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DAFTAR PUSTAKA

Adam, F., Othman, N. A., Yasin, N. H. M., Cheng, C. K., & Azman, N. A. M. (2022). Evaluation of Reinforced and Green Bioplastic from Carrageenan Seaweed with Nanocellulose. *Fibers and Polymers*, *23*(10), 2885–2896. https://doi.org/10.1007/s12221-022-4006-6

Afni, N. N., Kusumaningrum, W. B., Hermawan, D., Nurhamiyah, Y., Nurhayat, O. D., & Dimyati, A. (2024). Deep Eutectic Solvent Pre-treated Sweet Sorghum Stalk (Sorghum Bicolor (L.) Moench) Nanocellulose and Its Application to Agar-Based Bioplastics. *Waste and Biomass Valorization*, *0123456789*. https://doi.org/10.1007/s12649-024-02774-z

Aguilar, J. M., Bengoechea, C., Pérez, E., & Guerrero, A. (2020). Effect of different polyols as plasticizers in soy based bioplastics. *Industrial Crops and Products*, *153*(January). https://doi.org/10.1016/j.indcrop.2020.112522

Al-Arjan, W. S., Khan, M. U. A., Almutairi, H. H., Alharbi, S. M., & Razak, S. I. A. (2022). pH-Responsive PVA/BC-f-GO Dressing Materials for Burn and Chronic Wound Healing with Curcumin Release Kinetics. *Polymers*, *14*(10). https://doi.org/10.3390/polym14101949

Al Fath, M. T., Lubis, M., Ayu, G. E., & Dalimunthe, N. F. (2022). Pengaruh Selulosa Nanokristal dari Serat Buah Kelapa Sawit sebagai Pengisi dan Kalium Klorida sebagai Agen Pendispersi Terhadap Sifat Fisik Bioplastik Berbasis Pati Biji Alpukat (Persea americana). *Jurnal Teknik Kimia USU*, *11*(2), 89–94.

Al, M., Dharma, R., Hendradi, E., Pudjiastuti, P., & Teguh, R. (2021). *Analysis of Dissolution of Salicylamide from Carrageenan Based Hard-Shell Capsules : A Study of the Drug-Matrix Interaction*. *21*(1), 148–156. https://doi.org/10.22146/ijc.55047

Al Rizqi Dharma Fauzi, M., Pudjiastuti, P., Hendradi, E., & Teguh Widodo, R. (2023). Development of a potential carrageenan-based hard capsule as the alternative of conventional capsules by implementing the oligomerization reaction. *Journal of Saudi Chemical Society*, *27*(4), 101672. https://doi.org/10.1016/j.jscs.2023.101672

Askarizadeh, M., Esfandiari, N., Honarvar, B., Sajadian, S. A., & Azdarpour, A. (2023). Kinetic Modeling to Explain the Release of Medicine from Drug Delivery Systems. *ChemBioEng Reviews*, *10*(6), 1006–1049. https://doi.org/10.1002/cben.202300027

Asrofi, M., Abral, H., Putra, Y. K., Sapuan, S. M., & Kim, H. J. (2018). Effect of duration of sonication during gelatinization on properties of tapioca starch water hyacinth fiber biocomposite. *International Journal of Biological Macromolecules*, *108*, 167–

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

176. https://doi.org/10.1016/j.ijbiomac.2017.11.165

Asrofi, M., Setyobudi, R., Ilyas, R. A., Sanyang, M. L., Adegbenjo, A. O., Idris, I., Thiagamani, S. M. K., Midhun Dominic, C. D., Knight, V. F., Norrrahim, M. N. F., Rajeshkumar, L., & Asyraf, M. R. M. (2023). Influence of ultrasonication time on the various properties of alkaline-treated mango seed waste filler reinforced PVA biocomposite. *Reviews on Advanced Materials Science*, *62*(1). https://doi.org/10.1515/rams-2023-0137

Baghel, R. S., Reddy, C. R. K., & Singh, R. P. (2021). Seaweed-based cellulose: Applications, and future perspectives. *Carbohydrate Polymers*, *267*(March), 118241. https://doi.org/10.1016/j.carbpol.2021.118241

Balcerzak, J., & Mucha, M. (2010). Analysis of model drug release kinetics from complex matrices of polylactide-chitosan. *Progress on Chemistry and Application of Chitin and its Derivatives*, *XV*(15), 117–126.

Barbosa, J. A. C., Al-Kauraishi, M. M., Smith, A. M., Conway, B. R., & Merchant, H. A. (2019). Achieving gastroresistance without coating: Formulation of capsule shells from enteric polymers. *European Journal of Pharmaceutics and Biopharmaceutics*, *144*(May), 174–179. https://doi.org/10.1016/j.ejpb.2019.09.015

Cai, B., Mazahreh, J., Ma, Q., Wang, F., & Hu, X. (2022). Ultrasound-assisted fabrication of biopolymer materials: A review. *International Journal of Biological Macromolecules*, *209*(PB), 1613–1628. https://doi.org/10.1016/j.ijbiomac.2022.04.055

Carreira-Casais, A., Otero, P., Garcia-Perez, P., Garcia-Oliveira, P., Pereira, A. G., Carpena, M., Soria-Lopez, A., Simal-Gandara, J., & Prieto, M. A. (2021). Benefits and drawbacks of ultrasound-assisted extraction for the recovery of bioactive compounds from marine algae. *International Journal of Environmental Research and Public Health*, *18*(17). https://doi.org/10.3390/ijerph18179153

Chen, Q. J., Zong, Z. Y., Gao, X., Zhao, Y. L., & Wang, J. H. (2021). Preparation and characterization of nanostarch-based green hard capsules reinforced by cellulose nanocrystals. *International Journal of Biological Macromolecules*, *167*, 1241–1247. https://doi.org/10.1016/j.ijbiomac.2020.11.078

Chou, S. F., Carson, D., & Woodrow, K. A. (2015). Current strategies for sustaining drug release from electrospun nanofibers. *Journal of Controlled Release*, *220*, 584–591. https://doi.org/10.1016/j.jconrel.2015.09.008

Cunha, L., & Grenha, A. (2016). Sulfated seaweed polysaccharides as multifunctional

Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

materials in drug delivery applications. *Marine Drugs*, *14*(3). https://doi.org/10.3390/md14030042

De, D., Naga Sai, M. S., Aniya, V., & Satyavathi, B. (2021). Strategic biorefinery platform for green valorization of agro-industrial residues: A sustainable approach towards biodegradable plastics. *Journal of Cleaner Production*, *290*, 125184. https://doi.org/10.1016/j.jclepro.2020.125184

Diarsa, M., & Gupte, A. (2021). Preparation, characterization and its potential applications in Isoniazid drug delivery of porous microcrystalline cellulose from banana pseudostem fibers. *3 Biotech*, *11*(7), 1–13. https://doi.org/10.1007/s13205-021-02838-0

Ding, Y., Zhong, B., Yang, T., Zhang, F., Liu, C., & Chi, Z. (2024). Carboxyl-modified nanocellulose (cNC) enhances the stability of cNC/pullulan bio-nanocomposite hard capsule against moisture variation. *Carbohydrate Polymers*, *328*(October 2023), 121706. https://doi.org/10.1016/j.carbpol.2023.121706

El Allaoui, B., Benzeid, H., Zari, N., Qaiss, A. el kacem, & Bouhfid, R. (2023). Functional cellulose-based beads for drug delivery: Preparation, functionalization, and applications. *Journal of Drug Delivery Science and Technology*, *88*(August), 104899. https://doi.org/10.1016/j.jddst.2023.104899

Elmas, A., Akyüz, G., Bergal, A., Andaç, M., Elmas, A., Akyuz, G., Bergal, A., Andac, M., Mathematical, A. O., Release, D., Eng, R., & Mater, S. (2020). *Mathematical Modelling of Drug Release Online Publication Date : 30 March 2020 To cite this article*. *March*.

Erawati, E., Hamid, H., Musthofa, M., Fatoni, R., Nurwaini, S., & Rahmah, A. U. (2023). Drug release kinetics of capsule shells from seaweed carrageenan extract (Eucheuma cottonii) and potato starch as a gelling agent. *Bulletin of the National Research Centre*. https://doi.org/10.1186/s42269-023-01045-6

Erawati, E., Hamid, H., Musthofa, M., Fatoni, R., Nurwaini, S., Rahmah, A. U., & Setiawan, P. R. (2023). Drug release kinetics of capsule shells from seaweed carrageenan extract (Eucheuma cottonii) and potato starch as a gelling agent. *Bulletin of the National Research Centre*, *47*(1). https://doi.org/10.1186/s42269-023-01045-6

Fauzi, M. A. R. D., Pudjiastuti, P., Hendradi, E., Widodo, R. T., & Amin, M. C. I. M. (2020). Characterization, Disintegration, and Dissolution Analyses of Carrageenan-Based Hard-Shell Capsules Cross-Linked with Maltodextrin as a Potential

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Alternative Drug Delivery System. *International Journal of Polymer Science*, *2020*. https://doi.org/10.1155/2020/3565931

Fauzi, M. A. R. D., Pudjiastuti, P., & Wibowo, A. C. (2021). *Preparation , Properties and Potential of Carrageenan-Based Hard Capsules for Replacing Gelatine : A Review*.

Fauzi, M. A. R. D., Pudjiastuti, P., Wibowo, A. C., & Hendradi, E. (2021). Preparation, properties and potential of carrageenan-based hard capsules for replacing gelatine: A review. *Polymers*, *13*(16). https://doi.org/10.3390/polym13162666

Ferrara, K., Pollard, R., & Borden, M. (2007). Ultrasound microbubble contrast agents: Fundamentals and application to gene and drug delivery. *Annual Review of Biomedical Engineering*, *9*, 415–447. https://doi.org/10.1146/annurev.bioeng.8.061505.095852

Firmanda, A., Fahma, F., Syamsu, K., Purnawati, R., Irawan, F. H., Munif, A., Suryanegara, L., Mahardika, M., Dewi, I. A., & MacMillan, C. (2024). Immobilization of urea on beads based on OPEFB cellulose-alginate via blending to fabricate sustained release fertilizer. *International Journal of Biological Macromolecules*, *282*(P6), 137467. https://doi.org/10.1016/j.ijbiomac.2024.137467

World Fisheries and Aquaculture, FAO:Rome,2022, (2022).

Franc, A., Vetchý, D., & Fülöpová, N. (2022). Commercially Available Enteric Empty Hard Capsules, Production Technology and Application. *Pharmaceuticals*, *15*(11). https://doi.org/10.3390/ph15111398

Fu, Y., Kao, W. J., Fu, Y., & Kao, W. J. (2016). *Drug release kinetics and transport mechanisms of non-degradable and degradable polymeric delivery systems Drug release kinetics and transport mechanisms of non-degradable and degradable polymeric delivery systems*. *5247*(December). https://doi.org/10.1517/17425241003602259

Gómez-Mascaraque, L. G., Llavata-Cabrero, B., Martínez-Sanz, M., Fabra, M. J., & López-Rubio, A. (2018). Self-assembled gelatin-ι-carrageenan encapsulation structures for intestinal-targeted release applications. *Journal of Colloid and Interface Science*, *517*, 113–123. https://doi.org/10.1016/j.jcis.2018.01.101

Goyanes, A., Chang, H., Sedough, D., Hatton, G. B., Wang, J., Buanz, A., Gaisford, S., & Basit, A. W. (2015). Fabrication of controlled-release budesonide tablets via desktop (FDM) 3D printing. *International Journal of Pharmaceutics*, *496*(2), 414–420. https://doi.org/10.1016/j.ijpharm.2015.10.039

Hamdan, M. A., Khairatun Najwa, M. A., Jose, R., Martin, D., & Adam, F. (2021). Tuning

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

mechanical properties of seaweeds for hard capsules: A step forward for a sustainable drug delivery medium. *Food Hydrocolloids for Health*, *1*(August), 100023. https://doi.org/10.1016/j.fhfh.2021.100023

Hamdan, M. A., Ramli, N. A., Othman, N. A., Mohd Amin, K. N., & Adam, F. (2021). Characterization and property investigation of microcrystalline cellulose (MCC) and carboxymethyl cellulose (CMC) filler on the carrageenan-based biocomposite film. *Materials Today: Proceedings*, *42*, 56–62. https://doi.org/10.1016/j.matpr.2020.09.304

Hasan, M., Elkhoury, K., Kahn, C. J. F., Arab-tehrany, E., & Linder, M. (2019). Curcumin in Simulated Environments. *Molecules*, *24*, 1–14.

Herdiana, Y., Wathoni, N., Shamsuddin, S., & Muchtaridi, M. (2022). Drug release study of the chitosan-based nanoparticles. *Heliyon*, *8*(1), e08674. https://doi.org/10.1016/j.heliyon.2021.e08674

Hezaveh, H., & Muhamad, I. I. (2013). Modification and swelling kinetic study of kappa-carrageenan-based hydrogel for controlled release study. *Journal of the Taiwan Institute of Chemical Engineers*, *44*(2), 182–191. https://doi.org/10.1016/j.jtice.2012.10.011

Hook, M., & Smith, A. (1875). *The oldest polymer*.

Jafari, S., Soleimani, M., & Badinezhad, M. (2022). Application of different mathematical models for further investigation of in vitro drug release mechanisms based on magnetic nano-composite. *Polymer Bulletin*, *79*(2), 1021–1038. https://doi.org/10.1007/s00289-021-03537-9

Jawaid, M., & Mohammad, F. (2017). *Nanocellulose and Nanohydrogel Matrices: Biotechnological and Biomedical Applications*. Wiley-VCH.

Jiang, F., Zhang, J., Xu, H., Lu, Y., Wei, S., & Li, Z. (2023). In situ preparation of monodisperse lignin-poly (lactic acid) microspheres for efficient encapsulation of 2,4-dichlorophenoxyacetic acid and controlled release. *Reactive and Functional Polymers*, *184*(November 2022), 105517. https://doi.org/10.1016/j.reactfunctpolym.2023.105517

Johnson, C., Chen, B., Bhalla, A., Crowell, E., & Zhang, F. (2025). Elimination of “ lag ” and “ burst ” phases in drug release profiles of. *International Journal of Pharmaceutics*, *681*(April), 125822. https://doi.org/10.1016/j.ijpharm.2025.125822

Kalmer, R. R., Karimi, A., Moosavi, S., Ghanbari, M., Sadjadinia, A., Samandarian, D., Ramezanalizadeh, H., & Gholizadeh dogaheh, S. (2024). Novel formulation of

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

uncoated enteric capsule shells: Study the effect of gelling agents and salts on the rheology and physical properties. *Materials Chemistry and Physics*, *312*(July 2023), 128614. https://doi.org/10.1016/j.matchemphys.2023.128614

Kambayashi, A., Blume, H., & Dressman, J. B. (2014). Predicting the oral pharmacokinetic profiles of multiple-unit (pellet) dosage forms using a modeling and simulation approach coupled with biorelevant dissolution testing: Case example diclofenac sodium. *European Journal of Pharmaceutics and Biopharmaceutics*, *87*(2), 236–243. https://doi.org/10.1016/j.ejpb.2014.01.007

Kang, Y., Chen, J., Duan, Z., & Li, Z. (2023). Predicting Dissolution of Entecavir Using the Noyes Whitney Equation. *Dissolution Technologies*, *30*(1), 38–45. https://doi.org/10.14227/DT300123P38

Kassab, Z., Aziz, F., Hannache, H., Ben Youcef, H., & El Achaby, M. (2019). Improved mechanical properties of k-carrageenan-based nanocomposite films reinforced with cellulose nanocrystals. *International Journal of Biological Macromolecules*, *123*, 1248–1256. https://doi.org/10.1016/j.ijbiomac.2018.12.030

Kassab, Z., Daoudi, H., Salim, M. H., El Idrissi El Hassani, C., Abdellaoui, Y., & El Achaby, M. (2024). Process-structure-property relationships of cellulose nanocrystals derived from Juncus effusus stems on κ-carrageenan-based bio-nanocomposite films. *International Journal of Biological Macromolecules*, *265*(October 2023). https://doi.org/10.1016/j.ijbiomac.2024.130892

Kiew, H. Y. L. P. L., & Lam, L. S. T. M. K. (2023). Deciphering the effects of plasticizers in potato - based bioplastic for food and fresh produce packaging. *International Journal of Environmental Science and Technology*, *20*(12), 13703–13716. https://doi.org/10.1007/s13762-023-04936-3

Koshani, R., & Jafari, S. M. (2019). Ultrasound-assisted preparation of different nanocarriers loaded with food bioactive ingredients. *Advances in Colloid and Interface Science*, *270*, 123–146. https://doi.org/10.1016/j.cis.2019.06.005

Kruk, K., & Winnicka, K. (2024). Hard Gelatin Capsules with Alginate-Hypromellose Microparticles as a Multicompartment Drug Delivery System for Sustained Posaconazole Release. *International Journal of Molecular Sciences*, *25*(13). https://doi.org/10.3390/ijms25137116

Lee, J. H., & Yeo, Y. (2015). Controlled drug release from pharmaceutical nanocarriers. *Chemical Engineering Science*, *125*, 75–84. https://doi.org/10.1016/j.ces.2014.08.046

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Lelekakis, N., Wijaya, J., Martin, D., & Susa, D. (2014). The effect of acid accumulation in power-transformer oil on the aging rate of paper insulation. *IEEE Electrical Insulation Magazine*, *30*(3), 19–26. https://doi.org/10.1109/MEI.2014.6804738

Li, D. qiang, Wang, S. ya, Meng, Y. jie, Guo, Z. wei, Cheng, M. mei, & Li, J. (2021). Fabrication of self-healing pectin/chitosan hybrid hydrogel via Diels-Alder reactions for drug delivery with high swelling property, pH-responsiveness, and cytocompatibility. *Carbohydrate Polymers*, *268*(July 2020), 118244. https://doi.org/10.1016/j.carbpol.2021.118244

Liu, F., Duan, G., & Yang, H. (2023). Recent advances in exploiting carrageenans as a versatile functional material for promising biomedical applications. *International Journal of Biological Macromolecules*, *235*(October 2022), 123787. https://doi.org/10.1016/j.ijbiomac.2023.123787

Liu, Y., Liu, D., Zhu, L., Gan, Q., & Le, X. (2015). Temperature-dependent structure stability and in vitro release of chitosan-coated curcumin liposome. *Food Research International*, *74*, 97–105. https://doi.org/10.1016/j.foodres.2015.04.024

Mahardika, M., Abral, H., Kasim, A., Arief, S., & Asrofi, M. (2018). Production of Nanocellulose From Pineapple Leaf Fibers Via High-Shear Homogenization and Ultrasonication. *Fibers*, *6*(2), 1–12. https://doi.org/10.3390/fib6020028

Mahdavinia, G. R., Etemadi, H., & Soleymani, F. (2015). Magnetic/pH-responsive beads based on caboxymethyl chitosan and κ-carrageenan and controlled drug release. *Carbohydrate Polymers*, *128*, 112–121. https://doi.org/10.1016/j.carbpol.2015.04.022

Mansoorianfar, M., Khataee, A., Riahi, Z., Shahin, K., Asadnia, M., Razmjou, A., Hojjati-Najafabadi, A., Mei, C., Orooji, Y., & Li, D. (2020). Scalable fabrication of tunable titanium nanotubes via sonoelectrochemical process for biomedical applications. *Ultrasonics Sonochemistry*, *64*(July 2019), 104783. https://doi.org/10.1016/j.ultsonch.2019.104783

Mariia, K., Arif, M., Ding, Y., Chi, Z., & Liu, C. (2023). Preparation of Novel Hard Capsule Using Water-Soluble Polysaccharides and Cellulose Nanocrystals for Drug Delivery. *Journal of Pharmaceutical Innovation*, *18*(2), 675–686. https://doi.org/10.1007/s12247-022-09671-9

Maroni, A., Zema, L., Cerea, M., Foppoli, A., Palugan, L., & Gazzaniga, A. (2016). Journal of Drug Delivery Science and Technology Erodible drug delivery systems for time-controlled release into the gastrointestinal tract. *Journal of Drug Delivery*

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Science and Technology, *32*, 229–235. https://doi.org/10.1016/j.jddst.2015.10.001

Merchant, H. A. L. I. (2012). *In-vitro, in-vivo and in-silico models in oral drug delivery and their relevance to human gastrointestinal physiology*. University of London.

Merino, D., & Athanassiou, A. (2023). Alkaline hydrolysis of biomass as an alternative green method for bioplastics preparation: In situ cellulose nanofibrillation. *Chemical Engineering Journal*, *454*(P4), 140171. https://doi.org/10.1016/j.cej.2022.140171

Mirzaei-Mohkam, A., Garavand, F., Dehnad, D., Keramat, J., & Nasirpour, A. (2020). Physical, mechanical, thermal and structural characteristics of nanoencapsulated vitamin E loaded carboxymethyl cellulose films. *Progress in Organic Coatings*, *138*(September 2019), 105383. https://doi.org/10.1016/j.porgcoat.2019.105383

Mohammadian, M., Salami, M., Moghadam, M., Amirsalehi, A., & Emam-Djomeh, Z. (2021). Mung bean protein as a promising biopolymeric vehicle for loading of curcumin: Structural characterization, antioxidant properties, and in vitro release kinetics. *Journal of Drug Delivery Science and Technology*, *61*(October 2020), 102148. https://doi.org/10.1016/j.jddst.2020.102148

Mohammed, A., Gaduan, A., Chaitram, P., Pooran, A., Lee, K. Y., & Ward, K. (2023). Sargassum inspired, optimized calcium alginate bioplastic composites for food packaging. *Food Hydrocolloids*, *135*(July 2022), 108192. https://doi.org/10.1016/j.foodhyd.2022.108192

Nazrin, A., Ilyas, R. A., Rajeshkumar, L., Hazrati, K. Z., Jamal, T., Mahardika, M., Aisyah, H. A., Atiqah, A., & Radzi, A. M. (2025). Lignocellulosic fiber-reinforced starch thermoplastic composites for food packaging application: A review of properties and food packaging abetted with safety aspects. *Food Packaging and Shelf Life*, *47*(December 2024), 101431. https://doi.org/10.1016/j.fpsl.2025.101431

Noreen, S., Ma, J. X., Saeed, M., Pervaiz, F., Hanif, M. F., Ahmed, B., Farooq, M. I., Akram, F., Safdar, M., Madni, A., Naveed, M., & Chang-Xing, L. (2022). Natural polysaccharide-based biodegradable polymeric platforms for transdermal drug delivery system: a critical analysis. *Drug Delivery and Translational Research*, *12*(11), 2649–2666. https://doi.org/10.1007/s13346-022-01152-3

Nsor-Atindana, J., Chen, M., Goff, H. D., Zhong, F., Sharif, H. R., & Li, Y. (2017). Functionality and nutritional aspects of microcrystalline cellulose in food. *Carbohydrate Polymers*, *172*, 159–174. https://doi.org/10.1016/j.carbpol.2017.04.021

Othman, N. A., Adam, F., & Mat Yasin, N. H. (2020). Reinforced bioplastic film at

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

different microcrystalline cellulose concentration. *Materials Today: Proceedings*, *41*, 77–82. https://doi.org/10.1016/j.matpr.2020.11.1010

Paarakh, M. P., Jose, P. A. N. I., Setty, C. M., & Peter, G. V. (2019). Release Kinetics – Concepts and Applications. *International Journal of Pharmacy Research & Technology*, *8*(1), 12–20. https://doi.org/10.31838/ijprt/08.01.02

Paniz, O. G., Pereira, C. M. P., Pacheco, B. S., Wolke, S. I., Maron, G. K., Mansilla, A., Colepicolo, P., Orlandi, M. O., Osorio, A. G., & Carreño, N. L. V. (2020). Cellulosic material obtained from Antarctic algae biomass. *Cellulose*, *27*(1), 113–126. https://doi.org/10.1007/s10570-019-02794-2

Penjumras, P., Abdul Rahman, R., Talib, R. A., & Abdan, K. (2015). Response Surface Methodology for the Optimization of Preparation of Biocomposites Based on Poly(lactic acid) and Durian Peel Cellulose. *Scientific World Journal*, *2015*. https://doi.org/10.1155/2015/293609

Perdagangan, kementerian. (2023). *Laporan Perdagangan*.

Pudjiastuti, P., Wafiroh, S., Hendradi, E., Darmokoesoemo, H., Harsini, M., Fauzi, M. A. R. D., Nahar, L., & Sarker, S. D. (2020). Disintegration, in vitro Dissolution, and Drug Release Kinetics Profiles of k-Carrageenan-based Nutraceutical Hard-shell Capsules Containing Salicylamide. *Open Chemistry*, *18*(1), 226–231. https://doi.org/10.1515/chem-2020-0028

Putro, J. N., Soetaredjo, F. E., Lunardi, V. B., Irawaty, W., Yuliana, M., Santoso, S. P., Puspitasari, N., Wenten, I. G., & Ismadji, S. (2023). Polysaccharides gums in drug delivery systems: A review. *International Journal of Biological Macromolecules*, *253*(P4), 127020. https://doi.org/10.1016/j.ijbiomac.2023.127020

Qiu, W. Y., Cai, W. D., Wang, M., & Yan, J. K. (2019). Effect of ultrasonic intensity on the conformational changes in citrus pectin under ultrasonic processing. *Food Chemistry*, *297*(June), 125021. https://doi.org/10.1016/j.foodchem.2019.125021

Raghav, N., Vashisth, C., Mor, N., Arya, P., Sharma, M. R., Kaur, R., Bhatti, S. P., & Kennedy, J. F. (2023). Recent advances in cellulose, pectin, carrageenan and alginate-based oral drug delivery systems. *International Journal of Biological Macromolecules*, *244*(August 2022), 125357. https://doi.org/10.1016/j.ijbiomac.2023.125357

Rajmane, A., Trivedi, R., & Nandgude, T. (2022). A Novel approach to Enhance Gastric Retention for better Therapeutic Activity: Gastro Retentive Drug Delivery System. *Research Journal of Pharmacy and Technology*, *15*(7), 3324–3330.

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
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https://doi.org/10.52711/0974-360X.2022.00556

Ramli, N. A., Adam, F., Amin, K. N. M., Bakar, N. F. A., & Ries, M. E. (2023). Mechanical and Thermal Evaluation of Carrageenan/Hydroxypropyl Methyl Cellulose Biocomposite Incorporated with Modified Starch Corroborated by Molecular Interaction Recognition. *ACS Applied Polymer Materials*, *5*(1), 182–192. https://doi.org/10.1021/acsapm.2c01426

Ramli, N. A., Adam, F., Ries, M. E., & Ibrahim, S. F. (2024). DES-ultrasonication treatment of cellulose nanocrystals and the reinforcement in carrageenan biocomposite. *International Journal of Biological Macromolecules*, *270*(P2), 132385. https://doi.org/10.1016/j.ijbiomac.2024.132385

Ravi, P. R., Kotreka, U. K., & Saha, R. N. (2008). Controlled release matrix tablets of zidovudine: Effect of formulation variables on the in vitro drug release kinetics. *AAPS PharmSciTech*, *9*(1), 302–313. https://doi.org/10.1208/s12249-007-9030-8

Ren, G., He, Y., Liu, C., Ni, F., Luo, X., Shi, J., Song, Y., Li, T., Huang, M., Shen, Q., & Xie, H. (2022). Encapsulation of curcumin in ZEIN-HTCC complexes: Physicochemical characterization, in vitro sustained release behavior and encapsulation mechanism. *Lwt*, *155*, 112909. https://doi.org/10.1016/j.lwt.2021.112909

Rooze, J., Rebrov, E. V., Schouten, J. C., & Keurentjes, J. T. F. (2013). Dissolved gas and ultrasonic cavitation - A review. *Ultrasonics Sonochemistry*, *20*(1), 1–11. https://doi.org/10.1016/j.ultsonch.2012.04.013

Sabara, Z., Mutmainnah, A., Kalsum, U., Afiah, I. N., Husna, I., Saregar, A., Irzaman, & Umam, R. (2022). Sugarcane Bagasse as the Source of Nanocrystalline Cellulose for Gelatin-Free Capsule Shell. *International Journal of Biomaterials*, *2022*. https://doi.org/10.1155/2022/9889127

Sadati Behbahani, E., Ghaedi, M., Abbaspour, M., Rostamizadeh, K., & Dashtian, K. (2019). Curcumin loaded nanostructured lipid carriers: In vitro digestion and release studies. *Polyhedron*, *164*, 113–122. https://doi.org/10.1016/j.poly.2019.02.002

Salome, A. C., Godswill, C. O., & Ikechukwu, I. O. (2013). Kinetics and mechanisms of drug release from swellable and non swellable matrices: A review. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, *4*(2), 97–103.

Shinga, M. H., Kaseke, T., Pfukwa, T. M., & Fawole, O. A. (2025). Optimization of glycerol and cellulose nanofiber concentrations in Opuntia ficus-indica mucilage films functionalized with pomegranate peel extract for postharvest preservation of

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

banana. *Food Packaging and Shelf Life*, *47*(December 2024), 101428. https://doi.org/10.1016/j.fpsl.2024.101428

Son, G. H., Lee, B. J., & Cho, C. W. (2017). Mechanisms of drug release from advanced drug formulations such as polymeric-based drug-delivery systems and lipid nanoparticles. *Journal of Pharmaceutical Investigation*, *47*(4), 287–296. https://doi.org/10.1007/s40005-017-0320-1

Soraya, M., Laksono, H., Primasari, R., Putri, G., Royanti, I., Perwatasari, D. D., Aulia, R., Dewi, P., & Purwoto, H. (2025). Exploring disintegration and swelling dynamics in Kappa-Carrageenan-based seaweed capsule shells. *South African Journal of Chemical Engineering*, *53*(June 2024), 96–102. https://doi.org/10.1016/j.sajce.2025.04.015

Soundarrajan, C., Vennison S, J., Saraswathi, K., & Emmanuel E. S., C. (2011). Does Chip Size of the Lignocellulosic Bagasse Influence Lignin Degradation with NaOH treatment. *Biosci Biotech Res Asia*, *8*, 2.

Statistik, B. P. (2023). *Statistik Sumberdaya Laut dan Pesisir 2023* (D. S. K. Sosial (ed.); Volume 20). Badan Pusat Statistik.

Sudarwati, W., Hardjomidjojo, H., Machfud, & Setyaningsih, D. (2020). Literature review: Potential and opportunities for the development of seaweed agro-industry. *IOP Conference Series: Earth and Environmental Science*, *472*(1). https://doi.org/10.1088/1755-1315/472/1/012063

Syafri, E., Sudirman, Mashadi, Yulianti, E., Deswita, Asrofi, M., Abral, H., Sapuan, S. M., Ilyas, R. A., & Fudholi, A. (2019). Effect of sonication time on the thermal stability, moisture absorption, and biodegradation of water hyacinth (Eichhornia crassipes) nanocellulose-filled bengkuang (Pachyrhizus erosus) starch biocomposites. *Journal of Materials Research and Technology*, *8*(6), 6223–6231. https://doi.org/10.1016/j.jmrt.2019.10.016

Tecante, A., & Nez Santiago, M. del C. (2012). Solution Properties of κ-Carrageenan and Its Interaction with Other Polysaccharides in Aqueous Media. *Rheology*. https://doi.org/10.5772/36619

Thangavelu, M., & Kulandhaivelu, S. V. (2022). Development and Characterization of Pullulan-Carboxymethyl Cellulose Blend Film for Packaging Applications. *International Journal of Polymer Science*, *2022*. https://doi.org/10.1155/2022/9649726

Thennakoon, T. M., Ching, Y. C., Chuah, C. H., Rahman, N. A., & Nai-Shang, L. (2020).

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

pH-responsive poly(lactic acid)/sodium carboxymethyl cellulose film for enhanced delivery of curcumin in vitro. *Journal of Drug Delivery Science and Technology*, *58*(May), 101787. https://doi.org/10.1016/j.jddst.2020.101787

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

Trifol, J., Sillard, C., Plackett, D., Szabo, P., Bras, J., & Daugaard, A. E. (2017). Chemically extracted nanocellulose from sisal fibres by a simple and industrially relevant process. *Cellulose*, *24*(1), 107–118. https://doi.org/10.1007/s10570-016-1097-5

Tzanakis, I., Eskin, D. G., Georgoulas, A., & Fytanidis, D. K. (2014). Incubation pit analysis and calculation of the hydrodynamic impact pressure from the implosion of an acoustic cavitation bubble. *Ultrasonics Sonochemistry*, *21*(2), 866–878. https://doi.org/10.1016/j.ultsonch.2013.10.003

Ullah, H., Badshah, M., Mäkilä, E., Salonen, J., Shahbazi, M. A., Santos, H. A., & Khan, T. (2017). Fabrication, characterization and evaluation of bacterial cellulose-based capsule shells for oral drug delivery. *Cellulose*, *24*(3), 1445–1454. https://doi.org/10.1007/s10570-017-1202-4

Varma, M. V. S., Kaushal, A. M., Garg, A., & Garg, S. (2004). *Factors Affecting Mechanism and Kinetics of Drug Release from Matrix-Based Oral Controlled Drug Delivery Systems*. *2*(1), 43–57.

Wen, H., & Park, K. (2011). *Oral Controlled Release Formulation Design and Drug Delivery: Theory to Practice.* Wiley Professional, Reference & Trade (Wiley K&L). https://bookshelf.vitalsource.com/books/9781118060322

Wu, J., Kong, T., Wai, K., Yeung, K., Cheung, H., Man, K., Cheung, C., Wang, L., Kai, M., & To, T. (2013). Acta Biomaterialia Fabrication and characterization of monodisperse PLGA – alginate core – shell microspheres with monodisperse size and homogeneous shells for controlled drug release. *Acta Biomaterialia*, *9*(7), 7410–7419. https://doi.org/10.1016/j.actbio.2013.03.022

Xu, D., Cheng, Y., Wu, S., Zou, Q., Mondal, A. K., Ning, D., & Huang, F. (2022). Study on the effect of tunicate cellulose nanocrystals in the preparation of sodium alginate-based enteric capsule. *Cellulose*, *29*(4), 2497–2511. https://doi.org/10.1007/s10570-

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
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Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

022-04445-5

Yadav, M., & Chiu, F. C. (2019). Cellulose nanocrystals reinforced κ-carrageenan based UV resistant transparent bionanocomposite films for sustainable packaging applications. *Carbohydrate Polymers*, *211*(February), 181–194. https://doi.org/10.1016/j.carbpol.2019.01.114

Yu, T., Jiang, N., & Li, Y. (2014). Functionalized multi-walled carbon nanotube for improving the flame retardancy of ramie/poly(lactic acid) composite. *Composites Science and Technology*, *104*, 26–33. https://doi.org/10.1016/j.compscitech.2014.08.021

Zhang, Q., Xu, J., Gao, X., & Fu, X. (2013). Optimized water vapor permeability of sodium alginate films using response surface methodology. *Chinese Journal of Oceanology and Limnology*, *31*(6), 1196–1203. https://doi.org/10.1007/s00343-013-2125-z

Zhang, W., Wang, X. chuan, Wang, J. jun, & Zhang, L. le. (2019). Drugs adsorption and release behavior of collagen/bacterial cellulose porous microspheres. *International Journal of Biological Macromolecules*, *140*, 196–205. https://doi.org/10.1016/j.ijbiomac.2019.08.139

Zhao, J., Li, S., Zhao, Y., & Peng, Z. (2020). Effects of cellulose nanocrystal polymorphs and initial state of hydrogels on swelling and drug release behavior of alginate-based hydrogels. *Polymer Bulletin*, *77*(8), 4401–4416. https://doi.org/10.1007/s00289-019-02972-z

Zheng, B., Yu, Y., Yuan, X., Chen, X., & Yang, Y. (2023). *Sodium alginate / carboxymethyl starch / κ -carrageenan enteric soft capsule : Processing , characterization , and rupture time evaluation*. *244*(April).

Zhou, K., Yang, Y., Zheng, B., Yu, Q., Huang, Y., Zhang, N., Rama, S. M., Zhang, X., Ye, J., & Xiao, M. (2023). Enhancing Pullulan Soft Capsules with a Mixture of Glycerol and Sorbitol Plasticizers: A Multi-Dimensional Study. *Polymers*, *15*(10). https://doi.org/10.3390/polym15102247

Zhu, M., Ge, L., Lyu, Y., Zi, Y., Li, X., Li, D., & Mu, C. (2017). Preparation, characterization and antibacterial activity of oxidized κ-carrageenan. *Carbohydrate Polymers*, *174*, 1051–1058. https://doi.org/10.1016/j.carbpol.2017.07.029

Zia, K. M., Tabasum, S., Nasif, M., Sultan, N., Aslam, N., Noreen, A., & Zuber, M. (2017). A review on synthesis, properties and applications of natural polymer based carrageenan blends and composites. *International Journal of Biological*

UNIVERSITAS
GADJAH MADA
Pengembangan Cangkang Kapsul Berbasis ?-Karagenan dengan Penguat Selulosa Mikrokristalin
Manda Vais Jatul Fitri, Ir. Yuni Kusumastuti, S.T., M.Eng., D.Eng, IPM ; Dr. Melbi Mahardika, S.T
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Macromolecules, *96*, 282–301. https://doi.org/10.1016/j.ijbiomac.2016.11.095

Zilhadia, Z., Harahap, Y., Jaswir, I., & Anwar, E. (2022). *Evaluation and Characterization of Hard-Shell Capsules Formulated by Using Goatskin Gelatin*. 1–13.