UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Abdel-Raheem, S.M., S.M.S. Abd-Allah, and K.M.A. Hassanein. 2012. The effects of prebiotic, probiotic and synbiotic supplemenetation on intestinal microbial ecology and histomorphology of broiler chickens. Int. J. Agr. Vet. Med. Sci. 6(4):277-289.

Abdollahi, M.R., B.J. Hosking, D. Ning, and V. Ravindran. 2016. Influence of palm kernel meal inclusion and exogenous enzyme supplementation on growth performance, energy utilization, and nutrient digestibility in young broilers. Asian-Australas. J. Anim. Sci. 29:539‑548.

Akira, S., S. Uematsu, O. Takeuchi. 2006. Pathogen recognition and innate immunity. Cell. 124:783-801

Alimon, A.R. 2003. The nutritive value of palm kernel cake for animal feed. Asian-Aust. J. Anim. Sci. 17(7):923-932.

Alshelmani, M.I., T.C. Loh, H. L. Foo, A. Q. Sazili, and W. H. Lau. 2016b. Effect of feeding different levels of palm kernel cake fermented by *Paenibacillus polymyxa* ATCC 842 on broiler growth performance, blood biochemistry, carcass characteristics, and meat quality. Anim. Prod. Sci. 57:839.

Alshelmani, M.I., T.C. Loh, H.L. Foo, A.Q. Sazili, and W.H. Lau. 2016a. Effect of feeding different levels of palm kernel cake fermented by *Paenibacillus polymyxa* ATCC 842 on nutrient digestibility, intestinal morphology, and gut microflora in broiler chickens. Anim. Feed. Sci. Technol. 216:216–224.

Alshelmani, M.I., T.C. Loh, H.L. Foo, AQ. Sazili, and W.H. Lau. 2017. Effect of solid state fermentation on nutrient content and ileal amino acids digestibility of palm kernel cake in broiler chickens. Indian J. Anim. Sci. 87(9):1135‑1140.

Amasheh, S., N. Meiri, A.H. Gitter, T. Schoneberg, J. Mankertz, and J.D. Schulke. 2002. Claudin-2 expression induces cation-selevtive channels in *tight junction*s of epithelial cells. J. Cell. Sci. 115:4969-4976.

Anaeto, M., G.O. Chioma, and D.J. Omosebi. 2009. Palm kernel cake as substitute for maize in broiler finisher diet. Int. J. Poult. Sci. 8:1206-1208.

AOAC. 2005. Official Methods of Analysis. Association of official analytical chemist. 12th Ed. AOAC. Washington DC.

Archer, A.C., S.P. Muthukumar, and P.M. Halami. 2021. *Lactobacillus fermentum* MCC2759 and MCC2760 alleviate inflammation and intestinal function in high-fat diet-fed and Streptozotocin-Induced Diabetic Rats. Prob. Ant. Prot. 13:1068-1080.

Arora, S., R. Rani, and S. Ghosh. 2018. Bioreactors in solid state fermentation technology: Design, applications and engineering aspects. J. Biotechnol. 269:16-34.

Aviagen. Indian River Broiler Management Handbook. 2018. https://aviagen.com/assets/Tech_Center/LIR_Broiler/IR-BroilerHandbook2018-EN.pdf.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Aviagen. Indian River Broiler Nutrition Specifications. 2022. https://aviagen.com/assets/Tech_Center/LIR_Broiler/IRBroilerNutritionSpecifications2022-EN.pdf.

Awad, W.A., K. Ghareeb, S. Abdel-Raheem, and J. Böhm. 2009. Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weight, and intestinal histomorphology of broiler chickens. Poult. Sci. 88(1):49-56.

Aya, V., B.A. Ayanwale, A.T. Ijaiya, and A. Aremu. 2013. Performance and nutrient digestibility in broiler chicks as influenced by multienzyme addition to starter diets containing palm kernel meal. Biotech. Anim. Husb. 29(1):93-104.

Azam, M., M. Mohsin, H. Ijaz, U.R. Tulain, M.A. Ashraf, A. Fayyaz, Z. Abadeen, and Q. Kamran. 2017. Lactic acid bacteria in traditional fermented Asian foods. Pak. J. Pharm. Sci. 30(5):1803-1814.

Azizi, M.N., T.C. Loh, H.L. Foo, and E.L.T. Chung. 2021. Is palm kernel cake a suitable alternative feed ingredient for poultry?. Animals. 11:338.

Badan Pusat Statistik. 2023. Impor kedelai di Indonesia. https://www.bps.go.id/id/statistics-table/1/MjAxNSMx/impor-kedelai-menurut-negara-asal-utama--2017-2023.html. (Diakses pada 25 Juni 2024, 10:10 WIB)

Badan Pusat Statistik. 2024. Produksi daging ayam di Indonesia. https://www.bps.go.id/id/statistics-table/2/NDg4IzI=/produksi-daging-ayam-ras-pedaging-menurut-provinsi.html. (Diakses pada 25 Juni 2024, 10:06 WIB)

Barektain, R., P.V. Chrystal, G.S. Howarth, C.J. McLaughlan, S. Gilani, and G.S. Nattrass. 2019. Performance, intestinal permeability, and gene expression of selected *tight junction* proteins in broiler chickens fed reduced protein diets supplemented with arginine, glutamine, and glycine subjected to a leaky gut model. Poult. Sci. 98:6761-6771.

Beltrán-Barrientos, L.M., A. Hernández-Mendoza, M.J. Torres-Llanez, A.F. González-Córdova, and B. Vallejo-Córdoba. 2016. Invited review: Fermented milk as antihypertensive functional food. J. Dairy. Sci. 99:4099–4110.

Besten, G., K. Eunen, A.K. Groen, K. Venema, D.J. Reijngoud, and B.M. Bakker. 2013. The role of short-chain fatty acids in the interplay between diet, gut microbiota, and host energi metabolism. J. Lipid Res. 54:2325-2340.

Bintsis, T. 2018. Lactid acid bacteria: their application in foods. J. Bacteriol. Myco. 6(2):89-94.

Blajman, J.E., R.B. Paez, C.G. Vinderola, M.S. Lingua, and M.L. Signorini. 2018. A meta-analysis on the effectiveness of homofermentative and heterofermentative lactic acid bacteria for corn silage. J. Appl. Microbiol. 125(6):1655-1669.

Brown A.J., S.M. Goldsworthy, and A.A. Barnes. 2003. The orphan G protein-coupled receptors GPR41 and GPR43 are activated by propionate and other short chain carboxylic acids. J. Biol. Chem. 278:11312-11319.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Canani R.B., M. Di Costanzo, L. Leone, M. Pedata, R. Meli, and A. Calignano. 2011. Potential beneficial effects of butyrate in intestinal and extraintestinal diseases. World J. Gastroenterol. 17:1519

Canibe, N., and B.B. Jensen. 2012. Fermented liquid feed-Microbial and nutritional aspects and impact on enteric diseases in pigs. Anim. Feed Sci. Technol. 173:17–40.

Canoy, P.L.O., D.A. Jacobo, D. Guajardo-Flores, L.E.G. Amezquita, and T. Garcia-Cayuela. 2021. Solid-state fermentation for enhancing the nutraceutical content of agrifood byproducts: Recent advances and its industrial feasibility. Food Biosci. 41:100926.

Cao, G.T., X.F. Zeng, A.G. Chen, L. Zhou, L. Zhang, Y.P. Xiao, and C.M. Yang. 2013. Effect of a probiotic, Enterococcus faecium, on growth performance, intestinal morphology, immune response, and cecal microflora in broiler chickens challenged with Escherichia coli K88. Poult. Sci. 92:2949-2955.

Chen, W.L., J.B. Liang, M.F. Jahromi, N. Abdullah, Y.W. Ho, and V. Tufarelli. 2015. Enzyme treatment enhances release of prebiotic oligosaccharides from palm kernel expeller. BioResources. 10:196-209.

Chen, Z.P., A.G. Zhou, Z.S. Wang, D.C. Liu, and D.Y. Peng. 2011. Evaluation of nutritional quality of soybean meals fermented by Aspergillus oryzae. Chinese J. Anim. Sci. 9:40-44.

Chiba, H., M. Osanai, M. Murata, T. Kojima, and N. Sawada. 2008. Transmembrane proteins of *tight junction*s. Biochim. Biophys. Acta. 1778:588-600.

Chin, F. Y. 2016. Value of palm kernel co-products in swine diets. Kor. J. Agricult. Sci. 43(5):761-768.

Choi, W. J., J.H. Kim, H.W. Kim, K.E. Kim, dan D.Y. Kil. 2021. Effect of dieatary palm kernel meal and ß-xylanase on productive performance, fatty liver incidence, and excreta characteristics in laying hens. J. Anim. Sci. Tech. 63(6): 1275-1285.

Ciptaan, G., Mirnawati, Ferawati, and M. Makmur. 2022. The effect of fermented palm kernel cake layer quail rations on production performance and eggshell thickness. Int. J. Vet. Sci. 11(3):400-403.

Corrêa-Oliveira, R., J.L. Fachi, A. Vieira, F.T. Sato, and M.A.R. Vinolo. 2016. Regulation of immune cell function by short-chain fatty acids. Clin. Transl. Immunology 5:1-8.

Devi, P.C., Mirnawati, and Y. Marlida. 2023. The combination of *Bacillus subtilis* with *Lactobacillus fermentum* in improving the quality and nutrient content of fermented palm kernel meal (BISF). Int. J. Vet. Sci. 12(4):566-571.

Ding, L., Z. Lu, O. Foreman, R. Tatum, Q. Lu, R. Renegar, J. Cao, and Y.H. Chen. 2012. Inflammation and disruption of the mucosal architecture in claudin-7 deficient mice. Gastroentrology. 142(2):305-315.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Ditjenbun. 2024. Direktorat Jenderal Perkebunan: Statistik Perkebunan Indonesia, Kelapa Sawit 1967-2024. Sekretariat Direktorat Jenderal Perkebunan. Jakarta.

Djadouni, F. and M. Kihlal. 2012. Antimicrobial activity of lactic acid bacteria and the spectrum of their biopeptides against spoiling germs in foods. Food Feed Sci. Technol. 55(3):435-443.

Dong, L., Y. Li, Y. Zhang, Y. Zhang, J. Ren, J. Zheng, J. Diao, H. Ni, Y. Yin, R. Sun, F. Liang, P. Li, C. Zhou, and Y. Yang. 2023. Effects of organic zinc on production performance, meat quality, apparent nutrient digestibility and gut microbiota of broilers fed low-protein diets. Sci. Rep. 13: 10803.

Dong, W., S. Dong, Y. Li, Y. Lei, N. Peng, Y. Liang, S. Zhao, and X. Ge. 2022. Comprehensive utilization of palm kernel cake for producing mannose and mano-oligosaccaharide mixture and yeast culture. Appl. Microbiol. Biotechnol. 106:1045-1056.

Dong, W., S. Dong, Y. Li, Y. Lei, N. Peng, Y. Liang, S. Zhao, and X. Ge. 2022. Comprehensive utilization of palm kernel cake for producing mannose and manno-oligosaccharide micture and yeast culture. Appl. Microbiol. Biotechnol. 106:1045-1056.

Du, Y., C. He, Y. An, Y. Huang, H. Zhang, W. Fu, M. Wang, Z. Shan, J. Xie, and Y. Yang. 2024. The role of short chain fatty acids in inflammation and body health. Int. J. Mol. Sci. 25:7379.

Duncan, S.H., A. Barcenilla, C.S. Stewart, S.E. Pryde, and H.J. Flint. 2002. Acetate utilization and butyryl coenzyme A (CoA):acetate-CoA transferase in butyrate-producing bacteria from the human large intestine. Appl. Environ. Microbiol. 68:5186-5190.

Dusterhoft, E.M. and A.G.J. Voragen. 1991. Non starch polysaccharides from sunflower meal and palm kernel meal preparation of cell wall material and extraction of polysaccharide fraction. J. Sci. Food Agricult. 55:411-422.

Ebnet, K., C.U. Schulz, M.K. Meyer Zu Brickwedde, G.G. Pendl, and D. Vestweber. 2000. Junctional adhesion molecule interacts with the PDZ domain-containing proteins AF-6 and ZO-1. J. Biol. Chem. 275:27979-27988.

Escobar-España, J.C., J.R. Bárcena-Gama, A. Ley-De Coss, and M.M. Crosby-Galván. 2022. Nutrient content and in vitro degradability of the palm kernel meal produced in the state of Chiapas, Mexico, as feed for ruminants. Agro. Prod. 15(5):125-131.

Ezieshi, E.V. and J.M. Olomu. 2004. Comparative performance of broilers chickens fed varying levels of palm kernel meal and maize ffal. Pak. J. Nutr. 3(4):254:257.

Fan, G., W. Chen, J. He, D. Wang, and X. Yang. 2025. Bile acids alleviate intestinal inflammation by modulating gut microbiota composition in LPS-challenged broilers. Res. Vet. Sci. 184:105526.

FAO. 2023. OECD/FAO Agricultural Outlook 2023-2032. OECD Publishing, Paris/FAO, Rome, Italy.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Fasina, Y.O., and H.S. Lillehoj. 2019. Characterization of intestinal immune response to Clostridium perfringens infection in broiler chickens. Poult. Sci. 98:188-198.

Feng, W., Y. Wu, G. Chen, S. Fu, B. Li, B. Huang, and J. Liu. 2018. Sodium butyrate attenuates diarrhea in weaned piglets and promotes *tight junction* protein expression in colon in a GPR109A-dependent manner. Cell. Physiol. Biochem. 47:1617-1629.

Fernandes, J., W. Su, S. Rahat-Rozenbloom, T. M. Wolever, and E. M. Comelli. 2014. Adiporsity, gut microbita and faecal short chain fatty acids are linked in adult humans. Nutr. Diabetes. 4(6):e121.

Fernandez, F., M. Hintaon, and B. Van Gils. 2000. Evaluation of the effect of mannan oligosaccharides on the competitive exclusion of salmonella enteritidis colonization in broiler chicks. Avian Pathology. 29:575-581.

Fernandez, F., M. Hintaon, and B. Van Gils. 2002. Dietary mannan oligosaccharides and their effect on chicken caecal microflora in relation to salmonella enteritidis colonization. Avian Pathology. 31:49-58.

Fukuoka, A., and T. Yoshimoto. 2018. Barrier dysfunction in the nasal allergy. Allergo. Int. 67:18–23.

Gao, T., L. Lu, Q. Wu, and C. Wang. 2023. Complete genome sequence of Lactobacillus fermentum 9-4, a purine-degrading Lactobacillus probiotic isolated from Chinese fermented rice-flour noodles. J. Future. Foods. 3:169–174.

García-Villalba, R., J.A. Giménez-Bastida, M.T. García-Conesa, F.A. Tomás-Barberán, J. Carlos Espín, and M. Larrosa. 2012. Alternative method for gas chromatography-mass spectrometry analysis of short-chain fatty acids in faecal samples. J. Sep. Sci. 35:1906–1913.

Garrido-Galand, S., A. Asensio-Grau, J. Calvo-Lerma, A. Heredia, and A. Andres. 2021. The potential of fermentation on nutritional and technological improvement of cereal and legume flours: A review. Food Res. Int. 145:110398.

Ghiselli, F., L. en Yu, A. Piva, E. Grilli, and Y. Li. 2023. Evaluating protective effects of botanicals under inflammation and oxidative stress in chicken apical-out enteroids. Poult. Sci. 102:102821.

Gill, P. A., M.C. van Zelm, J.G. Muir, and P.R. Gibson. 2018. Review article: short chain fatty acids as potential therapeutic agents in human gastrointestinal and inflammatory disorders. Aliment. Pharmacol. Ther. 48:15-34.

Gunzel, D. and A.S. Yu. 2013. Claudins and the modulation of *tight junction* permeability. Physiol. Rev. 93:525-569.

Hakim, A. H., I. Zulkifli, A. Soleimani Farjam, E.A. Awad, N. Abdullah, W.L. Chen, and R. Mohamad. 2020. Passage time, apparent metabolisable energy and ileal amino acids digestibility of treated palm kernel cake in broilers under the hot and humid tropical climate. Italian J. Anim. Sci. 19(1):194-202.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Halimi, S., and A. Mirsalehian. 2016. Assessment and comparison of probiotic potential of four Lactobacillus species isolated from feces samples of Iranian infants. Microbiol. Immunol. 60:73–81.

Hassaan, M.S., M.A. Soltan, and A.M. Abdelmoez. 2015. Nutritive value of soybean meal after solid state fermentation with Saccharomyces cereviceae for *Nile tilapia, Oreochromis niloticus.* Anim. Feed. Sci. Tehcnol. 201:89:98.

Hati, S., K. Ramanju, B. Basaiawmoit, P. Koringa, M. Desai, D.J. Ghodasara, K. V. Joshi, M. Pathan, V. Sreeja, N.J. Bhagora, F.P. Savaliya, dan B.K. Mishra. 2022. Significance of *Limosilactobacillus fermentum* and *Saccharomyces cerevisiae* on the growth performance, haematological traits, serum biochemistry, faecal and caeca microbiota of broiler chickens. J. American Nutr. Assoc. 42(2023):7.

Heak, C., P. Sukon, S. Kongpechr, B. Tengjaroenkul, and K. Chuachan. 2017. Effect of direct-fed microbials on intestinal villus height in broiler chickens: A systematic review and meta-analysis of controlled trials. Int. J. Poult. Sci. 16:403–414.

Hetzel, M., M. Brock, T. Selmer, A.J. Pierik, B.T. Golding, and W. Buckel. 2003. Acryloyyl-CoA reductase from *Clostridium propionicum*. Eur. J. Biochem. 270:902-910.

Heuzé V., G. Tran, D. Sauvant, J. Noblet, D. Renaudeau, D. Bastianelli, dan F. Lebas. 2024. Palm kernel meal. Feedipedia, a programme by INRAE, CIRAD, AFZ, and FAO. https://www.feedipedia.org/node/43 Last updated on August 8, 2024, 10:45.

Hu, Y., W. Zhang, K. Yang, X. Lin, H. C. Liu, J. Odle, M.T. See, X. Cui, T. Li, S. Wang, X. Liao, L. Zhang, S. Li, Y. Hu, and X. Luo. 2024. Dietary Zn proteinate with moderate chelation strength alleviates heat stress-induced intestinal barrier function damage by promoting expression of tight junction proteins via the A20/NF-κB p65/MMP-2 pathway in the jejunum of broilers. J. Anim. Sci. Biotechnol. 15:115.

Ihim, S. A., S. D. Abubakar, Z. Zian, T. Sasaki, M. Saffarioun, S. Maleknia, dan G. Azizi. 2022. Interleukin-18 cytokine in immunity, inflammation, and autoimmunity: Biological role in induction, regulation, and treatment. Front. Immunol. 13.

Iskandar, S., P. Sinurat, A.B. Tiesnamurti, dan A. Bamualim. 2008. Bungkil inti sawit potensial untuk pakan ternak. Warta Penelitian dan Pengembangan Pertanian. 30(1):16-17.

Jamroz, D., K. Jakobsen, K.E. Bach Knudsen, A. Wiliczkiewicz, and J. Orda. 2002. Digestibility and energy value of non-starch polysaccharides in young chickens, ducks and geese, fed diets containing high amounts of barley. Comp. Biochem. Physiol. A. Mol. Integr. Physiol. 131:657-68.

Jha, R. and P. Mishra. 2021. Dietary fiber in poultry nutrition and their effects on nutrient utilization, performance, gut health, and on the environment: a review. J. Anim. Sci. Bio. 12:51.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Jha, R., and J.F. Berrocoso 2016. Dietary fiber and protein fermentation in the intestine of swine and their interactive effects on gut health and on the environment: a review. Anim. Feed Sci. Technol. 212:18-26.

Jha, R., J.M. Fouhse, U.P. Tiwari, L. Li, and B.P. Willing. 2019. Dietary fiber and intestinal health of monogastric animals. Front. Vet. Sci. 6.

Jiang, W., Y. Zhang, H. Cheng, X. Hu, W. You, E. Song, Z. Hu, and F. Jiang. 2024. Fermented palm kernel cake improves the rumen microbiota and metabolome of beef cattle. Animals. 14:3088.

Józefiak, D., A. Rutkowski, M. Fratczak, and D. Boros. 2004. The effect dieatary fibre fractions from different cereals and microbial enzyme supplementation on performance, ileal viscosity and short-chain fatty acid concentratios in the caeca of broiler chickens. J. Anim. Feed Sci. 13:487-496.

Józefiak, D., A. Rutkowski, S. Kaczmarek, B.B. Jensen, R. M. Engberg, and O. Højberg. 2010. Effect of β-glucanase and xylanase supplementation of barley-and rye-based diets on caecal microbiota of broiler chickens. Br. Poult. Sci. 51:546-557.

Kango, N., U. K. Jana, R. Choukade, and S. Nath. 2022. Advances in prebiotic mannooligosaccharides. Curr. Opin. Food Sci. 47:100883.

Karlyshev A.V., J. Villena, C. Gonzales, L. Abrracin, J. Barros, and A. Garcia, 2015. Draft genome sequence of a probiotic strain, *Lactocabcillus fermentum* UCO-979C. Gen. Announc. 3(6): e01439-15.

Kelly, C.J., L. Zheng, E. L. Campbell, B. Saeedi, C.C. Scholz, A.J. Bayless, and S.P. Colgan. 2015. Crosstalk between microbiota-derived short-chain fatty acids and intestinal epithelial HIF augments tissue barrier function. Cell Host Microb. 17:662-671.

Khattak, F.M., T. N. Pasha,Z. Hayat, and A. Mahmud. 2006. Enzymes in poultry nutrition. J. Anim. Plant. Sci. 16:1‑7.

Kimura, I., A. Ichimura, R. Ohue-Kitano, and M. Igarashi. 2020. Free fatty acid receptors in health and disease. Physiol. Rev. 100:171-210.

Kleyn, F. J. and M. Ciacciariello. 2021. Future demands of the poultry industry: will we meet our commietments sustainably in developed and developing economies. World's. Poult. Sci. J. 77(2):267-278.

Koh, A., F. De Vadder, P. Kovatcheva-Datchary, and F. Bäckhed. 2016. From dietary fiber to host physiology: short-chain fatty acids as key bacterial metabolites. Cell. 165(6):1332-1345.

König, H., and B. Berkelmann-Löhnertz. 2017. Maintenance of wine-associated microorganisms. In *Biologyof microorganism on Grapes, in Must and in Wine*. Springer: Cham, Switzerland. pp. 549-572. ISBN 9783319600215.

Krabi, R.E., A.A. Assamoi, F.A. Ehon, and S.L. Niamke. 2015. Screening of lactid acid bacteria as potential starter for the production of attièkè, a fermented cassava food. J. F. Food. Eng. 14(1):21-29.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Kung, L., R.D. Shaver, R.J. Grant, and R.J. Schmidt. 2018. Silage review: Interpretation of chemical, microbial, and organoleptic components of silages. J. Dairy. Sci. 101:4020–4033.

Latue, P.E., B. Ariyadi, A. Kurniawati, and M.A. Anas. 2025. Positive effect of fermented sorghum on productivity, jejunal histomorphology, and *tight junction* gene expression in broiler chickens. Poult. Sci. 104:103548.

Lawal, T.E.E.A. Iyayi, B.A. Adeniyi, and O.A. Adaramoye. 2010. Biodegradation of palm kernel cake with multienzyme complexes from fungi and its feeding value for broilers. Int. J. Poult. Sci. 9(7):695-701.

Lee, J. J., H. Kwon, J.H. Lee, D.G. Kim, S.H. Jung, and J.Y. Ma. 2014. Fermented Soshiho-tang with *Lactobacillus plantarum* enhances the antiproliferative activity in vascular smooth muscle cell. BMC Complement. Altern. Med. 14:78.

Li, G., J. Lin, C. Zhang, H. Gao, H. Lu, X. Gao, R. Zhu, Z. Li, M. Li, and Z. Liu. 2021. Microbiota metabolite butyrate constrains neutrophil functions and ameliorates mucosal inflammation in inflammatory bowel disease. Gut. Microb. 13(1), e1968257.

Li, Z., C. Li, F. Lin, L. Yan, H. Wu, H. Zhou, Q. Guo, B. Lin, B. Xie, Y. Xu, Z. Lin, W. Liu, and Y. Huang. 2024. Duck compound probiotics fermented diet alters the growth performance by shaping the gut morphology, microbiota and metabolism. Poult Sci. 103:1-14.

Liu, L., Q. Li, Y. Yang, and A. Guo. 2021. Biological Function of Short-Chain Fatty Acids and Its Regulation on Intestinal Health of Poultry. Front. Vet. Sci. 8.

Liu, X., J. Shao, Y. T. Liao, L. N. Wang, Y. Jia, P. Dong, Z. Liu, D. He, C. Li, and X. Zhang. 2023. Regulation of short-chain fatty acids in the immune system. Front. Immunol. 14:1186892.

Liu, Y., Y. Liu, Y. Cao, and C. Wang. 2025. Pretreatment of palm kernel cake by enzyme-bacteria and its effects on growth performance in broilers. Animals. 15(116):1-19.

Livak, K.J. and T.D. Schmittgen. 2001. Analysis of relative gene expression data using real-time quantitative PCR and the 2-ΔΔCT method. Methods. 25:402-408.

Louis, P. and H.J. Flint. 2017. Formation of propionate and butyrate by the human colonic microbiota. Environ. Microbiol. 19(1):29-41

Louis, P., S.H. Duncan, S.I. McRae, J. Millar, M.S. Jackson, and H.J. Flint. 2004. Restricted distribution of the butyrate kinase pathway among butyrate-producing bacteria from the human colon. J. Bacteriol. 186:2099-2160.

Ma, B., F. Zhang, S.H.A. Raza, Z. Wu, Q. Su, Y. Zhang, Z. Wang, T.A. Almatrafi, B. H. Aloufi, H. I. Ghamry, M. Shukry, S. Hou, dan L. Gui. 2024. Palm kernel meal regulates the expression of genes involved in the amino acid metabolism in the liver of Tibetan sheep. BMC Veterinary Research. 20:333.

Madani, A.M.A., M. Muhlisin, A. Kurniawati, A.P. Baskara, and M.A. Anas. 2024. Dieatary jack bean (*Canavalia ensiformis* L.) supplementation enhanced

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

intestinal health by modulating intestinal integrity and immune responses of broiler chickens. Heliyon. 10(14):e34389.

Maesaroh, U., Dono, N.D., and Zuprizal. 2022. Performance, microbial populations, and jejunal morphology of broilers supplemented with nano-encapsulated graviola leaf extract. Trop. Anim. Sci. J. 45, 64-72

Mahmood, T. and Y. Guo. 2020. Dietary fiber and chickens microbiome interaction: Where will it lead to?. Anim. Nutr. 6:1-8.

Makkar, H.P.S., G. Tran, V. Heuze, and P. Ankers. 2014. State of the art on use of insects as animal feed. Anim. Feed Sci. Technol. 197:1-33.

Miao, W., J. Min, L. Heng, L. Z. Ming, L.C. Qin, X.Z. Hong, and S.J. Song. 2016. Investigation on the regular patterns of mannan oligosacaccharides degradation and utilization by lactic acid bacteria. Food Ferment. Industr. 42(11):20-24.

Mirnawati, G. Ciptaan, and Ferawati. 2021. The duck responses to the diets containing fermented palm kernel meal with Bacillus subtilis. IOP Conf. Ser.: Earth Environ. Sci. 709 012061.

Missotten, J.A.M., J. Michiels, J. Degroote, and S. De Smet. 2015. Fermented liquid feed for pigs: An ancient technique for the future. J. Anim. Sci. Biotechnol. 6:1-9.

Montagne, L., J.R. Pluske, and D.J. Hampson. 2003. A review of interactions between dietary fibre and the intestinal mucosa, and their consequences on digestive health in young non-ruminant animals. Anim. Feed Sci. Technol. 108:95–117.

Mullenix, G.J., E.S. Greene, N.K. Emami, G. Tellez-Isaias, W.G. Bottje, G.F. Erf, M.T. Kidd, and S. Dridi. 2021. Spirulina platensis inclusion reverses circulating pro-inflammatory (chemo)cytokine profiles in broilers fed low-protein diets. Front. Vet. Sci. 8

Ng, K. L., M.K. Ayob, M. Said, M.A. Osman, dan A. Ismail. 2013. Optimization of enzymatic hydroliysis of palm kernel cake protein (PKCP) for producting hydrolysates with antiradical capacity. Industrial Crops and Products. 43:725-731.

Niccolai, E., S. Baldi. F. Ricci, E. Russo, G. Nannini, M. Menicatti, G. Poli, A. Taddei, G. Bartolucci, A. S. Calabro, F.C. Stingo, and A. Amedei. 2019. Evaluation and comparison of short cain fatty acids composition in gut diseases. World J. Gastroenterol. 25(36): 5543-5558.

Noferdiman, N., S. Sestilawarti, dan Z. Zubaidah. 2019. Penggunaan bungkil inti sawit dan enzim mannanase dalam ransum terhadap performa produksi telur puyuh (*Coturnix coturnix japonica*). Jurnal Lahan Suboptimal. 8(1):11-19.

Nur, F., Hafsan, dan A. Wahdiniar. 2015. Isolasi bakteri asam laktat berpotensi probiotik pada dangke, makanan tradisional dari susu kerbau di Curio Kabupaten Enrekang. Biogenesis: Jurnal Ilmiah Biologi. 3(1):60-65.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Ohira, H., Y. Fujioka, and C. Katagiri C. 2013. Butyrate attenuates inflammation and lipolysis generated by the interaction of adipocytes and macrophages. J. Atheroscler. Thromb. 20:425-442.

Okukpe, M.K., T.A. Aderibigde, and J.O. Atleh. 2019. Effect of supplementation of palm kernel cake (pkc) with enzyme xylanase on performances and gut microbiota of broiler chickens. Vidyodaya J. Sci. 22:12-28.

Ong, W. L., Z. Li, K. H. Ng, and K. Zhou. 2024. Improving mannanase production in *Bacillus subtilis* for fibre hydrolysis during solid-state fermentation of palm kernel meal. Biochem. Eng. J. 212:109479.

Ong, W. L., Z. Li, K.H. Ng, and K. Zhou. 2024. Improving mannanase production in Bacillus subtilis for fibre hydrolisis during solid-state fermentation of palm kernel meal. Biochem. Eng. J. 212:109479

Padmavathi, T., R. Bhargavi, P.R. Priyanka, N.R. Niranjan, and P.V. Pavitra. 2018. Screening of potential probiotic lactic acid bacteria and production of amylase and its partial purification. J. Gen. Eng. Biotech. 16:357-362.

Pangesti, W.A., Nahrowi, W. Hermana, dan A. Setiyono. 2023. Improvement of nutritional quality of processed palm kernel meal with protease enzyme as a substitution for rice bran on broiler performance. IOP Conf. Ser. Earth. Environ. Sci. 1286.

Paradis, T., H. Bègue, L. Basmaciyan, F. Dalle, and F. Bon. 2021. *Tight junction*s as a key for pathogens invasion in intestinal epithelial cells. Int. J. Mol. Sci. 22:1–21.

Pasaribu. 2018. Upaya meningkatkan kualitas bungkil inti sawit melalui teknologi fermentasi dan penambahan enzim untuk unggas. WARTAZOA. 28(3):119-128.

Peng, L., Z.R. Li, R.S. Green, I.R. Holzman, and J. Lin. 2009. Butyrate enhances the intestinal barrier by facilitating *tight junction* assembly via activation of AMP-activated protein kinase in Caco-2 cell monolayers. J. Nutri. 139:1619–1625.

Peterson, L.W. and D. Artis. 2014. Intestinal epithelial cells: Regulators of barrier function and immune homeostasis. Nat. Rev. Immunol. 14:141-153.

Pimentel, L.R., F.F. da Silva, R.R. Silva, A.F.P. Junior, E.G.L. Costa, A.R. Schio, D.D. de Souza, E.S. de Oliveira Rodrigues, G.M. da Silva, and M de Almeida Menezes. 2018. Production performance of crossbred dairy cows fed palm kernel cake in feedlots. Semina: Ciências Agrárias, Londrina. 39(5):2103-2112.

Pluznick, J. 2014. A novel SCFA receptor, the microbiota, and blood pressure regulation. Gut Microb. 5:202-207.

Proszkowiec-Weglarz, M., L.L. Schreier, S. Kahl, K. B. Miska, B. Russell, and T. H. Elsasser. 2020. Effect of delayed feeding post-hatch on expression of tight junction and gut barrier related genes in the small intestine of broiler chickens during neonatal development. Poult. Sci. 99:4714-4729.

Ramiah, S.K., N. Abdullah, M. Akhmal, S. Mookiah, A. Soleimani Farjam, C. Wei Li, L. Juan Boo, and Z. Idrus. 2019. Effect of feedingless shell, extruded

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

and enzymatically treated palm kernel cake on expression of growth-related genes in broiler chickens. Ital. J. Anim. Sci. 18:997–1004.

Reichardt, N., S.H. Duncan, P. Young, A. Belenguer, C. McWilliam Leitch, K.P. Scott, H.J. Flint, and P. Louis. 2014. Phylogenetic distribution of three pathways for propionate production within the human gut microbiota. ISME J. 8:1323-1335.

Rodríguez-Nogales, A., F. Algieri, J. Garrido-Mesa, T. Vezza, M.P. Utrilla, N. Chueca, F. Garcia, M. Olivares, M.E. Rodríguez-Cabezas, and J. Gálvez. 2017. Differential intestinal anti-inflammatory effects of Lactobacillus fermentum and Lactobacillus salivarius in DSS mouse colitis: impact on microRNAs expression and microbiota composition. Mol. Nutr. Food. Res. 61.

Rombenso, A., C. Crouse, and J. Trushenski. 2013. Comparison of traditional and fermented soybean meals as alternatives to fish meal in hybrid striped bass feeds. North American J. Aquaqult. 75:197-204.

Scott, K. P., J.C. Martin, G. Campbell, C.D. Mayer, and H.J. Flint. 2006. Whole-genome transcription profiling reveals genes up-regulated by growth on fucose in the human gut bacterium. "*Roseburia inulinivorans*". J. Bacteriol. 188:4340-4349.

Seftiadi, Y. Mirnawati, and Mirzah. 2020. The effect of the addition of palm kernel meal in making *Lactobacillus sp* inoculum on enzyme activity. J. Res. Agri. Anim. Sci. 7(5):1-5.

Senanayake, D., P.J. Torley, J. Chandrapala, and N.S. Terefe. 2023. Microbial fermentation for improving the sensory, nutritiona, and functional attributes of legumes. Fermentation. 9:1-25.

Shabani, A., V. Jazi, A. Ashayerizadeh, and R. Barekatain. 2019. Inclusion of fish waste silage in broiler diets affect gut microflora, cecal short-chain fatty acids, digestive enzyme activity, nutrient digestibility, and excreta gas emission. Poult. Sci. 98:4909-4918.

Shi, C., Y. Zhang, Y. Yin, and C. Wang. 2017. Amino acid and phosporus digestibility of fermented corn-soybean meal mixed feed with Bacillus subtilis and Enterococcus faecium fed to pigs. J. Anim. Sci. 95:3996-4004.

Shimelis, E.A. and S.K. Rakshit. 2008. Influence of natural and controlled fermentations on α-galactosides, antinutrients and protein digestibility of beans (Phaseolus vulgaris L.) Int. J. Food. Sci. Technol. 43:658-665.

Silva, E.A., A. Silvestroni, J.G. LeBlanc, J.C. Piard, G. Savoy de Giori, and F. Sesma. 2006. A thermostable α-galactosidase from *Lactobacillus fermentum* CRL722: genetic characterization and main properties. Current Microbiol. 53:374-378.

Singh, N., M. Thangaraju, and P.D. Prasad. 2010. Blockade of dendritic cell development by bacterial fermentation products butyrate and propionate through a transporter (Slc5a8)-dependent inhibition of histone deacetylases. J. Biol. Chem. 285: 27601-27608.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Sittiya, J., K. Yamauchi, and K. Takata. 2016. Effect of replacing corn with whole-grain paddy rice and brown rice in broiler diets on growth performance and intestinal morphology. J. Anim. Physiol. Anim. Nutr. 100:381-390.

Sklan, D., A. Smirnov, and I. Plavnik. 2003. The effect of dietary fibre on the small intestines and apparent digestion in the turkey. Br. Poult. Sci. 44:735-740.

Sleeth, M. L., E.L. Thompson, H.E. Ford, S.E. Zac-Varghese, and G. Frost. 2010. Free fatty acid receptor 2 and nutrient sensing: a proposed role for fibre, fermentable carbohydrates and short-chain fatty acids in appetite regulation. Nutr. Res. Rev. 23:135-145.

Slifer, Z.M. and A.T. Blikslager. 2020. The integral role of *tight junction* proteins in the repair of injured intestinal epithelium. Int. J. Mol. Sci. 21:972.

Smid, E.J. and M. Kleerebezem. 2014. Production of aroma compounds in lactic fermentations. Annu Rev Food Sci Technol 5:313–326.

Soares, C., F. Rossa, F.F. da Silva, A.P.G. Da Silva, L.V. Santos, D.M. Junior, and R.R. Silva. 2024. Effect of palm kernel cake inclusion in the supplement of pastur-finished heifers on performance, carcass traits, and meat quality. N. Z. J. Agric. Res. 67:251-267.

Soltan, M.A. 2009. Growth performance, immune response and carcass traits of broiler chicks fed on graded levels of palm kernel cake without or with enzyme supplementation. Livest. Res. Rural Dev. 21:37‑55.

Soomro, R.N., R. Hu, Y. Qiao, M.E.A. El-Hack, I.H.R. Abbasi, M.A.E. Mohamed, B.M. Bodinga, M. Alagawany, and X. Yang 2017. Effect of dietary protein sources and amino acid balances on performance, intestinal permeability and morphology in broiler Chickens. Int. J. Pharmacol. 13:378-387.

Spring, P., C. Wenk, K.A. Dawson, and K.E. Newman. 2000. The effects of dietary mannanoligosaccharides on cecal parameters and the concentration of enteric bacteria in the ceca of sacvblmonella-challenge broiler chicks. Poult. Sci. 79:205-211.

Steinbacher, T. and K. Ebnet. 2018. The regulation of junctional actin dynamics by cell adhesion receptors. Histo. Cell Bio. 150:341-350.

Su, R., K. Ini, T. Wang, X. Yang, J. Zhang, Y. Liu, W. Shi, L. Yan, C. Jie, and J. Zhoung. 2019. Effects of ferulic acid esterase-producing *Lactobacillus fermentum* and cellulace additives on the fermentation quality and microbial community of alfalfa silage. PeerJ. 7:e7712.

Su, W., Z. Jiang, C. Wang, Y. Zhang, T. Gong, F. Wang, M. Jin, Y. Wang, and Z. Lu. 2022. Co-fermented defatted rice bran alters gut microbiota and improves growth performance, antioxidant capacity, immune status and intestinal permeability of finishing pigs. Anim. Nutri. 11:413–424.

Sundu, B. A. and J. Dingle. 2003. Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. Proc. Queensland Poult. Sci. Symp. Australia. 11(14):1-15.

Sundu, B., A. Kumar, and J. Dingle. 2005. Response of birds fed increasing levels of palm kernel meal supplemented with enzymes. Aus. Poult. Sci. Symp. 17:227-228.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Sundu, B., A. Kumar, and J. Dingle. 2006. Palm kernel meal in broiler diets: Effect on chicken performance and health. World. Poult. Sci. J. 62:316-325.

Suzuki, T. 2020. Regulation of the intestinal barrier by nutrients: The role of tight junctions. Anim. Sci. J. 9(1):1-12.

Svihus B. 2011. The gizzard: function, influence of diet structure and effects on nutrient availability. World's Poult. Sci. J. 67:207-224.

Tafsin, M., N. D. Hanafi, and E. Yusraini. 2017. Extraction process of palm kernel cake as a source of mannan for feed additive on poultry diet. IOP Conf. Series: Earth. Environ. Sci. 65 012020.

Takeuchi, O. and S. Akira. 2010. Pattern recognition receptors and inflammation Cell. 140:805-820.

Tan, J., C. McKenzie, M. Potamitis, A.N. Thorburn, C.R. Mackay, and L. Macia. 2014. The role of short-chain fatty acids in health and disease. Advan. Immunol. 121:91-119.

Tanaka, H., M. Takechi, H. Kiyonari, G. Shioi, A. Tamura, and S. Tsukita. 2015. Intestinal deletion of claudin-7 enhances paracellular organic solute flux and initiaties colonic inflammation in mice. 64(10):1501-1502.

Tedelind, S., F. Werstberg, M. Kjerrulf, and A. Vidal. 2007. Anti-inflammatory properties of the short-chain fatty acids acetate and propionate: a study with relevance to inflammatory bowel disease. World J. Gastroenterol. 13(20):2826-2832.

Teng, P.Y., J. Choi, Y. Tompkins, H. Lillehoj, and W. Kim. 2021. Impacts of increasing challenge with Eimeria maxima on the growth performance and gene expression of biomarkers associated with intestinal integrity and nutrient transporters. Vet. Res. 52:81

Terpou, A., A. Papadaki, I. K. Lappa, V. Kachiramanidou, L.A. Bosnea, and N. Kopsahelis. 2019. Probiotics in food systems: Signicance and emerging strategies towards improved viability and delivery of enhanced beneficial value. Nutrients. 11:1591.

Tsai, P.Y., B. Zhang, W. Q. He, J.M. Zha, A. Matthew, Odenwald, G. Singh, A. Tamura, L. Shen, A. Sailer, S. Yeruva, W. T. Kuo, Y. X. Fu, S. Tsukita, and J. R. Turner. 2017. IL-22 upregulates epithelial claudin-2 to drive diarrhea and enteric pathogen clearance. Cell Host Microb. 21(6):671-681.e4.

Tsukita, S., H. Tanaka, and A. Tamura. 2019. The claudins: from *tight junction*s to biological systems. Trends. Biochem. Sci. 44(2):141-152.

Tsukita, S., M. Furuse, and M. Itoh. 2001. Multifunctional strands in *tight junction*s. Nat. Rev. Mol. Cell. Biol. 2:285-293.

Tsutsui, H., dan K. Nakanishi. 2012. Immunotherapeutic applications of IL-18. Immunotherapy. 4(12):1883–94.

Turner, D. L., P. Lamosa, A. Rodriguez, and B. Martinez. 2013. Structure and properties of the metastable bacteriocin Lcn972 from *Lactococcus lactis*. J. Mol. Struct. 1031:207-210.

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Van der Wielen, P. W., S. Biesterveld, S. Notermans, H. Hofstra, B.A. Urlings, and F. Knapen. 2000. Role of volatile acids in developmen of the cecal microflora in broiler chickens during growth. Appl. Environ. Microbiol. 66:2536-2540.

Vinolo, M.A.R., H.G. Rodrigues, R.T. Nachbar, and R. Curi. 2011. Regulation of inflammation by short chain fatty acids. Nutrients. 3(10):858-876.

Wada, M., A. Tamura, N. Takahashi, and S. Tsukita. 2013. Loss of claudins-2 and -15 from mice causes defects in paracellular Na^+ flow and nutrient transport in gut and leads to death from malnutrition. Gastroenterology. 144(2):369-380.

Wang, C., Y. Wang, W. Shan, Y. Han, and X. Li. 2024. Solid-state fermentation with lactic acid bacteria of citric acid degrading for hawthorn fruit improvement: Sensory, flavor, antioxidant properties. Food Biosci. 62:105402.

Wang, T., J. An, M. Chai, Z. Zhu, and Y. Jiang. 2023. Volatile metabolomics reveals the characteristics of the unique flavor substances in oats. Food Chem. 20:101000.

Wang, Y., X.T. Liu, H.L. Wang, D.F. Li, X.S. Piao, and W.Q. Lu. 2014. Optimization of processing conditions for solid-state fermented soybean meal and its effect on growth performance and nutrient digestibility of weaning pigs. Livestock Sci. 170(2014):91-99.

Wang, Z., D. Shao, K. Kang, S. Wu, G. Zhong, Z. Song, and S. Shi. 2022. Low protein with high amino acid diets improves the growth performance of yellow feather broilers by improving intestinal health under cyclic heat stress. J. Therm. Biol. 105:103219.

Wen, H., D.D. Watry, M.C. Marcondes, and H.S. Fox. 2004. Selective decrease in paracellular conductance of *tight junction*s: role of the first extracellular domain of claudin-5. Mol. Cell. Biol. 24:8608-8417.

Williams, A.G., S. Withers, and A.D. Sutherland. 2013. The potential of bacteria isolated from ruminal contents of seaweed-eating North Ronaldsay sheep to hydrolyse seaweed components and produce methane by anaerobic digestion in vitro. Microb. Biotechnol. 6:45-52.

Woo, V. and T. Alenghat. 2022. Epigenetic regulation by gut microbiota. Gut Microbes. 14:2022407.

Xie, Z., G. Shen, Y. Wang, and C. Wu. 2019. Curcumin supplementation regulates lipid metabolism in broiler chickens. Poult. Sci. 98:422-429.

Xu, Y., and Y. Zhu. 2021. Complete Replacement of Nitrite With a Lactobacillus fermentum on the Quality and Safety of Chinese Fermented Sausages. Front. Microbiol. 12.

Yan, H., and K. M. Ajuwon. 2017. Butyrate modifies intestinal barrier function in IPEC-J2 cell through a selective upregulation of *tight junction* proteins and activation of the Akt signaling pathway. Plos ONE. 12:e0179586.

Yáñez, R., A. Belén Moldes, J. Luis Alonso, and J. Carlos Parajó. 2003. Production of D(−)-lactic acid from cellulose by simultaneous saccharification and

UNIVERSITAS
GADJAH MADA
**Produktivitas, Histomorfologi Jejunum, Asam Lemak Rantai Pendek dan Ekspresi Gen Barrier Function
dan Inflamasi Ayam Broiler yang Diberi Pakan Fermentasi Bungkil Inti Sawit**
Dimas Fakhruddin, Dr. Ir. Muhsin Al Anas, S.Pt., IPP. ; Dr. Ir. Asih Kurniawati, S.Pt., M.Si., IPM.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

fermentation using Lactobacillus coryniformis subsp. torquens. Biotech. Letters. 25:1161-1164.

Yang, L., X. Zeng, and S. Qiao. 2021. Advances in research on solid-fermented feed and its utilization: The pioneer of private customization for intestinal microorganism. Anim. Nutr. 7:905-916.

Yang, R., A. Khalid, F. Khalid, M. Ye, Y. Li, K. Zhan, Y. Li, W. Liu, and Z. Wang. 2022. Effect of fermented corn by-products on production performance, blood biochemistry, and egg quality indices of laying hens. J. Anim. Sci. 100.

Yao, Y., X. Cai, W. Fei, Y. Ye, M. Zhao, and C. Zheng. 2020. The role of short-chain fatty acids in immunity, inflammation and metabolism. Critic. Rev. Food Sci. Nut. 62(1):1-12.

Yaophakdee, N., Y. Ruangpanit, and S. Attamangkune. 2018. Effects of palm kernel meal level on live performance and gut morphology of broilers. Agricult. Nat. Res. 52:75-78.

Yegani, M. and D.R. Korver. 2008. Factors afftecting intestinal health in poultry. Poult. Sci. 87:2052-2063.

Yue, X., S. Wen, D. Long-kun, Y. Man, S. Chang, Z. Min, L. Shuang-yu, Q. Xin, M. Jie, and W. Liang. 2022. Three important short-chain fatty acids (SCFAs) attenuate the inflammatory response induced by 5-FU and maintain the integrity of intestinal mucosal *tight junction*. BMC. Immunol. 23:19.

Zain, M., J. Rahman, dan Khasrad. 2014. Effect of palm oil by products on in vitro fermentation and nutrient digestibility. Anim. Nutr. Feed Tech. 14: 175-181.

Zhang, L., X. Wang, S. Huang, Y. Huang, H. Shi, and X. Bai. 2023. Effects of dietary essential oil supplementation on growth performance, carcass yield, meat quality, and intestinal tight junctions of broilers with or without Eimeria challenge. Poult. Sci. 102:102874.

Zhang, X., Q. Miao, C. Pan, J. Yin, L. Wang, L. Qu, Y. Yin, and Y. Wei. 2023. Research advances in probiotic fermentation of Chinese herbal medicines. iMeta. 2:e93.

Zhao, Y., K. Hong, J. Zhao, H. Zhang, Q. Zhai, and W. Chen. 2019. Lactobacillus fermentum and its potential immunomodulatory properties. J. Funct. Foods.56:21-32.

Zhu, X., L. Tao, H. Liu, and G. Yang. 2023. Effects of fermented feed on growth performance, immune organ indices, serum biochemical parameters, cecal odorous compound production, and the microbiota community in broilers. Poult. Sci. 102:102629.