

DAFTAR PUSTAKA

- Abdelalim, L. R., Abdallah, O. Y., & Elnaggar, Y. S. R. (2020). High efficacy, rapid onset nanobiologosomes of sildenafil as a topical therapy for erectile dysfunction in aged rats. *International Journal of Pharmaceutics*. <https://doi.org/10.1016/j.ijpharm.2020.119978>
- Abuzeineh, H., Abdel, S., Cespi, M., Bisharat, L., & Berardi, A. (2021). Time-controlled release by the incorporation of superdisintegrants within the coat of zein dry coated tablets. *Journal of Drug Delivery Science and Technology*, 65. <https://doi.org/10.1016/j.jddst.2021.102716>
- Akduman, Ç., Özgüney, I., & Kumbasar, E. P. A. (2014). Electrospun Thermoplastic Polyurethane Mats Containing Naproxen- Cyclodextrin Inclusion Complex. *Autex Research Journal*. <https://doi.org/10.2478/aut-2014-0024>
- Alvi, Z., Akhtar, M., Rahman, N. U., Hosny, K. M., Sindi, A. M., Khan, B. A., Nazir, I., & Sadaquat, H. (2021). Utilization of gelling polymer to formulate nanoparticles loaded with epalrestat-cyclodextrin inclusion complex: Formulation, characterization, in-silico modelling and in-vivo toxicity evaluation. *Polymers*, 13, 1–23. <https://doi.org/10.3390/polym13244350>
- Amoli, B. M., Gumfekar, S., Hu, A., Zhou, Y. N., & Zhao, B. (2012). Thiocarboxylate functionalization of silver nanoparticles: effect of chain length on the electrical conductivity of nanoparticles and their polymer composites. *Journal of Materials Chemistry*, 22. <https://doi.org/10.1039/C2JM33280A>
- Ananda, P. W. R., Elim, D., Zaman, H. S., Muslimin, W., Tunggeng, M. G. R., & Permana, A. D. (2021). Combination of transdermal patches and solid microneedles for improved transdermal delivery of primaquine. *International Journal of Pharmaceutics*, 609, 1–10. <https://doi.org/10.1016/j.ijpharm.2021.121204>
- Ananthapadmanabhan, K. P. Ā., Lips, A. Ā., Vincent, C. Ā., Meyer, F. Ā., Caso, S. Ā., Johnson, A., Subramanyan, K., Vethamuthu, M., Rattinger, G., & Moore, D. J. (2003). pH-induced alterations in stratum corneum properties. *International Journal of Cosmetic Science*, 25, 103–112.
- Anjani, Q. K., Domínguez-Robles, J., Utomo, E., Font, M., Martínez-Ohárriz, M. C., Permana, A. D., Cárcamo-Martínez, Á., Larrañeta, E., & Donnelly, R. F. (2022). Inclusion Complexes of Rifampicin with Native and Derivatized Cyclodextrins : In Silico Modeling , Formulation , and Characterization. *Pharmaceutics*. <https://doi.org/10.3390/ph15010020>

- Anjani, Q. K., Permana, A. D., Cárcamo-Martínez, Á., Domínguez-Robles, J., Tekko, I. A., Larrañeta, E., Vora, L. K., Ramadan, D., & Donnelly, R. F. (2021). Versatility of hydrogel-forming microneedles in in vitro transdermal delivery of tuberculosis drugs. *European Journal of Pharmaceutics and Biopharmaceutics*, *158*, 294–312. <https://doi.org/10.1016/j.ejpb.2020.12.003>
- Atipairin, A., Chunhachaichana, C., Nakpheng, T., Changsan, N., Srichana, T., & Sawatdee, S. (2020). Development of a sildenafil citrate microemulsion-loaded hydrogel as a potential system for drug delivery to the penis and its cellular metabolic mechanism. *Pharmaceutics*, *12*, 1–23. <https://doi.org/10.3390/pharmaceutics12111055>
- Aung, N. N., Ngawhirunpat, T., Rojanarata, T., Patrojanasophon, P., Pamornpathomkul, B., & Opanasopit, P. (2020). Fabrication, characterization and comparison of α -arbutin loaded dissolving and hydrogel forming microneedles. *International Journal of Pharmaceutics*, *586*, 1–9. <https://doi.org/10.1016/j.ijpharm.2020.119508>
- Badr-Eldin, S. M., & Ahmed, O. A. A. (2016). Optimized nano-transfersomal films for enhanced sildenafil citrate transdermal delivery: Ex vivo and in vivo evaluation. *Drug Design, Development and Therapy*, *10*, 1323–1333. <https://doi.org/10.2147/DDDT.S103122>
- Badshah, S. F., Akhtar, N., Usman, M., Ullah, K., Khan, S., Abdullah, O., & Naeem, A. (2021). Porous and highly responsive cross-linked β - cyclodextrin based nanomatrices for improvement in drug dissolution and absorption. *Life Sciences*, *267*. <https://doi.org/10.1016/j.lfs.2020.118931>
- Bahmani, S., Khajavi, R., Ehsani, M., Rahimi, M. K., & Kalaei, M. R. (2023). Transdermal drug delivery system of lidocaine hydrochloride based on dissolving gelatin / sodium carboxymethylcellulose microneedles. *AAPS Open*. <https://doi.org/10.1186/s41120-023-00074-9>
- Bharate, S. S. (2021). Carboxylic Acid Counterions in FDA-Approved Pharmaceutical Salts. *Pharm Res*, *38*, 1307–1326. <https://doi.org/10.1007/s11095-021-03080-2>
- Borba, P. A. A., Pinotti, M., Andrade, G. R. S., Jr, N. B. da C., Junior, L. R. O., Fernandes, D., Eduardo, C., Campos, M. de, & Stulzer, H. K. (2015). The effect of mechanical grinding on the formation, crystalline changes and dissolution behaviour of the inclusion complex of telmisartan and β -cyclodextrins. *Carbohydrate Polymers*. <https://doi.org/10.1016/j.carbpol.2015.06.098>
- Burnett, A. L., Nehra, A., Breau, R. H., Culkin, D. J., Faraday, M. M., Hakim, L. S., Heidelbaugh, J., Khera, M., McVary, K. T., Miner, M. M., Nelson,

- C. J., Sadeghi-Nejad, H., Seftel, A. D., & Shindel, A. W. (2018). Erectile Dysfunction: AUA Guideline. *Journal of Urology*, 200(3), 633–641. <https://doi.org/10.1016/j.juro.2018.05.004>
- Carneiro, S. B., Duarte, F. Í. C., Heimfarth, L., Quintans, J. de S. S., Quintans-Júnior, L. J., Júnior, V. F. da V., & de Lima, Á. A. N. (2019). Cyclodextrin – Drug Inclusion Complexes: In Vivo and In Vitro Approaches. *International Journal of Molecular Sciences*, 20(642), 1–23. <https://doi.org/10.3390/ijms20030642>
- Chaudhari, S., Kwon, Y., Moon, M., Shon, M., Park, Y., Song, H., Jang, B., & Nam, S. (2015). Water-selective Membrane from Crosslinking of Poly (vinyl alcohol) with Tartaric Acid and Its Pervaporation Separation Characteristics for a Water / Acetic Acid Mixture. *Bulletin of the Korean Chemical Society*, 2534–2541. <https://doi.org/10.1002/bkcs.10493>
- Chen, B. Z., Ashfaq, M., Zhu, D. D., Zhang, X. P., & Guo, X. D. (2018). Controlled Delivery of Insulin Using Rapidly Separating Microneedles Fabricated from Genipin-Crosslinked Gelatin. *Macromolecular Rapid Communication*, 1–6. <https://doi.org/10.1002/marc.201800075>
- Das, S. K., Kahali, N., Bose, A., & Khanam, J. (2018). Physicochemical characterization and in vitro dissolution performance of complexes. *Journal of Molecular Liquids*, 261, 239–249.
- David, N. Ben, Richtman, Y., Gross, A., Ibrahim, R., Nyska, A., Ramot, Y., & Mizrahi, B. (2023). Design and Evaluation of Dissolvable Microneedles for Treating Atopic Dermatitis. *Pharmaceutics*, 15, 1–12.
- Dharadhar, S., Majumdar, A., Dhoble, S., & Patravale, V. (2019). Microneedles for Transdermal Drug Delivery: A Systematic Review. *Drug Development and Industrial Pharmacy*, 45(2), 188–201. <https://doi.org/10.1080/03639045.2018.1539497>
- Dharmalingam, K., & Anandalakshmi, R. (2019). Fabrication , characterization and drug loading ef fi ciency of citric acid crosslinked NaCMC-HPMC hydrogel fi lms for wound healing drug delivery applications. *International Journal of Biological Macromolecules*, 134, 815–829. <https://doi.org/10.1016/j.ijbiomac.2019.05.027>
- Donnelly, R. F., Mccrudden, T. C., Alkilani, A. Z., Larran, E., Donnelly, R. F., Mcalister, E., Courtenay, A. J., Kearney, M., Raghu, T., Singh, R., Mccarthy, H. O., Kett, V. L., Caffarel-salvador, E., Al-zahrani, S., & Woolfson, A. D. (2014). Hydrogel-Forming Microneedles Prepared from “ Super Swelling ” Polymers Combined with Lyophilised Wafers for Transdermal Drug Delivery. *PLoS ONE*, 9(10), 1–12. <https://doi.org/10.1371/journal.pone.0111547>
- Donnelly, R. F., Raghu, T., Singh, R., Garland, M. J., Migalska, K., Majithiya,

- R., Mccrudden, C. M., Kole, P. L., Mazlelaa, T., Mahmood, T., Mccarthy, H. O., & Woolfson, A. D. (2012). Hydrogel-Forming Microneedle Arrays for Enhanced Transdermal Drug Delivery. *Advanced Functional Materials*, 22, 4879–4890. <https://doi.org/10.1002/adfm.201200864>
- Douroumis, D. D., Gryczke, A., & Schminke, S. (2011). Development and Evaluation of Cetirizine HCl Taste-Masked Oral Disintegrating Tablets. *AAPS PharmSciTech*, 12(1). <https://doi.org/10.1208/s12249-010-9569-7>
- Droupy, S., & Colson, M. H. (2022). Assessment of a New Formulation of Sildenafil on Common Practice: An Observational Study. *International Journal of Reproductive Medicine*, 2022, 1–8. <https://doi.org/10.1155/2022/9122099>
- Elim, D., Fitri, A. M. N., Mahfud, M. A. S., Afika, N., Sultan, N. A. F., Hijrah, Asri, R. M., & Permana, A. D. (2022). Hydrogel forming microneedle-mediated transdermal delivery of sildenafil citrate from polyethylene glycol reservoir: An ex vivo proof of concept study. *Colloids and Surfaces B: Biointerfaces*, 222, 1–13. <https://doi.org/10.1016/j.colsurfb.2022.113018>
- Faizi, H. S., Vora, L. K., Nasiri, M. I., Wu, Y., Mishra, D., Anjani, Q. K., Paredes, A. J., Raj, R., Thakur, S., Minhas, M. U., & Donnelly, R. F. (2022). Deferasirox Nanosuspension Loaded Dissolving Microneedles for Intradermal Delivery. *Pharmaceutics*, 14, 1–18. <https://doi.org/10.3390/pharmaceutics14122817>
- Fateminasab, F., Bordbar, A. K., Shityakov, S., & Saboury, A. A. (2020). Comprehensive Physico - Chemical Characterization of a Serotonin Inclusion Complex. *Journal of Solution Chemistry*, 49, 915–944. <https://doi.org/10.1007/s10953-020-00997-x>
- Fenyvesi, F., Nguyen, T. L. P., Haimhoffe, Á., Rusznyák, Á., Vasvári, G., Bácskay, I., Vecsernyés, M., Ignat, S.-R., Dinescu, S., Costache, M., Ciceu, A., Hermenean, A., & Váradi, J. (2020). *Cyclodextrin Complexation Improves the Solubility and Caco-2 Permeability of Chrysin*. 1–12.
- Fitri, A. M. N., Elim, D., Sya'ban Mahfud, M. A., Fitri Sultan, N. A., Saputra, M. D., Afika, N., Friandini, R. A., Natsir Djide, N. J., & Permana, A. D. (2022). Polymeric hydrogel forming microneedle-mediated transdermal delivery of sildenafil citrate from direct-compressed tablet reservoir for potential improvement of pulmonary hypertension therapy. *International Journal of Pharmaceutics*, 631, 1–11. <https://doi.org/10.1016/j.ijpharm.2022.122549>
- Garg, A., Ahmad, J., & Hassan, M. Z. (2021). Inclusion complex of thymol

and hydroxypropyl- β -cyclodextrin (HP- β -CD) in polymeric hydrogel for topical application: Physicochemical characterization, molecular docking, and stability evaluation. *Journal of Drug Delivery Science and Technology*, 64, 1–11. <https://doi.org/10.1016/j.jddst.2021.102609>

Geng, Q., Li, T., Wang, X., Chu, W., Cai, M., Xie, J., & Ni, H. (2019). The mechanism of bensulfuron- methyl complexation with β -cyclodextrin and its effect on soil adsorption and bio-activity. *Scientific Reports*, 9. <https://doi.org/10.1038/s41598-018-38234-7>

Gera, A. K., & Burra, R. K. (2022). The Rise of Polymeric Microneedles: Recent Developments, Advances, Challenges, and Applications with Regard to Transdermal Drug Delivery. *Journal of Functional Biomaterials*, 13(81). <https://doi.org/10.3390/jfb13020081>

Ghosh, B., Roy, N., Mandal, S., Ali, S., Bomzan, P., Roy, D., Salman Haydar, M., Dakua, V. K., Upadhyay, A., Biswas, D., Paul, K. K., & Roy, M. N. (2023). Host-Guest Encapsulation of RIBO with TSC4X: Synthesis, Characterization, and Its Application by Physicochemical and Computational Investigations. *ACS Omega*, 8, 6778–6790. <https://doi.org/10.1021/acsomega.2c07396>

Giri, B. R., Poudel, S., & Kim, D. W. (2021). Cellulose and its derivatives for application in 3D printing of pharmaceuticals. *Journal of Pharmaceutical Investigation*, 51, 1–22. <https://doi.org/10.1007/s40005-020-00498-5>

Goldstein, I., Goren, A., Mph, V. W. L., Mph, W. Y. T., & Hassan, T. A. (2019). Epidemiology Update of Erectile Dysfunction in Eight Countries with High Burden. *Sexual Medicine Review*. <https://doi.org/10.1016/j.sxmr.2019.06.008>

Gupta, I., Adin, S. N., Rashid, A., Alhamhoom, Y., Aqil, M., & Mujeeb, M. (2023). Spanlastics as a Potential Approach for Enhancing the Nose-To-Brain Delivery of Piperine: In Vitro Prospect and In Vivo Therapeutic Efficacy for the Management of Epilepsy. *Pharmaceutics*.

Gupta, J., Felner, E. I., & Prausnitz, M. R. (2009). Minimally invasive insulin delivery in subjects with type 1 diabetes using hollow microneedles. *Diabetes Technology and Therapeutics*, 11(7), 329–337. <https://doi.org/10.1089/dia.2009.0729>

Higuchi, T., & Connors, K. . (1965). *Advances in analytical chemistry and instrumentation: Phase-solubility techniques* (4th ed.). Wiley-Interscience.

Homburg, C., Bommer, M., Wuttge, S., Hobe, C., Beck, S., Dobbek, H., Deutscher, J., Licht, A., & Schneider, E. (2017). Inducer exclusion in Firmicutes: insights into the regulation of a carbohydrate ATP binding

cassette transporter from *Lactobacillus casei* BL23 by the signal transducing protein P-Ser46-HPr. *Molecular Microbiology*. <https://doi.org/10.1111/mmi.13680>

Hosny, K. M., El-say, K. M., & Ahmed, O. A. (2016). Optimized sildenafil citrate fast orodissolvable film : a promising formula for overcoming the barriers hindering erectile dysfunction treatment Optimized sildenafil citrate fast orodissolvable film : a promising formula for overcoming the barriers hinder. *Drug Delivery*, 23(1). <https://doi.org/10.3109/10717544.2014.916763>

Hoti, G., Caldera, F., Ceccone, C., Pedrazzo, A. R., Anceschi, A., Appleton, S. L., Monfared, Y. K., & Trotta, F. (2021). Effect of the Cross-Linking Density on the Swelling and Rheological Behavior of Ester-Bridged. *Materials*. <https://doi.org/10.3390/ma14030478>

Huang, M., Hou, Y., Li, Y., Wang, D., & Zhang, L. (2017). High performances of dual network PVA hydrogel modified by PVP using borax as the structure-forming accelerator. *Designed Monomers and Polymers*, 20(1), 505–513. <https://doi.org/10.1080/15685551.2017.1382433>

Husain, M. S. B., Gupta, A., Alashwal, B. Y., & Sharma, S. (2018). Synthesis of PVA / PVP based hydrogel for biomedical applications : a review. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–6. <https://doi.org/10.1080/15567036.2018.1495786>

Iervolino, M., Raghavan, S. L., & Hadgraft, J. (2000). Membrane penetration enhancement of ibuprofen using supersaturation. *International Journal of Pharmaceutics*, 198, 229–238. [https://doi.org/10.1016/S0378-5173\(00\)00346-X](https://doi.org/10.1016/S0378-5173(00)00346-X)

Imam, S. S., Alshehri, S., Alzahrani, T. A., Hussain, A., & Altamimi, M. A. (2020). Formulation and Evaluation of Supramolecular Food-Grade Piperine HP β CD and TPGS Complex: Dissolution, Physicochemical Characterization, Molecular Docking, In Vitro Antioxidant Activity, and Antimicrobial Assessment. *Molecules*, 1–21. <https://doi.org/10.3390/molecules25204716>

Kamoun, E. A., Kenawy, E. R. S., Tamer, T. M., El-Meligy, M. A., & Mohy Eldin, M. S. (2015). Poly (vinyl alcohol)-alginate physically crosslinked hydrogel membranes for wound dressing applications: Characterization and bio-evaluation. *Arabian Journal of Chemistry*, 8(1), 38–47. <https://doi.org/10.1016/j.arabjc.2013.12.003>

Khan, M. F. A., Rehman, A. U., Howari, H., Alhodaib, A., Ullah, F., Mustafa, Z. ul, Elaissari, A., & Ahmed, N. (2022). Hydrogel Containing Solid Lipid Nanoparticles Loaded with. *Gels*.

- Kr, V., Yalavarthi, P. R., Vadlamudi, H. C., & Kalluri, J. K. Y. K. (2017). Process , Physicochemical Characterization and In-Vitro Assessment of Albendazole Microcrystals. *Adv Pharm Bull*, 7(3), 419–425. <https://doi.org/10.15171/apb.2017.050>
- Lambers, H., Piessens, S., Bloem, A., Pronk, H., & Finkel, P. (2006). Natural skin surface pH is on average below 5 , which is beneficial for its resident flora Natural skin surface pH is on average below 5 , which is beneficial for its resident flora. *International Journal of Cosmetic Science*, 28, 359–370. <https://doi.org/10.1111/j.1467-2494.2006.00344.x>
- Larrañeta, E., Moore, J., Vicente-Pérez, E. M., González-Vázquez, P., Lutton, R., Woolfson, A. D., & Donnelly, R. F. (2014). A proposed model membrane and test method for microneedle insertion studies. *International Journal of Pharmaceutics*, 472, 65–73. <https://doi.org/10.1016/j.ijpharm.2014.05.042>
- Laszlo, E., Crescenzo, G. De, Nieto-argüello, A., Banquy, X., & Brambilla, D. (2021). Superswelling Microneedle Arrays for Dermal Interstitial Fluid (Prote) Omics. *Advanced Functional Materials*, 1–14. <https://doi.org/10.1002/adfm.202106061>
- Lee, L. J., Maguire, T. A., Maculaitis, M. C., Emir, B., Li, V. W., Jeffress, M., Li, J. Z., Zou, K. H., Donde, S. S., & Taylor, D. (2020). Increasing access to erectile dysfunction treatment via pharmacies to improve healthcare provider visits and quality of life: Results from a prospective real-world observational study in the United Kingdom. *International Journal of Clinical Practice*, 75, 1–11. <https://doi.org/10.1111/ijcp.13849>
- Lestari, P. M., Widayanti, A., & Afifah, H. (2019). The Effect of Pregelatinized Taro Starch (Colocasia Esculenta (L .) Schott) Temperature as Filler on Thiamine Hydrochloride Tablet. *Journal of Medical Sciences*, 7(22), 3827–3832.
- Li, H., Zhang, G., Wang, W., Chen, C., Jiao, L., & Wu, W. (2021). Preparation, characterization, and bioavailability of host-guest inclusion complex of ginsenoside re with gamma-cyclodextrin. *Molecules*, 26, 1–18. <https://doi.org/10.3390/molecules26237227>
- Lieberman, H. A., Lachman, L., & Schwartz, J. B. (1989). *Pharmaceutical Dosage Forms: Tablets Volume 1* (Second). Marcel Dekker, Inc.
- Limpongsa, E., Tabboon, P., Pongjanyakul, T., & Jaipakdee, N. (2022). Preparation and Evaluation of Directly Compressible Orally Disintegrating Tablets of Cannabidiol Formulated Using Liquisolid Technique. *Pharmaceutics*.

- Liu, G. S., Kong, Y., Wang, Y., Luo, Y., Fan, X., Xie, X., Yang, B. R., & Wu, M. X. (2020). Microneedles for transdermal diagnostics: Recent advances and new horizons. *Biomaterials*. <https://doi.org/10.1016/j.biomaterials.2019.119740>
- Liu, J., Hua, D., Zhang, Y., Japip, S., & Chung, T. S. (2018). Precise Molecular Sieving Architectures with Janus Pathways for Both Polar and Nonpolar Molecules. *Advanced Materials*, 1–7. <https://doi.org/10.1002/adma.201705933>
- Lukić, M., Pantelić, I., & Savić, S. D. (2021). Towards Optimal pH of the Skin and Topical Formulations: From the Current State of the Art to Tailored Products. *Cosmetics*, 8(69), 1–18.
- Luo, Z., Sun, W., Fang, J., Lee, K., Li, S., Gu, Z., Dokmeci, M. R., & Khademhosseini, A. (2018). Biodegradable Gelatin Methacryloyl Microneedles for Transdermal Drug Delivery. *Advanced Healthcare Materials*, 1–9. <https://doi.org/10.1002/adhm.201801054>
- Mady, F. M., & Aly, U. F. (2017). Experimental , molecular docking investigations and bioavailability study on the inclusion complexes of finasteride and cyclodextrins. *Drug Design, Development and Therapy*, 11, 1681–1692. <https://doi.org/10.2147/DDDT.S135084>
- Mahfud, M. A. S., Maqhfirah, A., Fitri, N., Elim, D., Aisha, N., Sultan, F., Saputra, M. D., Afika, N., Friandini, R. A., Himawan, A., Rahman, L., & Permana, A. D. (2023). Combination of synthetic and natural polymers on the characteristics and evaluation of transdermal hydrogel-forming microneedles preparations integrated with direct compressed tablets reservoir sildenafil citrate. *Journal of Drug Delivery Science and Technology*, 85. <https://doi.org/10.1016/j.jddst.2023.104611>
- Mahfufah, U., Fitri Sultan, N. A., Nurul Fitri, A. M., Elim, D., Sya'ban Mahfud, M. A., Wafiah, N., Ardita Friandini, R., Chabib, L., Aliyah, & Permana, A. D. (2022). Application of multipolymers system in the development of hydrogel-forming microneedle integrated with polyethylene glycol reservoir for transdermal delivery of albendazole. *European Polymer Journal*, 183, 1–12. <https://doi.org/10.1016/j.eurpolymj.2022.111762>
- Mahmood, A., Sharif, A., Muhammad, F., Sarfraz, R. M., Abrar, M. A., Qaisar, M. N., Anwer, N., Amjad, M. W., & Zaman, M. (2019). Development and in vitro evaluation of (β - cyclodextrin-g-methacrylic acid)/ Na + - montmorillonite nanocomposite hydrogels for controlled delivery of lovastatin. *International Journal Of Nanomedicine*, 14. <https://doi.org/10.2147/IJN.S209662>
- Mangolim, C. S., Moriwaki, C., Nogueira, A. C., Sato, F., Baesso, M. L., Neto, A. M., & Matioli, G. (2014). Curcumin- β -cyclodextrin inclusion complex: Stability, solubility, characterisation by FT-IR, FT-Raman, X-

- ray diffraction and photoacoustic spectroscopy, and food application. *Food Chemistry*, *153*, 361–370. <https://doi.org/10.1016/j.foodchem.2013.12.067>
- Marim, B. M., Mantovan, J., Pereira, J. F., Debiagi, F., & Mali, S. (2023). Sustainable process based on reactive extrusion to modify cellulose from oat hull with sodium trimetaphosphate and tartaric acid. *Polymer Bulletin*. <https://doi.org/10.1007/s00289-023-04825-2>
- Matsuo, K., Yokota, Y., Zhai, Y., Quan, Y., Kamiyama, F., & Mukai, Y. (2012). A low-invasive and effective transcutaneous immunization system using a novel dissolving microneedle array for soluble and particulate antigens. *Journal of Controlled Release*, *161*(1), 10–17. <https://doi.org/10.1016/j.jconrel.2012.01.033>
- Mc Crudden, M. T. C., Larrañeta, E., Clark, A., Jarrahian, C., Rein-Weston, A., Creelman, B., Moyo, Y., Lachau-Durand, S., Niemeijer, N., Williams, P., McCarthy, H. O., Zehring, D., & Donnelly, R. F. (2019). Design, Formulation, and Evaluation of Novel Dissolving Microarray Patches Containing Rilpivirine for Intravaginal Delivery. *Advanced Healthcare Materials*. <https://doi.org/10.1002/adhm.201801510>
- McAlister, E., Kirkby, M., Domínguez-Robles, J., Paredes, A. J., Anjani, Q. K., Moffatt, K., Vora, L. K., Hutton, A. R. J., McKenna, P. E., Larrañeta, E., & Donnelly, R. F. (2021). The role of microneedle arrays in drug delivery and patient monitoring to prevent diabetes induced fibrosis. *Advanced Drug Delivery Reviews*. <https://doi.org/10.1016/j.addr.2021.06.002>
- Mohamed, J. M. M., Ahmad, F., Alqahtani, A., Raju, V. K., & Anusuya, M. (2021). Studies on Preparation and Evaluation of Soluble 1 : 1 Stoichiometric Curcumin Complex for Colorectal Cancer Treatment. *Trends In Science*, *18*(24), 1–15.
- Nair, A. B., Attimarad, M., Al-dhubiab, B. E., Wadhwa, J., Harsha, S., & Ahmed, M. (2014). Enhanced oral bioavailability of acyclovir by inclusion complex using hydroxypropyl- β -cyclodextrin. *Drug Delivery*, *21*(7), 540–547. <https://doi.org/10.3109/10717544.2013.853213>
- Nguyen, H. M. T., Gabrielson, A. T., & Hellstrom, W. J. G. (2017). Erectile Dysfunction in Young Men — A Review of the Prevalence and Risk Factors. *Sexual Medicine Review*. <https://doi.org/10.1016/j.sxmr.2017.05.004>
- Nichols, D. J., Muirhead, G. J., & Harness, J. A. (2002). Pharmacokinetics of sildenafil citrate after single oral doses in healthy male subjects: absolute bioavailability, food effects and dose proportionality. *J Clin Pharmacol*.

- Obeid, S., & Mad, M. (2021). Tailoring amlodipine release from 3D printed tablets: Influence of infill patterns and wall thickness. *International Journal of Pharmaceutics*, 610.
- Orkin, C., Arasteh, K., Górgolas Hernández-Mora, M., Pokrovsky, V., Overton, E. T., Girard, P.-M., Oka, S., Walmsley, S., Bettacchi, C., Brinson, C., Philibert, P., Lombaard, J., St. Clair, M., Crauwels, H., Ford, S. L., Patel, P., Chounta, V., D'Amico, R., Vanveggel, S., ... Spreen, W. R. (2020). Long-Acting Cabotegravir and Rilpivirine after Oral Induction for HIV-1 Infection. *New England Journal of Medicine*. <https://doi.org/10.1056/nejmoa1909512>
- Ouranidis, A., Tsiaxerli, A., Vardaka, E., Markopoulou, C. K., Zacharis, C. K., Nicolaou, I., Hatzichristou, D., Haidich, A., Kostomitsopoulos, N., & Kachrimanis, K. (2021). Sildenafil 4 . 0 — Integrated Synthetic Chemistry , Formulation and Analytical Strategies Effecting Immense Therapeutic and Societal Impact in the Fourth Industrial Era. *Pharmaceutics*, 14(365), 1–43. <https://doi.org/https://doi.org/10.3390/ph14040365>
- Pan, X., Li, Y., Pang, W., Xue, Y., Wang, Z., Jiang, C., Shen, C., Liu, Q., & Liu, L. (2022). Preparation, characterisation and comparison of glabridin-loaded hydrogel-forming microneedles by chemical and physical cross-linking. *International Journal of Pharmaceutics*, 617, 1–13. <https://doi.org/10.1016/j.ijpharm.2022.121612>
- Patel, R., Bhimani, D., Patel, J., & Patel, D. (2008). Solid-state characterization and dissolution properties of ezetimibe – cyclodextrins inclusion complexes. *J Incl Phenom Macrocycl Chem*, 60, 241–251. <https://doi.org/10.1007/s10847-007-9371-7>
- Penedo, A. C., Tom, V. D., Ferreira, A. F., Barcia, M. G., & Espinar, F. J. O. (2021). Enhancement in corneal permeability of riboflavin using cyclodextrin derivatives complexes as a previous step to transepithelial cross-linking Miguel Gonz a. *European Journal of Pharmaceutics and Biopharmaceutics*, 162, 12–22. <https://doi.org/10.1016/j.ejpb.2021.02.012>
- Permana, A. D., Tekko, I. A., Mccrudden, M. T. C., Kurnia, Q., Ramadon, D., Mccarthy, H. O., & Donnelly, R. F. (2019). Solid lipid nanoparticle-based dissolving microneedles: A promising intradermal lymph targeting drug delivery system with potential for enhanced treatment of lymphatic filariasis. *Journal of Controlled Release*, 316, 34–52. <https://doi.org/10.1016/j.jconrel.2019.10.004>
- Phatale, V., Vaiphei, K. K., Jha, S., Patil, D., Agrawal, M., & Alexander, A. (2022). Overcoming skin barriers through advanced transdermal drug delivery approaches. *Journal of Controlled Release*, 361–380. <https://doi.org/10.1016/j.jconrel.2022.09.025>

- Pizzol, D., Xiao, T., Yang, L., Demurtas, J., Mcdermott, D., Garolla, A., Nardelotto, A., Grabovac, I., Soysal, P., Kazancioglu, R. T., Veronese, N., & Smith, L. (2021). Prevalence of erectile dysfunction in patients with chronic kidney disease : a systematic review and meta-analysis. *IJIR: Your Sexual Medicine Journal*, 33, 508–515. <https://doi.org/10.1038/s41443-020-0295-8>
- Poulson, B. G., Alsulami, Q. A., Sharfalddin, A., El Agammy, E. F., Mouffouk, F., Emwas, A.-H., Jaremko, L., & Jaremko, M. (2022). Cyclodextrins: Structural, Chemical, and Physical Properties, and Applications. *Polysaccharides*, 3, 1–31. <https://doi.org/10.3390/polysaccharides3010001>
- Proksch, E. (2018). pH in nature , humans and skin. *Journal of Dermatology*, 1–9. <https://doi.org/10.1111/1346-8138.14489>
- Rahman, L., Lembang, R. S., Lallo, S., Handayani, S. R., Usmanengsi, & Permana, A. D. (2021). Bioadhesive dermal patch as promising approach for improved antibacterial activity of bioactive compound of Zingiber cassumunar Roxb in ex vivo Staphylococcus aureus skin infection model. *Journal of Drug Delivery Science and Technology*, 63, 1–8. <https://doi.org/10.1016/j.jddst.2021.102522>
- Ramadon, D., Ulayya, F., Sakinah, A., & Iskandarsyah, I. (2023). Combination of Dissolving Microneedles with Nanosuspension and Co-Grinding for Transdermal Delivery of Ketoprofen. *Pharmaceutics*.
- Ranjan Yadav, P., Iqbal Nasiri, M., Vora, L. K., Larrañeta, E., Donnelly, R. F., Pattanayek, S. K., & Bhusan Das, D. (2022). Super-swelling hydrogel-forming microneedle based transdermal drug delivery: Mathematical modelling, simulation and experimental validation. *International Journal of Pharmaceutics*. <https://doi.org/10.1016/j.ijpharm.2022.121835>
- Reena, Kumar, A., Mahto, V., & Choubey, A. K. (2020). Synthesis and characterization of cross-linked hydrogels using polyvinyl alcohol and polyvinyl pyrrolidone and their blend for water shut-off treatments. *Journal of Molecular Liquids*, 301. <https://doi.org/10.1016/j.molliq.2020.112472>
- Rinkūnienė, E., Gimžauskaitė, S., Badarienė, J., Dženkevičiūtė, V., Kovaitė, M., & Čypienė, A. (2021). The prevalence of erectile dysfunction and its association with cardiovascular risk factors in patients after myocardial infarction. *Medicina (Lithuania)*, 57(1103), 1–12. <https://doi.org/10.3390/medicina57101103>
- Sabri, A. H. Bin, Anjani, Q. K., Utomo, E., Ripolin, A., & Donnelly, R. F. (2022). Development and characterization of a dry reservoir-hydrogel-forming microneedles composite for minimally invasive delivery of

- cefazolin. *International Journal of Pharmaceutics*, 617, 1–16. <https://doi.org/10.1016/j.ijpharm.2022.121593>
- Sadab, S., Sahu, S., Patel, S., Khan, R., Khare, B., Thakur, B. S., Jain, A., & Jain, P. K. (2022). A Comprehensive Review: Transdermal Drug Delivery System: A Tool For Novel Drug Delivery System. *Asian Journal of Dental and Health Sciences*, 2(4), 40–47. <https://doi.org/10.22270/ajdhs.v2i4.24>
- Saigal, N., Baboota, S., Ahuja, A., & Ali, J. (2009). Microcrystalline Cellulose as a Versatile Excipient in Drug Research. *J Young Pharm.* <https://doi.org/10.4103/0975-1483.51868>
- Saka, N., Iwamoto, H., Malle, D., Takahashi, N., Mizutani, K., & Mikami, B. (2018). Elucidation of the mechanism of interaction between *Klebsiella pneumoniae* pullulanase and cyclodextrin. *Acta Crystallographica Section D: Structural Biology*, 74(11), 1115–1123. <https://doi.org/10.1107/S2059798318014523>
- Saokham, P., Muankaew, C., Jansook, P., & Loftsson, T. (2018). Solubility of Cyclodextrins and Drug/Cyclodextrin Complexes. *Molecules*, 23(1161), 1–15. <https://doi.org/10.3390/molecules23051161>
- Sapte, S., & Pore, Y. (2016). Inclusion complexes of cefuroxime axetil with β -cyclodextrin: Physicochemical characterization, molecular modeling and effect of L-arginine on complexation. *Journal of Pharmaceutical Analysis*, 6, 300–306. <https://doi.org/10.1016/j.jpha.2016.03.004>
- Sarfaraz, M., Dhruv, R. K., Doddappa, H., & Khan, K. A. A. (2020). Factorial Design Based Optimization of Hydroxyzine Hydrochloride Fast Dissolving Tablets. *Indian Journal of Pharmaceutical Sciences*.
- Sawatdee, S., Pakawatchai, C., Nitichai, K., Srichana, T., & Phetmung, H. (2015). Why sildenafil and sildenafil citrate monohydrate crystals are not stable? *Saudi Pharmaceutical Journal*. <https://doi.org/10.1016/j.jsps.2015.01.019>
- Sayyad, F. J., Tulsankar, S. L., & Kolap, U. B. (2013). Design and development of liquisolid compact of candesartan cilexetil to enhance dissolution. *Journal of Pharmacy Research*, 7, 381–388. <https://doi.org/10.1016/j.jopr.2013.05.012>
- Sharff, A. J., Quioco, F. A., Rodseth, L. E., & Quioco, F. A. (1993). Refined 1.8-Å Structure Reveals the Mode of Binding of β -Cyclodextrin to the Maltodextrin Binding Protein. *Biochemistry*, 32, 10553–10559. <https://doi.org/10.1021/bi00091a004>
- Sharifi, N., Mortazavi, S. A., Rabbani, S., Torshabi, M., Talimi, R., & Haeri,

- A. (2022). Fast dissolving nanofibrous mats for diclofenac sodium delivery: Effects of electrospinning polymer and addition of super-disintegrant. *Journal of Drug Delivery Science and Technology*, 73. <https://doi.org/10.1016/j.jddst.2022.103356>
- Shi, Y., Xiong, D., Liu, Y., Wang, N., & Zhao, X. (2016). Swelling, mechanical and friction properties of PVA/PVP hydrogels after swelling in osmotic pressure solution. *Materials Science and Engineering C*, 65, 172–180. <https://doi.org/10.1016/j.msec.2016.04.042>
- Singh, A., & Bali, A. (2016). Formulation and characterization of transdermal patches for controlled delivery of duloxetine hydrochloride. *Journal of Analytical Science and Technology*, 7(25), 1–13. <https://doi.org/10.1186/s40543-016-0105-6>
- Singh, T. R. R., Garland, M. J., Migalska, K., Salvador, E. C., Shaikh, R., Mccarthy, H. O., Woolfson, A. D., & Donnelly, R. F. (2012). Influence of a Pore-Forming Agent on Swelling , Network Parameters , and Permeability of Poly (ethylene glycol) -Crosslinked Poly (methyl vinyl ether- co -maleic acid) Hydrogels : Application in Transdermal Delivery Systems. *Journal of Applied Polymer Science*. <https://doi.org/10.1002/app>
- Soares, R. N., Ximenes, E. C. P. de A., Araújo, S. B., da Silva, R. L., de Souza, V. M. O., Coelho, L. C. B. B., Neto, J. L. de F., Neto, P. J. R., de Araújo, H. D. A., Aires, A. de L., & Albuquerque, M. C. P. de A. (2023). Evaluation of β -lapachone-methyl- β -cyclodextrin inclusion complex prepared by spray drying and its application against different developmental stages of *Schistosoma mansoni* in murine model. *Chemico-Biological Interactions*, 373.
- Sonker, A. K., & Verma, V. (2018). Influence of crosslinking methods toward poly (vinyl alcohol) properties : Microwave irradiation and conventional heating. *Journal of Applied Polymer Science*, 1–8. <https://doi.org/10.1002/app.46125>
- Suksaeree, J., Monton, C., Charoenchai, L., & Chankana, N. (2023). Microwave - assisted drying of Prasakanphlu herbal granules and formulation development of Prasakanphlu tablets: Design of Experiments approach. *Advances in Traditional Medicine*. <https://doi.org/10.1007/s13596-023-00681-7>
- Suliman, A. S., Khoder, M., Tolaymat, I., Webster, M., Alany, R. G., Wang, W., Elhissi, A., & Najlah, M. (2021). Cyclodextrin Diethyldithiocarbamate Copper II Inclusion Complexes : A Promising Chemotherapeutic Delivery System against Chemoresistant Triple Negative Breast Cancer Cell Lines. *Pharmaceutics*, 13(84), 1–12. <https://doi.org/10.3390/pharmaceutics13010084>

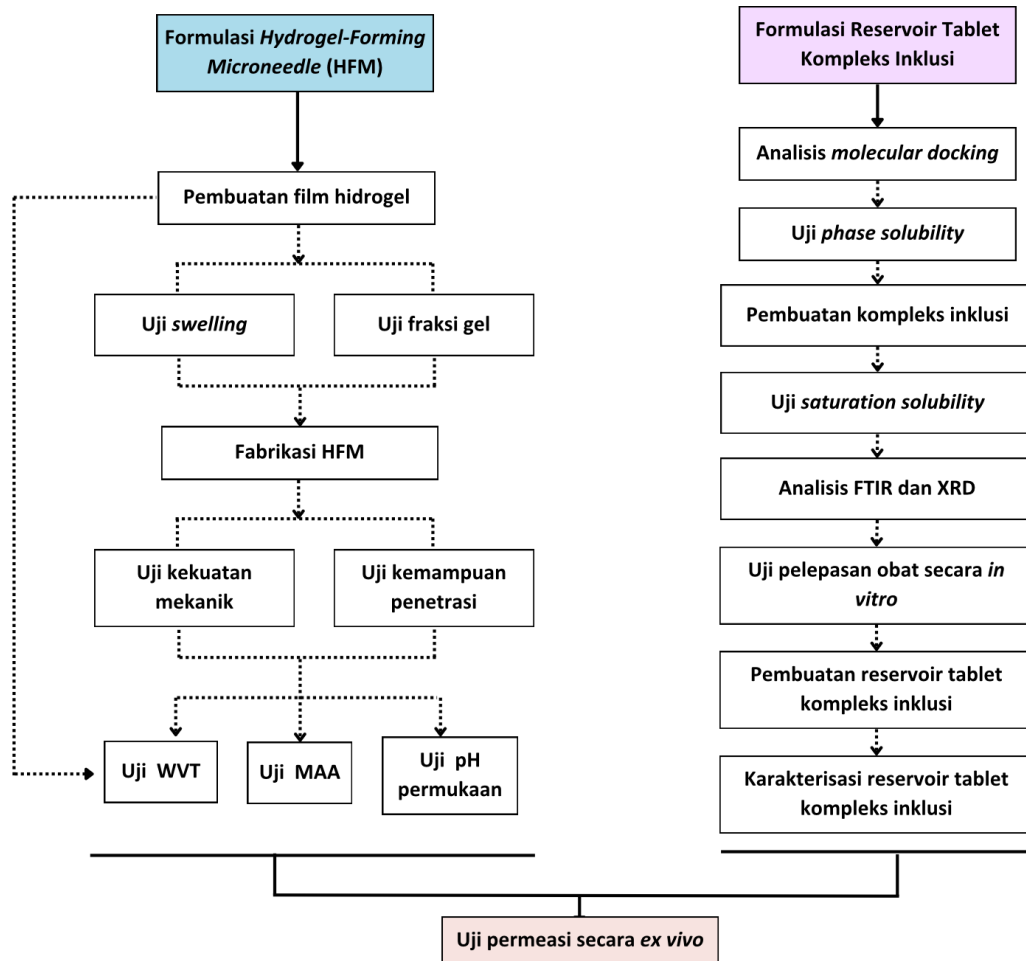
- Sun, X., Zhu, J., Liu, C., Wang, D., & Wang, C. Y. (2022). Fabrication of fucoxanthin/2-hydroxypropyl- β -cyclodextrin inclusion complex assisted by ultrasound procedure to enhance aqueous solubility, stability and antitumor effect of fucoxanthin. *Ultrasonics Sonochemistry*, 1–9. <https://doi.org/10.1016/j.ultsonch.2022.106215>
- Syafika, N., Binti, S., Azis, A., Enggi, C. K., Qonita, H. A., Resky, T., Mahmud, A., Abizart, A., Asri, R. M., & Permana, A. D. (2023). Glucose-Responsive Microparticle-Loaded Dissolving Microneedles for Selective Delivery of Metformin: A Proof-of-Concept Study. *Pharmaceutics*. <https://doi.org/10.1021/acs.molpharmaceut.2c00936>
- Tan, L. S., Tan, H. L., Deekonda, K., Yin, Y., Muniyandy, S., Hashim, K., & Pushpamalar, J. (2021). Fabrication of radiation cross-linked diclofenac sodium loaded carboxymethyl sago pulp / chitosan hydrogel for enteric and sustained drug delivery. *Carbohydrate Polymer Technologies and Applications*, 2(May), 100084. <https://doi.org/10.1016/j.carpta.2021.100084>
- Teepakakorn, A. P., & Ogawa, M. (2021). Composition-Dependent Thermal Stability and Water-Induced Self-Healing Behavior of Smectite/Waterborne Polymer Hybrid Film. *Langmuir*. <https://doi.org/10.1021/acs.langmuir.1c01908>
- Tekko, I. A., Chen, G., Domínguez-robles, J., Raj, R., Thakur, S., Hamdan, I. M. N., Vora, L., Larrañeta, E., Mcelnay, J. C., Mccarthy, H. O., Rooney, M., & Donnelly, R. F. (2020). Development and characterisation of novel poly (vinyl alcohol)/ poly (vinyl pyrrolidone) -based hydrogel-forming microneedle arrays for enhanced and sustained transdermal delivery of methotrexate. *International Journal of Pharmaceutics*, 586. <https://doi.org/10.1016/j.ijpharm.2020.119580>
- Teodorescu, M., Bercea, M., & Morariu, S. (2019). Biomaterials of PVA and PVP in medical and pharmaceutical applications : Perspectives and challenges ☆. *Biotechnology Advances*, 37, 109–131. <https://doi.org/10.1016/j.biotechadv.2018.11.008>
- Thakur, S., Anjum, M., Jaiswal, S., Kumar, A., Deepak, P., Anand, S., Singh, S., & Rajinikanth, P. S. (2023). Novel Synergistic Approach: Tazarotene-Calcipotriol-Loaded-PVA / PVP- Novel Synergistic Approach: Tazarotene-Calcipotriol-Loaded-PVA / PVP-Nanofibers Incorporated in Hydrogel Film for Management and Treatment of Psoriasis. *January*. <https://doi.org/10.1021/acs.molpharmaceut.2c00713>
- Turner, J. G., White, L. R., Estrela, P., & Leese, H. S. (2020). Hydrogel-Forming Microneedles: Current Advancements and Future Trends. *Macromolecular Bioscience*, 1–18. <https://doi.org/10.1002/mabi.202000307>

- Uranga, J., Puertas, A. I., Etxabide, A., Dueñas, M. T., Guerrero, P., & Caba, K. De. (2018). Citric acid-incorporated fish gelatin/chitosan composite films. *Food Hydrocolloids*.
<https://doi.org/10.1016/j.foodhyd.2018.02.018>
- Volpe-Zanutto, F., Vora, L. K., Tekko, I. A., McKenna, P. E., Permana, A. D., Sabri, A. H., Anjani, Q. K., McCarthy, H. O., Paredes, A. J., & Donnelly, R. F. (2022). Hydrogel-forming microarray patches with cyclodextrin drug reservoirs for long-acting delivery of poorly soluble cabotegravir sodium for HIV Pre-Exposure Prophylaxis. *Journal of Controlled Release*, 348, 771–785.
<https://doi.org/10.1016/j.jconrel.2022.06.028>
- Vora, L. K., Courtenay, A. J., Tekko, I. A., Larrañeta, E., & Donnelly, R. F. (2020). Pullulan-based dissolving microneedle arrays for enhanced transdermal delivery of small and large biomolecules. *International Journal of Biological Macromolecules*, 146, 290–298.
<https://doi.org/10.1016/j.ijbiomac.2019.12.184>
- Vora, L. K., Moffatt, K., Tekko, I. A., Paredes, A. J., Volpe-zanutto, F., Mishra, D., Peng, K., Raj, R., Thakur, S., & Donnelly, R. F. (2021). Microneedle array systems for long-acting drug delivery. *European Journal of Pharmaceutics and Biopharmaceutics*, 159, 44–76.
<https://doi.org/10.1016/j.ejpb.2020.12.006>
- Waghule, T., Singhvi, G., Dubey, S. K., Pandey, M. M., Gupta, G., Singh, M., & Dua, K. (2019). Microneedles: A smart approach and increasing potential for transdermal drug delivery system. *Biomedicine and Pharmacotherapy*, 109, 1249–1258.
<https://doi.org/10.1016/j.biopha.2018.10.078>
- Walfish, S. (2006). Analytical Methods: A Statistical Perspective on the ICH Q2A and Q2B Guidelines for Validation of Analytical Methods. *BioPharm International*, 1–6.
- Wang, R., Zhou, H., Siu, S. W. I., Gan, Y., Wang, Y., & Ouyang, D. (2015). Comparison of three molecular simulation approaches for cyclodextrin-ibuprofen complexation. *Journal of Nanomaterials*, 1–9.
<https://doi.org/10.1155/2015/193049>
- Xu, J., Xu, D., Xuan, X., & He, H. (2021). Advances of Microneedles in Biomedical Applications. *Molecules*.
- Yadav, A. V., & Urade, M. N. (2019). Formulation and Evaluation of Chitosan Based Transdermal Patches of Lornoxicam for Prolonged Drug Release and to Study the Effect of Permeation Enhancer. *Indian Journal of Pharmaceutical Education and Research* |, 53(1).
<https://doi.org/10.5530/ijper.53.1.12>

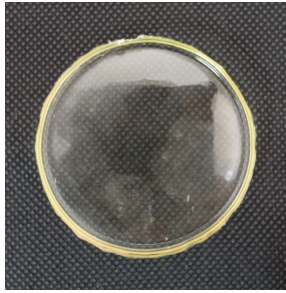
- Yafi, F. A., Jenkins, L., Albersen, M., Corona, G., Isidori, A. M., Goldfarb, S., Maggi, M., Nelson, C. J., Parish, S., Salonia, A., Tan, R., Mulhall, J. P., & Hellstrom, W. J. G. (2016). Erectile dysfunction. *Nature Reviews Disease Primers*, 2(1), 1–47. <https://doi.org/10.1038/NRDP.2016.3>
- Yang, P., Shi, Y., Li, D., Chen, R., Zheng, M., Ma, K., Xu, N., Dong, L., & Li, T. (2022). Antimicrobial and Mechanical Properties of β - Cyclodextrin Inclusion with Octyl Gallate in Chitosan Films and their Application in Fresh Vegetables. *Food Biophysics*, 598–611. <https://doi.org/10.1007/s11483-022-09746-7>
- Yang, Y., Xia, L., Ning, X., Hu, T., Xu, C., & Liu, W. (2021). Enhanced Drug Permeation into Human Keloid Tissues by Sonophoresis-Assisted Microneedling. *SLAS Technology*, 26(6), 660–666. <https://doi.org/10.1177/24726303211024568>
- Yavuz, B., Chambre, L., Harrington, K., Kluge, J., Valenti, L., & Kaplan, D. L. (2020). Silk Fibroin Microneedle Patches for the Sustained Release of Levonorgestrel. *ACS Applied Bio Materials*, 3(8), 5375–5382. <https://doi.org/10.1021/acsabm.0c00671>
- Zhang, W., Jiang, Q., Shen, J., Gao, P., Yu, D., Xu, Y., & Xia, W. (2022). The role of organic acid structures in changes of physicochemical and antioxidant properties of crosslinked chitosan films. *Food Packaging and Shelf Life*, 31. <https://doi.org/10.1016/j.fpsl.2021.100792>
- Zhang, Y., Zhou, W., Wu, X., Liu, G., Dai, Y., Jiang, H., & Zhang, X. (2021). Cavernous artery intima- - media thickness predicts the response to sildenafil in erectile dysfunction patients as a morphological parameter. *Andrologia*, 1–8. <https://doi.org/10.1111/and.14149>
- Zhao, L., Vora, L. K., Kelly, S. A., Li, L., Larrañeta, E., McCarthy, H. O., & Donnelly, R. F. (2023). Hydrogel-forming microarray patch mediated transdermal delivery of tetracycline hydrochloride. *Journal of Controlled Release*, 356, 196–204. <https://doi.org/10.1016/j.jconrel.2023.02.031>

LAMPIRAN

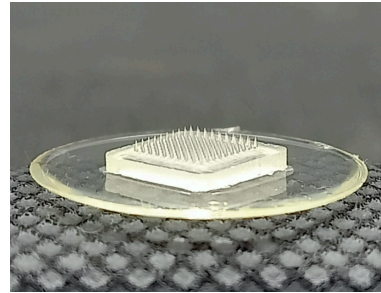
Lampiran 1. Alur Penelitian



Lampiran 2. Dokumentasi Penelitian



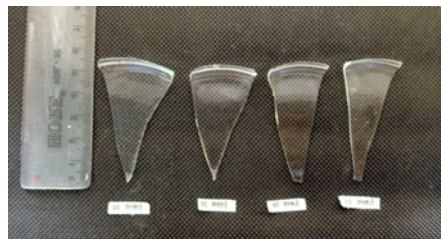
Gambar 16. Film hidrogel yang telah dicetak



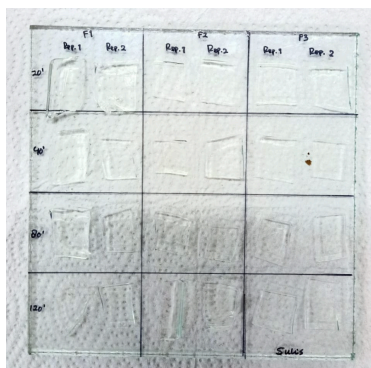
Gambar 17. HFM yang telah dicetak



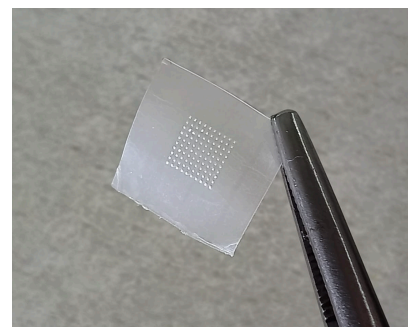
Gambar 18. Film hidrogel sebelum *swelling*



Gambar 19. Film hidrogel setelah *swelling*



Gambar 20. Pengujian fraksi gel



Gambar 21. Karakterisasi HFM menggunakan Parafilm® M



Gambar 22. Pembuatan kompleks inklusi



Gambar 23. Karakterisasi reservoir tablet kompleks inklusi



Gambar 24. Studi permeasi secara *ex vivo*