



DAFTAR PUSTAKA

- Afifah, DN., Purnamasari, F., Khusna, L., *et al.*, 2021. Musa balbisiana and musa paradisiaca starches increase SCFA and caspase-3 as well as decrease β -glucuronidase and MDA of mouse model for colon cancer. *Indonesian Biomedical Journal*. 13(1):91–96.
- Agustina, M., Rimbawan, R., Setiawan, B., Herminati, A., 2021. Pengaruh pemberian diet rendah protein dan restriksi pakan pada pertumbuhan dan protein serum tikus lepas sapih. *Nutri-Sains: Jurnal Gizi, Pangan dan Aplikasinya*. 5(1):1–14.
- Ahmad, F., Megia, R., Poerba, Y.S., 2014. Genetic diversity of Musa balbisiana Colla in Indonesia based on AFLP marker. *HAYATI Journal of Biosciences*. 21(1):39–47.
- Ali, S., ElGibaly, R., Abdel-Maksoud, S., 2018. Effect of Musa sapientum (banana) on indomethacin-induced gastric mucosal injury in rats: histological study. *Journal of Medical Histology*. 2(1):11–28.
- Anstead, GM., Chandrasekar, B., Zhao, W., *et al.*, 2001. Malnutrition alters the innate immune response and increases early visceralization following Leishmania donovani infection. *Infection and Immunity*. 69(8):4709–4718.
- Arafat, H., Naim, M., Shaalan, A., Hosny, S., 2020. Possible protective effect of capsaicin against indomethacininduced damage in jejunum of adult male albino rats (histological and histochemical study). *Journal of Medical Histology*. 4(1):1–11.
- Arsenault, J.E., Brown, K.H. 2017. Effects of protein or amino-acid supplementation on the physical growth of young children in low-income countries. *Nutrition Reviews*. 75(9):699–717.
- Assis, T., Silva, T., Franco, E., Leite, A., Moraes, S., Maia, M., 2011. Impact of early malnourishment on the chronic inflammatory response and its implications for the effect of indomethacin on Wistar rats. *British Journal of Nutrition*. 106(6):845–851.
- Attia, S., Feenstra, M., Swain, N., Cuesta, M., Bandsma, R.H.J., 2017. starved guts: morphologic and functional intestinal changes in malnutrition. *Journal of Pediatric Gastroenterology and Nutrition*. 65(5):491–495.
- Aviello, G., Knaus, UG., 2017. ROS in gastrointestinal inflammation: rescue or sabotage? *British Journal of Pharmacology*. 174(12):1704–1718.
- Ayuningtyas, D., Hapsari, D., Rachmalina, R., Amir, V., Rachmawati, R., Kusuma, D., 2022. geographic and socioeconomic disparity in child undernutrition across 514 districts in Indonesia. *Nutrients*. 14(4):1–18.



Azevedo, J.F., Hermes-Uliana, C., Lima, D.P., et al., 2014. Probiotics protect the intestinal wall of morphological changes caused by malnutrition. *Anais da Academia Brasileira de Ciencias.* 86(3):1303–1314.

Balaha, M.F., Almalki, Z.S., Alahmari, A.K., Ahmed, N.J., Balaha, M.F., 2022. AMPK/mTOR-driven autophagy & Nrf2/HO-1 cascade modulation by amentoflavone ameliorates indomethacin-induced gastric ulcer. *Biomedicine and Pharmacotherapy.* 151:113200.

Barcelo, A., Claustre, J., Moro, F., Chayvialle J.A., Cuber, J.C., Plaisancie, P., 2000. Mucin secretion is modulated by luminal factors in the isolated vascularly perfused rat colon. *Gut.* 46(2):218–224.

Barekatain, R., Nattras, G., Tilbrook, A.J., Chosalkar, K., Gilani, S., 2019. Reduced protein diet and amino acid concentration alter intestinal barrier function and performance of broiler chickens with or without synthetic glucocorticoid. *Poultry Science.* 98(9):3662–3675.

Behera, S.S., Ray, R.C., Zdolec, N., 2018. Lactobacillus plantarum with functional properties: an approach to increase safety and shelf-life of fermented foods. *BioMed Research International.* 2018:1-18.

Bergmans, R.S., Nikodemova, M., Stull, V.J., Rapp, A., Malecki, K., 2020. Comparison of cricket diet with peanut-based and milk-based diets in the recovery from protein malnutrition in mice and the impact on growth, metabolism and immune function. *PLoS ONE.* 15:1–16.

Bharti, V., Mehta, A., Kumar, G., Ahirwal, L., Shukla, S., 2016. Anti-hypercholesterolemia and Anti-hyperlipidemic Effect of *Lactobacillus plantarum* and *Lactobacillus acidophilus* in Diabetic Rats. *Food & Pharma International.* 1(3):150–155.

Bidell, M.R., Hobbs, A.L.V. and Lodise, T.P., 2022. Gut microbiome health and dysbiosis: A clinical primer. *Pharmacotherapy.* 42(11):849–857.

Borborah, K., Borthakur, S.K., Tanti, B., 2016. *Musa balbisiana colla*-taxonony, traditional knowledge and economic potentialities of the plant in Assam, India. *Indian Journal of Traditional Knowledge,* 15(1):116–120.

Brownlee, I.A., Knight, J., Dettmar, P.W., Pearson, J., 2007. Action of reactive oxygen species on colonic mucus secretions. *Free Radical Biology and Medicine.* 43(5):800–808.

Bu, Y., Liu, Y., Liu, Y., Cao, J., Zhang, Z., Yi, H., 2023. Protective effects of bacteriocin-producing lactiplantibacillus plantarum on intestinal barrier of mice. *Nutrients.* 15(16): 1–14.

Buwono, M., Amanto, B.S., Widowati, E., 2018. Study of physical, chemical, and



sensory characteristics of modified square banana flour (*Musa balbisiana*). *Indonesian Food and Nutrition Progress.* 15(1):30-42.

Castelo-Branco, V.N., Gulmaraes, J.N., Souza, L., Guedes, M.R., *et al.*, 2017. The use of green banana (*Musa balbisiana*) pulp and peel flour as an ingredient for tagliatelle pasta. *Brazilian Journal of Food Technology.* 20:1-8.

Cervantes-García, D., Bahena-Delgado, A.I., Jiménez, M., *et al.*, 2020. Glycomacropeptide ameliorates indomethacin-induced enteropathy in rats by modifying intestinal inflammation and oxidative stress. *Molecules.* 25(10):2351.

Chen, X., Song, P., Fan, P., He, T., Jacobs, D., Levesque, CL., Jongston, L.J., Ji, L., Ma, N., Chen, Y., Zhang, J., Zhao, J., Ma, X., 2018. Moderate dietary protein restriction optimized gut microbiota and mucosal barrier in growing pig model. *Frontiers in Cellular and Infection Microbiology.* 8(246):1-15.

Chotikatum, S., Naim HY, El-Najjar, N., 2018. Inflammation induced ER stress affects absorptive intestinal epithelial cells function and integrity. *International Immunopharmacology.* 55:336–344.

Christian, V.J., Miller, K.R. and Martindale, R.G., 2020. Food Insecurity, Malnutrition, and the Microbiome. *Current Nutrition Reports.* 9(4):356–360.

Cobo, E.R., Kissin-Singh, V., Moreau, F., Chadee, K., 2015. Colonic MUC2 mucin regulates the expression and antimicrobial activity of β-defensin 2. *Mucosal Immunology.* 8(6):1360–1372.

D'Acquisto, F., May, M.J., Ghosh, S., 2002. Inhibition of nuclear factor kappa B (NF-κB): an emerging theme in anti-inflammatory therapies. *Molecular Interventions.* 2(1):22–35.

Damiano, S., Sasso, A., Felice, B., *et al.*, 2018. Quercetin increases MUC2 and MUC5AC gene expression and secretion in intestinal goblet cell-like LS174T via PLC/PKC α /ERK1-2 pathway. *Frontiers in Physiology.* 9(APR):1–11.

Darmastuti, A., Hasan, P., Wikandari, R., Utami, T., Rahayu, E., Suroto, D., 2021. Adhesion properties of *lactobacillus plantarum* dad-13 and *lactobacillus plantarum* mut-7 on sprague dawley rat intestine. *Microorganisms.* 9(11):1-13.

Ding, Y., Chen, D., Yan, Y., *et al.*, 2021. Effects of long-term consumption of polysaccharides from the fruit of *Lycium barbarum* on host's health. *Food Research International.* 139(2020):109913.

Dock-Nascimento DB, Junqueira K and De Aguilar-Nascimento JE, 2007. Rapid restoration of colonic goblet cells induced by a hydrolyzed diet containing probiotics in experimental malnutrition. *Acta Cirurgica Brasileira.* 22:72–76.



- Domene, A., Orozco, H., Rodríguez-Viso, P., Monedero, V., Velez, D., Devesa, V., 2024. Lactobacillus strains reduce the toxic effects of a subchronic exposure to arsenite through drinking water. *Environmental Research.* 245(2023):117989.
- Edyanto, A.S, Huriyati, E., Nisa, A., Nurrahma, B.A., Farmawati, A., 2023. Iron-fortified klutuk banana (*Musa balbisiana Colla*) flour supplementation prevented growth failure by suppressing FGF21 in malnourished rats. *Nutrition & Food Science.* 53(7):1166-1178.
- Estrela, D., Lemes, C., Guimarães, A., Malafaia, G., 2014. Effects of short-term malnutrition in rats. *Scientia Plena.* 10(7):1–13.
- Fança-Berthon, P., Michel, C., Pagniez, A., Rival, M., Seuningen, I., Darmaun, D., Hoebler, C., 2009. Intrauterine growth restriction alters postnatal colonic barrier maturation in rats. *Pediatric Research.* 66(1):47–52.
- Farmawati, 2023. *Pengembangan Suplemen Nutrasetikal Berbahan Dasar Tepung Pisang Klutuk Terfortifikasi Fe dan Lactobacillus plantarum Dad13*, belum dipublikasikan.
- Faure, M., Mettraux, C., Moennoz, D., et al., 2006. Specific amino acids increase mucin synthesis and microbiota in dextran sulfate sodium-treated rats. *Journal of Nutrition.* 136(6):1558–1564.
- Ferreira-Paes, T., Seixas-Costa, P., Almeida-Amaral, E.E., 2021. Validation of a feed protocol in a mouse model that mimics marasmic malnutrition. *Frontiers in Veterinary Science.* 8(11):1–10.
- Fluitman, K.S., De Clercq, N.C., Keijser, B.J.F., Visser, M., Nieuwdorp, M., Ijzerman, R.G., 2017. The intestinal microbiota, energy balance, and malnutrition: emphasis on the role of short-chain fatty acids. *Expert Review of Endocrinology and Metabolism.* 12(3):215–226.
- Gallop, M.R., Wilson, V.C., Ferrante, A.W., 2021. Post-oral sensing of fat increases food intake and attenuates body weight defense. *Cell Reports.* 37(3):109845.
- Gamage, H.K.A.H., Chong, R.W.W., Bucio-Noble, D., et al., 2020. Changes in dietary fiber intake in mice reveal associations between colonic mucin O-glycosylation and specific gut bacteria. *Gut Microbes.* 12(1):1–15.
- Gamal, M. and Ibrahim, M.A. 2024. Introducing the f 0% method: a reliable and accurate approach for qPCR analysis. *BMC Bioinformatics.* 25(1):1–18.
- Gatya, M., Fibri, D., Utami, T., Suroto, D., Rahayu, E., 2022. Gut microbiota composition in undernourished children associated with diet and sociodemographic factors: a case-control study in Indonesia. *Microorganisms.* 10(9):1-17.



UNIVERSITAS
GADJAH MADA

Efek Suplementasi Tepung Pisang Klutuk (*Musa balbisiana Colla*) Terfortifikasi Zat Besi dan *Lactobacillus plantarum* Dad-13 terhadap Ekspresi dan Kadar Protein Mucin-2 (MUC2) pada Kolon Tikus

Malnutrisi

Shofia Nur Inayah, dr. Arta Farmawati, Ph.D; Dr. dr. Emy Huriyati, M.Kes

Universitas Gadjah Mada, 2024 | Diunduh dari <http://etd.repository.ugm.ac.id/>

Genton, L., Cani, P.D., Schrenzel, J., 2015. Alterations of gut barrier and gut microbiota in food restriction, food deprivation and protein-energy wasting. *Clinical Nutrition*. 34(3):341–349.

Ghio, A.J., Soukup, J.M., Dailey, L.A., Roggeli, V., 2023. Mucus increases cell iron uptake to impact the release of pro-inflammatory mediators after particle exposure. *Scientific Reports*. 13(1):1–12.

Gourbeyre, P., Desbards, N., Grémy, G., et al., 2012. Exposure to a galactooligosaccharides/inulin prebiotic mix at different developmental time points differentially modulates immune responses in mice. *Journal of Agricultural and Food Chemistry*. 60(48):11942–11951.

Gurumayum, N., Sarma, P.P., Khound, P., Jana, U.K., Devi, R., 2023. Nutritional composition and pharmacological activity of musa balbisiana colla seed: an insight into phytochemical and cellular bioenergetic profiling. *Plant Foods for Human Nutrition*. 78(3):520-525.

Gustafsson, J.K., Johansson, M.E.V., 2022. The role of goblet cells and mucus in intestinal homeostasis. *Nature Reviews Gastroenterology and Hepatology*. 19(12):785–803.

Han, J. et al. 2023. Physiological effects of resistant starch and its applications in food: a review'. *Food Production, Processing and Nutrition*, 5(1).

Han, Y.M., Park, J., Kang, J., et al., 2016. Mitigation of indomethacin-induced gastrointestinal damages in fat-1 transgenic mice via gate-keeper action of ω-3-polyunsaturated fatty acids. *Scientific Reports*. 6:1–12.

Hashemi, Z., Fouhse, J., Im, H.S., Chan, C.B., Willing, B.P., 2017. Dietary pea fiber supplementation improves glycemia and induces changes in the composition of gut microbiota, serum short chain fatty acid profile and expression of mucins in glucose intolerant rats. *Nutrients*. 9(11):1236.

Haslinda, W.H., Cheng, L.H., Chong, L.C., Aziah, A.A.N., 2009. Chemical composition and physicochemical properties of green banana (*Musa acuminata* × *balbisiana* Colla cv. Awak) flour. *International Journal of Food Sciences and Nutrition*. 60(4):232–239.

Hastuti, H., 2021. Pisang batu musa balbisiana colla: kajian botani dan pemanfaatannya. *EduMatSains : Jurnal Pendidikan, Matematika dan Sains*. 5(2):249–262.

Heazlewood, C.K., Cook, M.C., Eri, R., et al., 2008. Aberrant mucin assembly in mice causes endoplasmic reticulum stress and spontaneous inflammation resembling ulcerative colitis. *PLoS Medicine*. 5(3):0440–0460.

Herath, M., Hosie, S., Bornstein, J., Franks, A., Hill-Yardin, E., 2020. The role of



the gastrointestinal mucus system in intestinal homeostasis: implications for neurological disorders. *Frontiers in Cellular and Infection Microbiology*. 10(248):1-14.

Hermes, C., Azevedo, J.F., Araújo, E.J.D.A, Ana, D.M.G.S., 2008. Intestinal ascending colon morphometrics in rats submitted to severe protein malnutrition. *International Journal of Morphology*. 26(1):5–11.

Hidalgo-Villeda, F. et al., 2023. Prolonged dysbiosis and altered immunity under nutritional intervention in a physiological mouse model of severe acute malnutrition. *iScience*. 26(6).

Hurrell, R.F., 2021. Iron fortification practices and implications for iron addition to salt. *Journal of Nutrition*. 151:3S–14S.

Hurrell, R.F., 2022. Ensuring the efficacious iron fortification of foods: a tale of two barriers. *Nutrients*. 14(8):1-19.

Iebba, V. et al., 2016. Eubiosis and dysbiosis: The two sides of the microbiota', *New Microbiologica*. 39(1):1–12.

Ito, H., Satsukawa, M., Arai, E., et al., 2009. Soluble fiber viscosity affects both goblet cell number and small intestine mucin secretion in rats. *Journal of Nutrition*. 139(9):1640–1647.

Iwai, T., Ichikawa, T., Goso, Y., et al., 2009. Effects of indomethacin on the rat small intestinal mucosa: Immunohistochemical and biochemical studies using anti-mucin monoclonal antibodies. *Journal of Gastroenterology*. 44(4):277–284.

Jacobi, S.K., Odle, J., 2012. Nutritional factors influencing intestinal health of the neonate. *Advances in Nutrition*. 3(5):687–696.

Johansson, M.E.V., Holmén Larsson, J.M., Hansson, G.C., 2011. The two mucus layers of colon are organized by the MUC2 mucin, whereas the outer layer is a legislator of host-microbial interactions. *Proceedings of the National Academy of Sciences of the United States of America*. 108:4659–4665.

Kamil, R.Z., Murdiati, A., Juffrie, M., Rahayu, E.S., 2022. Gut microbiota modulation of moderate undernutrition in infants through gummy *Lactobacillus plantarum* Dad-13 consumption: a randomized double-blind controlled trial. *Nutrients*. 14(5):1-19.

Kane, A. V., Dinh, D.M., Ward, H.D., 2015. Childhood malnutrition and the intestinal microbiome. *Pediatric Research*. 77(1):256–262.

Karlen, Y. et al. 2007. Statistical significance of quantitative PCR. *BMC Bioinformatics*. 8:1–16.



Karima, H.A., 2017. *Identifikasi kandungan mineral dan antioksidan tepung pisang raja bandung, tepung pisang kluthuk, dan tepung pisang tanduk* [Skripsi]. Universitas Gadjah Mada.

Kemenkes RI, 2016. *Peraturan Menteri Kesehatan Republik Indonesia Nomor 51 Tahun 2016 tentang Standar Produk Suplementasi Gizi*, Kementerian Kesehatan RI.

Kemenkes RI, 2022. *Kemenkes RI no HK.01.07/MENKES/1928/2022 Tentang Pedoman Nasional Pelayanan Kedokteran Tata Laksana Stunting*, Kementerian Kesehatan RI.

Kemenkes RI, 2023. *Hasil Survei Status Gizi Indonesia*, Kementerian Kesehatan RI.

Kilberg, M.S., Balasubramanian, M., Fu, L., Shan, J., 2012. The transcription factor network associated with the amino acid response in mammalian cells. *Advances in Nutrition*. 3(3):295–306.

Kitamura M, 2013. The unfolded protein response triggered by environmental factors. *Seminars in Immunopathology*. 35(3):259–275.

Koçpinar, E.F., Baltaci, N.G., Ceylan, H., Kalin, S.N., Erdogan, O., Budak, H., 2020. Effect of a prolonged dietary iron intake on the gene expression and activity of the testicular antioxidant defense system in rats. *Biological Trace Element Research*. 195(1):135–141.

Koh, A. et al. 2016. From dietary fiber to host physiology: Short-chain fatty acids as key bacterial metabolites. *Cell*. 165(6): 1332–1345.

Kracht, M., Müller-Ladner, U., Schmitz, M.L., 2020. Mutual regulation of metabolic processes and proinflammatory NF-κB signaling. *Journal of Allergy and Clinical Immunology*. 146(4):694–705.

Kumar, R.S., Kanmani, P., Yuvaraj, N., et al. 2012. *Lactobacillus plantarum* AS1 isolated from south Indian fermented food Kallappam suppress 1,2-dimethyl hydrazine (DMH)-induced colorectal cancer in male Wistar rats. *Appl. Biochem*. 166:620–631.

Kumari, S., Katare, P.B., Elancheran, R., Nizami, H., Paramesha, B., et al., 2020. *Musa balbisiana* fruit rich in polyphenols attenuates isoproterenol-induced cardiac hypertrophy in rats via inhibition of inflammation and oxidative stress. *Oxidative Medicine and Cellular Longevity*. 2020:1-14.

Leite, S.N., Andrade, T.A.M., Frade, M.A.C., Junior, A.A.J., Masson, D.S., 2011. Experimental models of malnutrition and its effect on skin trophism. *Anais brasileiros de dermatologia*. 86(4):681–8.



Lemes, C.G.C., Gumaraes, T.B., Silva, A.M.S., Mendes, B.O., Estrela, D.C., Santos, A.S., Junior, J.R.F.A., Torres, I.L.S., Talvani, A., Malafaia, G., *et al.*, 2016. The association of malnutrition and chronic stress models does not present overlay effects in male wistar rats. *The Open Access Journal of Science and Technology*. 4:1-13.

Leon-Coria, A., Kumar, M., Workentine M., Moreau, F., Surette, M., Chadee, K., 2021. Muc2 mucin and nonmucin microbiota confer distinct innate host defense in disease susceptibility and colonic injury. *Cmgh*. 11(1):77–98.

Li, P., Li, M., Song, Y., Huang, X., Wu, T., Cu, Z.Z., Lu, H., 2022. Green banana flour contributes to gut microbiota recovery and improves colonic barrier integrity in mice following antibiotic perturbation. *Frontiers in Nutrition*. 9(832848):1–13.

Ling, P.R., Bistrian, B.R., 2009. Comparison of the effects of food versus protein restriction on selected nutritional and inflammatory markers in rats. *Metabolism: Clinical and Experimental*. 58(6):835–842.

Lippo, B.R., Batista, T.M., Rezende, L.F., Cappelli, A.P., Camargo, R.L., Branco, R.C.S., Sampaio, H.C.B., Protzek, A.O.P., Wanderley, M.I., Arantes, V.C., Corat, M.A.F., Carneiro, E.M., Udrisar, D.P., Wanderley, A.G., Ferreira, F., 2015. Low-protein diet disrupts the crosstalk between the PKA and PKC signaling pathways in isolated pancreatic islets. *Journal of Nutritional Biochemistry*. 26(5):556–562.

Liu, S., Dong, Z., Tang, W., Zhou, J., Guo, L., Gong, C., Liu, G., Wan, D., Yin, Y., 2023. Dietary iron regulates intestinal goblet cell function and alleviates *Salmonella typhimurium* invasion in mice. *Science China Life Sciences*. 66(9):2006–2019.

Liu, Y., Beyer, A., Aebersold, R., 2016. On the dependency of cellular protein levels on mRNA abundance. *Cell*. 165(3):535–550.

Liu, Y., Yu, X., Zhao, J., Zhang, H., Zhai, Q., Chen, W., 2020. The role of MUC2 mucin in intestinal homeostasis and the impact of dietary components on MUC2 expression. *International Journal of Biological Macromolecules*. 164:884–891.

Liu, Y., Yu, Z., Zhu, L., *et al.*, 2023. Orchestration of MUC2 — the key regulatory target of gut barrier and homeostasis: a review. *International Journal of Biological Macromolecules*. 236:123862.

Luo, Q., Lao, C., Huang, C., Xia, Y., Wenjing, M., Liu, W., Chen, Z., 2021. Iron overload resulting from the chronic oral administration of ferric citrate impairs intestinal immune and barrier in mice. *Biological Trace Element Research*. 199(3):1027–1036.



- Ma, S., Yeom, J., Lim, Y.H., 2022. Specific activation of hypoxia-inducible factor-2 α by propionate metabolism via a β -oxidation-like pathway stimulates MUC2 production in intestinal goblet cells. *Biomedicine and Pharmacotherapy*. 155:113672.
- Ma, Y., Zhou, G., Li, Y., Zhu, Y., Xiabo Y., Zhao F., Li H., 2018. Intake of fish oil specifically modulates colonic Muc2 expression in middle-aged rats by suppressing the glycosylation process. *Molecular Nutrition and Food Research*. 62(4):1–9.
- Mall, J-P.G., Fart, F., Sabet, J.A., et al., 2020. Effects of dietary fibres on acute indomethacin-induced intestinal hyperpermeability in the elderly: a randomised placebo controlled parallel clinical trial. *Nutrients*. 12(7):1954.
- McGuckin, M.A., Thornton, D.J., Whitsett, J.A., 2015. *Mucins and Mucus* Fourth Edi., Elsevier, pp. 231-250.
- Meidistria, T.R., Sembiring, L., Rahayu, E.S., Haedar, N., Dwyana, Z., 2020. Survival of *Lactobacillus plantarum* dad 13 in probiotic cheese making. *IOP Conference Series: Earth and Environmental Science*. 575(1):1-8.
- Melgar-Lalanne, G., Rivera-Espinoza, Y., Hernández-Sánchez, H., 2012. *Lactobacillus plantarum*: An overview with emphasis in biochemical and healthy properties. *Lactobacillus: Classification, Uses and Health Implications*. pp.1–34.
- Mello, R.O., Silva, C.M.G., Fonte, F.P., 2012. Evaluation of the number of goblet cells in crypts of the colonic mucosa with and without fecal transit. *Revista do Colegio Brasileiro de Cirurgioes*. 39(2):139–145.
- Meng, Y., Wang, J., Wang, Z., Zhang, G., Liu, L., Huo, G. Li, C., 2019. *Lactobacillus plantarum* KLDS1.0318 ameliorates impaired intestinal immunity and metabolic disorders in cyclophosphamide-treated mice. *Frontiers in Microbiology*. 10(APR):1-11
- Meyers, G.R., Samouda, H., Bohn, T., 2022. Short chain fatty acid metabolism in relation to gut microbiota and genetic variability. *Nutrients*. 14(24):1–48.
- Michael, H., Amimo, J.O., Rajashekara, G., Saif, L.J., Vlasova, A., 2022. Mechanisms of kwashiorkor-associated immune suppression: insights from human, mouse, and pig studies. *Frontiers in Immunology*, 13:1–19.
- Minelli, E.B., Benini, A., 2008. Relationship between number of bacteria and their probiotic effects. *Microbial Ecology in Health and Disease*. 20(4):180–183.
- Mirzaei, R. et al. 2022. Dual role of microbiota-derived short-chain fatty acids on host and pathogen. *Biomedicine and Pharmacotherapy*. 145:112352.



- Molina, J.R., Adjei, A.A., 2006. The Ras/Raf/MAPK Pathway. *Journal of Thoracic Oncology* 1(1):7–9.
- Moro, J. *et al.* 2021. Severe protein deficiency induces hepatic expression and systemic level of FGF21 but inhibits its hypothalamic expression in growing rats. *Scientific Reports*. 11(1):1–9.
- Mrimi, E.C., Palmeirim, M.S., Minja, E.G., Long, K.Z., Keiser, J., 2022. Malnutrition, anemia, micronutrient deficiency and parasitic infections among schoolchildren in rural Tanzania. *PLoS Neglected Tropical Diseases*. 16(3):1–16.
- Muhammad, H, 2017. *Imunologi gizi*. Gadjah Mada University Press
- Naik, A.A., Patro, I.K., Patro, N., 2015. Slow physical growth, delayed reflex ontogeny, and permanent behavioral as well as cognitive impairments in rats following intra-generational protein malnutrition. *Frontiers in Neuroscience*. 9(DEC):1–18.
- Nandi, J., Saud, B., Zinkievich, M., Yong, Z., Levine, R.A., 2010. TNF- α modulates iNOS expression in an experimental rat model of indomethacin-induced jejunoleitis. *Molecular and Cellular Biochemistry*. 336(1–2):17–24.
- Oliveira, D.C., Hastreiter, A.A., Mello, A.S., Beltran, J.S.O., Santos, E.W.C.O., Borelli, P., Fock, R.A., 2014. The effects of protein malnutrition on the TNF-RI and NF- κ B expression via the TNF- α signaling pathway. *Cytokine*. 69(2):218–225.
- Paone, P., Cani, P.D., 2020. Mucus barrier, mucins and gut microbiota: The expected slimy partners?. *Gut*. 69(12):2232–2243.
- Park, M.H., Hong, J.T., 2016. Roles of NF- κ B in cancer and inflammatory diseases and their therapeutic approaches. *Cells*. 5(2):1–13.
- Paassen, N., Vincent A, Puiman PJ, *et al.*, 2009. The regulation of intestinal mucin MUC2 expression by short-chain fatty acids: implications for epithelial protection. *Biochemical Journal*. 420(2):211–219.
- Pelaseyed, T., Bergstrom, J.H., Gustafsson, J.K., rmund, A., Birchenough, G.MH., Schutte, A., Post S., Svensson, F., Rodnguez-Pineiro, A., Nystrom, E., Wising, C., Johansson, M., Hansson, G., 2014. The mucus and mucins of the goblet cells and enterocytes provide the first defense line of the gastrointestinal tract and interact with the immune system. *Immunological Reviews*. 260(1):8–20.
- Pezeshki, A. *et al.* 2016. Low protein diets produce divergent effects on energy balance. *Scientific Reports*. 6:1–13.



- Pongmalai, P., Devahastin, S., 2020. Profiles of prebiotic fructooligosaccharides, inulin and sugars as well as physicochemical properties of banana and its snacks as affected by ripening stage and applied drying methods. *Drying Technology*. 38(5–6):724–734.
- Putra, A.I.Y.D., Setiawan, N.B.W., Sanjiwani, M.I.D., Wahyuniari, I.A.I., Indrayani, A.W., 2021. Nutrigenomic and biomolecular aspect of moringa oleifera leaf powder as supplementation for stunting children. *Journal of Tropical Biodiversity and Biotechnology*. 6(1):1–15.
- Rahayu, E., Mustangin, A., Suharman, S., Elvira, I., Mariyatun, M., Pamungkatingtyas, F.H., Hasan, P.N., Utami, T., Cahyanto, M.N., Juffrie, M., 2021. Effects of Dietary Intake and Supplementation of Indigenous Probiotic *Lactobacillus Plantarum Dad-13* on Body Mass Index , Faecal Short-Chain Fatty Acid , and Gut Microbiota of Undernourished Children in East Lombok , Indonesia. *Research Square*. pp.1–17.
- Reimegård, J., Tarbier, M., Danielsson, M., et al., 2021. A combined approach for single-cell mRNA and intracellular protein expression analysis. *Communications Biology*. 4(1):1–11.
- Rodríguez, L., Cervantes, E., Ortiz, R., 2011. Malnutrition and gastrointestinal and respiratory infections in children: a public health problem. *International journal of environmental research and public health*. 8(4):1174–1205.
- Rohr, M.W., Narimhulu, C., Rohr-Rudeski, R., Parthasarathy, S., 2020. Negative effects of a high-fat diet on intestinal permeability: a review. *Advances in Nutrition*. 11(1):77–91.
- Ruiz-Villalba, A., Ruijter, J.M, van den Hoff, M.J.B. 2021. Use and misuse of cq in qpcr data analysis and reporting. *Life*. 11(6):1–22.
- Salameh, E., Jarreau, M., Morel, F.B., Zeilani, M., Aziz, M., Dechelotte, P., Marion-Letellier, R., 2020. Modeling undernutrition with enteropathy in mice. *Scientific Reports*. 10(1):1–15.
- Salvetti, E., Torriani, S., Felis, G.E., 2012. The genus lactobacillus: a taxonomic update. *Probiotics and Antimicrobial Proteins*. 4(4):217–226.
- Sang, X., Wang, Q., Ning Y., Wang, H., Zhang, R., Li, Y., Fang, B., Lv, C., Zhang, Y., Wang, X., Ren, F., 2023. Age-Related Mucus Barrier Dysfunction in Mice Is Related to the Changes in Muc2 Mucin in the Colon. *Nutrients*. 15(8):1-13.
- Sani, F.I., 2015. *Identifikasi kandungan karbohidrat, protein, lemak, asam amino, dan asam lemak, serta estimasi umur simpan berdasarkan sifat fisik pada tepung pisang raja bandung, tepung pisang kluthuk, dan tepung pisang tanduk [Skripsi]*. Universitas Gadjah Mada.



Savla, R., Olga, H., Chin, L., Wei, W., Loretz, B., Lehr, C.M., 2018. *Oral delivery of macromolecular drugs*. Springer Dordrecht Heidelberg New York.

Sengupta, R., Altermann, E., Anderson, R., McNabb, W.C., Moughan, P.J., Roy, N.C., 2013. The role of cell surface architecture of lactobacilli in host-microbe interactions in the gastrointestinal tract. *Mediators of Inflammation*. 2013:1-16.

Silva S, Robbe-Masselot C, Ait-Belgnaoui A, et al., 2014. Stress disrupts intestinal mucus barrier in rats via mucin O-glycosylation shift: prevention by a probiotic treatment. *American Journal of Physiology - Gastrointestinal and Liver Physiology*. 307(4):G420-G429.

Stelmasiak, M., Balan, B.J., Mikaszewska-Sokolewicz, M., Niewinski, G., Kosalka, K., Szczepanowaska, E., Slotwinski, R., 2021. The relationship between the degree of malnutrition and changes in selected parameters of the immune response in critically ill patients. *Central European Journal of Immunology*. 46(1):82–91.

Sturgeon, J.P., Njuge, J., Bourke C., Gonzales G., Robertson., Bwakura-Dangarembizi M., Berkley., Kelly P., Prendergast A., 2023. Inflammation: the driver of poor outcomes among children with severe acute malnutrition? *Nutrition Reviews*, 0(0):1–17.

Sunandar, A., Kahar, A.P., 2018. Karakter morfologi dan anatomi pisang diploid dan triploid. *Scripta Biologica*. 5(1):31-36.

Suroto, D.A., Hasan, P.N., Rahayu, E.S., 2021. Genomic insight of two indigenous probiotics *lactobacillus plantarum* dad-13 and *lactobacillus plantarum* mut-7 from different origins of indonesian fermented foods. *Biodiversitas*. 22(12):5491–5500.

Swargiary, A., Boro, H., Roy, M.K., Akram, M., 2021. Phytochemistry and pharmacological property of *Musa balbisiana Colla*: a mini-review. *Pharmacognosy Reviews*. 15(29):91–95.

Syed, Z.A., Zhang, L., Ten Hagen, K.G., 2022. In vivo models of mucin biosynthesis and function. *Advanced Drug Delivery Reviews*. 184:114182.

Tadesse, S., Corner, G., Dhima, E., Houston, M., Guha, C., Augenlicht, L., Velcich, A., 2017. MUC2 mucin deficiency alters inflammatory and metabolic pathways in the mouse intestinal mucosa. *Oncotarget*. 8(42):71456–71470.

Takada, Y., Bhardwaj, A., Potdar, P., Aggarwal, B.B., 2004. Nonsteroidal anti-inflammatory agents differ in their ability to suppress NF-κB activation, inhibition of expression of cyclooxygenase-2 and cyclin D1, and abrogation of tumor cell proliferation. *Oncogene*. 23(57):9247–9258.



Takele, Y., Adem, E., Getahun, M., Tajebe, F., *et al.*, 2016. Malnutrition in healthy individuals results in increased mixed cytokine profiles, altered neutrophil subsets and function. *PLoS ONE*. 11(8):1–18.

Tashiro, M. *et al.*, 2017. The N-terminal region of serum amyloid A3 protein activates NF- κ B and up-regulates MUC2 mucin mRNA expression in mouse colonic epithelial cells. *PLoS ONE*. 12(7):1–13.

Tawiah, A., Moreau, F., Kumar, M., Tiwari, S., Falguera, J., Chadee, K., 2018. High MUC2 mucin biosynthesis in goblet cells impedes restitution and wound healing by elevating endoplasmic reticulum stress and altered production of growth factors. *American Journal of Pathology*. 188(9):2025–2041.

Thorpe, D., Sultani, M., Stringer, A., 2019. Irinotecan induces enterocyte cell death and changes to muc2 and muc4 composition during mucositis in a tumour-bearing DA rat model. *Cancer Chemotherapy and Pharmacology*. 83(5):893–904.

Tiwari, S., Begum, S., Moreaau, F., Gorman, G., Chadee, K., 2021. Autophagy is required during high MUC2 mucin biosynthesis in colonic goblet cells to contend metabolic stress. *American Journal of Physiology - Gastrointestinal and Liver Physiology*. 321(5):G489–G499.

Triawanti, Yunanto, A., Sanyoto, D., Nur'Amin H., 2018. Nutritional status improvement in Malnourished rat (*Rattus norvegicus*) after Seluang fish (*Rasbora* spp.) treatment. *Current Research in Nutrition and Food Science*. 6(1):127–134.

Tomás-Pejó, E. *et al.* 2023. Production of short-chain fatty acids (SCFAs) as chemicals or substrates for microbes to obtain biochemicals. *Biotechnology for Biofuels and Bioproducts*. 16(1):1–17.

Vezza, T., Molina-Tijeras, J.A., Rodríguez-Nogales, A., *et al.*, 2023. The antioxidant properties of salvia verbenaca extract contribute to its intestinal antiinflammatory effects in experimental colitis in rats. *Antioxidants*. 12(12):2071.

Veerabagu, M.P. *et al.* 1996. Mode of food intake reduction in Lewis rats with indomethacin-induced ulcerative ileitis. *Physiology and Behavior*. 60(2): 381–387.

Vidal-Lletjós, S., Andriamihaja, M., Blais, A., *et al.*, 2019. Dietary protein intake level modulates mucosal healing and mucosa-adherent microbiota in mouse model of colitis. *Nutrients*. 11(3):1–16.

Vincenzo, F., Gaudio, A.D., Petito, V., Lopetuso, L.R., Scaldaferrri, F., 2023. Gut microbiota, intestinal permeability, and systemic inflammation: a narrative



review. *Internal and Emergency Medicine*. 19(2):275-293.

- Volstatova, T., Marchica, A., Hroncova, Z., Bernardi, R., Doskocil, I., Havlik, J., 2019. Effects of chlorogenic acid, epicatechin gallate, and quercetin on mucin expression and secretion in the Caco-2/HT29-MTX cell model. *Food Science and Nutrition*. 7(2):492–498.
- Watanabe, T., Fujiwara, Y. & Chan, F.K.L., 2020. Current knowledge on non-steroidal anti-inflammatory drug-induced small-bowel damage: a comprehensive review. *Journal of Gastroenterology*. 55(5):481–495.
- Wen, Z.S., Du, M., Tang, Z., et al., 2019. Low molecular seleno-aminopolysaccharides protect the intestinal mucosal barrier of rats under weaning stress. *International Journal of Molecular Sciences*. 20(22):5727.
- Xia, Y., Luo, Q., Huang, C., et al., 2023. Ferric citrate-induced colonic mucosal damage associated with oxidative stress, inflammation responses, apoptosis, and the changes of gut microbial composition. *Ecotoxicology and Environmental Safety*. 249(2022): 114364.
- Xiao, Y., Zhou, Y., Sun, S., et al., 2021) Effect of Promoter Methylation on the Expression of Porcine MUC2 Gene and Resistance to PEDV Infection. *Frontiers in Veterinary Science*. 8:1-12.
- Yamashita, M.S., Melo, E.O., 2018. Mucin 2 (MUC2) promoter characterization: an overview. *Cell and Tissue Research*. 374(3):455–463.
- Yan, Y., Zhou, X., Guo, K., Zhou, F., Yang, H., 2020. Chlorogenic Acid Protects Against Indomethacin-Induced Inflammation and Mucosa Damage by Decreasing Bacteroides-Derived LPS. *Frontiers in Immunology*. 11:1–10.
- Yersin, S. and Vonaesch, P., 2024. Small intestinal microbiota: from taxonomic composition to metabolism. *Trends in Microbiology*. xx(xx):1–14.
- Zhao, T., Zhang, Y., Nan, L., et al., 2023. Impact of structurally diverse polysaccharides on colonic mucin O-glycosylation and gut microbiota. *Biofilms and Microbiomes*. 9(1):97.
- Zhou, X., Zhang, K., Qi, W., Zhou, Y., Hong, T., Xiong, T., Xie, M., Nie, S., 2019. Exopolysaccharides from *Lactobacillus plantarum* NCU116 enhances colonic mucosal homeostasis by controlling epithelial cell differentiation and c-Jun/Muc2 signaling. *Journal of Agricultural and Food Chemistry*. 67(35):9831–9839.