Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Abdollahi, M. and I. Undeland. 2019. Physicochemical and gel-forming properties of protein isolated from salmon, cod and herring by-products using the pH-shift method. LWT. 101: 678–684.

Aji, F. M. R., dan L. Sahubawa. 2024. Karakteristik fish cake dari surimi lele dumbo (*Clarias gariepinus*) dengan bahan pengikat yang berbeda. Jurnal Pengolahan Hasil Perikanan Indonesia. 27(9): 819-833.

Andhikawati, A., R. Permana, N. Akbarsyah, dan P. K. D. N. Y. Putra. 2020. Karakteristik minyak ikan lemuru yang disimpan selama 30 hari pada suhu rendah (5 °C). Jurnal Akuatek. 1(1): 46-52.

AOAC. 2005. Official Methods of Analysis of AOAC International. 18th ed. AOAC International, Gaithersburg, Maryland.

Asfar, M., F. Maksum, A. Laga, A. B. Tawali, M. Mahendradatta, A. W. Akil, M. Paena, and D. Lestari. 2025. Nutritional characterization and functional properties of milkfish (*Chanos chanos*) protein concentrate and whole fish powder as protein and calcium ingredient products. Food Chemistry Advances. 9(1): 1-7.

Asriani, J. Santoso, dan S. Listyarini. 2018. Nilai gizi konsentrat protein ikan lele dumbo (*Clarias gariepenus*) ukuran jumbo. Jurnal Kelautan dan Perikanan Terapan. 1(2): 77-86.

Asyari, M., E. Afrianto, dan R. I. Pratama. 2016. Fortifikasi surimi lele dumbo sebagai sumber protein terhadap tingkat kesukaan donat ubi jalar. Jurnal Perikanan Kelautan. 7(2): 71-79.

Badan Standardisasi Nasional. 2021. SNI 2694:2021 Surimi Beku. Badan Standardisasi Nasional, Jakarta.

Benjakul, S., M.T. Morrissey, T.A. Seymour, and H. An. 1997. Recovery of proteinase from Pacific whiting surimi wash water. Journal of Food Biochemistry, 21: 431–443.

Benjakul, S., W. Visessanguan, S. Riebroy, S. Ishizaki, and M. Tanaka. 2004. Gel-forming properties of surimi produced from bigeye snapper, *Priacanthus tayenus* and *P. macracanthus*, stored in ice. Journal of the Science of Food and Agriculture, 82(13): 1442–1451.

Bhambere, D., K. A. Gaidhani, M. Harwalkar, and P. S. Nirgude. 2015. Lyophilization / freeze drying – a review. World Journal of Pharmaceutical Research. 4(8): 516-543.

UNIVERSITAS
GADJAH MADA
**Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru**
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Bharane, P. R., C. Bethi, and T. Kudre. 2020. Effect of catla catla roe protein isolate on textural and sensorial properties of surimi gel from *Piaractus brachypomus*. Journal of Food Measurement and Characterization. 14(5): 1391-1401.

Bourtoom, T., M. S. Chinnan, P. Jantawat, and R. Sanguandeekul. 2009. Recovery and characterization of proteins precipitated from surimi wash-water. Food Science and Technology. 42(2): 599-605.

Brishti, F. H., M. Zarei, S. K. S. Muhammad, M. R. Ismail, R. Shukri, and N. Saari. 2017. Evaluation of the functional properties of mung bean protein isolate for development of textured vegetable protein. International Food Research Journal. 24(4): 1595-1605.

Buyruk, G., M. Çelik, A. Küçükgülmez, and A.E. Kadak. 2023. The chemical composition, sensory properties, and myofibrillar proteins of surimi produced from tilapia (*Oreochromis niloticus*) meat. Marine Science and Technology Bulletin, 12(3): 402–410.

Canti, M., and K. L. Martawidjaja. 2024. Physicochemical and sensory properties of kamaboko produces from asian seabass surimi-catfish protein isolate (*Clarias gariepinus*). Measurement: Food. 15(1): 1-10.

Chaijan, M., S. Benjakul, W. Visessanguan, and C. Faustman. 2005. Changes of pigments and color in sardine (*Sardinella gibbosa*) and mackerel (*Rastrelliger kanagurta*) muscle during iced storage. Food Chemistry. 93(4): 607-617.

Codex Alimentarius Commission. 1989. General Standard for Soy Protein Products (CXS 175-1989). FAO/WHO, Rome.

Damodaran, S., K. L. Parkin, and O. R. Fennema. 2007. *Fennema's Food Chemistry* (5th ed.). CRC Press, Florida.

Ding, H.C., D.F. Li, X.Y. Wei, Y.W. Huang, S. Cui, H.J. Xie, and T. Zhou. 2017. Protein–peptide nutritional material prepared from surimi wash-water using immobilized chymotrypsin–trypsin. Journal of the Science of Food and Agriculture. 97(6): 1746–1752.

Ding, J., X. Zhao, X. Li, and Q. Huang. 2022. Effects of different recovered sarcoplasmic proteins on the gel performance water distribution network structure of silver carp surimi. Food Hydrocolloids. 131: 107835.

Direktorat Jenderal Perikanan Budi Daya. 2024. Laporan Kinerja Direktorat Jenderal Perikanan Budi Daya Tahun 2024. Kementerian Kelautan dan Perikanan, Jakarta.

Duan, W., H. Qiu, K. K. Htwe, Z. Wang, Y. Liu, S. Wei, Q. Xia, Q. Sun, Z. Han, and S. Liu. 2023. Correlation between water characteristics and gel strength in the gel formation of golden pompano surimi induced by dense phase carbon dioxide. Food. 12(5) : 1-18.

UNIVERSITAS
GADJAH MADA
**Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru**
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Fais, N. dan G. Mahasri. 2019. Analisis critical control point (CCP) pada proses produksi surimi beku di PT. Bintang Karya Laut, Kabupaten Rembang Propinsi Jawa Tengah. Journal of Marine and Coastal Science. 8(3): 98–106.

Fang, M., S. Xiong, Y. Hu, T. Yin, and J. You. 2019. In vitro pepsin digestion of silver carp (*Hypophthalmichthys molitrix*) surimi gels after cross-linking by microbial transglutaminase (MTGase). Food Hydrocolloids, 95: 152–160.

Firmansyah, A. R., A. D. Anggo, dan L. Purnamayati. 2022. Pengaruh kombinasi *leaching* dan *egg white powder* (EWP) terhadap kualitas gel kamaboko ikan cobia (*Rachycentron canadum*). Jurnal Ilmu dan Teknologi Perikanan. 4(2): 110–119.

García-Sifuentes, C., R. Pacheco-Aguilar, M. Lugo-Sánchez, G. García-Sánchez, J.C. Ramirez-Suarez, and F. Garcia-Carreño. 2009. Properties of recovered solids from stick-water treated by centrifugation and pH shift. Food Chemistry. 114(1): 197–203.

Gehring, C. K., J. C. Gigliotti, J. S. Moritz, J. C. Tou, and J. Jaczynski. 2011. Functional and nutritional characteristics of proteins and lipids recovered by isoelectric processing of fish by-products and low-value fish: a review. Food Chemistry. 124(2): 422-431.

Ghalamara, S., E. R. Coscueta, S. Silva, C. Brazinha, C. D. Pereira, and M. E. Pintado. 2022. Intergrated ultrafiltration, nanofiltration, and reverse osmosis pilot process to produce bioactice/peptide fractions from sardine cooking effluent. Journal of Enviroemental Management. 317: 115344.

Ghaly, A. E., V. V. Ramakrishnan, M. S. Brooks, S. M. Budge, and D. Dave. 2013. Fish processing wastes as a potential source of proteins, amino acids and oils: A critical review. Journal of Microbial & Biochemical Technology. 5(4): 107–129.

Habibi, N. A., S. Fathia, C. T. Utami. 2019. Perubahan karakteristik bahan pangan pada keripik buah dengan metode freeze drying (review). Jurnal Sains Terapan. 5(2): 67-76.

Halik, A., Fatmawati, S. Sutanto, S. Laga, dan Ramdanis. 2021. Komposit rumput laut dan surimi lele terhadap mutu bakso. Jurnal Ilmiah Ecosytem. 21(3): 561-571.

Hasdinda, P. Satrimafitrah, S. Bahri, A. R. Razak, D. J. Puspitasari, Indriani, dan A. A. Amar. 2023. Produksi konsentrat protein dari ampas kelapa (*Cocos nucifera* L.) menggunakan naoh dan (nh4)2so4. Jurnal Riset Kimia. 9(1): 63-69.

Hikmayani, Y., T. Aprilliani, dan T. R. Adi. 2017. Alternatif solusi bagi keberlanjutan industri surimi di Indonesia. Buletin Ilmiah “MARINA” Sosial Ekonomi Kelautan dan Perikanan. 3(1): 39-50.

Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Huang, X., Q. Liu, P. Wang, C. Song, H. Ma, P. Hong, and C. Zhou. 2024. Tapioca starch improves the quality of *Virgatus nemipterus* surimi gel by enhancing molecular interaction in the gel system. Foods. 13(1): 169.

Iwashita, K., M. Sumida, K. Shirota, and K. Shiraki. 2016. Recovery method for surimi washwater protein by pH shift and heat treatment. Food Science and Technology Research. 22(6): 743-749.

Jafarpour, A. and E.M. Gorczyca. 2012. Contribution of sarcoplasmic proteins to myofibrillar proteins gelation. Journal of Food Science, 77(2): 73–81.

Jao, C., and W. Ko. 2002. Utilization of cooking juice of young tuna processed into canned tuna as condiments: effect of enzymatic hydrolysis and membrane treatment. Fisheries Science. 68(6): 1344-1351.

Jatisworo, D., B. Sukresno, D. W. Kusuma, and E. Susilo. 2022. Bali strait's potential fishing zone of *Sardinella lemuru*. Indonesian Journal of Geography. 54(2).

Junianto, A. H. Fauziyah, S. K. Ramadhani, A. M. Nabil, A. A. Aziz, dan I. Meisyandi. 2025. Pengalengan Ikan: Teknologi Proses dan Mutu Produk. PT. Revormasi Jangkar Philosphia, Purwokerto.

Kakko, T., E. Aitta, O. Laaksonen, P. Tolvanen, L. Jokela, T. Salmi, A. Damerau, and B. Yang. 2022. Baltic herring (*Clupea harengus membras*) protein isolate produced using the ph-shift process and its application in food models. Food Research International. 158(1): 1-14.

Kamani, M. H., A. Singh, P. Nuthong, M. A. Fenelon, E. G. Murphy, and S. Benjakul. 2024. Insight into gelation quality of low-grade surimi as affected by fava bean protein isolate. International Journal of Food Science Technology. 59(11): 8743-8754.

Karthikeyan, M., B. A. Shamasundar, S. Mathew, P. R. Kumar, and V. Prakash. 2004. Physico-chemical and functional properties of proteins from pelagic fatty fish (*Sardinella longiceps*) as a function of water washing. International Journal of Food Properties. 7(3): 353-365.

Kartika, G. R. A., A., A. Sartimbul, dan Widodo. 2017. Varian Genetik *Sardinella lemuru* di perairan Selat Bali. Jurnal Kelautan. 10(1).

Khatprathum, A., P. Siriwongpaisaan, and W. Youravong. 2010. Concentration of protein in fish mince wash water discharged from surimi processing plant by ultrafiltration. Desalination and Water Treatment. 21(1): 1-7.

Kristinsson, H. G., A. E. Theodore, and B. Ingadottir. 2007. Chemical Processing Methods for Protein Recovery from Marine By-Products and Underutilized Fish Species. In: F. Shahidi (Ed.), Maximising the Value of Marine By-Products. Woodhead Publishing, Cambridge, pp. 144-168.

Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Kristinsson, H. G., and B. A Rasco. 2000. Fish protein isolation by isoelectric precipitation and its applications. Critical Reviews in Food Science and Nutrition. 40(1): 43–81.

Kumoro, A. C., D. H. Wardhani, T. D. Kusworo, M. Djaeni, T. C. Ping, and Y. M. F. Azis. 2022. Fish protein concentrate for human consumption: a review of its preparation by solvent extraction methods and potential for food applications. Annals of Agricultural Sciences. 67(1): 42-59.

Lanier, T. C. 1992. Measurement of surimi composition and functional properties. Surimi Technology. Marcel Dekker Inc, New York.

Lestari, Y. 2019. Perbandingan kerja alat pengeringan tipe spray dryer dan freeze dryer dalam proses pengeringan bahan berbentuk cair. Jurnal Ilmiah Kohesi. 3(3).

Ling, L., Y. Liu, X. Zhang, T. Aziz, M. Shahzad, M.Y. Sameeh, Y. Wang, C. Cai, and Y. Zhu. 2023. Effect of Flammulina velutipes polysaccharides on the physicochemical properties of catfish surimi and myofibrillar protein oxidation during frozen storage. Frontiers in Nutrition. 10: 1268580.

Mabrur, U. S. A. Rahmy, R. Sasmita, dan Badruzsaufari. 2018. Profil protein ikan haruan (*Channa striata*) asal Kalimantan Selatan. Prosiding Seminar Nasional Lingkungan Lahan Basah. 3(1): 39-45.

Mahyuddin, K. 2008. Panduan Lengkap Agribisnis Lele. Penebar Swadaya, Jakarta.

Marchetti, M. D., C. J. Perez, M. Czerner, and A. B. G. Loredo. 2025. Multi-method evaluation of surimi quality from a bycatch species (*Trachurus lathami*): physicochemical, textural, sensory, and thermal responses to washing conditions. Food and Bioproducts Processing. 153: 400-409.

Meng, L., X. Jiao, B. Yan, J. Huang, J. Zhao, H. Zhang, W. Chen, and D. Fan. 2021. Effect of fish mince size on physicochemical and gelling properties of silver carp (*Hypophthalmichthys molitrix*) surimi gel. LWT, 149: 111912.

Morr, C.V., B. German, J.E. Kinsella, J.M. Regenstein, J.P. Van Buren, A. Kilara, B.A. Lewis, and M.E. Mangino. 1985. A collaborative study to develop a standardized food protein solubility procedure. Journal of Food Science. 50(6): 1715–1718.

Naghdi, S., M. M. Rezaei, M. Tabarsa, and M. Abdollahi. 2025. Expanding the ph-shift technique for sequential extraction of intact proteins and sulfated polysaccharide from fish heads: a novel biorefinery approach. Food Science & Nutrition. 13(8): e70673

Nguyen, H. T., H. N. D. Bao, H. T. T. Dang, T. Tómasson, S. Arason, and M. Gudjónsdóttir. 2022. Protein recovery of tra catfish (*Pangasius hypophtalmus*) protein-rich side streams by the ph-shift methods. Foods. 11(11): 1-18.

UNIVERSITAS
GADJAH MADA
**Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru**
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Nolsøe, H., and I. Undeland. 2009. The acid and alkaline solubilization process for the isolation of muscle proteins: state of the art. Food Bioproc Technology. 2(1): 1-27.

Park, J. W. 2013. *Surimi and Surimi Seafood* (3rd ed.). CRC Press, Florida.

Park, J.W. and Z.H. Reed. 2014. Seafood proteins and surimi. In Z. Ustunol (Ed.), Applied Food Protein Chemistry. John Wiley & Sons.

Partanen, M., K. Honkapaa, J. Hiidenhovi, T. Kakko, S. Makinen, S. Kivinen, E. Aitta, K. Vakevainen, and H. Aisala. 2023. Comparison of commercial fish proteins' chemical and sensory properties for human consumption. Foods. 12(5): 1-23.

Pathare, P.B., U.L. Opara, and F.A.J. Al-Said. 2013. Colour measurement and analysis in fresh and processed foods: a review. Food and Bioprocess Technology, 6: 36–60.

Pertami, N. D., M. F. Rahardjo, dan P. A. R. P. Tampubolon. 2016. Perikanan lemuru, *Sardinella lemuru Bleeker* 1853 di Selat Bali: status, permasalahan dan pengelolaan. Prosiding Seminar Nasional Ikan ke-9. 1: 484-495.

Pertiwi, E. D., dan Yuniarti. 2020. Tepung Ikan Lemuru. Penerbit NEM, Pekalongan.

Poernomo, D., S. H. Suseno, dan B. P. Subekti. 2014. Karakteristik fisika kimia bakso dari daging lumat ikan layaran (*Istiophorus orientalis*). Jurnal Pengolahan Hasil Perikanan Indonesia. 16(1): 58–68.

Poulter, R., D. A. Ledward, S. Y. Godber, G. Hall, and B. Rowlands. 1985. Heat stability of fish muscle proteins. Journal of Food Technology. 20(2): 203-217.

Prastasari, C., I. Sinaga, dan L. Amanda. 2023. Ekstraksi konsentrat protein ikan gabus (*Channa striata*) dengan bahan pengekstrak aseton. Jurnal Perikanan dan Kelautan. 13(1): 78-86.

Putra, M. P., and P. Hastuti. 2014. Isolation and characterization of the functional properties of the major protein fraction from nyamplung (*Calophyllum inophyllum*). Indonesian Food and Nutrition Progress. 13(1): 17-23.

Qi, X., Q. Lu, S. Shenjie, and W. Tianwei. 2015. Recovering protein from surimi wash water after isoelectrically precipitate by chitosan flocculation. Transactions of the Chinese Society of Agricultural Engineering. 31(6): 327-332.

Radityo, C., Y. S. Darmanto, dan Romadhon. 2014. Pengaruh penambahan egg white powder dengan konsentrasi 3% terhadap kemampuan pembentukan gel surimi dari berbagai jenis ikan. Jurnal Pengolahan dan Bioteknologi Hasil Perikanan. 3(4): 1-9.

Ramadhan, F.D., R.I. Pratama, and W. Lili. 2022. The effect of soy protein isolate addition on gel strength of ariid catfish (*Arius thalassinus*) surimi. International Journal of Advance Research and Innovative Ideas in Education. 8(5): 932–937.

Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Rieuwpassa, F. J., E. J. Karimela, dan M. C. Karaeng. 2020. Analisis fisiko kimia konsentrat protein ikan nila (*Oreochromis niloticus*) yang diekstrak menggunakan pelarut etanol. Jurnal Teknologi Perikanan dan Kelautan. 11(1): 45-52.

Rochim, B.A. 2024. Pengaruh Penambahan Isolat Protein dari Hasil Samping Ekstraksi Fikosianin Spirulina (*Arthrospira platensis*) terhadap Mutu Surimi Lele. Fakultas Pertanian. Universitas Gadjah Mada. Skripsi.

Rustad, T., I. Storrø, and R. Slizyte. 2011. Possibilities for the utilisation of marine by-products. International Journal of Food Science & Technology. 46(10): 2001–2014.

Sahubawa, L., and S. A. Pratomo. 2022. Nutritional composition and consumer preference level from hanpen fish cake on african catfish surimi and casava flour. International and National Seminar on Fisheries and Marine Science. 1118(1): 012072.

Santoso, S., W.S. Yanti, and R.D.U.A. 2019. Pengolahan ikan lele menjadi nugget sehat untuk menumbuhkan kreativitas masyarakat dalam berwirausaha. Jurnal Abdikarya: Jurnal Karya Pengabdian Dosen dan Mahasiswa. 3(3): 218–221.

Sari, M., dan M. A. Moulina. 2020. Pengaruh variasi waktu perendaman sampel dan jumlah pelarut homogenasi terhadap persentase ekstrak daun kelor (*Moringa oleifera*). Agritepa. 7(1): 51-56.

Selmi, S., I. Batista, S. Sadok, N.M. Bandarra, and M.L. Nunes. 2010. Chemical composition changes and fat oxidation in sardine mince following sodium bicarbonate and sodium chloride washing. Journal of Food Processing Engineering. 33(6): 1036–1051.

Setyarini, D., Bustami, dan J. Santoso. 2024. Karakteristik kimia dan sifat fungsional konsentrat protein ikan (kpi) dan tepung tulang dari ikan lele. Jurnal Pengolahan Hasil Perikanan Indonesia. 27(6): 456-473.

Shahidi, F., and J. Synowiecki. 1991. Isolation and characterization of nutrients and value-added products from snow crab processing discards. Journal of Agricultural and Food Chemistry. 39(8): 1527–1532.

Shaviklo, A. R. 2015. Development of fish protein powder as an ingredient for food applications. Journal Food Science Technology. 52(2): 648-661.

Sikorski, Z. E., A. Kolakowska, and B. S. Pan. 1994. Seafood: Resources, Nutritional Composition, and Preservation. CRC Press, Florida.

Somjid, P., W. Panpipat, L. Cheong, and M. Chaijan. 2022. Comparative effect of cricket protein powder and soy protein isolate on gel properties on indian mackerel surimi. Foods. 11(21): 1-22.

UNIVERSITAS
GADJAH MADA
**Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru**
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Somjid, P., W. Panpipat, L.Z. Cheong, and M. Chaijan. 2021. Reduced washing cycle for sustainable mackerel (*Rastrelliger kanagurta*) surimi production: evaluation of bio-physico-chemical, rheological, and gel-forming properties. Foods, 10(11): 2717.

Sun, H., D. S. Johnson, and R. E. Aluko. 2025. Structural and functional properties of dried fish protein isolates. AIMS Agriculture and Food. 10(3): 770-789.

Supit, L. S., T, Moniharapon, dan F. Pattipeilohy. 2021. Efektifitas pencucian dengan larutan atung terhadap kuantitas dan kualitas surimi daging merah ikan tuna (*Thunnus albacares*). Molluca Journal of Chemistry Education. 11(2): 81-92.

Surasani, V.K.R., A. C.V. Raju, U. Shafiq, M. V. Chandra, and L. P. Lakshmisha. 2019. Influence of protein isolates from Pangas processing waste on physicochemical, textural, rheological and sensory quality characteristics of fish sausages. Food Science and Technology. 117: 1-8.

Surasani, V.K.R., S. O. Khairnar, S. A. Holeyappa, A. Tyagi, A. Singh, and A. Mandal. 2022. Influence of Protein Isolates from Pangas Processing Waste on the Quality of Tilapia (GIFT) Patties During Storage at 4°C. Aquatic Food Studies. 2(1).

Surilayani, D., R. Irnawati, dan R.P. Aditia. 2019. Mutu surimi ikan gulamah dengan perbedaan frekuensi pencucian. Jurnal Perikanan dan Kelautan, 9(2): 225–234.

Suryaningrum, T.D., H.E. Irianto, and D. Ikasari. 2015. Characteristics of kamaboko from catfish (*Clarias gariepinus*) surimi processed with carrot and beet root as filler and natural food colorants. Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology, 10(3): 99–108.

Susanti, E., I. S. Setiasih, dan E. Wulandari. 2019. Analisis kekuatan gel surimi ikan lele (*Clarias gariepinus*) hasil ozonasi selama penyimpanan pada suhu 4 ± 1°C. Pasundan Food Technology Journal. 6(2): 91-94.

Suzuki, T. 1981. Fish and Krill Protein: Processing Technology. Springer, Netherlands.

Syamsir, A. S. Naiu, dan N. Yusuf. 2022. Karakteristik mutu surimi berbagai ikan dari perairan kota gorontalo. Jurnal Ilmiah Perikanan dan Kelautan. 10(2): 84-91.

Tolano-Villaverde, I. J., W. Torres-Arreola, V. M. Ocaño-Higuera, and E. Marquez-Rios. 2016. Thermal gelation of myofibrillar proteins from aquatic organisms. CYTA-Journal of Food. 14(3): 502-508.

Torres, J. A., Y. C. Chen, J. Rodrigo-Gracia, and J. Jacyznski. 2007. Recovery of by-products from seafood processing waste streams. CRC Press, Boca Raton.

Trinh, S. K., L. T. Nguyen, T. T. Le, and H. T. N. Le. 2017. Production of fish protein concentrate (fpc) from *Palgasius catfish* and study on the effect of sodium

Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

chloride, sodium tripolyphosphate, sucrose and sorbitol to the protein solubility and water holding capacity of fpc. 1(1): 86-95.

Ubaidillah, A., dan W. Hersulistyorini. 2010. Kadar protein dan sifat organoleptik nugget rajungan dengan subtitusi ikan lele (*Clarias griepinus*). Jurnal Pangan dan Gizi. 1(2).

Utami, P., S. Lestari, dan S. D. Lestari. 2016. Pengaruh metode pemasakan terhadap komposisi kimia dan asam amino ikan seluang (*Rasbora argyrotaenia*). Jurnal Teknologi Hasil Perikanan. 5(1): 73-84.

Utami, Y. P., Z. Amody, A. Anggraeni, L. T. Rerung, M, A. Mulki, J. Suriawati, Imrawati, Latirah, S. M. Tulandi, S. Duenggo, Patimah, D. Arisanty, dan F. Usman. 2025. Teknik Ekstraksi dan Isolasi Bahan Alam. CV Eureka Media Aksara, Purbalingga.

Wang, Y., D. Wang, J. Liu, and X. Yu. 2023. Effects of rice bran ferruloyl oligosaccharides on gel properties and microstructure of grass carp surimi. Food Chemistry. 407 : 1-10.

Wang, Y., Y. Tian, J. Sun, and H. Yang. 2023. Physicochemical properties of grass carp surimi as affected by pH and NaCl concentration during washing. International Journal of Food Properties, 26(1): 952–962.

Wibowo, S., G. Velazquez, V. Savant, and J.A. Torres. 2005. Surimi wash water treatment for protein recovery: effect of chitosan–alginate complex concentration and treatment time on protein adsorption. Bioresource Technology. 96(6): 665–671.

Wijayanti, I., J. Santoso, and A.M. Jacoeb. 2012. The effect of leaching times on the gel properties of catfish (*Clarias gariepinus*) surimi. Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology, 8(1): 32–37.

Wijayanti, I., J. Santoso, dan A. M. Jacob. 2015. Karakteristik tekstur dan daya ikat air gel surimi ikan lele (*Clarias batrachus*) dengan penambahan asam tanat dan ekstrak fenol teh teroksidasi. Jurnal Saintek Perikanan. 10(2): 84-90.

Wijayanti, I., T. Surti, T. W. Agustini, dan Y. S. Darmanto. 2014. Perubahan asam amino surimi ikan lele dengan frekuensi pencucian yang berbeda. Jurnal Pengolahan Hasil Perikanan Indonesia. 17(1): 29-41.

Wulansari, K., A. Razak, dan Vauziah. 2022. Pengaruh suhu terhadap pertumbuhan ikan lele sangkuriang (*Clarias gariepinus*) dan ikan lele dumbo (*Clarias gariepinus* x *Clarias fiscus*). Konservasi Hayati. 18(1): 31-39.

Xie, D., Y. Tang, and G. Dong. 2024. Various factors affecting the gel properties of surimi: a review. Journal of Texture Studies. 55(3): e12847.

UNIVERSITAS
GADJAH MADA
**Penambahan Kualitas Gel Surimi Ikan Lele dengan Penambahan Konsentrat Protein yang Dipulihkan dari
Limbah Cair Industri Pengolahan Tepung Lemuru**
Nabilah Alya Krisnawati, Ir. Mgs. Muh. Prima Putra, S.Pi., M.Sc., Ph.D., IPM., ASEAN Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Yan-yan, W., X. Tian, L. Lai-hao, and Y. Xian-qing. 2018. A review of studies on thermal denaturations of fish protein. Science and Technology of Food Industry. 39(5): 343-347.

Yin, T. and J.W. Park. 2023. Comprehensive review: by-products from surimi production and better utilization. Food Science and Biotechnology. 32(14): 1957–1980.

Zhang, X., H. Pan, X. Jiang, and W. Shi. 2023. Study on the mechanism of soy protein isolate to improve quality of reduced-salt *Hypophthalmichthys molitrix* surimi gel: focus on gel quality, protein structure, and in vitro digestibility. Food Chemistry: X. 12(20): 100878.

Zhang, X., Y. Zhang, H. Ding, W. Zhang, and Z. Dai. 2022. Effect of washing times on the quality characteristics and protein oxidation of silver carp surimi. Foods, 11(16): 2397.

Zhao, Q., B. Zheng, J. Li, K.L. Cheong, R. Li, J.P. Chen, X. Liu, X. Jia, B. Song, Z. Wang, and S.Y. Zhong. 2024. Emulsion-filled surimi gel: a promising approach for enhancing gel properties, water holding capacity, and flavor. Trends in Food Science and Technology, 152: 104663.

Zhao, X., T. Mei, and B. Cui. 2024. Effect and mechanism of different exogenous biomolecules on the thermal-induced gel properties of surimi: a review. Journal of Food Science. 89(12): 10266-10282.

Zhao, Y., K. Wei, J. Chen, G. Wei, J. Li, B. Zheng, Y. Song, P. Gao, and R. Zhou. 2024. Enhancement of myofibrillar protein gelation by plant proteins for improved surimi gel characteristics: mechanisms and performance. LWT. 98: 116045.

Zuraida, I., S. Raharjo, P. Hastuti, and R. Indrati. 2017. Research article catfish (*Clarias gariepinus*): a potential alternative raw material for surimi production. Pakistan Journal of Nutrition. 16(12): 928-934.

Zuraida, I., S. Raharjo, P. Hastuti, dan R. Indrati. 2018. Effect of setting condition on the gel properties of surimi from catfish (*Clarias gariepinus*). Journal of Biological Sciences. 18(5): 223-230.