

## DAFTAR PUSTAKA

- Ahmadi, A., Halim, A., & Oktarin, K. (2019). Mikroenkapsulasi Ekstrak Etanol Rimpang Temulawak (*Curcuma xanthorrhiza* Roxb.) dengan Penyalut Natrium Alginat Menggunakan Metode Penyemprotan Kering. In *Jurnal Farmasi Higea* (Vol. 11, Issue 2).
- AOAC. (2005). *Official Methods of Analysis of the Association of Official Analytical Chemist*. Association of Analytical Chemist.
- Badan Pusat Statistik. (2024). Produksi Tanaman Biofarmaka (Obat) 2021 – 2023. Diambil dari [\[https://www.bps.go.id/id/statistics-table/2/NjMjMg==/produksi-tanaman-biofarmaka-obat-.html\]](https://www.bps.go.id/id/statistics-table/2/NjMjMg==/produksi-tanaman-biofarmaka-obat-.html), Diakses pada 14 Maret 2025.
- Badan Standardisasi Nasional. (1995). *Rempah-rempah Bubuk*. SNI-01-3709-1995. Jakarta
- Basu, S., Shivhare, U. S., & Muley, S. (2013). Moisture adsorption isotherms and glass transition temperature of pectin. *Journal of Food Science and Technology*, 50(3), 585–589. <https://doi.org/10.1007/s13197-011-0327-y>
- Cegledi, E., Garofulić, I. E., Zorić, Z., Roje, M., & Dragović-Uzelac, V. (2022a). Effect of Spray Drying Encapsulation on Nettle Leaf Extract Powder Properties, Polyphenols and Their Bioavailability. *Foods*, 11(18). <https://doi.org/10.3390/foods11182852>
- Cegledi, E., Garofulić, I. E., Zorić, Z., Roje, M., & Dragović-Uzelac, V. (2022b). Effect of Spray Drying Encapsulation on Nettle Leaf Extract Powder Properties, Polyphenols and Their Bioavailability. *Foods*, 11(18). <https://doi.org/10.3390/foods11182852>
- Chaudhary, V., Thakur, N., Kajla, P., Thakur, S., & Punia, S. (2021). Application of Encapsulation Technology in Edible Films: Carrier of Bioactive Compounds. In *Frontiers in Sustainable Food Systems* (Vol. 5). Frontiers Media S.A. <https://doi.org/10.3389/fsufs.2021.734921>
- Cho, J. Y., Hwang, J. K., & Chun, H. S. (2011). Xanthorrhizol attenuates dextran sulfate sodium-induced colitis via the modulation of the expression of inflammatory genes in mice. *Life Sciences*, 88(19–20), 864–870. <https://doi.org/10.1016/j.lfs.2011.03.007>
- Darlina. (2016). Potensi vitamin sebagai radioprotektor. *Buletin Alara*, 18(1), 7–15.
- Dib, T., Pan, H., & Chen, S. (2023). Recent Advances in Pectin-based Nanoencapsulation for Enhancing the Bioavailability of Bioactive Compounds: Curcumin Oral Bioavailability. In *Food Reviews International* (Vol. 39, Issue 6, pp. 3515–3533). Taylor and Francis Ltd. <https://doi.org/10.1080/87559129.2021.2012796>
- Dickinson, E. (2003). *Hydrocolloids at interfaces and the influence on the properties of dispersed systems*. [www.elsevier.com/locate/foodhyd](http://www.elsevier.com/locate/foodhyd)
- Einhorn-Stoll, U. (2018). Pectin-water interactions in foods – From powder to gel. *Food Hydrocolloids*, 78, 109–119. <https://doi.org/10.1016/j.foodhyd.2017.05.029>
- Erpina, E., Rafi, M., Darusman, L. K., Vitasari, A., Putra, B. R., & Rohaeti, E. (2017a). Simultaneous quantification of curcuminoids and xanthorrhizol in *Curcuma xanthorrhiza* by high-performance liquid chromatography. *Journal of Liquid Chromatography and Related Technologies*, 40(12), 635–639. <https://doi.org/10.1080/10826076.2017.1343729>

- Erpina, E., Rafi, M., Darusman, L. K., Vitasari, A., Putra, B. R., & Rohaeti, E. (2017b). Simultaneous quantification of curcuminoids and xanthorrhizol in *Curcuma xanthorrhiza* by high-performance liquid chromatography. *Journal of Liquid Chromatography and Related Technologies*, 40(12), 635–639. <https://doi.org/10.1080/10826076.2017.1343729>
- Fang, Z., & Bhandari, B. (2017). Spray drying of bioactives. In *Food Engineering Series* (pp. 261–284). Springer. [https://doi.org/10.1007/978-1-4939-6595-3\\_10](https://doi.org/10.1007/978-1-4939-6595-3_10)
- Galanakis, C. M. (2021). *Food Bioactives and Health*.
- Gan, J., Chen, H., Liu, J., Wang, Y., Nirasawa, S., & Cheng, Y. (2016). Interactions of  $\beta$ -Conglycinin (7S) with different phenolic acids-impact on structural characteristics and proteolytic degradation of proteins. *International Journal of Molecular Sciences*, 17(10). <https://doi.org/10.3390/ijms17101671>
- Gani, A., Masoodi, F. A., Shah, U., & Shah, A. (2019). *Food Hydrocolloids as Encapsulating Agents in Delivery Systems*.
- Gao, Y., Liu, R., & Liang, H. (2024). Food Hydrocolloids: Structure, Properties, and Applications. In *Foods* (Vol. 13, Issue 7). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/foods13071077>
- Gaonkar, A. G., Vasisht, N., Khare, A. R., & Sobel, R. (2014). *Microencapsulation in the Food Industry A Practical Implementation Guide*.
- Gulzar, S., & Benjakul, S. (2020). Nanoliposome Powder Containing Shrimp Oil Increases Free Flowing Behavior and Storage Stability. *European Journal of Lipid Science and Technology*, 122(6). <https://doi.org/10.1002/ejlt.202000049>
- Hadi, S., Artanti, A. N., Rinanto, Y., & Wahyuni, D. S. C. (2018). Curcuminoid content of *Curcuma longa* L. and *Curcuma xanthorrhiza* rhizome based on drying method with NMR and HPLC-UV. *IOP Conference Series: Materials Science and Engineering*, 349(1). <https://doi.org/10.1088/1757-899X/349/1/012058>
- Hatcher, H., Planalp, R., Cho, J., Torti, F. M., & Torti, S. V. (2008). Curcumin: From ancient medicine to current clinical trials. In *Cellular and Molecular Life Sciences* (Vol. 65, Issue 11, pp. 1631–1652). <https://doi.org/10.1007/s00018-008-7452-4>
- Hu, R., Dong, D., Hu, J., & Liu, H. (2023). Improved viability of probiotics encapsulated in soybean protein isolate matrix microcapsules by coacervation and cross-linking modification. *Food Hydrocolloids*, 138. <https://doi.org/10.1016/j.foodhyd.2023.108457>
- Huang, X., Liu, Y., Zou, Y., Liang, X., Peng, Y., McClements, D. J., & Hu, K. (2019). Encapsulation of resveratrol in zein/pectin core-shell nanoparticles: Stability, bioaccessibility, and antioxidant capacity after simulated gastrointestinal digestion. *Food Hydrocolloids*, 93, 261–269. <https://doi.org/10.1016/j.foodhyd.2019.02.039>
- Jantrawut, P., Assifaoui, A., & Chambin, O. (2013). Influence of low methoxyl pectin gel textures and in vitro release of rutin from calcium pectinate beads. *Carbohydrate Polymers*, 97(2), 335–342. <https://doi.org/10.1016/j.carbpol.2013.04.091>
- Jaramillo, D. P., Roberts, R. F., & Coupland, J. N. (2011). Effect of pH on the properties of soy protein-pectin complexes. *Food Research International*, 44(4), 911–916. <https://doi.org/10.1016/j.foodres.2011.01.057>

- Johanson, K., Eckert, C., Ghose, D., Djomlija, M., & Hubert, M. (2005). Quantitative measurement of particle segregation mechanisms. *Powder Technology*, *159*(1), 1–12. <https://doi.org/10.1016/j.powtec.2005.06.003>
- Juarez-Enriquez, E., Olivas, G. I., Ortega-Rivas, E., Zamudio-Flores, P. B., Perez-Vega, S., & Sepulveda, D. R. (2019). Water activity, not moisture content, explains the influence of water on powder flowability. *LWT*, *100*, 35–39. <https://doi.org/10.1016/j.lwt.2018.10.043>
- Kang, J., Won, J., Hwang, J. K., & Kang, W. (2022). Bioavailability of xanthorrhizol following oral administration of a supercritical extract of Java turmeric. *Food Science and Biotechnology*, *31*(10), 1309–1313. <https://doi.org/10.1007/s10068-022-01124-w>
- Konrade, D., Gaidukovs, S., Vilaplana, F., & Sivan, P. (2023). Pectin from Fruit- and Berry-Juice Production by-Products: Determination of Physicochemical, Antioxidant and Rheological Properties. *Foods*, *12*(8). <https://doi.org/10.3390/foods12081615>
- Kustina, E., Misfadhila, S., & Author, C. (2020). Traditional uses, Phytochemistry and Pharmacology of *Curcuma xanthorrhiza* Roxb.: A Review. In *International Journal of Science and Healthcare Research (www.ijshr.com)* (Vol. 5). [www.ijshr.com](http://www.ijshr.com)
- Li, L., Tao, L., Geng, M., & Tian, Y. (2025). Regulating association strength between SPI and pectin via sodium alginate: Ternary composite construction and potential-use assessment. *Food Hydrocolloids*, *166*. <https://doi.org/10.1016/j.foodhyd.2025.111349>
- Li, R., Fan, H., Li, B., Ge, J., Zhang, Y., Xu, X., Pan, S., & Liu, F. (2024). Comparison on emulsifying and emulgelling properties of low methoxyl pectin with varied degree of methoxylation from different de-esterification methods. *International Journal of Biological Macromolecules*, *263*. <https://doi.org/10.1016/j.ijbiomac.2024.130432>
- Liu, C., Xu, Z., Liu, J., Huang, X., & Shan, Y. (2021). Enabling direct dense encapsulation of water-insoluble powder in hydrogel microcapsules by bubble-assisted encapsulation method. *Materials and Design*, *209*. <https://doi.org/10.1016/j.matdes.2021.109952>
- Liu, F., Ma, C., McClements, D. J., & Gao, Y. (2016). Development of polyphenol-protein-polysaccharide ternary complexes as emulsifiers for nutraceutical emulsions: Impact on formation, stability, and bioaccessibility of  $\beta$ -carotene emulsions. *Food Hydrocolloids*, *61*, 578–588. <https://doi.org/10.1016/j.foodhyd.2016.05.031>
- Locali Pereira, A. R., Gonçalves Cattelan, M., & Nicoletti, V. R. (2019). Microencapsulation of pink pepper essential oil: Properties of spray-dried pectin/SPI double-layer versus SPI single-layer stabilized emulsions. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *581*. <https://doi.org/10.1016/j.colsurfa.2019.123806>
- Ma, X., Yan, T., Hou, F., Chen, W., Miao, S., & Liu, D. (2019). Formation of soy protein isolate (SPI)-citrus pectin (CP) electrostatic complexes under a high-intensity ultrasonic field: Linking the enhanced emulsifying properties to physicochemical and structural properties. *Ultrasonics Sonochemistry*, *59*. <https://doi.org/10.1016/j.ultsonch.2019.104748>

- Mai, J., Li, W., Ledesma-Amaro, R., & Ji, X. J. (2021). Engineering Plant Sesquiterpene Synthesis into Yeasts: A Review. In *Journal of Agricultural and Food Chemistry* (Vol. 69, Issue 33, pp. 9498–9510). American Chemical Society. <https://doi.org/10.1021/acs.jafc.1c03864>
- Mamta, Misra, K., Dhillon, G. S., Brar, S. K., & Verma, M. (2014). Antioxidants. In *Biotransformation of Waste Biomass into High Value Biochemicals* (Vol. 9781461480051, pp. 117–138). Springer New York. [https://doi.org/10.1007/978-1-4614-8005-1\\_6](https://doi.org/10.1007/978-1-4614-8005-1_6)
- Marton, L. T., Barbalho, S. M., Sloan, K. P., Sloan, L. A., Goulart, R. de A., Araújo, A. C., & Bechara, M. D. (2022). Curcumin, autoimmune and inflammatory diseases: going beyond conventional therapy—a systematic review. In *Critical Reviews in Food Science and Nutrition* (Vol. 62, Issue 8, pp. 2140–2157). Taylor and Francis Ltd. <https://doi.org/10.1080/10408398.2020.1850417>
- Ma'tan. Meilany Elseday, Pinaria, A. G., Kaligis, J. B., Watung, J. F., Paat, F. J., & Pioh, D. D. (2022). Morfologi Tanaman Dan Analisis Curcumin Temulawak Kuning (*Curcuma xanthorrhiza* Roxb.) di Kelurahan Kinilow. *Jurnal Agroteknologi Terapan*, 3 No 2.
- McClements, D. J., Decker, E. A., Park, Y., & Weiss, J. (2009). Structural design principles for delivery of bioactive components in nutraceuticals and functional foods. *Critical Reviews in Food Science and Nutrition*, 49(6), 577–606. <https://doi.org/10.1080/10408390902841529>
- McClements, D. Julian. (2016). *Food emulsions : principles, practices, and techniques*. CRC Press LLC.
- Mohammadi, M., Hamishehkar, H., McClements, D. J., Shahvalizadeh, R., & Barri, A. (2023). Encapsulation of Spirulina protein hydrolysates in liposomes: Impact on antioxidant activity and gastrointestinal behavior. *Food Chemistry*, 400. <https://doi.org/10.1016/j.foodchem.2022.133973>
- Mu, J., Hu, R., Tang, Y., Dong, W., & Zhang, Z. (2024). Microencapsulation of green coffee oil by complex coacervation of soy protein isolate, sodium casinate and polysaccharides: Physicochemical properties, structural characterisation, and oxidation stability. *International Journal of Biological Macromolecules*, 256. <https://doi.org/10.1016/j.ijbiomac.2023.128064>
- Ngaeni, A. N. (*unpublished*). *KARAKTERISTIK MIKROKAPSUL EKSTRAK TEMULAWAK (*Curcuma xanthorrhiza* Roxb.) DENGAN PENYALUT KONJUGAT KONSENTRAT PROTEIN KEDELAI – PEKTIN*. (Skripsi, Fakultas Teknologi Pertanian, Universitas Gadjah Mada, Yogyakarta)
- Ngum, J. A., Tatang, F. J., Toumeni, M. H., Nguengo, S. N., Simo, U. S. F., Mezajou, C. F., Kamani, C., Ngongang, N. N., Tchinda, M. F., Dongho Dongmo, F. F., Akami, M., Ngane Ngonon, A. R., & Tamgue, O. (2023). An overview of natural products that modulate the expression of non-coding RNAs involved in oxidative stress and inflammation-associated disorders. In *Frontiers in Pharmacology* (Vol. 14). Frontiers Media SA. <https://doi.org/10.3389/fphar.2023.1144836>

- O'Flynn, T. D., Hogan, S. A., Daly, D. F. M., O'Mahony, J. A., & McCarthy, N. A. (2021). Rheological and solubility properties of soy protein isolate. *Molecules*, 26(10). <https://doi.org/10.3390/molecules26103015>
- Oon, S. F., Nallappan, M., Tee, T. T., Shohaimi, S., Kassim, N. K., Sa'ariwijaya, M. S. F., & Cheah, Y. H. (2015). Xanthorrhizol: A review of its pharmacological activities and anticancer properties. In *Cancer Cell International* (Vol. 15, Issue 1). BioMed Central Ltd. <https://doi.org/10.1186/s12935-015-0255-4>
- Park, J. H., Mohamed, M. A. A., Jung, Y. J., Shrestha, S., Lee, T. H., Lee, C. H., Han, D., Kim, J., & Baek, N. I. (2015). Germacrane sesquiterpenes isolated from the rhizome of *Curcuma xanthorrhiza* Roxb. inhibit UVB-induced upregulation of MMP-1, -2, and -3 expression in human keratinocytes. *Archives of Pharmacal Research*, 38(10), 1752–1760. <https://doi.org/10.1007/s12272-014-0525-z>
- Pereira Souza, A. C., Deyse Gurak, P., & Damasceno Ferreira Marczak, L. (2017). Maltodextrin, pectin and soy protein isolate as carrier agents in the encapsulation of anthocyanins-rich extract from jaboticaba pomace. *Food and Bioprocess Technology*, 102, 186–194. <https://doi.org/10.1016/j.fbp.2016.12.012>
- Prada-Ramírez, H. A., Montes-Tamara, J. P., Rico-Jimenez, E. A., & Fonseca, J. C. (2024). Stability Study Through Water Activity Measurements for Dispensed Powdered Raw Materials. *Journal of AOAC International*, 107(3), 487–492. <https://doi.org/10.1093/jaoacint/qsae005>
- Qin, Z., Balasubramanian, S. K., Wolkers, W. F., Pearce, J. A., & Bischof, J. C. (2014). Correlated Parameter Fit of Arrhenius Model for Thermal Denaturation of Proteins and Cells. *Annals of Biomedical Engineering*, 42(12), 2392–2404. <https://doi.org/10.1007/s10439-014-1100-y>
- Qualls, M., Pallin, D. J., & Schuur, J. D. (2010). Parametric versus nonparametric statistical tests: The length of stay example. *Academic Emergency Medicine*, 17(10), 1113–1121. <https://doi.org/10.1111/j.1553-2712.2010.00874.x>
- Rosidi, A., Farha, R., Jauharany, F. F., Sulistyanningrum, H., Fitriyanti, A. R., Nurhidajah, Sulistyowati, E., & Lahdji, A. (2023). The thermostability of temulawak extract encapsulation with several coating variations of sodium tripolyphosphate and chitosan. *Food Research*, 7(6), 214–219. [https://doi.org/10.26656/fr.2017.7\(6\).909](https://doi.org/10.26656/fr.2017.7(6).909)
- Safdar, M. N., Kausar, T., Jabbar, S., Mumtaz, A., Ahad, K., & Saddozai, A. A. (2017a). Extraction and quantification of polyphenols from kinnow (*Citrus reticulata* L.) peel using ultrasound and maceration techniques. *Journal of Food and Drug Analysis*, 25(3), 488–500. <https://doi.org/10.1016/j.jfda.2016.07.010>
- Safdar, M. N., Kausar, T., Jabbar, S., Mumtaz, A., Ahad, K., & Saddozai, A. A. (2017b). Extraction and quantification of polyphenols from kinnow (*Citrus reticulata* L.) peel using ultrasound and maceration techniques. *Journal of Food and Drug Analysis*, 25(3), 488–500. <https://doi.org/10.1016/j.jfda.2016.07.010>
- Sande, S. A. (2005). Pectin-based oral drug delivery to the colon. In *Expert Opinion on Drug Delivery* (Vol. 2, Issue 3, pp. 441–450). <https://doi.org/10.1517/17425247.2.3.441>
- Sarabandi, K., & Jafari, S. M. (2020). Improving the antioxidant stability of flaxseed peptide fractions during spray drying encapsulation by surfactants: Physicochemical

- and morphological features. *Journal of Food Engineering*, 286. <https://doi.org/10.1016/j.jfoodeng.2020.110131>
- Simamora, A., Timotius, K. H., Setiawan, H., Yerer, M. B., Ningrum, R. A., & Mun'im, A. (2024). Xanthorrhizol: Its bioactivities and health benefits. *Journal of Applied Pharmaceutical Science*, 14(2), 27–39. <https://doi.org/10.7324/JAPS.2024.159484>
- Simamora, A., Timotius, K. H., Yerer, M. B., Setiawan, H., & Mun'im, A. (2022). Xanthorrhizol, a potential anticancer agent, from *Curcuma xanthorrhiza* Roxb. In *Phytomedicine* (Vol. 105). Elsevier GmbH. <https://doi.org/10.1016/j.phymed.2022.154359>
- Sukri, N., Annisa, D. S., Djali, M., Cahyana, Y., Mahani, M., & Huda, S. (2023). *Effect of Whey Protein Isolate (WPI)–Pectin Ratio on Phenolic Content Stability of Propolis Microcapsules*. <https://doi.org/10.20944/preprints202306.0516.v1>
- Sun, L., Wang, X., Wang, Z., Zhou, S., Wei, Y., Huang, Y., & Li, G. (2023). Rapid spheronization of irregular polymeric particles via microwave heating without stirring. *Powder Technology*, 415. <https://doi.org/10.1016/j.powtec.2022.118189>
- Udayakumar, N., Reefa Fathima, K., Umme Hani, P. S., & Mounika, N. (2024). A Review on Phytochemical Analysis and In-vitro Antioxidant Activity of Curcumin from *Curcuma longa* L. Rhizomes. In *International Journal of Drug Delivery Technology* (Vol. 14, Issue 2, pp. 1106–1109). Dr. Yashwant Research Labs Pvt. Ltd. <https://doi.org/10.25258/ijddt.14.2.75>
- VITANTI, T. A. P., KAWIJL, K., & NURHARTADI, E. (2017). Effect of extraction method on *Curcuma xanthorrhiza* oleoresin using solar dryer to concentration of curcuminoid, total phenol and antioxidant activity. *Biofarmasi Journal of Natural Product Biochemistry*, 14(1), 1–9. <https://doi.org/10.13057/biofar/f140101>
- Wang, J. M., Xia, N., Yang, X. Q., Yin, S. W., Qi, J. R., He, X. T., Yuan, D. B., & Wang, L. J. (2012). Adsorption and dilatational rheology of heat-treated soy protein at the oil-water interface: Relationship to structural properties. *Journal of Agricultural and Food Chemistry*, 60(12), 3302–3310. <https://doi.org/10.1021/jf205128v>
- Wang, L., Wu, P., Hu, Z., Chen, Y., Jin, X., Deng, R., Kirk, T. V., & Chen, X. D. (2024). Curcumin-loaded microcapsules with soy and whey protein as wall material: In vitro release, and ex vivo absorption based on the rat small intestine. *Journal of Food Engineering*, 383. <https://doi.org/10.1016/j.jfoodeng.2024.112254>
- Wang, Y., Lu, Z., Lv, F., & Bie, X. (2009). Study on microencapsulation of curcumin pigments by spray drying. *European Food Research and Technology*, 229(3), 391–396. <https://doi.org/10.1007/s00217-009-1064-6>
- Wang, Y., Sun, R., Xu, X., Du, M., Zhu, B., & Wu, C. (2021). Structural interplay between curcumin and soy protein to improve the water-solubility and stability of curcumin. *International Journal of Biological Macromolecules*, 193, 1471–1480. <https://doi.org/10.1016/j.ijbiomac.2021.10.210>
- Wu, Y., Liu, H., Li, Z., Huang, D., Nong, L., Ning, Z., Hu, Z., Xu, C., & Yan, J. K. (2019). Pectin-decorated selenium nanoparticles as a nanocarrier of curcumin to achieve enhanced physicochemical and biological properties. *IET Nanobiotechnology*, 13(8), 880–886. <https://doi.org/10.1049/iet-nbt.2019.0144>
- Xiao, J., Sarker, S. D., & Asakawa, Y. (2019). *Handbook of Dietary Phytochemicals*.

- Xie, J., Bi, J., Jacquet, N., Blecker, C., Feng, S., Liu, X., & Lyu, J. (2024). Structure formation mechanism of pectin-soy protein isolate gels: Unraveling the role of peach pectin fractions. *International Journal of Biological Macromolecules*, 281. <https://doi.org/10.1016/j.ijbiomac.2024.136429>
- Yang, B., Kealey, K., Chen, J., & Solval, K. M. (2022). Developing microencapsulated powders containing polyphenols and pectin extracted from Georgia-grown pomegranate peels. *LWT*, 154. <https://doi.org/10.1016/j.lwt.2021.112644>
- Young Cho, J., Yeon Kim, H., Me Kim, H., Na Song, H., Hong, E., Hwang, J. K., & Chun, H. S. (2017). Standardized ethanolic extract of the rhizome of *Curcuma xanthorrhiza* prevents murine ulcerative colitis by regulation of inflammation. *Journal of Functional Foods*, 30, 282–289. <https://doi.org/10.1016/j.jff.2017.01.020>
- Zhang, Y., Zhou, F., Zhao, M., Ning, Z., Sun-Waterhouse, D., & Sun, B. (2017). Soy peptide aggregates formed during hydrolysis reduced protein extraction without decreasing their nutritional value. *Food and Function*, 8(12), 4384–4395. <https://doi.org/10.1039/C7FO00812K>