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DAFTAR PUSTAKA

Acateca-Hernández, M. I., Hernández-Cázares, A. S., Hidalgo-Contreras, J. V., Jiménez-Munguía, M. T., & Ríos-Corripio, M. A. (2024). Evaluation of the functional properties of a protein isolate from Arthrospira maxima and its application in a meat sausage. *Heliyon*, *10*(13). https://doi.org/10.1016/j.heliyon.2024.e33500

Afdhaliah, N., Ningrum, A., & Setiowati, A. D. (2024). Red Palm Oil Gelled Emulsion Stabilized by Spirulina (Arthrospira platensis) Protein and Carrageenan as Fat Replacer in Beef Patty. *Food and Bioprocess Technology*, *0123456789*. https://doi.org/10.1007/s11947-024-03680-x

Agoda-Tandjawa, G., Le Garnec, C., Boulenguer, P., Gilles, M., & Langendorff, V. (2017). Rheological behavior of starch/carrageenan/milk proteins mixed systems: Role of each biopolymer type and chemical characteristics. *Food Hydrocolloids*, *73*, 300–312. https://doi.org/10.1016/j.foodhyd.2017.07.012

Al Hinai, M., Al Kalbani, A., Al Rubkhi, B., Al Kalbani, U., & Walke, S. (2019). Protein extraction from spirulina platensis. *International Journal of Innovative Technology and Exploring Engineering*, *8*(12), 1524–1530. https://doi.org/10.35940/ijitee.L3110.1081219

AlFadhly, N. K. Z., Alhelfi, N., Altemimi, A. B., Verma, D. K., Cacciola, F., & Narayanankutty, A. (2022). Trends and Technological Advancements in the Possible Food Applications of Spirulina and Their Health Benefits: A Review. *Molecules*, *27*(17), 1–40. https://doi.org/10.3390/molecules27175584

Aliabbasi, N., Emam-Djomeh, Z., Askari, G., & Salami, M. (2021). Pinto bean protein-based acid-induced cold-set gels as carriers for curcumin delivery: Fabrication and characterization. *Food Hydrocolloids for Health*, *1*(May), 100035. https://doi.org/10.1016/j.fhfh.2021.100035

Anderson, R. A., Conway, H. F., & Peplinski, A. J. (1970). Gelatinization of Corn Grits by Roll Cooking, Extrusion Cooking and Steaming. *Starch - Stärke*, *22*(4), 130–135. https://doi.org/10.1002/star.19700220408

Angonese, M., Sá, A. G. A., Emiliano Motta, G., de Oliveira, D., Di Luccio, M., & Carciofi, B. A. M. (2023). Methods for Physically Structuring Meat Analogs: Challenges and Perspectives. *Food Reviews International*, *39*(9), 6805–6833. https://doi.org/10.1080/87559129.2022.2124416

Anton Paar Application Report. (2021). Protein Hydrolysis for Total Amino Acid Analysis in Proteins and Peptides.

Anvar, A. A., & Nowruzi, B. (2021). Bioactive Properties of Spirulina: A Review. *Microbial Bioactives*, *4*(1), 134–142.

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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https://doi.org/10.25163/microbbioacts.412117b0719110521

AOAC, (1970). *Official Methods of Analysis of the Association of Official Analytical Chemists.* Washington, DC.

AOAC, (1995). Official Methods of Analysis of Association of Official Analytical Chemist. AOAC International. Virginia USA.

AOAC, (2005). *Official Methods of Analysis of AOAC INTERNATIONAL 18th Edition.* Maryland.

AOAC, 988.15. (2005). *Tryptophan in Foods and Food and Feed Ingredient. Ion Exchanger Chromatographic Method.*

Arjeh, E., Rostami, H., Pirsa, S., & Fathi, M. (2022). Synthesis and characterization of novel Spirulina protein isolate (SPI)-based hydrogels through dual-crosslinking with genipin/Zn2+. *Food Research International*, *162*, 112107. https://doi.org/10.1016/J.FOODRES.2022.112107

Azimi, M., Varshosaz, J., & Mirian, M. (2024). Spirulina protein concentrate hydrogel reinforced by hydroxyapatite nanoparticles and hydroxychloroquin: A novel platform for bone regeneration. *Materials Today Communications*, *41*, 110574. https://doi.org/10.1016/J.MTCOMM.2024.110574

Bakhsh, A., Park, J., Baritugo, K. A., Kim, B., Sil Moon, S., Rahman, A., & Park, S. (2023). A holistic approach toward development of plant-based meat alternatives through incorporation of novel microalgae-based ingredients. *Frontiers in Nutrition*, *10*(May), 1–15. https://doi.org/10.3389/fnut.2023.1110613

Barkallah, M., Atitallah, A. Ben, Hentati, F., Dammak, M., Hadrich, B., Fendri, I., Ayadi, M. A., Michaud, P., & Abdelkafi, S. (2019). Effect of Spirulina platensis biomass with high polysaccharides content on quality attributes of common Carp (Cyprinus carpio) and Common Barbel (Barbus barbus) fish burgers. *Applied Sciences (Switzerland)*, *9*(11). https://doi.org/10.3390/app9112197

Begum, H., Yusoff, F. M. D., Banerjee, S., Khatoon, H., & Shariff, M. (2016). Availability and Utilization of Pigments from Microalgae. *Critical Reviews in Food Science and Nutrition*, *56*(13), 2209–2222. https://doi.org/10.1080/10408398.2013.764841

Bialik-Wąs, K., Kulawik-Pióro, A., Sienkiewicz, A., Łętocha, A., Osińska, J., Malarz, K., Mrozek-Wilczkiewicz, A., Barczewski, M., Lanoue, A., Giglioli-Guivarc'h, N., & Miastkowska, M. (2024). Design and development of multibiocomponent hybrid alginate hydrogels and lipid nanodispersion as new materials for medical and cosmetic applications. *International Journal of Biological Macromolecules*, *278*(August).

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

https://doi.org/10.1016/j.ijbiomac.2024.134405

Boccacci Mariani, M., Giannetti, V., & Testani, E. (2014). HS-SPME/GC-MS Method to Characterise the Flavour of Italian Pasta: Potential Application to Assess the Quality of the Products. *Food Analytical Methods*, *7*(1), 64–72. https://doi.org/10.1007/s12161-013-9599-3

Bourdon, E., Loreau, N., Lagrost, L., & Blache, D. (2005). Differential effects of cysteine and methionine residues in the antioxidant activity of human serum albumin. *Free Radical Research*, *39*(1), 15–20. https://doi.org/10.1080/10715760400024935

Cao, C., Xu, Y., Kong, B., Xia, X., Chen, Q., Zhang, H., & Liu, Q. (2023). Changes of rheological behavior, thermal and microstructural properties of myofibrillar protein-κ-carrageenan mixed sol as mediated by NaCl concentration. *Food Bioscience*, *55*, 103035. https://doi.org/10.1016/J.FBIO.2023.103035

Caporgno, M. P., Böcker, L., Müssner, C., Stirnemann, E., Haberkorn, I., Adelmann, H., Handschin, S., Windhab, E. J., & Mathys, A. (2020). Extruded meat analogues based on yellow, heterotrophically cultivated Auxenochlorella protothecoides microalgae. *Innovative Food Science and Emerging Technologies*, *59*(November 2019), 102275. https://doi.org/10.1016/j.ifset.2019.102275

Carballo, J. (2021). Sausages: Nutrition, safety, processing and quality improvement. *Foods*, *10*(4), 1–9. https://doi.org/10.3390/foods10040890

Chang, L., Kong, B., Liu, Q., Du, X., & Xia, X. (2025). Effect of freeze-thaw processes on the water-absorption ability and mechanical properties of hydrogel pads with chitosan/poly(vinyl alcohol) based on citrate crosslinks. *Food Chemistry*, *471*(November 2024), 142785. https://doi.org/10.1016/j.foodchem.2025.142785

Chantanuson, R., Nagamine, S., Kobayashi, T., & Nakagawa, K. (2022). Preparation of soy protein-based food gels and control of fibrous structure and rheological property by freezing. *Food Structure*, *32*(January), 100258. https://doi.org/10.1016/j.foostr.2022.100258

Chantanuson, R., Nagamine, S., Kobayashi, T., & Nakagawa, K. (2024). Effect of dry heat treatment of soy protein powder on aligned structure formation in soy protein-based food gels during freezing. *Journal of Food Engineering*, *363*(August 2023), 111779. https://doi.org/10.1016/j.jfoodeng.2023.111779

Chattopadhyay, K., Xavier, K. A. M., Layana, P., Balange, A. K., & Nayak, B. B. (2019). Chitosan hydrogel inclusion in fish mince based emulsion sausages: Effect of gel interaction on functional and physicochemical qualities. *International Journal of Biological Macromolecules*, *134*, 1063–1069. https://doi.org/10.1016/j.ijbiomac.2019.05.148

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Cheng, Y., Xu, J., Zhang, R., Lin, J., Zhou, M., Qin, X., Wang, K., Zhou, Y., Zhu, Q., Jin, Y., & Liu, Y. (2024). Development of multi-cross-linking, rapid curing, and easy cleaning, edible hydrogels for meat preservation. *Food Hydrocolloids*, *155*(May), 110186. https://doi.org/10.1016/j.foodhyd.2024.110186

Cheng, Z., Xiang, M., Qiao, D., Zhao, S., Pi, X., & Zhang, B. (2025). Incorporating κ-carrageenan regulates the gel properties and structural characteristics of corn starch-soy protein isolate based ternary system. *Food Hydrocolloids*, *159*, 110654. https://doi.org/10.1016/J.FOODHYD.2024.110654

Commission Regulation (EC) No. 152/2009. Laying Down the Methods of Sampling and Analysis For the Official Control of Feed: Annex III Point F. Determination of Amino Acids. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009R0152-20170524/ (accessed 27 March 2025).

Costa, J. A. V., Freitas, B. C. B., Rosa, G. M., Moraes, L., Morais, M. G., & Mitchell, B. G. (2019). Operational and economic aspects of Spirulina-based biorefinery. *Bioresource Technology*, *292*(July), 121946. https://doi.org/10.1016/j.biortech.2019.121946

Dahl-Lassen, R., van Hecke, J., Jørgensen, H., Bukh, C., Andersen, B., & Schjoerring, J. K. (2018). High-throughput analysis of amino acids in plant materials by single quadrupole mass spectrometry. *Plant Methods*, *14*(1), 1–9. https://doi.org/10.1186/s13007-018-0277-8

de Alcântara, M. G., de Freitas Ortega, N., Souza, C. J. F., & Garcia-Rojas, E. E. (2020). Electrostatic hydrogels formed by gelatin and carrageenan induced by acidification: Rheological and structural characterization. *Food Structure*, *24*, 100137. https://doi.org/10.1016/J.FOOSTR.2020.100137

Dekkers, B. L., Boom, R. M., & van der Goot, A. J. (2018). Structuring processes for meat analogues. *Trends in Food Science and Technology*, *81*(August), 25–36. https://doi.org/10.1016/j.tifs.2018.08.011

Djenane, D., Khaled, B. M., Ben Miri, Y., Metahri, M. S., Montañés, L., Aider, M., & Ariño, A. (2025). Improved Functionality, Quality, and Shelf Life of Merguez-Type Camel Sausage Fortified with Spirulina as a Natural Ingredient. In *Foods* (Vol. 14, Issue 1). https://doi.org/10.3390/foods14010059

Du, Q., Tu, M., Liu, J., Ding, Y., Zeng, X., & Pan, D. (2023). Plant-based meat analogs and fat substitutes, structuring technology and protein digestion: A review. *Food Research International*, *170*(January), 112959. https://doi.org/10.1016/j.foodres.2023.112959

Dyachenko, E. I., & Bel'skaya, L. V. (2024). The Role of Amino Acids in Non-

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Enzymatic Antioxidant Mechanisms in Cancer: A Review. *Metabolites*, *14*(1). https://doi.org/10.3390/metabo14010028

Feng, T., Wu, K., Xu, J., Hu, Z., & Zhang, X. (2021). Low Molecular Weight Kappa-Carrageenan Based Microspheres. *Processes*, *9*(1240), 1–12. https://doi.org/https://doi.org/10.3390/pr9071240 School

Fradique, M., Batista, A. P., Nunes, M. C., Gouveia, L., Bandarra, N. M., & Raymundo, A. (2013). Isochrysis galbana and Diacronema vlkianum biomass incorporation in pasta products as PUFA's source. *LWT - Food Science and Technology*, *50*(1), 312–319. https://doi.org/10.1016/J.LWT.2012.05.006

Godschalk-Broers, L., Sala, G., & Scholten, E. (2022). Meat Analogues: Relating Structure to Texture and Sensory Perception. *Foods*, *11*(15). https://doi.org/10.3390/foods11152227

Gorissen, S. H. M., Crombag, J. J. R., Senden, J. M. G., Waterval, W. A. H., Bierau, J., Verdijk, L. B., & van Loon, L. J. C. (2018). Protein content and amino acid composition of commercially available plant-based protein isolates. *Amino Acids*, *50*(12), 1685–1695. https://doi.org/10.1007/s00726-018-2640-5

Grover, P., Bhatnagar, A., Kumari, N., Narayan Bhatt, A., Kumar Nishad, D., & Purkayastha, J. (2021). C-Phycocyanin-a novel protein from Spirulina platensis- In vivo toxicity, antioxidant and immunomodulatory studies. *Saudi Journal of Biological Sciences*, *28*(3), 1853–1859. https://doi.org/10.1016/j.sjbs.2020.12.037

Guldas, M., Ziyanok-Demirtas, S., Sahan, Y., Yildiz, E., & Gurbuz, O. (2021). Antioxidant and anti-diabetic properties of spirulina platensis produced in Turkey. *Food Science and Technology (Brazil)*, *41*(3), 615–625. https://doi.org/10.1590/fst.23920

Guo, J., Huang, Y., Gu, X., & Meng, Z. (2025). Spirulina platensis protein-based emulsion gel as fat substitute in meat analogs: Evaluation performance across post-processing. *Food Chemistry*, *463*(P4), 141414. https://doi.org/10.1016/j.foodchem.2024.141414

Guo, Y., Li, L., & Yang, X. (2025). Fabrication of mung bean protein-sugar beet pectin hydrogels by duo-induction of heating and laccase: Gelling properties and delivery of riboflavin. *Food Hydrocolloids*, *159*, 110690. https://doi.org/10.1016/J.FOODHYD.2024.110690

Guo, Z., Wei, Y., Zhang, Y., Xu, Y., Zheng, L., Zhu, B., & Yao, Z. (2022). Carrageenan oligosaccharides: A comprehensive review of preparation, isolation, purification, structure, biological activities and applications. *Algal Research*, *61*(December 2021), 102593. https://doi.org/10.1016/j.algal.2021.102593

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Hamid, N. H., & Navaranjan, N. (2023). Quality characteristics of low-fat chicken sausages formulated with whey protein isolate and guar gum at different storage conditions. *International Journal of Food Properties*, *26*(2), 3544–3555. https://doi.org/10.1080/10942912.2023.2292470

Han, P., Li, J., Zhong, H., Xie, J., Zhang, P., Lu, Q., Li, J., Xu, P., Chen, P., Leng, L., & Zhou, W. (2021). Anti-oxidation properties and therapeutic potentials of spirulina. *Algal Research*, *55*(March), 102240. https://doi.org/10.1016/j.algal.2021.102240

Hanson, B. S., Brown, C. P., Laurent, H., Hughes, M. D. G., & Dougan, L. (2020). Hierarchical biomechanics: student engagement activities with a focus on biological physics. *Physics Education*, *55*(2). https://doi.org/10.1088/1361-6552/ab687e

Hao, Z., Feng, J., Chen, Q., Lin, H., Zhou, X., Zhuang, J., Wang, J., Tan, Y., Sun, Z., Wang, Y., & Yu, B. (2023). Comparative volatiles profiling in milk-flavored white tea and traditional white tea Shoumei via HS-SPME-GC-TOFMS and OAV analyses. *Food Chemistry: X*, *18*(February), 100710. https://doi.org/10.1016/j.fochx.2023.100710

Hellebois, T., Gaiani, C., & Soukoulis, C. (2022). Freeze − thaw induced structuration of whey protein − alfalfa (Medicago sativa L.) galactomannan binary systems. *Food Hydrocolloids*, *125*, 107389. https://doi.org/10.1016/J.FOODHYD.2021.107389

Hsia, S. Y., Hsiao, Y. H., Li, W. T., & Hsieh, J. F. (2016). Aggregation of soy protein-isoflavone complexes and gel formation induced by glucono-Î-lactone in soymilk. *Scientific Reports*, *6*(May), 1–10. https://doi.org/10.1038/srep35718

Hu, Q., Qiu, L., Zhu, Y., Huang, Y., Liu, L., Han, T., Song, Y., & Zhu, X. (2025). Impact of freeze-thaw cycles on the structural and quality characteristics of soy protein gels with different 11S/7S protein ratios. *Food Chemistry*, *475*, 143329. https://doi.org/https://doi.org/10.1016/j.foodchem.2025.143329

Jia, X., Cui, H., Qin, S., Ren, J., Zhang, Z., An, Q., Zhang, N., Yang, J., Yang, Y., Fan, G., & Pan, S. (2024). Characterizing and decoding the key odor compounds of Spirulina platensis at different processing stages by sensomics. *Food Chemistry*, *461*(17). https://doi.org/10.1016/j.foodchem.2024.140944

Jiang, S., Ma, Y., Wang, Y., Wang, R., & Zeng, M. (2022). Effect of κ-carrageenan on the gelation properties of oyster protein. *Food Chemistry*, *382*(January), 132329. https://doi.org/10.1016/j.foodchem.2022.132329

Kamani, M. H., Meera, M. S., Bhaskar, N., & Modi, V. K. (2019). Partial and total replacement of meat by plant-based proteins in chicken sausage: evaluation of mechanical, physico-chemical and sensory characteristics.

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Journal of Food Science and Technology, *56*(5), 2660–2669. https://doi.org/10.1007/s13197-019-03754-1

Kartik, A., Akhil, D., Lakshmi, D., Panchamoorthy Gopinath, K., Arun, J., Sivaramakrishnan, R., & Pugazhendhi, A. (2021). A critical review on production of biopolymers from algae biomass and their applications. *Bioresource Technology*, *329*(November 2020), 124868. https://doi.org/10.1016/j.biortech.2021.124868

Khadka, Y. R. (2021). Amino Acid- Essentiality to Human Body. *Patan Pragya*, *8*(01), 196–206. https://doi.org/10.3126/pragya.v8i01.42437

Kim, B.Y., Park JW. (2000) Rheology and texture properties of surimi gels. In: Park JW (ed) Surimi and surimi seafoods. Marcel Dekker, Inc., Astoria, Oregon, pp 267–324.

Kim, J. H., Jang, H. J., Cho, W. Y., Yeon, S. J., & Lee, C. H. (2020). In vitro antioxidant actions of sulfur-containing amino acids. *Arabian Journal of Chemistry*, *13*(1), 1678–1684. https://doi.org/10.1016/j.arabjc.2017.12.036

Kim, J., Zhang, Y., Han, Y., Lee, Kang, C., Jung, H., & Gu, B. J. (2025). The impact of cooking methods on the texture and color characteristics of beef, pork, and chicken. *Food Science and Preservation*, *32*(2), 246–259. https://doi.org/10.11002/fsp.2025.32.2.246

Klost, M., & Drusch, S. (2019). Structure formation and rheological properties of pea protein-based gels. *Food Hydrocolloids*, *94*(November 2018), 622–630. https://doi.org/10.1016/j.foodhyd.2019.03.030

Ko, S., Yoo, S. H., Lee, S., Cho, S., Kim, K. H., & Hwang, R. (2011). Effect of long low temperature-short high temperature cooking cycle on physicochemical properties of beef. *Food Science and Technology Research*, *17*(1), 11–16. https://doi.org/10.3136/fstr.17.11

Krintiras, G. A., Göbel, J., Van Der Goot, A. J., & Stefanidis, G. D. (2015). Production of structured soy-based meat analogues using simple shear and heat in a Couette Cell. *Journal of Food Engineering*, *160*, 34–41. https://doi.org/10.1016/J.JFOODENG.2015.02.015

Krishnan, H. B., Kim, W.-S., Jang, S., & Kerley, M. S. (2009). All Three Subunits of Soybean β-Conglycinin Are Potential Food Allergens. *Journal of Agricultural and Food Chemistry*, *57*(3), 938–943. https://doi.org/10.1021/jf802451g

Krop, E. M., Lewin, R., Holmes, M., & Sarkar, A. (2020). *Food Hydrocolloids Tribology and rheology of bead-layered hydrogels : Influence of bead size on sensory perception*. *104*(October 2019). https://doi.org/10.1016/j.foodhyd.2020.105692

Kumar, A., Ramamoorthy, D., Verma, D. K., Kumar, A., Kumar, N., Kanak, K.

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Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

R., Marwein, B. M., & Mohan, K. (2022). Antioxidant and phytonutrient activities of Spirulina platensis. *Energy Nexus*, *6*(April), 100070. https://doi.org/10.1016/j.nexus.2022.100070

Lafarga, T., Fernández-Sevilla, J. M., González-López, C., & Acién-Fernández, F. G. (2020). Spirulina for the food and functional food industries. *Food Research International*, *137*(April), 109356. https://doi.org/10.1016/j.foodres.2020.109356

Le, X. T., Rioux, L. E., & Turgeon, S. L. (2017). Formation and functional properties of protein–polysaccharide electrostatic hydrogels in comparison to protein or polysaccharide hydrogels. *Advances in Colloid and Interface Science*, *239*, 127–135. https://doi.org/10.1016/j.cis.2016.04.006

Li, J., Chuang, R., Liu, M., Ma, Y., Zhang, H., Li, H., Xia, N., Rayan, A. M., & Ghamry, M. (2025). Kappa-carrageenan enhances the mechanical and rheological properties of egg yolk low-density lipoprotein gels with an interpenetrating network structure. *Food Hydrocolloids*, *166*(February), 111343. https://doi.org/10.1016/j.foodhyd.2025.111343

Li, J., Jia, X., & Yin, L. (2021). Hydrogel: Diversity of Structures and Applications in Food Science. *Food Reviews International*, *37*(3), 313–372. https://doi.org/10.1080/87559129.2020.1858313

Li, X. L., Meng, R., Xu, B. C., Zhang, B., Cui, B., & Wu, Z. Z. (2022). Function emulsion gels prepared with carrageenan and zein/carboxymethyl dextrin stabilized emulsion as a new fat replacer in sausages. *Food Chemistry*, *389*, 133005. https://doi.org/10.1016/J.FOODCHEM.2022.133005

Lin, J., Pang, Y., Huo, Y., Jiang, J., Zhou, B., & Shang, C. (2025). Extraction, purification and characterization of Spirulina phycocyanin. *Algal Research*, *85*, 103861. https://doi.org/10.1016/J.ALGAL.2024.103861

Lin, S., Liang, X., Zhang, J., Kong, B., Sun, F., Cao, C., Zhang, H., & Liu, Q. (2024). Combined effect of ultrasound treatment and κ-carrageenan addition on the enhancement of gelling properties and rheological behavior of myofibrillar protein: An underlying mechanisms study. *International Journal of Biological Macromolecules*, *257*(P1), 128569. https://doi.org/10.1016/j.ijbiomac.2023.128569

Liu, C., Song, J., Wang, L., Wang, P., Ma, J., Zhao, B., Chen, X., Wang, Y., Zhang, W., & Wen, P. (2025). The impacts of different modification techniques on the gel properties and structural characteristics of fish gelatin. *Food Hydrocolloids*, *158*, 110536. https://doi.org/10.1016/J.FOODHYD.2024.110536

Liu, F.-F., Li, Y.-Q., Sun, G.-J., Wang, C.-Y., Liang, Y., Zhao, X.-Z., He, J.-X., & Mo, H.-Z. (2022). Influence of ultrasound treatment on the physicochemical and antioxidant properties of mung bean protein

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

hydrolysate. *Ultrasonics Sonochemistry*, *84*, 105964. https://doi.org/https://doi.org/10.1016/j.ultsonch.2022.105964

Liu, K., Chen, Y. Y., Zha, X. Q., Li, Q. M., Pan, L. H., & Luo, J. P. (2021). Research progress on polysaccharide/protein hydrogels: Preparation method, functional property and application as delivery systems for bioactive ingredients. *Food Research International*, *147*(April), 110542. https://doi.org/10.1016/j.foodres.2021.110542

Liw, W. T., Xing, J., & Zhan, Z. (2019). *Microwave Digestion and On-line Pre-Column Derivatization UHPLC Method for Analysis of Total Amino Acids in Feed*.

Long, G., Ji, Y., Pan, H., Sun, Z., Li, Y., & Qin, G. (2015). Characterization of thermal denaturation structure and morphology of soy glycinin by FTIR and SEM. *International Journal of Food Properties*, *18*(4), 763–774. https://doi.org/10.1080/10942912.2014.908206

Lu, Z., Lee, P. R., & Yang, H. (2023). Kappa-carrageenan improves the gelation and structures of soy protein isolate through the formation of hydrogen bonding and electrostatic interactions. *Food Hydrocolloids*, *140*(January), 108585. https://doi.org/10.1016/j.foodhyd.2023.108585

Lupatini Menegotto, A. L., Souza, L. E. S. de, Colla, L. M., Costa, J. A. V., Sehn, E., Bittencourt, P. R. S., Moraes Flores, É. L. de, Canan, C., & Colla, E. (2019). Investigation of techno-functional and physicochemical properties of Spirulina platensis protein concentrate for food enrichment. *Lwt*, *114*(March), 108267. https://doi.org/10.1016/j.lwt.2019.108267

Majchrzak, T., Wojnowski, W., & Wasik, A. (2021). Revealing dynamic changes of the volatile profile of food samples using PTR–MS. *Food Chemistry*, *364*, 130404. https://doi.org/10.1016/J.FOODCHEM.2021.130404

Marti-Quijal, F. J., Zamuz, S., Tomašević, I., Gómez, B., Rocchetti, G., Lucini, L., Remize, F., Barba, F. J., & Lorenzo, J. M. (2019). Influence of different sources of vegetable, whey and microalgae proteins on the physicochemical properties and amino acid profile of fresh pork sausages. *Lwt*, *110*(October 2018), 316–323. https://doi.org/10.1016/j.lwt.2019.04.097

McGuire, R. G. (2019). Reporting of Objective Color Measurements. *HortScience*, *27*(12), 1254–1255. https://doi.org/10.21273/hortsci.27.12.1254

Mirarab Razi, S., Motamedzadegan, A., Shahidi, A., & Rashidinejad, A. (2018). The effect of basil seed gum (BSG) on the rheological and physicochemical properties of heat-induced egg albumin gels. *Food Hydrocolloids*, *82*, 268–277. https://doi.org/10.1016/J.FOODHYD.2018.01.013

Moghadam, A. S., Mirmohammad Meiguni, M. S., Salami, M., Askari, G.,

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Emam-djomeh, Z., Miran, M., Buttar, H. S., & Brennan, C. (2024). Characterization of physicochemical properties of mung bean protein isolate and κ-carrageenan hydrogel as a delivery system for propolis extract. *Food Research International*, *197*(P1), 115221. https://doi.org/10.1016/j.foodres.2024.115221

Mosibo, O. K., Ferrentino, G., & Udenigwe, C. C. (2024). Microalgae Proteins as Sustainable Ingredients in Novel Foods: Recent Developments and Challenges. *Foods*, *13*(5). https://doi.org/10.3390/foods13050733

Nath, P. C., Debnath, S., Sridhar, K., Inbaraj, B. S., Nayak, P. K., & Sharma, M. (2023). A Comprehensive Review of Food Hydrogels: Principles, Formation Mechanisms, Microstructure, and Its Applications. *Gels*, *9*(1). https://doi.org/10.3390/gels9010001

Nishinari, K., & Fang, Y. (2018). Perception and measurement of food texture: Solid foods. *Journal of Texture Studies*, *49*(2), 160–201. https://doi.org/10.1111/jtxs.12327

Orlien, V., Aalaei, K., Poojary, M. M., Nielsen, D. S., Ahrné, L., & Carrascal, J. R. (2023). Effect of processing on in vitro digestibility (IVPD) of food proteins. *Critical Reviews in Food Science and Nutrition*, *63*(16), 2790–2839. https://doi.org/10.1080/10408398.2021.1980763

Ozel, B., Cikrikci, S., Aydin, O., & Oztop, M. H. (2017). Polysaccharide blended whey protein isolate-(WPI) hydrogels: A physicochemical and controlled release study. *Food Hydrocolloids*, *71*, 35–46. https://doi.org/10.1016/J.FOODHYD.2017.04.031

Palanisamy, M., Töpfl, S., Berger, R. G., & Hertel, C. (2019). Physico-chemical and nutritional properties of meat analogues based on Spirulina/lupin protein mixtures. *European Food Research and Technology*, *245*(9), 1889–1898. https://doi.org/10.1007/s00217-019-03298-w

Paraskevopoulou, A., Kaloudis, T., Hiskia, A., Steinhaus, M., Dimotikali, D., & Triantis, T. M. (2024). Volatile Profiling of Spirulina Food Supplements. *Foods*, *13*(8). https://doi.org/10.3390/foods13081257

Pargiyanti, P. (2019). Optimasi Waktu Ekstraksi Lemak dengan Metode Soxhlet Menggunakan Perangkat Alat Mikro Soxhlet. *Indonesian Journal of Laboratory*, *1*(2), 29. https://doi.org/10.22146/ijl.v1i2.44745

Peng, S., Li, Y., Liu, H., Tuo, Y., Dang, J., Wang, W., You, H., Du, S., Wang, L., & Ding, L. (2024). Influence of germination and roasting on the characteristic volatile organic compounds of quinoa using sensory evaluation, E-nose, HS-GC-IMS, and HS-SPME-GC-MS. *Food Chemistry: X*, *22*(May), 101441. https://doi.org/10.1016/j.fochx.2024.101441

Phillips, G. O., & Williams, P. A. (2009). Handbook of Hydrocolloids: Second

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Edition. In *Handbook of Hydrocolloids: Second Edition*. https://doi.org/10.1533/9781845695873

Purdi, T. S., Setiowati, A. D., & Ningrum, A. (2023). Ultrasound-assisted extraction of Spirulina platensis protein: physicochemical characteristic and techno-functional properties. *Journal of Food Measurement and Characterization*, *17*(5), 5474–5486. https://doi.org/10.1007/s11694-023-02051-y

Qi, X., Zhang, M., Su, T., Pan, W., Tong, X., Zeng, Q., Xiong, W., Jiang, N., Qian, Y., Li, Z., He, X., Shen, L., Zhou, Z., & Shen, J. (2020). Biocompatible Hydrogels Based on Food Gums with Tunable Physicochemical Properties as Scaffolds for Cell Culture. *Journal of Agricultural and Food Chemistry*, *68*(12), 3770–3778. https://doi.org/10.1021/acs.jafc.9b06120

Qiao, D., Zhang, Y., Sun, F., Yoo, M., Zhao, G., & Zhang, B. (2025). Enhancement mechanism of ι-carrageenan on the network structure and gel-related properties of soy protein isolate/λ-carrageenan system. *Food Chemistry*, *468*, 142476. https://doi.org/10.1016/J.FOODCHEM.2024.142476

Rhein-Knudsen, N., Ale, M. T., & Meyer, A. S. (2015). Seaweed hydrocolloid production: An update on enzyme assisted extraction and modification technologies. *Marine Drugs*, *13*(6), 3340–3359. https://doi.org/10.3390/md13063340

Roccia, P., Ribotta, P. D., Pérez, G. T., & León, A. E. (2009). Influence of soy protein on rheological properties and water retention capacity of wheat gluten. *LWT - Food Science and Technology*, *42*(1), 358–362. https://doi.org/https://doi.org/10.1016/j.lwt.2008.03.002

Rocha De Souza, M. C., Marques, C. T., Guerra Dore, C. M., Ferreira Da Silva, F. R., Oliveira Rocha, H. A., & Leite, E. L. (2007). Antioxidant activities of sulfated polysaccharides from brown and red seaweeds. *Journal of Applied Phycology*, *19*(2), 153–160. https://doi.org/10.1007/s10811-006-9121-z

Rohman, A., and Gandjar, I.G., (2007). Metode Kromatografi Untuk Analisis Makanan (pp. 43-75). Pustaka Pelajar.

Rosenthal, A. J., & Thompson, P. (2021). What is cohesiveness?—A linguistic exploration of the food texture testing literature. *Journal of Texture Studies*, *52*(3), 294–302. https://doi.org/10.1111/jtxs.12586

Roth, W., Zadeh, K., Vekariya, R., Ge, Y., & Mohamadzadeh, M. (2021). Tryptophan Metabolism and Gut-Brain Homeostasis Kynurenine pathway Tryptophan Serotonin pathway Indole pathway. *International Journal of Molecular Sciences*, *22*, 2973.

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Rusdiansyah, R., Dwiloka, B., & Pramono, Y. B. (2021). Karakteristik Susut Masak dan Hedonik Sosis Daging Dada dan Paha Kalkun (Meleagris gallopavo). *Jurnal Ilmu Dan Teknologi Peternakan*, *9*(1), 38–43. https://doi.org/10.20956/jitp.v9i1.12347

Rustagi S, (2020). Food Texture and Its Perception, Acceptance and Evaluation. Biosci Biotech Res Asia, *17*(3).

Sangaré, M., & Karoui, R. (2023). Evaluation and monitoring of the quality of sausages by different analytical techniques over the last five years. *Critical Reviews in Food Science and Nutrition*, *63*(26), 8136–8160. https://doi.org/10.1080/10408398.2022.2053059

Santiago-Díaz, P., Rivero, A., Rico, M., & Gómez-Pinchetti, J. L. (2022). Characterization of Novel Selected Microalgae for Antioxidant Activity and Polyphenols, Amino Acids, and Carbohydrates. *Marine Drugs*, *20*(1). https://doi.org/10.3390/md20010040

Santos-Sánchez, G., Miralles, B., Brodkorb, A., Dupont, D., Egger, L., & Recio, I. (2024). Current advances for in vitro protein digestibility. *Frontiers in Nutrition*, *11*(May), 1–15. https://doi.org/10.3389/fnut.2024.1404538

Saranraj, P. (2010). *Spirulina Cultivation: A Review Related papers*. *3*(6), 1327–1341. www.ijpba.info

Senn, K., Cantu, A., & Heymann, H. (2021). Characterizing the chemical and sensory profiles of traditional American meads. *Journal of Food Science*, *86*(3), 1048–1057. https://doi.org/10.1111/1750-3841.15607

Severo, I. A., de Lira, G. S., Ambati, R. R., Gokare, R. A., Vargas, J. V. C., Ordonez, J., & Mariano, A. B. (2024). Disruptive potential of microalgae proteins: Shaping the future of the food industry. *Future Foods*, *9*(November 2023), 100318. https://doi.org/10.1016/j.fufo.2024.100318

Shahid, A., Fan, Z., Su, K., Zhao, A., Mehmood, M. A., Chang, J. S., Solovchenko, A. E., Alam, M. A., & Xu, J. (2025). Sensory chemistry of Spirulina: Unveiling trends and innovations in aromatic volatile organic compound biosynthesis in off-flavors and odor mitigation strategies. *Trends in Food Science & Technology*, *156*, 104886. https://doi.org/10.1016/J.TIFS.2025.104886

Shen, K.-Z., Zhang, Y., Yu, S.-L., Ya, Q., & Wan, Q.-J. (2013). Reviews of Spirulina algae in clinical application for children. *Modern Food Science and Technology*, *29*(3), 683–686.

Shen, S., Wu, H., Li, T., Sun, H., Wang, Y., & Ning, J. (2023). Formation of aroma characteristics driven by volatile components during long-term storage of An tea. *Food Chemistry*, *411*(November 2022), 135487. https://doi.org/10.1016/j.foodchem.2023.135487

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Shiroodi, S. G., Rasco, B. A., & Lo, Y. M. (2015). Influence of Xanthan-Curdlan Hydrogel Complex on Freeze-Thaw Stability and Rheological Properties of Whey Protein Isolate Gel over Multiple Freeze-Thaw Cycle. *Journal of Food Science*, *80*(7), E1498–E1505. https://doi.org/10.1111/1750-3841.12915

Shkolnikov Lozober, H., Okun, Z., & Shpigelman, A. (2021). The impact of high-pressure homogenization on thermal gelation of Arthrospira platensis (Spirulina) protein concentrate. *Innovative Food Science and Emerging Technologies*, *74*(October), 102857. https://doi.org/10.1016/j.ifset.2021.102857

Sibt-E-Abbas, M., Butt, M. S., Riaz, M. N., Teferra, T. F., & Ul-Haq, I. (2022). Amino Acid Profiling and SDS-PAGE Analysis of Protein Isolates Obtained from Nonconventional Sources. *Journal of Food Quality*, *2022*. https://doi.org/10.1155/2022/1926527

Singh, A., & Sit, N. (2022). Meat Analogues: Types, Methods of Production and Their Effect on Attributes of Developed Meat Analogues. *Food and Bioprocess Technology*, *15*(12), 2664–2682. https://doi.org/10.1007/s11947-022-02859-4

Soni, R. A., Sudhakar, K., & Rana, R. S. (2017). Spirulina – From growth to nutritional product: A review. *Trends in Food Science and Technology*, *69*, 157–171. https://doi.org/10.1016/j.tifs.2017.09.010

Suita, R. V., Dewi, N., & Susanto, E. (2023). The Effect of Addition Spirulina platensis on Characteristics and Nutrition Value of Boba. *Jurnal Ilmu Dan Teknologi Perikanan*, *5*(2), 131–141.

Sun, C., Fu, J., Chang, Y., Li, S., & Fang, Y. (2022). Structure Design for Improving the Characteristic Attributes of Extruded Plant-Based Meat Analogues. *Food Biophysics*, *17*(2), 137–149. https://doi.org/10.1007/s11483-021-09692-w

Sun, X. D., & Holley, R. A. (2011). Factors Influencing Gel Formation by Myofibrillar Proteins in Muscle Foods. *Comprehensive Reviews in Food Science and Food Safety*, *10*(1), 33–51. https://doi.org/10.1111/j.1541-4337.2010.00137.x

Surasani, V. K. R., Raju, C. V., Shafiq, U., Chandra, M. V., & Lakshmisha, I. P. (2020). Influence of protein isolates from Pangas processing waste on physico-chemical, textural, rheological and sensory quality characteristics of fish sausages. *Lwt*, *117*(June 2019), 108662. https://doi.org/10.1016/j.lwt.2019.108662

Surasani, V. K. R., Raju, C. V., Singh, A., & Joshi, S. (2022). Quality changes in fish sausages supplemented with pangas protein isolates as affected by frozen storage and casing material. *Journal of Food Science and*

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Technology, *59*(6), 2127–2140. https://doi.org/10.1007/s13197-021-05222-1

Taghavi Takyar, M. B., Haghighat Khajavi, S., & Safari, R. (2019). Evaluation of antioxidant properties of Chlorella vulgaris and Spirulina platensis and their application in order to extend the shelf life of rainbow trout (Oncorhynchus mykiss) fillets during refrigerated storage. *Lwt*, *100*(July 2018), 244–249. https://doi.org/10.1016/j.lwt.2018.10.079

Taghian Dinani, S., van der Harst, J. P., Boom, R., & van der Goot, A. J. (2023). Effect of l-cysteine and l-ascorbic acid addition on properties of meat analogues. *Food Hydrocolloids*, *134*, 108059. https://doi.org/10.1016/J.FOODHYD.2022.108059

Tanaka, Y., Resurrección, A. P., Juliano, B. O., & Bechtel, D. B. (1978). Properties of whole and undigested fraction of protein bodies of milled rice. *Agricultural and Biological Chemistry*, *42*(11), 2015–2023. https://doi.org/10.1080/00021369.1978.10863302

Tang, C. H., Chen, L., & Foegeding, E. A. (2011). Mechanical and water-holding properties and microstructures of soy protein isolate emulsion gels induced by CaCl2, glucono-δ-lactone (GDL), and transglutaminase: Influence of thermal treatments before and/or after emulsification. *Journal of Agricultural and Food Chemistry*, *59*(8), 4071–4077. https://doi.org/10.1021/jf104834m

Tasende, M. G., & Manríquez-Hernández, J. A. (2016). Carrageenan properties and applications: A review. *Carrageenans: Sources and Extraction Methods, Molecular Structure, Bioactive Properties and Health Effects*, *September 2016*, 17–49.

Tornberg, E. (2013). Engineering processes in meat products and how they influence their biophysical properties. *Meat Science*, *95*(4), 871–878. https://doi.org/10.1016/j.meatsci.2013.04.053

Udenigwe, C. C., & Aluko, R. E. (2011). Chemometric analysis of the amino acid requirements of antioxidant food protein Hydrolysates. *International Journal of Molecular Sciences*, *12*(5), 3148–3161. https://doi.org/10.3390/ijms12053148

Varshney, N., Sahi, A. K., Poddar, S., Vishwakarma, N. K., Kavimandan, G., Prakash, A., & Mahto, S. K. (2022). Freeze–Thaw-Induced Physically Cross-linked Superabsorbent Polyvinyl Alcohol/Soy Protein Isolate Hydrogels for Skin Wound Dressing: In Vitro and In Vivo Characterization. *ACS Applied Materials & Interfaces*, *14*(12), 14033–14048. https://doi.org/10.1021/acsami.1c23024

Wahyuningtyas, A. S. H., Abidin, Z., Putri, W. D. R., Maligan, J. M., Berlian, G. O., & Ningrum, P. F. W. (2024). Consumer's willingness to try new microalgae-based food in Indonesia. *Journal of Agriculture and Food*

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
Cindy Sannia Wulandari, Dr. Arima Diah Setiowati, S.T.P., M.Sc.
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Research, *18*(June), 101367. https://doi.org/10.1016/j.jafr.2024.101367

Wang, F., Zhang, Y., Xu, L., & Ma, H. (2020). An efficient ultrasound-assisted extraction method of pea protein and its effect on protein functional properties and biological activities. *Lwt*, *127*(March), 109348. https://doi.org/10.1016/j.lwt.2020.109348

Wang, M., Yin, Z., Sun, W., Zhong, Q., Zhang, Y., & Zeng, M. (2023). Microalgae play a structuring role in food: Effect of spirulina platensis on the rheological, gelling characteristics, and mechanical properties of soy protein isolate hydrogel. *Food Hydrocolloids*, *136*(PA), 108244. https://doi.org/10.1016/j.foodhyd.2022.108244

Wang, Y. H., Zhao, J. W., Xu, F., Zhang, Q. D., Ai, Z. L., & Li, B. Y. (2021). GC-MS analyses of volatile compounds of steamed breads fermented by Chinese traditional starter "Jiaozi" from different regions. *Journal of Food Processing and Preservation*, *45*(3), 1–13. https://doi.org/10.1111/jfpp.15267

Wang, Y., Zheng, Z., Zhang, C., Wu, C., Tan, C. P., & Liu, Y. (2024). Comparative structural, digestion and absorption characterization of three common extruded plant proteins. *Food Research International*, *177*, 113852. https://doi.org/10.1016/J.FOODRES.2023.113852

Waters. (2012). *Acquity UPLC H-Class and H-Class Bio Amino Acid Analysis System Guide Revision B*. https://www.waters.com/webassets/cms/support/docs/acq_uplc_h-class_aaa_sysgd_rev_b.pdf?srsltid=AfmBOor9Ob2VIS8TAJxWedoiB3pQwrPlxomd2c6DPbFjMzH5Yt1dZZ0W

Wehrmaker, A. M., Zenker, H. E., de Groot, W., Sanders, M., van der Goot, A. J., Janssen, A. E. M., Keppler, J., & Bosch, G. (2022). Amino Acid Modifications During the Production (Shearing, Sterilization) of Plant-Based Meat Analogues: An Explorative Study Using Pet Food Production as an Example. *ACS Food Science & Technology*, *2*(11), 1753–1765. https://doi.org/10.1021/acsfoodscitech.2c00242

Widyastuti, W., Herliansyah, M. K., & Herianto, H. (2024). Proses Produksi, Sumber Material Protein dan Karakteristik Produk Daging Analog: Review. *Performa: Media Ilmiah Teknik Industri*, *23*(1), 42. https://doi.org/10.20961/performa.23.1.82813

Wu, C., Ma, W., Chen, Y., Navicha, W. B., Wu, D., & Du, M. (2019). The water holding capacity and storage modulus of chemical cross-linked soy protein gels directly related to aggregates size. *Lwt*, *103*(December 2018), 125–130. https://doi.org/10.1016/j.lwt.2018.12.064

Xiao, R., Flory, J., Alavi, S., & Li, Y. (2025). Physicochemical and functional properties of plant proteins before and after extrusion texturization. *Food*

UNIVERSITAS
GADJAH MADA
Restrukturisasi Hidrogel dari Konsentrat Protein Spirulina (Arthrospira platensis) dan Karagenan dengan Teknik Freeze-Thaw serta Aplikasinya pada Sosis Ikan
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Hydrocolloids, *163*, 111119. https://doi.org/10.1016/J.FOODHYD.2025.111119

Xiao, Y., Huang, Y., Chen, Y., Xiao, L., Zhang, X., Yang, C., Li, Z., Zhu, M., Liu, Z., & Wang, Y. (2022). Discrimination and characterization of the volatile profiles of five Fu brick teas from different manufacturing regions by using HS–SPME/GC–MS and HS–GC–IMS. *Current Research in Food Science*, *5*(August), 1788–1807. https://doi.org/10.1016/j.crfs.2022.09.024

Yan, J., Zhang, Z., Lai, B., Wang, C., & Wu, H. (2024). Recent advances in marine-derived protein/polysaccharide hydrogels: Classification, fabrication, characterization, mechanism and food applications. *Trends in Food Science and Technology*, *151*(May), 104637. https://doi.org/10.1016/j.tifs.2024.104637

Yang, C., Zhang, Z., Liu, L., Li, Y., Dong, X., & Chen, W. (2022). Fabrication of soy protein isolate/κ-carrageenan hydrogels for release control of hydrophilic compounds: Flax lignans. *International Journal of Biological Macromolecules*, *223*(PA), 821–829. https://doi.org/10.1016/j.ijbiomac.2022.11.007

You, S., Yang, S., Li, L., Zheng, B., Zhang, Y., & Zeng, H. (2022). Processing Technology and Quality Change during Storage of Fish Sausages with Textured Soy Protein. *Foods*, *11*(22), 1–14. https://doi.org/10.3390/foods11223546

Yu, J., Xiao, H., Song, L., Xue, Y., & Xue, C. (2023). Impact of O/W emulsion stabilized by different soybean phospholipid/sodium caseinate ratios on the physicochemical, rheological and gel properties of surimi sausage. *Lwt*, *175*(October 2022), 114461. https://doi.org/10.1016/j.lwt.2023.114461

Yuliarti, O., Kiat Kovis, T. J., & Yi, N. J. (2021). Structuring the meat analogue by using plant-based derived composites. *Journal of Food Engineering*, *288*(May 2020), 110138. https://doi.org/10.1016/j.jfoodeng.2020.110138

Yusof, N., Jaswir, I., Jamal, P., & Jami, M. S. (2019). Texture Profile Analysis (TPA) of the jelly dessert prepared from halal gelatin extracted using High Pressure Processing (HPP). *Malaysian Journal of Fundamental and Applied Sciences*, *15*(4), 604–608. https://doi.org/10.11113/mjfas.v15n4.1583

Zeng, X., Zhong, W., He, F., Huang, C., Tong, C., Pang, J., & Wu, C. (2024). Tailoring structural and mechanical properties of konjac glucomannan/curdlan composite hydrogels by freeze-thaw treatment. *International Journal of Biological Macromolecules*, *282*(P5), 137116. https://doi.org/10.1016/j.ijbiomac.2024.137116

Zhang, F., Yongde, Z., Wu, J., Yang, Z., Zhang, W., Fan, J., & Zeng, X. (2022). Insights into the endogenous cathepsins on modori of fermented carp (Cyprinus carpio) sausage gels in acid environment. *International Journal of*

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GADJAH MADA
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Food Science and Technology, *57*(9), 5673–5688. https://doi.org/10.1111/ijfs.15862

Zhang, Q., Gu, L., Su, Y., Chang, C., Yang, Y., & Li, J. (2021). Development of soy protein isolate/κ-carrageenan composite hydrogels as a delivery system for hydrophilic compounds: Monascus yellow. *International Journal of Biological Macromolecules*, *172*, 281–288. https://doi.org/10.1016/j.ijbiomac.2021.01.044

Zhang, S., Han, J., Kwok, E., Kan, X., Iordache, M., & Chen, L. (2025). The impact of κ -carrageenan on the pea protein gelation by high pressure processing and the gelling mechanisms study. *Food Hydrocolloids*, *158*(May 2024), 110577. https://doi.org/10.1016/j.foodhyd.2024.110577

Zhang, Y., Shao, F., Wan, X., Zhang, H., Cai, M., Hu, K., & Duan, Y. (2024). Effects of rapeseed protein addition on soybean protein-based textured protein produced by low-moisture extrusion: Changes in physicochemical attributes, structural properties and barrel flow behaviors. *Food Hydrocolloids*, *149*(September 2023), 109631. https://doi.org/10.1016/j.foodhyd.2023.109631

Zhang, Y., Zhang, P., Peng, H., Chen, Q., Jiao, X., Jia, J., Pan, Z., Cheng, J., & Wang, L. (2023). Effects of Cooking Processes on Protein Nutritional Values. *Foods*, *12*. https://doi.org/https://doi.org/10.3390/foods12173169

Zhao, Q., Yousaf, L., Xue, Y., & Shen, Q. (2020). Changes in flavor of fragrant rice during storage under different conditions. *Journal of the Science of Food and Agriculture*, *100*(8), 3435–3444. https://doi.org/10.1002/jsfa.10379

Zheng, T., Zhang, Q., Li, P., Wu, X., Liu, Y., Yang, Z., Li, D., Zhang, J., & Du, G. (2022). Analysis of Microbial Community, Volatile Flavor Compounds, and Flavor of Cigar Tobacco Leaves From Different Regions. *Frontiers in Microbiology*, *13*(June), 1–15. https://doi.org/10.3389/fmicb.2022.907270

Zhou, L., Li, K., Duan, X., Hill, D., Barrow, C., Dunshea, F., Martin, G., & Suleria, H. (2022). Bioactive compounds in microalgae and their potential health benefits. *Food Bioscience*, *49*(July), 101932. https://doi.org/10.1016/j.fbio.2022.101932

Zielbauer, B. I., Franz, J., Viezens, B., & Vilgis, T. A. (2016). Physical Aspects of Meat Cooking: Time Dependent Thermal Protein Denaturation and Water Loss. *Food Biophysics*, *11*(1), 34–42. https://doi.org/10.1007/s11483-015-9410-7