doi.org/10.1039/c6tb01249c>
- 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(9–10), 897–903.
- Lu, P., Liu, R., Liu, X., & Wu, M. (2018). *Preparation of Self-supporting Bagasse Cellulose Nanofibrils Hydrogels Induced by Zinc Ions*. 1–14.
<https://doi.org/10.3390/nano8100800>
- Lu, P., Yang, Y., Liu, R., Liu, X., Ma, J., Wu, M., & Wang, S. (2020a). Preparation of sugarcane bagasse nanocellulose hydrogel as a colourimetric freshness indicator for intelligent food packaging. *Carbohydrate Polymers*, 249(July), 116831. <https://doi.org/10.1016/j.carbpol.2020.116831>
- Lu, P., Yang, Y., Liu, R., Liu, X., Ma, J., Wu, M., & Wang, S. (2020b). Preparation of sugarcane bagasse nanocellulose hydrogel as a colourimetric freshness indicator for intelligent food packaging. *Carbohydrate Polymers*, 249(May), 116831. <https://doi.org/10.1016/j.carbpol.2020.116831>
- Luchese, C. L., Abdalla, V. F., Spada, J. C., & Tessaro, I. C. (2018). Evaluation of blueberry residue incorporated cassava starch film as pH indicator in different simulants and foodstuffs. *Food Hydrocolloids*, 82, 209–218.
<https://doi.org/10.1016/j.foodhyd.2018.04.010>
- Luo, X., & Zhang, L. (2013). New solvents and functional materials prepared from

- cellulose solutions in alkali/urea aqueous system. *Food Research International*, 52(1), 387–400. <https://doi.org/10.1016/j.foodres.2010.05.016>
- Ma, C., Gerhard, E., Lu, D., & Yang, J. (2018). Citrate chemistry and biology for biomaterials design. *Biomaterials*, 178, 383–400. <https://doi.org/10.1016/j.biomaterials.2018.05.003>
- Ma, Q., Liang, T., Cao, L., & Wang, L. (2018). Intelligent poly (vinyl alcohol)-chitosan nanoparticles-mulberry extracts films capable of monitoring pH variations. *International Journal of Biological Macromolecules*, 108, 576–584. <https://doi.org/10.1016/j.ijbiomac.2017.12.049>
- Ma, Q., Ren, Y., Gu, Z., & Wang, L. (2017). Developing an intelligent film containing *Vitis amurensis* husk extracts: The effects of pH value of the film-forming solution. *Journal of Cleaner Production*, 166, 851–859. <https://doi.org/10.1016/j.jclepro.2017.08.099>
- Ma, Q., & Wang, L. (2016). Preparation of a visual pH-sensing film based on tara gum incorporating cellulose and extracts from grape skins. *Sensors and Actuators, B: Chemical*, 235, 401–407. <https://doi.org/10.1016/j.snb.2016.05.107>
- Maitra, J., & Shukla, V. K. (2019). *Cross-linking in Hydrogels - A Review. January 2014*. <https://doi.org/10.5923/j.ajps.20140402.01>
- 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(4), 657–667. <https://doi.org/10.4172/pharmaceutical-sciences.1000405>
- Malucelli, L. C., Lacerda, L. G., Dziedzic, M., & da Silva Carvalho Filho, M. A. (2017). Preparation, properties and future perspectives of nanocrystals from agro-industrial residues: a review of recent research. *Reviews in Environmental Science and Biotechnology*, 16(1), 131–145. <https://doi.org/10.1007/s11157-017-9423-4>
- Margaritis, A. G., & Kalfoglou, N. K. (1988). Compatibility of poly(vinyl chloride) with epoxidized polybutadiene. *European Polymer Journal*, 24(11), 1043–1047. [https://doi.org/10.1016/0014-3057\(88\)90063-8](https://doi.org/10.1016/0014-3057(88)90063-8)
- Marsano, E., Bianchi, E., & Sciutto, L. (2003). Microporous thermally sensitive hydrogels based on hydroxypropyl cellulose crosslinked with poly-ethyleneglicol diglycidyl ether. *Polymer*, 44(22), 6835–6841. [https://doi.org/10.1016/S0032-3861\(03\)00693-1](https://doi.org/10.1016/S0032-3861(03)00693-1)
- Martinez-Garcia, F. D., Fischer, T., Hayn, A., Mierke, C. T., Burgess, J. K., & Harmsen, M. C. (2022). A Beginner's Guide to the Characterization of Hydrogel Microarchitecture for Cellular Applications. *Gels*, 8(9), 1–20. <https://doi.org/10.3390/gels8090535>
- Martínková, L., Grulich, M., Pátek, M., Křístková, B., & Winkler, M. (2023). Bio-Based Valorization of Lignin-Derived Phenolic Compounds: A Review. *Biomolecules*, 13(5). <https://doi.org/10.3390/biom13050717>
- Mary, S. K., Koshy, R. R., Daniel, J., Koshy, J. T., Pothan, L. A., & Thomas, S.

- (2020). Development of starch based intelligent films by incorporating anthocyanins of butterfly pea flower and TiO₂ and their applicability as freshness sensors for prawns during storage. *RSC Advances*, 10(65), 39822–39830. <https://doi.org/10.1039/d0ra05986b>
- Mekonnen, T., Mussone, P., Khalil, H., & Bressler, D. (2013). Progress in bio-based plastics and plasticizing modifications. *Journal of Materials Chemistry A*, 1(43), 13379–13398. <https://doi.org/10.1039/c3ta12555f>
- Merci, A., Urbano, A., Grossmann, M. V. E., Tischer, C. A., & Mali, S. (2015). Properties of microcrystalline cellulose extracted from soybean hulls by reactive extrusion. *Food Research International*, 73, 38–43. <https://doi.org/10.1016/j.foodres.2015.03.020>
- Miranda, P. S., Garnica, O., Sagahon, L. V., & Cardenas, G. (2004). Water Vapor Permeability and Mechanical Properties of Chitosan Films . WATER VAPOR PERMEABILITY AND MECHANICAL PROPERTIES OF CHITOSAN COMPOSITE FILMS. *J.Chil.Chem.Soc*, 49(2), 173–178. <https://doi.org/10.4067/S0717-97072004000200013>
- Moazami Goodarzi, M., Moradi, M., Tajik, H., Forough, M., Ezati, P., & Kuswandi, B. (2020). Development of an easy-to-use colorimetric pH label with starch and carrot anthocyanins for milk shelf life assessment. *International Journal of Biological Macromolecules*, 153, 240–247. <https://doi.org/10.1016/j.ijbiomac.2020.03.014>
- Mohamad Haafiz, M. K., Eichhorn, S. J., Hassan, A., & Jawaid, M. (2013). Isolation and characterization of microcrystalline cellulose from oil palm biomass residue. *Carbohydrate Polymers*, 93(2), 628–634. <https://doi.org/10.1016/j.carbpol.2013.01.035>
- Mohamed, B. N., Chin, S. F., & Wasli, M. E. (2023). *Effects of Plasticiser on the Morphology and Swelling Properties of Cellulose-based Hydrogels Derived from Wastepaper*. 34(3), 53–65.
- Mohammad Padzil, F. N., Gan, S., Zakaria, S., Mohamad, S. F., Mohamed, N. H., Seo, Y. B., & Ellis, A. V. (2018). Increased solubility of plant core pulp cellulose for regenerated hydrogels through electron beam irradiation. *Cellulose*, 25(9), 4993–5006. <https://doi.org/10.1007/s10570-018-1933-x>
- Mohammad Padzil, F. N., Lee, S. H., Ainun, Z. M. A. ari, Lee, C. H., & Abdullah, L. C. (2020). Potential of oil palm empty fruit bunch resources in nanocellulose hydrogel production for versatile applications: A review. *Materials*, 13(5). <https://doi.org/10.3390/ma13051245>
- Mohd, N. H., Kargazadeh, H., Miyamoto, M., Uemiya, S., Sharer, N., Baharum, A., Lee Peng, T., Ahmad, I., Yarmo, M. A., & Othaman, R. (2021). Aminosilanes grafted nanocrystalline cellulose from oil palm empty fruit bunch aerogel for carbon dioxide capture. *Journal of Materials Research and Technology*, 13, 2287–2296. <https://doi.org/10.1016/j.jmrt.2021.06.018>
- Mohebi, E., & Marquez, L. (2015). Intelligent packaging in meat industry: An overview of existing solutions. *Journal of Food Science and Technology*, 52(7), 3947–3964. <https://doi.org/10.1007/s13197-014-1588-z>

- Moon, R. J., Martini, A., Nairn, J., Simonsen, J., & Youngblood, J. (2011). Cellulose nanomaterials review: Structure, properties and nanocomposites. In *Chemical Society Reviews* (Vol. 40, Issue 7). <https://doi.org/10.1039/c0cs00108b>
- Moradi, M., Tajik, H., Almasi, H., Forough, M., & Ezati, P. (2019). A novel pH-sensing indicator based on bacterial cellulose nanofibers and black carrot anthocyanins for monitoring fish freshness. *Carbohydrate Polymers*, 222, 115030. <https://doi.org/10.1016/j.carbpol.2019.115030>
- Morais, J. P. S., Rosa, M. D. F., De Souza Filho, M. D. S. M., Nascimento, L. D., Do Nascimento, D. M., & Cassales, A. R. (2013). Extraction and characterization of nanocellulose structures from raw cotton linter. *Carbohydrate Polymers*, 91(1), 229–235. <https://doi.org/10.1016/j.carbpol.2012.08.010>
- Mori, K., Goto-Yamamoto, N., Kitayama, M., & Hashizume, K. (2007). Loss of anthocyanins in red-wine grape under high temperature. *Journal of Experimental Botany*, 58(8), 1935–1945. <https://doi.org/10.1093/jxb/erm055>
- Mussatto, S. I., Rocha, G. J. M., & Roberto, I. C. (2008). Hydrogen peroxide bleaching of cellulose pulps obtained from brewer's spent grain. *Cellulose*, 15(4), 641–649. <https://doi.org/10.1007/s10570-008-9198-4>
- Nafu, Y. R., Foba-tendo, J., Njeugna, E., Oliver, G., & Cooke, K. O. (2015). Extraction and Characterization of Fibres from the Stalk and Spikelets of Empty Fruit Bunch. *Journal of Applied Chemistry*, 2015(ID 750818), 1–10.
- Nakamura, S., Tanaka, C., Yuasa, H., & Sakamoto, T. (2019). *Brief / Technical Note Utility of Microcrystalline Cellulose for Improving Drug Content Uniformity in Tablet Manufacturing Using Direct Powder Compression*. 1–12. <https://doi.org/10.1208/s12249-019-1365-4>
- Nam, S., French, A. D., Condon, B. D., & Concha, M. (2016). Segal crystallinity index revisited by the simulation of X-ray diffraction patterns of cotton cellulose I β and cellulose II. *Carbohydrate Polymers*, 135, 1–9. <https://doi.org/10.1016/j.carbpol.2015.08.035>
- Namazi, H., & Dadkhah, A. (2010). Convenient method for preparation of hydrophobically modified starch nanocrystals with using fatty acids. *Carbohydrate Polymers*, 79(3), 731–737. <https://doi.org/10.1016/j.carbpol.2009.09.033>
- Nasution, H., Harahap, H., Suherman, P., & Kelvin, K. (2020). Isolation and characterization of microcrystalline cellulose from coconut fiber using acid hydrolysis process. *Proceedings of ICOSTEERR*, 222–226. <https://doi.org/10.5220/0010077802220226>
- Nataraj, D., Reddy, R., & Reddy, N. (2020). Crosslinking electrospun poly (vinyl) alcohol fibers with citric acid to impart aqueous stability for medical applications. *European Polymer Journal*, 124, 109484. <https://doi.org/10.1016/j.eurpolymj.2020.109484>
- Nazir, M. S., Wahjoedi, B. A., Yussof, A. W., & Abdullah, M. A. (2013). Eco-

- friendly extraction and characterization of cellulose from oil palm empty fruit bunches. *BioResources*, 8(2), 2161–2172. <https://doi.org/10.15376/biores.8.2.2161-2172>
- Ng, H. M., Sin, L. T., Tee, T. T., Bee, S. T., Hui, D., Low, C. Y., & Rahmat, A. R. (2015). Extraction of cellulose nanocrystals from plant sources for application as reinforcing agent in polymers. *Composites Part B: Engineering*, 75, 176–200. <https://doi.org/10.1016/j.compositesb.2015.01.008>
- Ng, L. Y., Wong, T. J., Ng, C. Y., & Amelia, C. K. M. (2021). A review on cellulose nanocrystals production and characterization methods from *Elaeis guineensis* empty fruit bunches. *Arabian Journal of Chemistry*, 14(9), 103339. <https://doi.org/10.1016/j.arabjc.2021.103339>
- Nor Amalini, A., Noor Haida, M. K., Imran, K., & Mohamad Haafiz, M. K. (2019). Relationship between dissolution temperature and properties of oil palm biomass based-regenerated cellulose films prepared via ionic liquid. *Materials Chemistry and Physics*, 221(September 2018), 382–389. <https://doi.org/10.1016/j.matchemphys.2018.09.028>
- Novia, W., Zakaria, W. A., & Lestari, D. A. H. (2013). Analisis Nilai Tambah Dan Kelayakan Pengembangan Agroindustri Beras Siger. *Jiia*, 1(3), 211–217.
- O'sullivan, A. C. (1997). Cellulose: the structure slowly unravels. *Cellulose*, 4(3), 173–207. <http://link.springer.com/article/10.1023/A:1018431705579>
- Ofori-Boateng, C., & Lee, K. T. (2014). Sono-assisted organosolv/H₂O₂ pretreatment of oil palm (*Elaeis guineensis* Jacq.) fronds for recovery of fermentable sugars: Optimization and severity evaluation. *Fuel*, 115, 170–178. <https://doi.org/10.1016/j.fuel.2013.07.020>
- Ogunneye, A., Ibikunle, A. A., Sanyaolu, N. O., & R, G. M. (2020). Optimized Carboxymethyl Cellulose preparation from Cocoa Pod. *J. Chem Soc. Nigeria*, 45 No.1(February), 1–13.
- Ohwoavworhua, F. O., & Adelakun, T. A. (2007). Some Physical Characteristics of Microcrystalline Cellulose Obtained from Raw Cotton of *Cochlospermum planchonii*. *Tropical Journal of Pharmaceutical Research*, 4(2), 501–507. <https://doi.org/10.4314/tjpr.v4i2.14626>
- Okahisa, Y., Furukawa, Y., Ishimoto, K., Narita, C., Intharapichai, K., & Ohara, H. (2018). Comparison of cellulose nanofiber properties produced from different parts of the oil palm tree. *Carbohydrate Polymers*, 198(March), 313–319. <https://doi.org/10.1016/j.carbpol.2018.06.089>
- Okahisa, Y., Matsuoka, K., Yamada, K., & Wataoka, I. (2020). Comparison of polyvinyl alcohol films reinforced with cellulose nanofibers derived from oil palm by impregnating and casting methods. *Carbohydrate Polymers*, 250(August), 116907. <https://doi.org/10.1016/j.carbpol.2020.116907>
- Olaru, N., & Olaru, L. (2001). Influence of organic diluents on cellulose carboxymethylation. *Macromolecular Chemistry and Physics*, 202(1), 207–211. [https://doi.org/10.1002/1521-3935\(20010101\)202:1<207::AID-MACP207>3.0.CO;2-Q](https://doi.org/10.1002/1521-3935(20010101)202:1<207::AID-MACP207>3.0.CO;2-Q)

- Othman, M., Yusup, A. A., Zakaria, N., & Khalid, K. (2018). Bio-polymer chitosan and corn starch with extract of hibiscus rosa-sinensis (hibiscus) as PH indicator for visually-smart food packaging. *AIP Conference Proceedings*, 1985. <https://doi.org/10.1063/1.5047198>
- Owolabi, A. F., Ghazali, A., Khalil, H. P. S. A., Hassan, A., Arjmandi, R., Fazita, M. R. N., & Haafiz, M. K. M. (2016). Isolation and characterization of microcrystalline cellulose from oil palm fronds using chemomechanical process. *Wood and Fiber Science*, 48(4), 260–270.
- Owolabi, A. F., Haafiz, M. K. M., Hossain, M. S., Hussin, M. H., & Fazita, M. R. N. (2017). Influence of alkaline hydrogen peroxide pre-hydrolysis on the isolation of microcrystalline cellulose from oil palm fronds. *International Journal of Biological Macromolecules*, 95, 1228–1234. <https://doi.org/10.1016/j.ijbiomac.2016.11.016>
- Pa, M., & Ahola, S. (2007). *Enzymatic Hydrolysis Combined with Mechanical Shearing and High-Pressure Homogenization for Nanoscale Cellulose Fibrils and Strong Gels*. 1934–1941.
- Pangsang, N., Rattanapan, U., Thanapimmetha, A., Srinopphakhun, P., Liu, C. G., Zhao, X. Q., Bai, F. W., & Sakdaronnarong, C. (2019). Chemical-free fractionation of palm empty fruit bunch and palm fiber by hot-compressed water technique for ethanol production. *Energy Reports*, 5, 337–348. <https://doi.org/10.1016/j.egy.2019.02.008>
- Parid, D. M., Baharuddin, A. S., Mohammed, M. A. P., Johari, A. M., Zubaidah, S., & Razak, A. (2018). *com Synthesis and Characterization of Carboxymethyl Cellulose from Oil Palm Empty Fruit Bunch Stalk Fibres*. 13(1), 535–554.
- Parid, D. M., Rahman, N. A. A., Baharuddin, A. S., Kadir Basha, R. P., Mohammed, M. A., Mat Johari, A., & Abd Razak, S. Z. (2021). Effects of carboxymethyl cellulose extracted from oil palm empty fruit bunch stalk fibres on the physical properties of low-fat ice cream. *Food Research*, 5, 1–7. [https://doi.org/10.26656/fr.2017.5\(S1\).017](https://doi.org/10.26656/fr.2017.5(S1).017)
- Pereira, V. A., de Arruda, I. N. Q., & Stefani, R. (2015). Active chitosan/PVA films with anthocyanins from Brassica oleraceae (Red Cabbage) as Time-Temperature Indicators for application in intelligent food packaging. *Food Hydrocolloids*, 43, 180–188. <https://doi.org/10.1016/j.foodhyd.2014.05.014>
- Pitaloka, A. B., & Rukmana, A. S. (2021). *Synthesis and Characterization of Carboxy Methyl Cellulose-Based Hydrogel Cross-linked with Citric Acid*. 5(1), 7–11.
- Poletto, M., Pistor, V., Zeni, M., & Zattera, A. J. (2011). Crystalline properties and decomposition kinetics of cellulose fibers in wood pulp obtained by two pulping processes. *Polymer Degradation and Stability*, 96(4), 679–685. <https://doi.org/10.1016/j.polymdegradstab.2010.12.007>
- Popescu, C. M., Popescu, M. C., Singurel, G., Vasile, C., Argyropoulos, D. S., & Willfor, S. (2007). Spectral characterization of eucalyptus wood. *Applied Spectroscopy*, 61(11), 1168–1177. <https://doi.org/10.1366/000370207782597076>

- Priyadarshi, R., Ezati, P., & Rhim, J.-W. (2021). Recent Advances in Intelligent Food Packaging Applications Using Natural Food Colorants. *ACS Food Science & Technology*, *1*(2), 124–138. <https://doi.org/10.1021/acsfoodscitech.0c00039>
- Prusov, A. N., Prusova, S. M., Radugin, M. V., & Zakharov, A. G. (2014). Interrelation between the crystallinity of polysaccharides and water absorption. *Russian Journal of Physical Chemistry A*, *88*(5), 813–818. <https://doi.org/10.1134/S0036024414050239>
- Pujiasih, S., Kurnia, Masykur, A., Kusumaningsih, T., & Saputra, O. A. (2018a). Silylation and characterization of microcrystalline cellulose isolated from Indonesian native oil palm empty fruit bunch. *Carbohydrate Polymers*, *184*(August 2017), 74–81. <https://doi.org/10.1016/j.carbpol.2017.12.060>
- Pujiasih, S., Kurnia, Masykur, A., Kusumaningsih, T., & Saputra, O. A. (2018b). Silylation and characterization of microcrystalline cellulose isolated from Indonesian native oil palm empty fruit bunch. *Carbohydrate Polymers*, *184*, 74–81. <https://doi.org/10.1016/j.carbpol.2017.12.060>
- Pushpamalar, V., Langford, S. J., Ahmad, M., Hashim, K., & Lim, Y. Y. (2013). Preparation of carboxymethyl sago pulp hydrogel from sago waste by electron beam irradiation and swelling behavior in water and various pH media. *Journal of Applied Polymer Science*, *128*(1), 451–459. <https://doi.org/10.1002/app.38192>
- Pushpamalar, V., Langford, S. J., Ahmad, M., & Lim, Y. Y. (2006). Optimization of reaction conditions for preparing carboxymethyl cellulose from sago waste. *Carbohydrate Polymers*, *64*(2), 312–318. <https://doi.org/10.1016/j.carbpol.2005.12.003>
- Qiabi, A., Rigal, L., & Gaset, A. (1994). Comparative studies of hemicellulose hydrolysis processes: application to various lignocellulosic wastes. *Industrial Crops and Products*, *3*(1–2), 95–102. [https://doi.org/10.1016/0926-6690\(94\)90082-5](https://doi.org/10.1016/0926-6690(94)90082-5)
- Qin, X., Lu, A., Cai, J., & Zhang, L. (2013). Stability of inclusion complex formed by cellulose in NaOH/urea aqueous solution at low temperature. *Carbohydrate Polymers*, *92*(2), 1315–1320. <https://doi.org/10.1016/j.carbpol.2012.10.004>
- Qin, Y., Liu, Y., Yong, H., Liu, J., Zhang, X., & Liu, J. (2019). Preparation and characterization of active and intelligent packaging films based on cassava starch and anthocyanins from *Lycium ruthenicum* Murr. *International Journal of Biological Macromolecules*, *134*, 80–90. <https://doi.org/10.1016/j.ijbiomac.2019.05.029>
- Qin, Y., Yun, D., Xu, F., Chen, D., Kan, J., & Liu, J. (2021). Smart packaging films based on starch/polyvinyl alcohol and *Lycium ruthenicum* anthocyanins-loaded nano-complexes: Functionality, stability and application. *Food Hydrocolloids*, *119*(February), 106850. <https://doi.org/10.1016/j.foodhyd.2021.106850>
- Qureshi, M. A., Nishat, N., Jadoun, S., & Ansari, M. Z. (2020). Polysaccharide based superabsorbent hydrogels and their methods of synthesis: A review.

- Carbohydrate Polymer Technologies and Applications*, 1(September), 100014. <https://doi.org/10.1016/j.carpta.2020.100014>
- Rachmelia, D., & Imawan, C. (2018). Time Temperature Indicator Label using Black Corn Extract and Chitosan Matrix. *Journal of Physics: Conference Series*, 1120(1). <https://doi.org/10.1088/1742-6596/1120/1/012041>
- Rachtanapun, P., Luangkamin, S., Tanprasert, K., & Suriyatem, R. (2012). Carboxymethyl cellulose film from durian rind. *LWT - Food Science and Technology*, 48(1), 52–58. <https://doi.org/10.1016/j.lwt.2012.02.029>
- Ragheb, A. A., Nassar, S. H., Abd El-Thalouth, I., Ibrahim, M. A., & Shahin, A. A. (2012). Preparation, characterization and technological evaluation of CMC derived from rice-straw as thickening agents in discharge, discharge-resist and burn-out printing. *Carbohydrate Polymers*, 89(4), 1044–1049. <https://doi.org/10.1016/j.carbpol.2012.03.054>
- Rahmi, Lelifajri, Julinawati, & Shabrina. (2017). Preparation of chitosan composite film reinforced with cellulose isolated from oil palm empty fruit bunch and application in cadmium ions removal from aqueous solutions. *Carbohydrate Polymers*, 170, 226–233. <https://doi.org/10.1016/j.carbpol.2017.04.084>
- Ramlee, N. A., Naveen, J., & Jawaid, M. (2021). Potential of oil palm empty fruit bunch (OPEFB) and sugarcane bagasse fibers for thermal insulation application – A review. *Construction and Building Materials*, 271, 121519. <https://doi.org/10.1016/j.conbuildmat.2020.121519>
- Ramli, R., Junadi, N., Beg, M. D. H., & Yunus, R. M. (2015). Microcrystalline cellulose (MCC) from oil palm empty fruit bunch (EFB) fiber via simultaneous ultrasonic and alkali treatment. *International Journal of Materials and Metallurgical Engineering*, 9(1), 8–11. <https://doi.org/10.5281/zenodo.1337783>
- Ran, R., Wang, L., Su, Y., He, S., He, B., Li, C., Wang, C., Liu, Y., & Chen, S. (2021). Preparation of pH-indicator films based on soy protein isolate/bromothymol blue and methyl red for monitoring fresh-cut apple freshness. *Journal of Food Science*, June, 1–17. <https://doi.org/10.1111/1750-3841.15884>
- Rasid, N. S. A., Zainol, M. M., & Amin, N. A. S. (2021). Synthesis and characterization of carboxymethyl cellulose derived from empty fruit bunch. *Sains Malaysiana*, 50(9), 2523–2535. <https://doi.org/10.17576/jsm-2021-5009-03>
- Rasoulzadeh, M., & Namazi, H. (2017). Carboxymethyl cellulose/graphene oxide bio-nanocomposite hydrogel beads as anticancer drug carrier agent. *Carbohydrate Polymers*, 168, 320–326. <https://doi.org/10.1016/J.CARBPOL.2017.03.014>
- Raucci, M. G., Alvarez-Perez, M. A., Demitri, C., Giugliano, D., De Benedictis, V., Sannino, A., & Ambrosio, L. (2015). Effect of citric acid crosslinking cellulose-based hydrogels on osteogenic differentiation. *Journal of Biomedical Materials Research - Part A*, 103(6), 2045–2056. <https://doi.org/10.1002/jbm.a.35343>

- Raza, M. A., Jeong, J.-O., & Park, S. H. (2021). State-of-the-Art Irradiation Technology for Polymeric Hydrogel Fabrication and Application in Drug Release System. *Frontiers in Materials*, 8(November), 1–6. <https://doi.org/10.3389/fmats.2021.769436>
- Reduwan Billah, S. M., Mondal, M. I. H., Somoal, S. H., & Nahid Pervez, M. (2019). *Cellulose-Based Hydrogel for Industrial Applications* (Issue October 2020). https://doi.org/10.1007/978-3-319-77830-3_63
- Ren, L., Zhang, Y., Wang, Q., Zhou, J., Tong, J., Chen, D., & Su, X. (2018). Convenient Method for Enhancing Hydrophobicity and Dispersibility of Starch Nanocrystals by Crosslinking Modification with Citric Acid. *International Journal of Food Engineering*, 14(4), 1–13. <https://doi.org/10.1515/ijfe-2017-0238>
- Ren, Y., Sun, X., Chen, L., Li, Y., Sun, M., Duan, X., & Liang, W. (2021). Structures and impact strength variation of chemically crosslinked high-density polyethylene: effect of crosslinking density. *RSC Advances*, 11(12), 6791–6797. <https://doi.org/10.1039/d0ra10365a>
- Rimduhit, S., Somsaeng, K., Kewsuwan, P., Jubsilp, C., & Tiptipakorn, S. (2012). Comparison of gamma radiation crosslinking and chemical crosslinking on properties of methylcellulose hydrogel. *Engineering Journal*, 16(4), 15–28. <https://doi.org/10.4186/ej.2012.16.4.15>
- Rizkiansyah, R. R., Mardiyati, Steven, & Suratman, R. (2016). Crystallinity and thermal resistance of microcrystalline cellulose prepared from manau rattan (Calamusmanan). *AIP Conference Proceedings*, 1725(4), 1–6. <https://doi.org/10.1063/1.4945525>
- Rodsamran, P., & Sothornvit, R. (2020). Carboxymethyl cellulose from rice stubble waste. *Songklanakarinn Journal of Science and Technology*, 42(2), 454–460. <https://doi.org/10.14456/sjst-psu.2020.59>
- Rohaizu, R., & Wanrosli, W. D. (2017). Sono-assisted TEMPO oxidation of oil palm lignocellulosic biomass for isolation of nanocrystalline cellulose. *Ultrasonics Sonochemistry*, 34, 631–639. <https://doi.org/10.1016/j.ultsonch.2016.06.040>
- Romaní, A., Michelin, M., Domingues, L., & Teixeira, J. A. (2018). Valorization of wastes from agrofood and pulp and paper industries within the biorefinery concept: Southwestern europe scenario. *Waste Biorefinery: Potential and Perspectives*, 487–504. <https://doi.org/10.1016/B978-0-444-63992-9.00016-1>
- Rooney, M. L. (1995). Active packaging in polymer films. *Active Food Packaging*, 74–110. https://doi.org/10.1007/978-1-4615-2175-4_4
- Roro, R., Yusrina, A., & Suryadi, H. (2018). Preparation and characterization of microcrystalline cellulose produced from betung bamboo (*Dendrocalamus asper*) through acid hydrolysis. *Journal of Young Pharmacists*, 10(2), 79–83. <https://doi.org/10.5530/jyp.2018.2s.15>
- Rosa, M. F., Medeiros, E. S., Malmonge, J. A., Gregorski, K. S., Wood, D. F., Mattoso, L. H. C., Glenn, G., Orts, W. J., & Imam, S. H. (2010). Cellulose

- nanowhiskers from coconut husk fibers: Effect of preparation conditions on their thermal and morphological behavior. *Carbohydrate Polymers*, 81(1), 83–92. <https://doi.org/10.1016/j.carbpol.2010.01.059>
- Rosli, N. A., Ahmad, I., & Abdullah, I. (2013). Isolation and characterization of cellulose nanocrystals from agave angustifolia fibre. *BioResources*, 8(2), 1893–1908. <https://doi.org/10.15376/biores.8.2.1893-1908>
- Roy, N., Saha, N., Kitano, T., & Saha, P. (2012). Biodegradation of PVP-CMC hydrogel film: A useful food packaging material. *Carbohydrate Polymers*, 89(2), 346–353. <https://doi.org/10.1016/j.carbpol.2012.03.008>
- Roy, N., Saha, N., & Saha, P. (n.d.). *Biodegradable Hydrogel Film for Food Packaging Centre of Polymer Systems*. 329–334.
- Ryoo, J., Choi, J., & Ki, C. S. (2020). Effect of ethanol treatment on physical property of photopolymerized hyaluronic acid/silk fibroin hybrid hydrogel. *Polymer*, 202. <https://doi.org/10.1016/j.polymer.2020.122733>
- Saba, N., Jawaid, M., Paridah, M. T., & Alothman, O. (2017). Physical, structural and thermomechanical properties of nano oil palm empty fruit bunch filler based epoxy nanocomposites. *Industrial Crops and Products*, 108(July), 840–843. <https://doi.org/10.1016/j.indcrop.2017.07.048>
- Salama, A., Shukry, N., & El-Sakhawy, M. (2015). Carboxymethyl cellulose-g-poly(2-(dimethylamino) ethyl methacrylate) hydrogel as adsorbent for dye removal. *International Journal of Biological Macromolecules*, 73(1), 72–75. <https://doi.org/10.1016/J.IJBIOMAC.2014.11.002>
- Salehudin, M. H., Salleh, E., Mamat, S. N. H., & Muhamad, I. I. (2014). Starch based Active Packaging Film Reinforced with Empty Fruit Bunch (EFB) Cellulose Nanofiber. *Procedia Chemistry*, 9, 23–33. <https://doi.org/10.1016/j.proche.2014.05.004>
- Salihu, R., Abd Razak, S. I., Ahmad Zawawi, N., Rafiq Abdul Kadir, M., Izzah Ismail, N., Jusoh, N., Riduan Mohamad, M., & Hasraf Mat Nayan, N. (2021). Citric acid: A green cross-linker of biomaterials for biomedical applications. *European Polymer Journal*, 146(November 2020), 110271. <https://doi.org/10.1016/j.eurpolymj.2021.110271>
- Saliu, F., & Della Pergola, R. (2018). Carbon dioxide colorimetric indicators for food packaging application: Applicability of anthocyanin and poly-lysine mixtures. *Sensors and Actuators, B: Chemical*, 258, 1117–1124. <https://doi.org/10.1016/j.snb.2017.12.007>
- Salleh, K. M., Zakaria, S., Sajab, M. S., Gan, S., & Kaco, H. (2019). Superabsorbent hydrogel from oil palm empty fruit bunch cellulose and sodium carboxymethylcellulose. *International Journal of Biological Macromolecules*, 131, 50–59. <https://doi.org/10.1016/j.ijbiomac.2019.03.028>
- Sanaeifar, N., Mäder, K., & Hinderberger, D. (2022). Macro- and Nanoscale Effect of Ethanol on Bovine Serum Albumin Gelation and Naproxen Release. *International Journal of Molecular Sciences*, 23(13). <https://doi.org/10.3390/ijms23137352>

- Sani, M. A., Tavassoli, M., Hamishehkar, H., & McClements, D. J. (2021). Carbohydrate-based films containing pH-sensitive red barberry anthocyanins: Application as biodegradable smart food packaging materials. *Carbohydrate Polymers*, 255(November), 117488. <https://doi.org/10.1016/j.carbpol.2020.117488>
- Sannino, A., Demitri, C., & Madaghiele, M. (2009). *Biodegradable Cellulose-based Hydrogels: Design and Applications*. 353–373. <https://doi.org/10.3390/ma2020353>
- Santana, J. S., Marques, J., Pola, C., & Otoni, C. G. (2016). *Cassava starch-based nanocomposites reinforced with cellulose nanofibers extracted from sisal*. 44637, 1–9. <https://doi.org/10.1002/app.44637>
- Saputra, A. H., Qadhayna, L., & Pitaloka, A. B. (2014). Synthesis and Characterization of Carboxymethyl Cellulose (CMC) from Water Hyacinth Using Ethanol-Isobutyl Alcohol Mixture as the Solvents. *International Journal of Chemical Engineering and Applications*, 5(1), 36–40. <https://doi.org/10.7763/ijcea.2014.v5.347>
- Sari, I. R. M., Zakaria, W. A., & Affandi, M. I. (2015). Kinerja Produksi Dan Nilai Tambah Agroindustri Emping Melinjo Di Kota Bandar Lampung. *Journal of Agribusiness Science*, 3(1), 18–24. <https://jurnal.fp.unila.ac.id/index.php/JIA/article/view/1013/918>
- Ščetar, M., & Kurek, M. (2010). Trends in Fruit and Vegetable Packaging – a Review. *Croatian Journal of Food Technology, Biotechnology and Nutrition*, 5(3–4), 69–86.
- Schenzel, K., Almlöf, H., & Germgård, U. (2009). Quantitative analysis of the transformation process of cellulose I → cellulose II using NIR FT Raman spectroscopy and chemometric methods. *Cellulose*, 16(3), 407–415. <https://doi.org/10.1007/s10570-009-9286-0>
- Sedyakina, N., Kuskov, A., Velonia, K., Feldman, N., Lutsenko, S., & Avramenko, G. (2020). Modulation of entrapment efficiency and in vitro release properties of BSA-loaded chitosan microparticles cross-linked with citric acid as a potential protein-drug delivery system. *Materials*, 13(8). <https://doi.org/10.3390/MA13081989>
- Seo, M., Seo, M., Choi, S. E., Shin, K., Lee, J. B., Yang, D. Y., & Kim, J. W. (2020). Cellulose nanofiber-multilayered fruit peel-mimetic gelatin hydrogel microcapsules for micropackaging of bioactive ingredients. *Carbohydrate Polymers*, 229(November 2019), 115559. <https://doi.org/10.1016/j.carbpol.2019.115559>
- Septevani, A. A., Burhani, D., & Sudiyarmanto, S. (2018). Pengaruh Proses Pemutihan Multi Tahap Serat Selulosa Dari Limbah Tandan Kosong Kelapa Sawit. *Jurnal Kimia Dan Kemasan*, 40(2), 71. <https://doi.org/10.24817/jkk.v40i2.3508>
- Septevani, A. A., Rifathin, A., Sari, A. A., Sampora, Y., Ariani, G. N., Sudiyarmanto, & Sondari, D. (2020). Oil palm empty fruit bunch-based nanocellulose as a super-adsorbent for water remediation. *Carbohydrate*

- Polymers*, 229(September 2019), 115433.
<https://doi.org/10.1016/j.carbpol.2019.115433>
- Setu, M. N. I., Mia, M. Y., Lubna, N. J., & Chowdhury, A. A. (2014). Preparation of microcrystalline cellulose from cotton and its evaluation as direct compressible excipient in the formulation of naproxen tablets. *Dhaka University Journal of Pharmaceutical Sciences*, 13(2), 187–192. <https://doi.org/10.3329/dujps.v13i2.21899>
- Sevastyanova, O., Li, J., & Geilerstedt, G. (2006). On the reaction mechanism of the thermal yellowing of bleached chemical pulps. *Nordic Pulp and Paper Research Journal*, 21(2), 188–192. <https://doi.org/10.3183/npptrj-2006-21-02-p188-192>
- Sharma, A., Thakur, M., Bhattacharya, M., Mandal, T., & Goswami, S. (2019). Commercial application of cellulose nano-composites – A review. *Biotechnology Reports*, 21, e00316. <https://doi.org/10.1016/j.btre.2019.e00316>
- Sharma, S., Sathasivam, T., Rawat, P., & Pushpamalar, J. (2021). Lycopene-loaded nanostructured lipid carrier from carboxymethyl oil palm empty fruit bunch cellulose for topical administration. *Carbohydrate Polymer Technologies and Applications*, 2(February), 100049. <https://doi.org/10.1016/j.carpta.2021.100049>
- Sharma, S., Virk, K., Sharma, K., Bose, S. K., Kumar, V., Sharma, V., Focarete, M. L., & Kalia, S. (2020). Preparation of gum acacia-poly(acrylamide-IPN-acrylic acid) based nanocomposite hydrogels via polymerization methods for antimicrobial applications. *Journal of Molecular Structure*, 1215, 128298. <https://doi.org/10.1016/j.molstruc.2020.128298>
- Sheltami, R. M., Abdullah, I., Ahmad, I., Dufresne, A., & Kargarzadeh, H. (2012). Extraction of cellulose nanocrystals from mengkuang leaves (*Pandanus tectorius*). *Carbohydrate Polymers*, 88(2), 772–779. <https://doi.org/10.1016/j.carbpol.2012.01.062>
- 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*, 18(1), 53–75. <https://doi.org/10.1039/c5gc02396c>
- Shet, R., Wong, H., Ashton, M., & Dodou, K. (2015). *Effect of Crosslinking Agent Concentration on the Properties of Unmedicated Hydrogels*. September. <https://doi.org/10.3390/pharmaceutics7030305>
- Silva-Pereira, M. C., Teixeira, J. A., Pereira-Júnior, V. A., & Stefani, R. (2015). Chitosan/corn starch blend films with extract from Brassica oleraceae (red cabbage) as a visual indicator of fish deterioration. *Lwt*, 61(1), 258–262. <https://doi.org/10.1016/j.lwt.2014.11.041>
- Silva, A. K. A., Richard, C., Bessodes, M., Scherman, D., & Merten, O. W. (2009). Growth factor delivery approaches in hydrogels. *Biomacromolecules*, 10(1), 9–18. <https://doi.org/10.1021/bm801103c>

- Silva, C. K. da, Mastrantonio, D. J. da S., Costa, J. A. V., & de Morais, M. G. (2019). Innovative pH sensors developed from ultrafine fibers containing açai (*Euterpe oleracea*) extract. *Food Chemistry*, 294(July 2018), 397–404. <https://doi.org/10.1016/j.foodchem.2019.05.059>
- Singh, S., Cheng, G., Sathitsuksanoh, N., Wu, D., Varanasi, P., George, A., Balan, V., Gao, X., Kumar, R., Dale, B. E., Wyman, C. E., & Simmons, B. A. (2015). Comparison of different biomass pretreatment techniques and their impact on chemistry and structure. *Frontiers in Energy Research*, 3(FEB), 1–12. <https://doi.org/10.3389/fenrg.2014.00062>
- Siqueira, G., Bras, J., & Dufresne, A. (2010). Cellulosic bionanocomposites: A review of preparation, properties and applications. *Polymers*, 2(4), 728–765. <https://doi.org/10.3390/polym2040728>
- Soetaredjo, F. E., Santoso, S. P., Waworuntu, G. L., & Darsono, F. L. (2022). Cellulose nanocrystal (Cnc) capsules from oil palm empty fruit bunches (opefb). *Biointerface Research in Applied Chemistry*, 12(2), 2013–2021. <https://doi.org/10.33263/BRIAC122.20132021>
- Sonego, J. M., Santagapita, P. R., Perullini, M., & Jobbágy, M. (2016). Ca(II) and Ce(III) homogeneous alginate hydrogels from the parent alginic acid precursor: A structural study. *Dalton Transactions*, 45(24), 10050–10057. <https://doi.org/10.1039/c6dt00321d>
- Soppimath, K. S., Aminabhavi, T. M., Dave, A. M., Kumbar, S. G., & Rudzinski, W. E. (2002). Stimulus-responsive “smart” hydrogels as novel drug delivery systems. *Drug Development and Industrial Pharmacy*, 28(8), 957–974. <https://doi.org/10.1081/DDC-120006428>
- Sulaeman, A. P., Gao, Y., Dugmore, T., Remón, J., & Matharu, A. S. (2021). From unavoidable food waste to advanced biomaterials: microfibrillated lignocellulose production by microwave-assisted hydrothermal treatment of cassava peel and almond hull. *Cellulose*, 28(12), 7687–7705. <https://doi.org/10.1007/s10570-021-03986-5>
- Sulaiman, F., Abdullah, N., Gerhauser, H., & Shariff, A. (2011). An outlook of Malaysian energy , oil palm industry and its utilization of wastes as useful resources. *Biomass and Bioenergy*, 35(9), 3775–3786. <https://doi.org/10.1016/j.biombioe.2011.06.018>
- Sun, G., Chi, W., Zhang, C., Xu, S., Li, J., & Wang, L. (2019). Developing a green film with pH-sensitivity and antioxidant activity based on κ-carrageenan and hydroxypropyl methylcellulose incorporating *Prunus maackii* juice. *Food Hydrocolloids*, 94, 345–353. <https://doi.org/10.1016/j.foodhyd.2019.03.039>
- Sun, G., Zhang, X., Bao, Z., Lang, X., Zhou, Z., Li, Y., Feng, C., & Chen, X. (2018). Reinforcement of thermoplastic chitosan hydrogel using chitin whiskers optimized with response surface methodology. *Carbohydrate Polymers*, 189(July 2017), 280–288. <https://doi.org/10.1016/j.carbpol.2018.01.083>
- Sun, R. C., Fang, J. M., & Tomkinson, J. (2000). Delignification of rye straw using hydrogen peroxide. *Industrial Crops and Products*, 12(2), 71–83. [https://doi.org/10.1016/S0926-6690\(00\)00039-X](https://doi.org/10.1016/S0926-6690(00)00039-X)

- Sun, Y., & Cheng, J. (2002). Hydrolysis of lignocellulosic materials for ethanol production: A review. *Bioresource Technology*, 83(1), 1–11. [https://doi.org/10.1016/S0960-8524\(01\)00212-7](https://doi.org/10.1016/S0960-8524(01)00212-7)
- Sun, Y., Lin, L., Deng, H., Li, J., He, B., Sun, R., & Ouyang, P. (2008). Structural changes of bamboo cellulose in formic acid. *BioResources*, 3(2), 297–315. <https://doi.org/10.15376/biores.3.2.297-315>
- Supian, M. A. F., Amin, K. N. M., Jamari, S. S., & Mohamad, S. (2020). Production of cellulose nanofiber (CNF) from empty fruit bunch (EFB) via mechanical method. *Journal of Environmental Chemical Engineering*, 8(1), 103024. <https://doi.org/10.1016/j.jece.2019.103024>
- Sutradhar, S., & Fatehi, P. (2023). Latest development in the fabrication and use of lignin-derived humic acid. *Biotechnology for Biofuels and Bioproducts*, 16(1), 1–20. <https://doi.org/10.1186/s13068-023-02278-3>
- Tano, K., Kamenan, A., & Arul, J. (2009). Respiration and transpiration characteristics of selected fresh fruits and vegetables. *Agronomie Africaine*, 17(2), 103–115. <https://doi.org/10.4314/aga.v17i2.1662>
- Tanveer, M., Farooq, A., Ata, S., Bibi, I., Sultan, M., Iqbal, M., Jabeen, S., Gull, N., Islam, A., Khan, R. U., & Al-Mijalli, S. H. (2021). Aluminum nanoparticles, chitosan, acrylic acid and vinyltrimethoxysilane based hybrid hydrogel as a remarkable water super-absorbent and antimicrobial activity. *Surfaces and Interfaces*, 25(June), 101285. <https://doi.org/10.1016/j.surfin.2021.101285>
- Tarchoun, A. F., Trache, D., & Klapötke, T. M. (2019). Microcrystalline cellulose from *Posidonia oceanica* brown algae: Extraction and characterization. *International Journal of Biological Macromolecules*, 138, 837–845. <https://doi.org/10.1016/j.ijbiomac.2019.07.176>
- Terinte, N., Ibbett, R., & Schuster, K. C. (2011). Overview on native cellulose and microcrystalline cellulose I structure studied by X-ray diffraction (WAXD): Comparison between measurement techniques. *Lenzinger Berichte*, 89(January 2011), 118–131.
- Thoorens, G., Krier, F., Leclercq, B., Carlin, B., & Evrard, B. (2014a). Microcrystalline cellulose, a direct compression binder in a quality by design environment - A review. *International Journal of Pharmaceutics*, 473(1–2), 64–72. <https://doi.org/10.1016/j.ijpharm.2014.06.055>
- Thoorens, G., Krier, F., Leclercq, B., Carlin, B., & Evrard, B. (2014b). Microcrystalline cellulose, a direct compression binder in a quality by design environment — A review. *Elsevier B.V.* <https://doi.org/10.1016/j.ijpharm.2014.06.055>
- Tian, B., Wang, J., Liu, Q., Liu, Y., & Chen, D. (2021). Formation chitosan-based hydrogel film containing silicon for hops β -acids release as potential food packaging material. *International Journal of Biological Macromolecules*, 191(July), 288–298. <https://doi.org/10.1016/j.ijbiomac.2021.09.086>
- Toğrul, H., & Arslan, N. (2003). Production of carboxymethyl cellulose from sugar

- beet pulp cellulose and rheological behaviour of carboxymethyl cellulose. *Carbohydrate Polymers*, 54(1), 73–82. [https://doi.org/10.1016/S0144-8617\(03\)00147-4](https://doi.org/10.1016/S0144-8617(03)00147-4)
- Tomé, L. C., Freire, M. G., Rebelo, L. P. N., Silvestre, A. J. D., Neto, C. P., Marrucho, I. M., & Freire, C. S. R. (2011). Surface hydrophobization of bacterial and vegetable cellulose fibers using ionic liquids as solvent media and catalysts. *Green Chemistry*, 13(9), 2464–2470. <https://doi.org/10.1039/c1gc15432j>
- Torskangerpoll, K., & Andersen, Ø. M. (2005). Colour stability of anthocyanins in aqueous solutions at various pH values. *Food Chemistry*, 89(3), 427–440. <https://doi.org/10.1016/j.foodchem.2004.03.002>
- Trache, D. (2017). Microcrystalline cellulose and related polymer composites: Synthesis[1] D. Trache, “Micr[1] D. Trache, “Microcrystalline cellulose and related polymer composites: Synthesis[1] D. Trache, ‘Microcrystalline cellulose and related polymer composites: Synthesi. *Handbook of Composites from Renewable Materials*, 1–8, 61–91.
- Trache, D., Hussin, M. H., Hui Chuin, C. T., Sabar, S., Fazita, M. R. N., Taiwo, O. F. A., Hassan, T. M., & Haafiz, M. K. M. (2016). Microcrystalline cellulose: Isolation, characterization and bio-composites application—A review. *International Journal of Biological Macromolecules*, 93, 789–804. <https://doi.org/10.1016/j.ijbiomac.2016.09.056>
- Tran, R. T., Yang, J., & Ameer, G. A. (2015). Citrate-Based Biomaterials and Their Applications in Regenerative Engineering. *Annual Review of Materials Research*, 45(March), 277–310. <https://doi.org/10.1146/annurev-matsci-070214-020815>
- Turturică, M., Oancea, A. M., Râpeanu, G., & Bahrim, G. (2015). Anthocyanins: Naturally occurring fruit pigments with functional properties. *Annals of the University Dunarea de Jos of Galati, Fascicle VI: Food Technology*, 39(1), 9–24.
- Udoetok, I. A., Wilson, L. D., & Headley, J. V. (2018). “ Pillaring Effects ” in *Cross-Linked Cellulose Biopolymers : A Study of Structure and Properties. 2018.*
- Uranga, J., Nguyen, B. T., Si, T. T., Guerrero, P., & De la Caba, K. (2020). The effect of cross-linking with citric acid on the properties of agar/fish gelatin films. *Polymers*, 12(2), 1–12. <https://doi.org/10.3390/polym12020291>
- Uyanga, K. A., & Daoud, W. A. (2021). Green and sustainable carboxymethyl cellulose-chitosan composite hydrogels: Effect of crosslinker on microstructure. *Cellulose*, 28(9), 5493–5512. <https://doi.org/10.1007/s10570-021-03870-2>
- Vartiainen, J., Lucenius, J., Hippinen, U., Serimaa, R., & Laine, J. (2013). A Fast Method to Produce Strong NFC Films as a Platform for Barrier and Functional Materials.
- Vasco-Correa, J., Ge, X., & Li, Y. (2016). Biological Pretreatment of

- Lignocellulosic Biomass. *Biomass Fractionation Technologies for a Lignocellulosic Feedstock Based Biorefinery*, 561–585. <https://doi.org/10.1016/B978-0-12-802323-5.00024-4>
- Vasile, C., & Baican, M. (2023). Lignins as Promising Renewable Biopolymers and Bioactive Compounds for High-Performance Materials. *Polymers*, 15(15), 1–52. <https://doi.org/10.3390/polym15153177>
- Vehovec, T., Gartner, A., Planincek, O., & Obreza, A. (2012). Influence of different types of commercially available microcrystalline cellulose on degradation of perindopril erbumine and enalapril maleate in binary mixtures. *Acta Pharmaceutica*, 62(4), 515–528. <https://doi.org/10.2478/v10007-012-0039-5>
- Ventura-Cruz, S., Flores-Alamo, N., & Tecante, A. (2020). Preparation of microcrystalline cellulose from residual Rose stems (*Rosa* spp.) by successive delignification with alkaline hydrogen peroxide. *International Journal of Biological Macromolecules*, 155, 324–329. <https://doi.org/10.1016/j.ijbiomac.2020.03.222>
- Ventura-Cruz, S., & Tecante, A. (2019). Extraction and characterization of cellulose nanofibers from Rose stems (*Rosa* spp.). *Carbohydrate Polymers*, 220, 53–59. <https://doi.org/10.1016/j.carbpol.2019.05.053>
- Vo, T., & Dang, T. (2019). Chitosan / Poly (vinyl alcohol) / Anthocyanin Extracted from Red Cabbage. *Polymers*, 11(1088), 1–12.
- Vranova, V., Rejsek, K., & Formanek, P. (2013). Carbohydrates in Soil : A Review. *The ScientificWorld Journal*, 2013.
- Wang, N., Zhang, X., Han, N., & Bai, S. (2009). Effect of citric acid and processing on the performance of thermoplastic starch/montmorillonite nanocomposites. *Carbohydrate Polymers*, 76(1), 68–73. <https://doi.org/10.1016/j.carbpol.2008.09.021>
- Wang, Y., Zhao, Y., & Deng, Y. (2008). Effect of enzymatic treatment on cotton fiber dissolution in NaOH/urea solution at cold temperature. *Carbohydrate Polymers*, 72(1), 178–184. <https://doi.org/10.1016/j.carbpol.2007.08.003>
- Wanrosli, W. D., Rohaizu, R., & Ghazali, A. (2011). Synthesis and characterization of cellulose phosphate from oil palm empty fruit bunches microcrystalline cellulose. *Carbohydrate Polymers*, 84(1), 262–267. <https://doi.org/10.1016/j.carbpol.2010.11.032>
- Waresindo, W. X., Luthfianti, H. R., Edikresnha, D., Suciati, T., Noor, F. A., & Khairurrijal, K. (2021). A freeze-thaw PVA hydrogel loaded with guava leaf extract: physical and antibacterial properties. *RSC Advances*, 11(48), 30156–30171. <https://doi.org/10.1039/d1ra04092h>
- West, M. E., & Mauer, L. J. (2013). Color and chemical stability of a variety of anthocyanins and ascorbic acid in solution and powder forms. *Journal of Agricultural and Food Chemistry*, 61(17), 4169–4179. <https://doi.org/10.1021/jf400608b>
- Wszelaki, A. L., & Mitcham, E. J. (2000). Effects of superatmospheric oxygen on strawberry fruit quality and decay. *Postharvest Biology and Technology*,

20(2), 125–133. [https://doi.org/10.1016/S0925-5214\(00\)00135-6](https://doi.org/10.1016/S0925-5214(00)00135-6)

- Wu, C., Sun, J., Chen, M., Ge, Y., Ma, J., Hu, Y., Pang, J., & Yan, Z. (2019). Effect of oxidized chitin nanocrystals and curcumin into chitosan films for seafood freshness monitoring. *Food Hydrocolloids*, 95, 308–317. <https://doi.org/10.1016/j.foodhyd.2019.04.047>
- Wu, C., Sun, J., Zheng, P., Kang, X., Chen, M., Li, Y., Ge, Y., Hu, Y., & Pang, J. (2019). Preparation of an intelligent film based on chitosan/oxidized chitin nanocrystals incorporating black rice bran anthocyanins for seafood spoilage monitoring. *Carbohydrate Polymers*, 222, 115006. <https://doi.org/10.1016/j.carbpol.2019.115006>
- Xiang, L. Y., Mohammed, M. A. P., & Baharuddin, A. S. (2016). Characterisation of microcrystalline cellulose from oil palm fibres for food applications. *Carbohydrate Polymers*, 148, 11–20. <https://doi.org/10.1016/j.carbpol.2016.04.055>
- Xiang, L. Y., Mohammed, M. A., & Samsu Baharuddin, A. (2016). Characterisation of microcrystalline cellulose from oil palm fibres for food applications. *Carbohydrate Polymers*, 148, 11–20. <https://doi.org/10.1016/j.carbpol.2016.04.055>
- Xiao, Y., Kang, S., Liu, Y., Guo, X., Li, M., & Xu, H. (2021). Effect and mechanism of calcium ions on the gelation properties of cellulose nanocrystals-whey protein isolate composite gels. *Food Hydrocolloids*, 111(September), 106401. <https://doi.org/10.1016/j.foodhyd.2020.106401>
- Xiao, Y., Li, J., Liu, Y., Peng, F., Wang, X., Wang, C., Li, M., & Xu, H. (2020). Gel properties and formation mechanism of soy protein isolate gels improved by wheat bran cellulose. *Food Chemistry*, 324, 126876. <https://doi.org/10.1016/j.foodchem.2020.126876>
- Xiao, Y., Liu, Y., Kang, S., Cui, M., & Xu, H. (2021). Development of pH-responsive antioxidant soy protein isolate films incorporated with cellulose nanocrystals and curcumin nanocapsules to monitor shrimp freshness. *Food Hydrocolloids*, 120(November 2020), 106893. <https://doi.org/10.1016/j.foodhyd.2021.106893>
- Xiao, Y., Liu, Y., Kang, S., & Xu, H. (2021). Insight into the formation mechanism of soy protein isolate films improved by cellulose nanocrystals. *Food Chemistry*, 359(March), 129971. <https://doi.org/10.1016/j.foodchem.2021.129971>
- Xu, X., Jiang, L., Zhu, J. Y., & Haagensohn, D. M. (2013). *Cellulose Nanocrystals vs. Cellulose Nanofibrils: A Comparative Study on Their Microstructures and Effects as Polymer Reinforcing Agents*. March. <https://doi.org/10.1021/am302624t>
- Yan, L., Wang, L., Gao, S., Liu, C., Zhang, Z., Ma, A., & Zheng, L. (2019). Celery cellulose hydrogel as carriers for controlled release of short-chain fatty acid by ultrasound. *Food Chemistry*, 309(March 2019), 125717. <https://doi.org/10.1016/j.foodchem.2019.125717>

- Yang, J., Shen, M., Luo, Y., Wu, T., Chen, X., Wang, Y., & Xie, J. (2021). Advanced applications of chitosan-based hydrogels: From biosensors to intelligent food packaging system. *Trends in Food Science and Technology*, *110*(235), 822–832. <https://doi.org/10.1016/j.tifs.2021.02.032>
- Yang, J., Webb, A. R., & Ameer, G. A. (2004). Novel Citric Acid-Based Biodegradable Elastomers for Tissue Engineering. *Advanced Materials*, *16*(6), 511–516. <https://doi.org/10.1002/adma.200306264>
- Yang, Z., Peng, H., Wang, W., & Liu, T. (2010). Crystallization behavior of poly(ϵ -caprolactone)/layered double hydroxide nanocomposites. *Journal of Applied Polymer Science*, *116*(5), 2658–2667. <https://doi.org/10.1002/app>
- Yaşar, F., Toğrul, H., & Arslan, N. (2007). Flow properties of cellulose and carboxymethyl cellulose from orange peel. *Journal of Food Engineering*, *81*(1), 187–199. <https://doi.org/10.1016/j.jfoodeng.2006.10.022>
- Yimlamai, B., Choorit, W., Chisti, Y., & Prasertsan, P. (2021). Cellulose from oil palm empty fruit bunch fiber and its conversion to carboxymethylcellulose. *Journal of Chemical Technology and Biotechnology*, *96*(6), 1656–1666. <https://doi.org/10.1002/jctb.6689>
- Yong, H., Wang, X., Zhang, X., Liu, Y., Qin, Y., & Liu, J. (2019). Effects of anthocyanin-rich purple and black eggplant extracts on the physical, antioxidant and pH-sensitive properties of chitosan film. *Food Hydrocolloids*, *94*, 93–104. <https://doi.org/10.1016/j.foodhyd.2019.03.012>
- Zailuddin, N. L. I., & Husseinsyah, S. (2016). Tensile Properties and Morphology of Oil Palm Empty Fruit Bunch Regenerated Cellulose Biocomposite Films. *Procedia Chemistry*, *19*, 366–372. <https://doi.org/10.1016/j.proche.2016.03.025>
- Zainal, S. H., Mohd, N. H., Suhaili, N., Anuar, F. H., Lazim, A. M., & Othaman, R. (2021). Preparation of cellulose-based hydrogel: A review. *Journal of Materials Research and Technology*, *10*, 935–952. <https://doi.org/10.1016/j.jmrt.2020.12.012>
- Zeng, P., Chen, X., Qin, Y. R., Zhang, Y. H., Wang, X. P., Wang, J. Y., Ning, Z. X., Ruan, Q. J., & Zhang, Y. S. (2019). Preparation and characterization of a novel colorimetric indicator film based on gelatin/polyvinyl alcohol incorporating mulberry anthocyanin extracts for monitoring fish freshness. *Food Research International*, *126*(8), 108604 1-8. <https://doi.org/10.1016/j.foodres.2019.108604>
- Zhai, X., Li, Z., Zhang, J., Shi, J., Zou, X., Huang, X., Zhang, D., Sun, Y., Yang, Z., Holmes, M., Gong, Y., & Povey, M. (2018). Natural Biomaterial-Based Edible and pH-Sensitive Films Combined with Electrochemical Writing for Intelligent Food Packaging. *Journal of Agricultural and Food Chemistry*, *66*(48), 12836–12846. <https://doi.org/10.1021/acs.jafc.8b04932>
- Zhai, X., Shi, J., Zou, X., Wang, S., Jiang, C., Zhang, J., Huang, X., Zhang, W., & Holmes, M. (2017). Novel colorimetric films based on starch/polyvinyl alcohol incorporated with roselle anthocyanins for fish freshness monitoring. *Food Hydrocolloids*, *69*, 308–317.

<https://doi.org/10.1016/j.foodhyd.2017.02.014>

- Zhang, B. H., Wang, Z., Zhang, Z., Wu, J., Zhang, J., & He, J. (2007). *Regenerated-Cellulose / Multiwalled-Carbon-Nanotube Composite Fibers with Enhanced Mechanical Properties Prepared with the Ionic Liquid 1-Allyl-3-methylimidazolium Chloride* **. 2004, 698–704. <https://doi.org/10.1002/adma.200600442>
- Zhang, J., Choi, Y. S., Yoo, C. G., Kim, T. H., Brown, R. C., & Shanks, B. H. (2015). Cellulose-hemicellulose and cellulose-lignin interactions during fast pyrolysis. *ACS Sustainable Chemistry and Engineering*, 3(2), 293–301. <https://doi.org/10.1021/sc500664h>
- Zhang, X., Lu, S., & Chen, X. (2014). A visual pH sensing film using natural dyes from *Bauhinia blakeana* Dunn. *Sensors and Actuators, B: Chemical*, 198, 268–273. <https://doi.org/10.1016/j.snb.2014.02.094>
- Zhang, X., Zou, W., Xia, M., Zeng, Q., & Cai, Z. (2022). Intelligent colorimetric film incorporated with anthocyanins-loaded ovalbumin-propylene glycol alginate nanocomplexes as a stable pH indicator of monitoring pork freshness. *Food Chemistry*, 368(August 2021), 130825. <https://doi.org/10.1016/j.foodchem.2021.130825>
- Zhao, Y., He, M., Zhao, L., Wang, S., Li, Y., Gan, L., Li, M., Xu, L., Chang, P. R., Anderson, D. P., & Chen, Y. (2016). Epichlorohydrin-Cross-linked Hydroxyethyl Cellulose/Soy Protein Isolate Composite Films as Biocompatible and Biodegradable Implants for Tissue Engineering. *ACS Applied Materials and Interfaces*, 8(4), 2781–2795. <https://doi.org/10.1021/acsami.5b11152>
- Zhou, J., Tong, J., Su, X., & Ren, L. (2016). Hydrophobic starch nanocrystals preparations through crosslinking modification using citric acid. *International Journal of Biological Macromolecules*, 91, 1186–1193. <https://doi.org/10.1016/j.ijbiomac.2016.06.082>
- Zhou, X., Li, W., Mabon, R., & Broadbelt, L. J. (2017). A critical review on hemicellulose pyrolysis. *Energy Technology*, 5(1), 52–79. <https://doi.org/10.1002/ente.201600327>
- Zhou, Y., Luner, P., & Caluwe, P. (1995). Mechanism of Crosslinking of Papers with Polyfunctional Carboxylic Acids. *Journal of Applied of Polymer Science*, 58, 1523–1534.
- Zianor Azrina, Z. A., Beg, M. D. H., Rosli, M. Y., Ramli, R., Junadi, N., & Alam, A. K. M. M. (2017a). Spherical nanocrystalline cellulose (NCC) from oil palm empty fruit bunch pulp via ultrasound assisted hydrolysis. *Carbohydrate Polymers*, 162, 115–120. <https://doi.org/10.1016/j.carbpol.2017.01.035>
- Zianor Azrina, Z. A., Beg, M. D. H., Rosli, M. Y., Ramli, R., Junadi, N., & Alam, A. K. M. M. (2017b). Spherical nanocrystalline cellulose (NCC) from oil palm empty fruit bunch pulp via ultrasound assisted hydrolysis. *Carbohydrate Polymers*, 162(17), 115–120. <https://doi.org/10.1016/j.carbpol.2017.01.035>
- Zubair, M., Rauf, Z., Fatima, S., & Ullah, A. (2024). Lignin-derived

bionanocomposites as functional food packaging materials. *Sustainable Food Technology*, 2(4), 945–966. <https://doi.org/10.1039/d4fb00105b>

Zugenmaier, P. (2008). *Springer Series in Wood Science Series Editors Professor Dr . R upert W immer Department of Material Sciences and Process Engineering Springer Series in Wood Science.*