

## V. KESIMPULAN DAN SARAN

### 5.1. Kesimpulan

1. Penambahan bahan aktif ekstrak bunga telang dan tepung cangkang telur pada *smart edible packaging* memberikan pengaruh nyata terhadap aktivitas antioksidan, laju transmisi uap air (WVTR), kuat tarik, dan persen pemanjangan.
2. Penambahan tepung cangkang telur tidak memberikan pengaruh terhadap kadar total fenol dan antosianin.
3. Penambahan bahan aktif ekstrak bunga telang dan tepung cangkang telur pada *smart edible packaging* meningkatkan aktivitas antioksidan (15,09-57,86%), laju transmisi uap air (175,50-211,97 g/m<sup>2</sup>/24 jam), dan persen pemanjangan (2,24-67,28%).
4. Penambahan bahan aktif ekstrak bunga telang dan tepung cangkang telur pada *smart edible packaging* menurunkan nilai kuat tarik (13,02 – 1,27 N/mm<sup>2</sup>)
5. *Smart edible packaging* mampu menjadi indikator penurunan kualitas daging ayam selama penyimpanan karena terjadi perubahan warna *smart edible packaging* dari biru keunguan menjadi biru kehijauan
6. Penambahan bahan aktif ekstrak bunga telang dan tepung cangkang telur pada *smart edible packaging* mampu mempertahankan daging ayam selama penyimpanan, dilihat dari intensitas warna coklat daging ayam, aroma tidak sedap, dan pH daging ayam yang lebih rendah dibanding perlakuan kontrol (T dan TC)

### 5.2. Saran

Perlu dilakukan penelitian lebih lanjut untuk mencari bahan tambahan yang sesuai untuk meningkatkan ketahanan *smart edible packaging* terhadap uap air sehingga dapat lebih mudah untuk diaplikasikan pada produk pangan yang memiliki kadar air tinggi.

## DAFTAR PUSTAKA

- Abdi, E., Gharachorloo, M., & Ghavami, M. (2021). Investigation of using egg shell powder for bleaching of soybean oil. *Food Science and Technology*, 140, 1-5.
- Acevedo-Fani, A., Salvia-Trujillo, L., Rojas-Graü, M.A., & Martín-Belloso, O. (2015). Edible films from essential-oil-loaded nanoemulsions: Physicochemical characterization and antimicrobial properties. *Food Hydrocolloids*, 47, 168-177.
- Adamu, A.D., Jikan, S.S., Talip, B.H.A., Badarulzaman, N.A., & Yahaya, S. (2017). Effect of Glycerol on the Properties of Tapioca Starch Film. *Materials Science Forum*, 888, 239-243.
- Adawiyah, R., Widayastuti, S. & Werdiningsih, W. (2017). Pengaruh Pengemasan Vakum Terhadap Kualitas Mikrobiologis Ayam Bakar Asap Selama Penyimpanan. *Pro Food*, 2(2), 152-157.
- Ahmad, A.N., Lim, S.A., & Navaranjan, N. (2020). Development of sago (*Metroxylon sagu*)-based colorimetric indicator incorporated with butterfly pea (*Clitoria ternatea*) anthocyanin for intelligent food packaging. *Journal of Food Safety*, 40(4), 1-9.
- Ajiya, D.A., Jikan, S.S.B., Talip, B.A., Peralta, H.M.M., Badarulzaman, N.A. & Yahaya, S. (2017). Physical Properties of Edible Films Based on Tapioca Starch as Affected by the Glycerol Concentration. *International Journal of Current Research in Science Engineering & Technology*, 1, 410-415.
- Amanullah, S., Jahangir, M. M., Ikram, R. M., Sajid, M. Abbas, F. & Mallano, A. I. (2016). Aloe vera Coating Efficiency on Shelf Life of Eggplants at Differential Storage Temperatures. *Journal of Northeast Agricultural University*, 23(4), 15-25.
- Amaregouda, Y., Kamanna, K., & Gasti, T. (2022). Fabrication of intelligent/active films based on chitosan/polyvinyl alcohol matrices containing Jacaranda cuspidifolia anthocyanin for real-time monitoring of fish freshness. *International Journal of Biological Macromolecules*, 218, 799–815.  
<https://doi.org/10.1016/j.ijbiomac.2022.07.174>
- Ananta, R., Kusuma, S.B.W., & Harjono. (2017). Film Berbasis Ekstrak Antosianin Ubi Jalar Ungu Sebagai Bioindikator

- Kerusakan Daging Ayam. *Indonesian Journal of Chemical Science*, 6(1), 84-90.
- Anthika, B., Kusumocahyo, S.P., & Sutanto, H. (2015). Ultrasonic approach in *Clitoria ternatea* (Butterfly Pea) extraction in water and extract sterilization by ultrafiltration for eye drop active ingredient. *Procedia Chemistry*, 16(1), 237-244.
- Apak, R., Capanoglu, E., & Shahidi, F. (Eds.). (2018). *Measurement of Antioxidant Activity & Capacity: Recent Trends and Applications*. John Wiley & Sons.
- Asante-Pok, A. (2013). *Analysis of incentives and disincentives for cassava in Nigeria*. Technical notes series, MAFAP, FAO, Rome.
- Aydin, G., & Zorlu, E. B. (2022). Characterization and Antibacterial Properties of Novel Biodegradable Films Based on Alginate and Roselle (*Hibiscus sabdariffa L.*) Extract. *Waste and Biomass Valorization*, 13, 2991-3002.
- Bashir, A. S. M., Manusamy, Y., Chew, T. L., Ismail, H., & Ramasamy, S. (2017). Mechanical, thermal, and morphological properties of (egg-shell powder)-filled natural rubber latex foam. *Journal of Vinyl and Additive Technology*, 23(1), 3–12.
- Barbosa-Pereira, L., Aurrekoetxea, G. P., Angulo, I., Paseiro\_Losada, P., Cruz. J. M.(2014). Development of new active packaging films coated with natural phenolic compound to improve the oxidative stability of beef. *Meat Science*, 97, 249-254.
- Biji, K.B., Ravishankar, C.N., Mohan, C.O., & Srinivasa, G.T.K. (2015). Smart packaging systems for food applications: a review. *J Food Sci Technol*, 52, 6125–6135.
- Borges, J.A., Romani, V.P., Cortez-Vega, W.R., & Martins, V.G. (2015). Influence of different starch sources and plasticizers on properties of biodegradable films. *International Food Research Journal*, 22(6), 2346-2351.
- Budiasih, K.S. (2017). Kajian Potensi Farmakologis Bunga Telang (*Clitoria ternatea*). *Prosiding Seminar Nasional Kimia UNY*, 201-206.
- Rojas-Bravo, M., Rojas-Zenteno, E.G., Hernández-Carranza, Sosa, R.A., Sánchez, R.A., López, I.I.R., & Velasco, C.E.O. (2019). A Potential Application of Mango (*Mangifera indica L.* cv Manila) Peel Powder to Increase the Total Phenolic Compounds and Antioxidant Capacity of Edible Films and Coatings. *Food and Bioprocess Technology*, 12, 1584–1592.

- Chambi, H. N. M., de Costa, B. S., de Lima, W. C., Kassardjian., & Schmidt, F. L. (2020). Fruit juices in polysaccharides edible films. *African Journal of Food Science*, 14(3), 53-62.
- Chen, L. H., Chen, I. C., Chen, P. Y. & Huang, P. H. (2018). Application of butterfly pea flower extract in mask development. *Scientia Pharmaceutica*, 86(53), 1-9.
- Das, D., Panesar, P.S., Saini, C.S., & Kennedy, J.F. (2022). Improvement in properties of edible film through non-thermal treatments and nanocomposite materials: A review. *Food Packaging and Shelf Life*, 32(6), 1-10.
- Dehghani, S., Hosseini, S. V., & Regenstein, J. M. (2018). Edible films and coatings in seafood preservation: A review. *Food Chemistry*, 1(240), 505–513.
- DeMan, J.M., Finley, J.W., Hurst, W.J., & Lee, C.Y. (2018). *Principles of Food Chemistry, Fourth Edition*. Springer.
- Dinika, I. & Utama, G. L. (2019). Cheese whey as potential resource for antimicrobial edible film and active packaging production. *Foods and Raw Materials*, 7(2), 229-239.
- Djaeni, M., Ariani, N., Hidayat, R., & Utari, F. (2017). Ekstraksi Antosianin dari Kelopak Bunga Rosella (*Hibiscus sabdariffa* L.) Berbantu Ultrasonik: Tinjauan Aktivitas Antioksidan Ultrasonic Aided Anthocyanin Extraction of *Hibiscus sabdariffa* L. Flower Petal: Antioxidant Activity. *Jurnal Aplikasi Teknologi Pangan*, 6(3), 148-151.
- Dordevic, S., Dordevic, D., Sedlacek, P., KAolina, M., Tesikova, K., Antonic, B., Termlova, B., Treml, J., Mejezchlebova, M., Vapenka, L., Rajchl, A., & Bulakova, M. (2021). Incoporation of natural blue berry, red grapes, and parsley extract by-product into production of chitosan edible films. *Polymers*, 13, 338.
- Drago, E., Campardelli, R., Pettinato, M., & Perego, P. (2020). Innovations in Smart Packaging Concepts for Food: An Extensive Review. *Foods*, 9, 1628.
- Duy, N.Q., Hao, N.T.M., Lam, T.D., Pham, T.N., & Thanh, N.T. (2020). Extraction and Determination of Antioxidant Activity of Vietnamese Butterfly Pea (*Clitoria ternatia* L.). Materials Science Forum, 977, 207-211.
- Ekrami M, Roshani-Dehlaghi N, Ekrami A, Shakouri M, & Emam-Djomeh Z. (2022). pH-Responsive Color Indicator of Saffron (*Crocus sativus* L.) Anthocyanin-Activated Salep Mucilage

- Edible Film for Real-Time Monitoring of Fish Fillet Freshness. *Chemistry*, 4(4), 1360-1381.
- Eysturskarð, J. (2010). Mechanical Properties of Gelatin Gels; Effect of Molecular Weight and Molecular Weight Distribution, *Thesis*, Faculty of Natural Science and Technology, Norwegian University of Science and Technology.
- Faridah, D.N., & Thonthowi, A. (2020). Karakterisasi Fisik Pati Tapioka Modifikasi Gabungan Hidroksipropilasi dengan Fosfat-Ikat Silang. *Jurnal Mutu Pangan*, 7(1), 30-37.
- Gamage, G. C. V., Lim, Y. Y., & Choo, W. S. (2021). Anthocyanins from *Clitoria ternatea* flower: biosynthesis, extraction, Stability, antioxidant activity, and applications. *Front. Plant Sci.*, 12, 792303.
- Ge, Y., Li, Y., Bai, Y., Yuan, C., Wu, C., & Hu, Y. (2020). Intelligent gelatin/oxidized chitin nanocrystals nanocomposite films containing black rice bran anthocyanins for fish freshness monitorings. *International Journal of Biological Macromolecules*, 155, 1296–1306.
- Gelatin Manufacturers Institute of America (GMIA). (2012). *Gelatin*, Gelatin Manufacturers Institute of America, Inc., New York, NY.
- Gheribi, R., Puchot, L., Verge, P., Jaoued-Grayaa N, Mezni, M., Habibi, Y., & Khwaldia, K. (2018). Development of plasticized edible films from *Opuntia ficus-indica* mucilage: A comparative study of various polyol plasticizers. *Carbohydr Polym.*, 190, 204-211.
- Gomez-Aldapa, C. A., Diaz-cruz, C. A., Castro-Rosas, J., Jimenez-Regaladom E. J., Velazquez, G., Gutierrez, M. C., & Aguirre-Loredo, R. Y. (2021). Development of antimicrobial biodegradable films based on corn starch with aqueous extract of *Hibiscus sabdariffa L.* *Starch-Stärke*, 73, 1-2.
- Hamid, N., Thakur, S., Thakur, A., & Kumar, P. (2020). Effect of different drying modes on phenolics and antioxidant potential of different parts of wild pomegranate fruits. *Scientia Horticulturae*, 274, 1-8.
- Handito, D., Basuki, E., Saloko, S., Dwikasari, L.G., & Triani, E. (2022). Analisis Komposisi Bunga Telang (*Clitoreia ternatea*) sebagai Antioksidan Alami pada Produk Pangan. *Prosiding SAINTEK*, 4, 64-70.

- Hanani, Z. A., Husna, A. B. A., Syahida, S. N., Khaizura, M. A. B. N., & Jamilah, B. (2018). Effect of different fruit peels on the functional properties of gelatin/polyethylene bilayer films for active packaging. *Food Packaging and Shelf Life*, 18, 201-211.
- Hardikawati, H., Puspawati N. M., & Ratnayani, K. (2016). Kajian Pengaruh Variasi Konsentrasi Asam Sitrat Terhadap Kekuatan Gel Produk Gelatin Kulit Ayam Broiler Dikaitkan Dengan Pola Proteinnya. *Jurnal Kimia*, 10(1), 115-124.
- Hendra, A.A. (2015). Kajian Karakteristik Edible Film Dari Tapioka Dan Gelatin Dengan Perlakuan Penambahan Gliserol, *Skripsi*, Fakultas Teknologi Pertanian, Universitas Widya Mandala, Surabaya.
- Herawati, H. (2012). Teknologi Proses Produksi Food Ingredient Dari Tapioka Termodifikasi. *Jurnal Litbang Pertanian*, 31(2), 68-76.
- Immaningsih, N. (2012). Profil Gelatinisasi Beberapa Formulasi Tepung-Tepungan untuk Pendugaan Sifat Pemasakan. *Penelitian Gizi Makan*, 35(1), 13-22.
- Jagadeesh, D., Prashantha, K., Nayunigari, N. M. K. & Maity, A. (2016). Effect of gelatin content on potato starch green composite films. *Indian Journal of Advance Chemical Science*, 4(4), 355-361.
- Japanesse Industrial Standard. (1975). Japanesse Standards Association 2 1707. *J J-PAL*, 6(1).
- Jeevahan, J., Chandrasekaran, M., Durairaj, R. B., Mageshwaran, G., Joseph, G. B. (2017). A brief review on edible food packing material. *Journal of Global Engineering Problems and Solutions*, 1(1), 9-19.
- Jeyaraj, E.J., Lim, Y.Y., & Choo, W.S. (2020). Extraction methods of butterfly pea (*Clitoria ternatea*) flower and biological activities of its phytochemicals. *J. Food Sci. Technol.* 58, 2054-2067.
- Jiang, B., Li, S., Wu, Y., Song, J., Chen, S., Li, X., & Sun, H. (2018). Preparation and characterization of natural corn starch-based composite films reinforced by eggshell powder. *CYTA – JOURNAL OF FOOD*, 16(1), 1045-1054.
- Kabadurmus, O., Kaayikci, Y., Demir, S., & Koc, B. (2022). A data-driven decision support system with smart packaging in grocery store supply chains during outbreaks. *Socio-Economic Planning Sciences*.
- Kaewprachu, P., Osako, K., Benjakul, S., Rawdkuen, S. (2015). Quality attributes of minced pork wrapped with catechin-

- lysozyme incorporated gelatin film. *Food Packag. Shelf Life*, 3, 88–96.
- Khoiriyah, H., Kurniawati, N., Liviawaty, E., & Junianto. (2018). Concentration Addition Of Plasticizer Sorbitol To The Characteristics Of Carrageenan Edible Film. *GSJ*, 6(10), 1-9.
- Khoo, H. E., Azlan, A., Tang, S. T., & Lim, S. M. (2017). Anthocyanidins and Anthocyanins: Colored Pigments as Food, Pharmaceutical Ingredients, and the Potential Health Benefits. *Food and Nutrition Research*, 61(1), 1-21.
- Kim, H., Yang, H., Lee, K.Y., Beak, S.E., & Song, K.B. (2017). Characterization of red ginseng residue protein films incorporated with hibiscus extract. *Food Sci. Biotechnol.*, 26(2), 369-374
- Kong, J., Zhang, Y., Ju, J., Xie, Y., Guo, Y., Cheng, Y., & Yao, W. (2019). Antifungal effects of thymol and salicylic acid on cell membrane and mitochondria of *Rhizopus stolonifer* and their application in postharvest preservation of tomatoes. *Journal of Food chemistry*, 285, 380–388.
- Koosha, M.S., & Hamed. (2019). Intelligent chitosan/PVA nanocomposite films containing black carrot anthocyanin and bentonite nanoclays with improved mechanical, thermal and antibacterial properties. *Prog. Org. Coat.* 127, 338–347.
- Kumar, A.V., Hasan, M., Mangaraj, S., Pravitha, M., Verma, D.K., & Srisatav. (2022). Trends in Edible Packaging Films and its Prospective Future in Food: A Review. *Applied Food Research*, 2(1), 1-17.
- Kumar, N., Pratibha, Petkoska, A.T., Khojah, E., Sami, R., & Al-Mushhin, A.A.M. (2021). Chitosan Edible Films Enhanced with Pomegranate Peel Extract: Study on Physical, Biological, Thermal, and Barrier Properties. *Materials*, 14(3305), 1-18.
- Kurnia, R.D. (2020). Subtitusi Tepung Cangkang Telur Ayam Ras Terhadap Kandungan Kimia Dan Organoleptik Pada Seduhan Kopi Robusta, *Skripsi*, Fakultas Teknologi Pertanian, Universitas Semarang.
- Kusnandar, F. (2010). *Kimia Pangan: Makro Molekul*. Jakarta: PT Dian Rakyat.
- Lakshan, S.A.T., Pathirana, C.K., Jayanath, N.Y., Abeysekara, W.P.K.M., & Abeysekara, W.K.S.M. (2020). Antioxidant and selected chemical properties of the flowers of three different

- varieties of Butterfly Pea (*Clitoria ternatea* L.). *Ceylon Journal of Science*, 49(2), 195-201.
- Leong, C., Daud, N.S., Tong, W.Y., Cheng, S.Y., Tan, W.N., Hamin, N.S., & Paee, K.Z. (2021). Gelatine Film Incorporated with *Clitoria ternatea*-Derived Anthocyanin Microcapsules, A Food Packaging Material Effective Against Foodborne Pathogens. *Food Technol. Biotechnol.*, 59(4), 422–431.
- Lismawati. (2017). *Pengaruh Penambahan Plasticizer Gliserol Terhadap Karakteristik Edible Film dari Pati Kentang (Solanum tuberosum L.)*. Fakultas Sains dan Teknologi. UIN Alauddin Makassar.
- Liu, J., Wang, H., Guo, M., Li, L., Chen, M., Jiang, Suwei, Li, X., Jiang, & Shaotong. (2019). Extract from *Lycium ruthenicum* Murr. incorporating κ-carrageenan colorimetric film with a wide pH-sensing range for food freshness monitoring. *Food Hydrocolloids* 94, 1–10
- Lopusiewicz, L., Jedra, F. & Bartkowiak, A. (2018). New Active Packaging Films Made from Gelatin Modified with Fungal Melanin. *World Scientific News*, 101, 1-30.
- Marpaung, A.M., Lee, M., & Kartawiria, I.S. (2020). The Development of Butterfly pea (*Clitoria ternatea*) Flower Powder Drink by Co-crystallization. *Indonesian Food Science and Technology Journal*, 3(2), 34-37.
- Marin, R.F., Fernandes, S.C.M., Sánchez, M.A.A., & Labidi, J. (2022). Halochromic and antioxidant capacity of smart films of chitosan/chitin nanocrystals with curcuma oil and anthocyanins. *Food Hydrocolloids*, 123, 1-10.
- Misnawati. (2015). Studi Pembuatan Edible Film Dari Proporsi Karagenan - Kitosan Dan Penambahan Larutan Pati Kimpul, *Skripsi*, Fakultas Pertanian Peternakan, Universitas Muhammadiyah Malang.
- Mittal, A., Teotia, M., Soni, R. K., & Mittal, J. (2016). Applications of egg shell and egg shell membrane as adsorbents. A review. *Journal of Molecular Liquids*, 223, 376–387.
- Moulia, M,N. (2018). *Bionanokomposit edible coating/film dari pati ubi kayu, nanopartikel ZnO dan ekstrak bawang putih dengan kapasitas antibakteri*. Bogor (ID): Institut Pertanian Bogor.

- Mulyadi, A. F., Pulungan, M. H., & Qayyum, N. (2016). Pembuatan Edible Film Tapioka dan Uji Aktifitas Antibakteri (Kajian Konsentrasi Gliserol dan Ekstrak Daun Beluntas (*Pluchea Indica* L.)). *Jurnal Teknologi & Manajemen Agroindustri*, 5(3), 149-158.
- Murugan, S., Munusamy, Y., & Ismail, H. (2017). Effects of chicken eggshell filler size on the processing, mechanical and thermal properties of PVC matrix composite. *Plastics, Rubber and Composites*, 46(1), 42–51.
- Nabila, S. D. P., Kusdarwati, R., & Agustono. (2018). Pengaruh Penambahan Beeswax sebagai Plasticizer terhadap Karakteristik Fisik Edible Film Kitosan. *Jurnal Ilmiah Perikanan & Kelautan*, 10(1), 34-39.
- Nata, I.F., Irawan, C., Adawiyah, M., & Aribowo, S. (2020). Edible film cassava starch/eggshell powder composite containing antioxidant: preparation and characterization. *IOP Conference Series: Earth and Environmental Science*, 524, 1-7.
- Nawab, A., Alam, F., & Hasnain, A. (2017). Mango kernel starch as a novel edible coating for enhancing shelf-life of tomato (*Solanum lycopersicum*) fruit. *International Journal of Biological Macromolecules*, 103, 581–586.
- Nielsen, S. S. (Ed.). (2017). *Food Analysis*. Springer International Publishing.
- Ningsih, S.H. (2015). Pengaruh plasticizer gliserol terhadap karakteristik edible film campuran whey dan agar, *Skripsi*, Makassar, Universitas Hasanuddin.
- Nogueira, G. F., Fakhouri, F. M., & de Oliveira, R. A. (2018). Effect of incorporation of blackberry particles on the physicochemical properties of edible films of arrowroot starch. *Drying Technology*, 37(4), 448–457. <https://doi.org/10.1080/07373937.2018.1441153>
- Nollet, L. M., & Gutierrez-Uribe, J. A. (Eds.). (2018). *Phenolic compounds in food: characterization and analysis*. CRC Press.
- Octaviani, D.Y., Nugroho, T.T., & Dahliaty. A. (2016). Penentuan Total Konsentrasi Antosianin Dari Ubi Jalar Ungu (*Ipomoea Batatas* L.) Dengan Metode Ph Diferensial Spektrofotometri. Repository University Of Riau. Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Riau. 1-8

- Oleyaei, S. A., Almasi, H., Ghanbarzadeh, B., & Moayedi, A. A. (2016). Synergistic reinforcing effect of TiO<sub>2</sub> and montmorillonite on potato starch nanocomposite films: Thermal, mechanical and barrier properties. *Carbohydr Polym*, 152, 253–262.
- Pedreiro, S., Figueirinha, A., Silvva, A.S., & Ramos, F. (2021). Bioactive Edible Films and Coatings Based in Gums and Starch: Phenolic Enrichment and Foods Application. *Coatings*, 11, 1-26.
- Pham, T.N., Nguyen, D.C., Lam, T.D., Thinh, P.V., Le, X.T., Nguyen, D.V.V., Vu, Q.H., Nguyen, T.D., & Bach, L.G. (2019). Extraction of anthocyanins from Butterfly pea (*Clitoria ternatea* L. Flowers) in Southern Vietnam: Response surface modeling for optimization of the operation conditions. *IOP Conf. Series: Materials Science and Engineering*, 542, 1-5.
- Poungchawanwong, S., Klaypradit, W., Li, Q., Wang, J., & Hou, H. (2020). Interaction effect of phenolic compounds on Alaska Pollock skin gelatin and associated changes. *Food Science and Technology*, 133, 1-9.
- Praja, D. I. (2015). *Zat Aditif Makanan: Manfaat dan Bahayanya*. Penerbit Garudhawaca.
- Prasad, N., & Batra, E. (2015). Edible Coating (The Future of Packaging): Cheapest and Alternative Source To Extend the Post-Harvest Changes-A Review. *Asian Journal of Biochemical and Pharmaceutical Research*, 3(5), 45-50.
- Purwaniati, Arif, A.R., & Yuliantini, A. (2020). Analisis Kadar Antosianin Total Pada Sediaan Bunga Telang (*Clitoria ternatea*) Dengan Metode pH Diferensial Menggunakan Spektrofotometri Visible. *Jurnal Farmagazine*, 7(1), 18-23.
- Putra, T.T.N.M., Zainol, M.K., MohdIsa, N.S., & MohnMaidin, N. (2021). Chemical characterization of ethanolic extract of Butterfly pea flower (*Clitoria ternatea*). *Food Research*, 5(4), 127-134.
- Qiu, J. L., Zhou, Q., Zhu, J. M., Lu, X. T., Liu, B., Yu, D. Y., Lin, G., Ao, T., & Su, J. M. (2020). Organic trace mineral improve eggshell quality by improving the eggshell ultrastructure of laying hens during the late laying period. *Poultry Science*, 99(3), 1483-1490.

- Raghav, P. K. & Saini, M. (2018). Development of Mint (*Mentha viridis* L.) Herbal Edible Coating for Shelf Life Enhancement of Cucumber (*Cucumis sativus*). *International Journal of Green and Herbal Chemistry*, 7(2), 379-391.
- Rahayu, F., & Fitriyah, N.H. (2015). Pengaruh Waktu Ekstraksi Terhadap Rendemen Gelatin Dari Tulang Ikan Nila Merah. *Seminar Nasional Sains dan Teknologi Universitas Muhammadiyah Jakarta*, 1-6.
- Rahmawati, Y.D., & Hasdar, M. (2017). Kualitas Viskositas dan Kekutan Gel Gelatin Kulit Domba yang Dihidrolisis Menggunakan Larutan NaOH. *Jurnal Ilmu-Ilmu Pertanian*, 1(1), 70-74.
- Ramos, M., Valdés, A., Beltrán, A., & Garrigós, M.C. (2016). Gelatin-Based Films and Coatings for Food Packaging Applications. *Coatings*, 6(41), 1-20.
- Rawdkuen, S., Faseha, A., Benjakul, S., & Kaewprachu, P. (2020). Application of anthocyanin as a color indicator in gelatin films. *Food Bioscience*, 36, 1-9.
- Redha, A. (2010). Flavonoid: Struktur, Sifat Antioksidatif Dan Peranannya Dalam Sistem Biologis. *Journal Belian*, 9(2), 196-201.
- Risnoyatiningsih, S. (2011). Hidrolisis Pati Ubi Jalar Kuning Menjadi Glukosa Secara Enzimatis. *Jurnal Teknik Kimia*, 5(2), 417-424.
- Rodrigues, C., Souza, V. G. L., Coelhoso, I., & Fernando, A. L. (2021). Bio-based sensors for smart food packaging—current applications and future trends. *Sensors*, 21, 1-23.
- Rodriguez, P. C., Martucci J.F., Neira L.M., Arbelaitz A., Eceiza A., Ruseckaite R.A. (2015). Functional properties and in vitro antioxidant and antibacterial effectiveness of pigskin gelatin films incorporated with hydrolysable chestnut tannin. *Food Science and Technology International*, 21(3), 221-231.
- Roshandel-hesari, N., Esfahani, M.M., Taleghani, A., & Akbari, R. (2022). Investigation of physicochemical properties, antimicrobial and antioxidant activity of edible films based on chitosan/casein containing *Origanum vulgare* L. essential oil and its effect on quality maintenance of cherry tomato. *Food Chemistry*, 396, 1-10.
- Samart Sai-Ut. (2021). Using Anthocyanin Extracts from Butterfly Pea as pH Indicator for Intelligent Gelatin Film and

- Methylcellulose Film. *Current Applied Science and Technology*, 21, 652661. <https://doi.org/10.14456/CAST.2021.52>
- Saleh, F.H.M., Nugroho, A.Y., & Juliantama, M.R. (2017). Pembuatan Edible Film dari Pati Singkong Sebagai Pengemas Makanan. *Teknoin*, 23(1), 43-48.
- Sangadji, I., Jurianto, & Rijal, M. (2019). Lama Penyimpanan Daging Ayam Broiler Terhadap Kualitasnya Ditinjau Dari Kadar Protein Dan Angka Lempeng Total Bakteri. *Journal Biology Science & Education*, 8(1), 47-58.
- Santos, L.G., Alves-Silva, G.F., Martins, V.G. (2022) Active-intelligent and biodegradable sodium alginate films loaded with *Clitoria ternatea* anthocyanin-rich extract to preserve and monitor food freshness. *International Journal of Biological Macromolecules*, 220, 866-877.
- Sara, N. (2014). Pengaruh Jenis Bahan Dan Waktu Degreasing Terhadap Kualitas Dan Kuantitas Gelatin Tulang Ayam, *Skripsi*, Fakultas Peternakan, Universitas Hasanuddin, Makassar.
- Sari, Y., Santoni, A., & Elisabet. (2018). Comparative Test of Color Stability between Betalain Pigments of Red Dragon Fruits and Anthocyanin Pigments from Tamarillo Fruit at Various pH. *Jurnal Kimia Sains dan Aplikasi*, 21(3), 107-112.
- Schaefer, D., & Cheung, W.M. (2018). Smart Packaging: Opportunities and Challenges. *Procedia CIRP*, 72, 1022–1027.
- Schreiber, S.B., J.J. Bozell, D.G. Hayes, & S. Zivanovic. (2013). Introduction of primary antioxidant activity to chitosan for application as a multifunctional food packaging material. *Food Hydrocolloid*, 33, 207–214.
- Sedyadi, E., Aini, S.K., Anggraini, D., & Ekawati, D.P. (2016). Starch-Glycerol Based Edible Film and Effect of Rosella (*Hibiscus Sabdariffa* Linn) Extract and Surimi Dumbo Catfish (*Clarias gariepinus*) Addition on Its Mechanical Properties. *Biology, Medicine, & Natural Product Chemistry*, 5(2), 33-40.
- Seftiono, H., Pramesti, D. A., & Sumiasih, I. H. (2021). *Color Indicator Film From Butterfly Pea (Clitoria Ternatea L.) as Smart Packaging in Broiler Chicken Meat*. 13.
- Sharma, L., Sharma, H. K., & Saini, C. S. (2018). Edible films developed from carboxylic acid cross-linked sesame protein isolate: barrier, mechanical, thermal, crystalline and

- morphological properties. *Journal of Food Science and Technology*, 55(2), 532–539
- Singh, R., Yu, C., Chen, G.W., Chen, C.H., Sinaki, N.Y., Lin, J., & Koksel, F. (2022). Butterfly Pea Flower as a Novel Ingredient to Produce Antioxidant-Enriched Yellow Pea-Based Breakfast Cereals. *Foods*, 11, 1-14.
- Siregar, G.R.M., & Suprayitno, E. (2019). Amino Acid Composition of Gelatin from *Ephinephelus* sp. *Journal of Agriculture and Veterinary Science*, 12(4), 51-54.
- Sitanggang, A. B., Irsali, M. F., & Rawdkeun, S. (2020). Inkorporasi Oleat dan Ekstrak Antosianin pada Film Gelatin sebagai Indikator pH untuk Kemasan Pintar. *Jurnal Teknologi dan Industri Pangan*, 31(1), 66-75.
- Sohany, M., Tawakkal, I. S. M. A., Ariffin, S. H., Shah, N. N. A. K., & Yusof, Y. A. (2021). Characterization of Anthocyanin Associated Purple Sweet Potato Starch and Peel-Based pH Indicator Films. *Foods*, 10(9), 2005.
- Standar Nasional Indonesia [SNI]. (1995). SNI 06-3735-1995. *Mutu dan Cara Uji Gelatin*. Jakarta: Badan Standarisasi Nasional.
- Suarna, I. W., & Wijaya, I. M. S. (2021). Butterfly pea (*Clitoria ternatea* L: Fabaceae) and its morphological variation in Bali. *Journal of Tropical Biodiversity and Biotechnology*, 6(2), 1-12.
- Suhag, R., Kumar, N., Petkoska, A.T., & Upadhyay, A. (2020). Film formation and deposition methods of edible coating on food products: A review. *Food Research International*, 136, 1-16.
- Syahputra, S. Y., Agustina, R., & Putra, B. S. (2022). Kuat tarik *edible film* bahan dasar pati sagu dengan penambahan sorbitol sebagai plasticizer. *Jurnal Ilmiah Mahasiswa Pertanian*, 7(2), 464-471
- Togas, C., Berhimpon, S., Montolalu, R.I., Dien, H.A., & Menteng, F. (2017). Karakteristik Fisik Edible Film Komposit Karaginan Dan Lilin Lebah Menggunakan Proses Nanoemulsi. *JPHPI*, 20(3), 468-477.
- Thakur, R., Gupta, V., Ghosh, T., & Das, A.B. (2022). Effect of anthocyanin-natural deep eutectic solvent (lactic acid/fructose) on mechanical, thermal, barrier, and pH-sensitive properties of polyvinyl alcohol based edible films. *Food Packaging and Shelf Life*, 33, 1-9.
- Thuy, N.M., Minh, V.Q., Ben, T.C., Nguyn, M.T.T., Ha, H.T.N., & Tai, N.V. (2021). Identification of Anthocyanin Compounds in

- Butterfly Pea Flowers (*Clitoria ternatea* L.) by Ultra Performance Liquid Chromatography/Ultraviolet Coupled to Mass Spectrometry. Molecules, 26(4539), 1-13.
- Utami, R., Kawiji Khasanah, L.U., Nasution, M.I.A. (2017). Preservative effects of kaffir lime (*Citrus hystrix* DC) leaves oleoresin incorporation on cassava starch-based edible coatings for refrigerated fresh beef. *Int. Food Res. J.*, 24, 4.
- Vanderroost, M., Ragaert, P., Devlieghere, F., & De Meulenaer, B. (2014). Intelligent food packaging: The next generation. *Trends in Food Science & Technology*, 39(1), 47-62.
- Venkatesan, T., Choi, Y.W. & Kim, Y.K. (2019). Impact of Different Extraction Solvents on Phenolic Content and Antioxidant Potential of *Pinus densiflora* Bark Extract. *BioMed Research International*.
- Venkatesh, A., & Sutariya, H. (2019). Studies on formulation and properties of fruit peel waste incorporated edible film and its effect on quality of bread. *Journal of Packaging Technology and Research*, 3, 99–108.
- Verma, A. K., Rajkumar, V., Banerjee, R., Biswas, S., & Das, A. K. (2013). Guava (*Psidium guajava* L.) Powder as an Antioxidant Dietary Fibre in Sheep Meat Nuggets. *Asian-Australasian Journal of Animal Sciences*, 26, 886-895.
- Vieira, J. M., Flores-López, M. L., Jasso de Rodríguez, D., Sousa, M. C., Vicente, A. A. & Martins, J. T. (2016). Effect of chitosan–Aloe vera coating on postharvest quality of blueberry (*Vaccinium corymbosum*) fruit. *Postharvest Biology and Technology*, 116, 88-97.
- Vonnie, J. M., Rovina, K., Azhar, R. A., Huda, N., Erna, K. H., Felicia, W. X. L., Nur’Aqilah, M. N., & Halid, N. F. A. (2022). Development and Characterization of the Biodegradable Film Derived from Eggshell and Cornstarch. *Journal of Functional Biomaterials*, 13(2), 67. <https://doi.org/10.3390/jfb13020067>
- Vuong, T. T., & Hongsprabhas, P. (2021). Influences of pH on binding mechanisms of anthocyanins from butterfly pea flower ( *Clitoria ternatea* ) with whey powder and whey protein isolate. *Cogent Food & Agriculture*, 7(1), 1889098. <https://doi.org/10.1080/23311932.2021.1889098>

- Wang, S., Xia, P., Wang, S., Liang, J., Sun, Y., Yue, P., & Gao, X. (2019). Packaging films formulated with gelatin and anthocyanins nanocomplexes: Physical properties, antioxidant activity and its application for olive oil protection. *Food Hydrocolloids*, 96, 617–624.
- Wei, Y.C., Cheng, C.H., Ho, Y.C., Tsai, M.L., & Mi, F.L. (2017). Active gellan gum/purple sweet potato composite films capable of monitoring pH variations. *Food Hydrocolloids*, 69, 491–502.
- Widiastuti, D. R. (2016). *Kajian Kemasan Pangan Aktif dan Cerdas*. Badan Pengawas Obat dan Makanan.
- Wong, P.Y., & Tan, S.T. (2020). Comparison of total phenolic content and antioxidant activities in selected coloured plants. *British Food Journal*, 122(10), 3193-3201.
- Yong, H., Liu, J., Qin, Y., Bai, R., Zhang, X., & Liu, J. (2019). Antioxidant and pH-sensitive films developed by incorporating purple and black rice extracts into chitosan matrix. *International Journal of Biological Macromolecules*, 137, 307–316.
- Yun, D., Cai, H., Liu, Y., Xiao, L., Song, J., & Liu, J. (2019). Development of active and intelligent films based on cassava starch and Chinese bayberry (*Myrica rubra* Sieb. Et Zucc.) anthocyanins. *RSC Advances*, 9(53), 30905–30916. <https://doi.org/10.1039/C9RA06628D>
- Zahoorullah, S. M., Dakshayani, L., Rani, A. S. & Venkateswerlu, G. (2017). Effect of Chitosan Coating on the Post Harvest Quality of Banana during Storage. *Asian Journal of Biotechnology and Bioresource Technology*, 1(1), 1-10.
- Zeb, A. (2021). *Phenolic Antioxidants in Foods: Chemistry, Biochemistry and Analysis*. Springer Nature Switzerland.