UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC,
PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Abeyesinghe, S. M., N. M. Chancellor, D. Hernandez Moore, Y. M. Chang, J. Pearce, T. Demmers, and C. J. Nicol. 2021. Associations between behaviour and health outcomes in conventional and slow-growing breeds of broiler chicken. Animal. 15:7.

AboelAnin, M. A. 2020. Structure and physiological functions of ghrelin. Biomed. J. Sci. Tech. Res. 31:2.

Aderibigbe, A. S., K. M. Ajuwon, and O. Adeola. 2022. Dietary phosphorus level regulates appetite through modulation of gut and hypothalamic expression of anorexigenic genes in broiler chickens. Poult. Sci. 101:2.

Ali, A., D. Khan, V. Dubey, A. I. Tarasov, P. R. Flatt, and N. Irwin. 2024. Comparative effects of GLP-1 and GLP-2 on beta-cell function, glucose homeostasis and appetite regulation. Biomolecules. 14:12.

Anas, M. Al, M. A. Aprianto, Y. Sapan, F. N. Almira, R. E. Aldis, N. S. B. M. Atapattu, M. T. Kidd, H. Akit, and N. Montha. 2025. Black soldier fly larvae oil downregulated gene expression related to fat metabolism of broilers fed low protein diet. Poult. Sci. 104:4.

Anderson, G. H., and S. E. Moore. 2004. The emerging role of dairy proteins and bioactive peptides in nutrition and health dietary proteins in the regulation of food intake and body weight in humans 1. J. Nutr. 974-979.

Attia, Y. A., F. Bovera, J. Wang, M. A. Al-Harthi, and W. K. Kim. 2020. Multiple amino acid supplementations to low-protein diets: Effect on performance, carcass yield, meat quality and nitrogen excretion of finishing broilers under hot climate conditions. Animals. 10:1-11.

Aldis, R. E., M. Muhlisin, Z. Zuprizal, H. Sasongko, C. Hanim, and M. Al. Anas. 2024. Black soldier fly larvae meal supplementation in a low protein diet reduced performance, but improved nitrogen efficiency and intestinal morphology of duck. Anim. Biosci. 37:678-688.

Avian. 2018. Indian river broiler management handbook. Accessed Oktober 2023. https://aviagen.com/assets/Tech_Center/LIR_Broiler/IR-BroilerHandbook2018-EN.pdf

Aviagen. 2022. Indian river broiler nutrition specifications. Accessed April 2023. https://aviagen.com/assets/Tech_Center/LIR_Broiler/IR-BroilerNutritionSpecifications2022-EN.pdf

Baccari, M. C., M. G. Vannucchi, and E. Idrizaj. 2024. The possible involvement of glucagon-like peptide-2 in the regulation of food intake through the gut-brain axis. Nutrients. 16(18):3069.

Badan Pusat Statistik. 2023. Peternakan dalam angka 2023. Badan pusat statistik. Jakarta.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Bai, X., L. Zhang, H. Liang, D. Huang, M. Ren, and H. Mi. 2025. Dietary γ-aminobutyric acid promotes growth and immune system performance and improves erythropoiesis and angiogenesis in gibel carp (Carassius auratus gibelio). Animals. 15(2):125.

Barekatain, 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.

Barekatain, R., P. V. Chrystal, T. Nowland, A. F. Moss, G. S. Howarth, T. T. Hao Van, and R. J. Moore. 2023. Negative consequences of reduced protein diets supplemented with synthetic amino acids for performance, intestinal barrier function, and caecal microbiota composition of broiler chickens. Anim. Nutr. 13:216-228.

Barekatain, R., L. Hall, P. V. Chrystal, and A. Fickler. 2024. Nutrient utilisation and growth performance of broiler chickens fed standard or moderately reduced dietary protein diets with and without β-mannanase supplementation. Anim. Nutr. 19:131-138.

Beldowska, A., M. Barszcz, and A. Dunislawska. 2023. State of the art in research on the gut-liver and gut-brain axis in poultry. J. Anim. Sci. Biotechnol. 14:37.

Bergmeyer H. U. 1983. Methods of enzymatic analysis. Verlag Chemie, Weinheim.

Bhandage, A. K., Z. Jin, S. V. Korol, Q. Shen, Y. Pei, Q. Deng, D. Espes, P. O. Carlsson, M. Kamali-Moghaddam, and B. Birnir. 2018. GABA regulates release of inflammatory cytokines from peripheral blood mononuclear cells and CD4+ T cells and is immunosuppressive in type 1 diabetes. EBioMedicine. 30:283-294.

Brito, C. O., J. L. L. Dutra, T. N. Dias, L. T. Barbosa, C. S. Nascimento, A. P. G. Pinto, L. F. T. Albino, R. P. M. Fernandes, M. S. Macário, and J. S. Melo. 2017. Effect of dietary lysine on performance & expression of electron transport chain genes in the pectoralis major muscle of broilers. Animal. 11:778-783.

Brink, M., G. P. J. Janssens, P. Demeyer, Ö. Bağci, dan E. Delezie. 2022. Reduction of dietary crude protein and feed form: Impact on broiler litter quality, ammonia concentrations, excreta composition, performance, welfare, and meat quality. Anim. Nutr. 9:291-303.

Dar, S. A., P. P. Srivastava, T. Varghese, S. Gupta, P. Gireesh-Babu, and G. Krishna. 2018. Effects of starvation and refeeding on expression of ghrelin and leptin gene with variations in metabolic parameters in labeo rohita fingerlings. Aquaculture 484:219-227.

Camilleri, M. 2015. Peripheral mechanisms in appetite regulation. Gastroenterology 148:1219-1233.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Cardinal, K. M., M. L. de Moraes, I. Andretta, G. D. Schirmann, B. L. Belote, M. A. Barrios, E. Santin, and A. M. L. Ribeiro. 2019. Growth performance and intestinal health of broilers fed a standard or low-protein diet with the addition of a protease. Rev. Bras. Zootec. 48:1.

Chen, Z., and J. Xie. 2015. Protective effects of γ-aminobutyric acid (GABA) on the small intestinal mucosa in heat-stressed wenchang chicken. J. Anim. Plant. Sci. 25.

Diana, M., J. Quílez, and M. Rafecas. 2014. Gamma-aminobutyric acid as a bioactive compound in foods: A review. J. Funct. Foods. 10:407-420.

Drucker, D. J. 2018. Mechanisms of action and therapeutic application of glucagon-like peptide-1. Cell. Metab. 27:740-756.

El-Naggar, K., S. El-Kassas, S. E. Abdo, A. A. K. Kirrella, and R. A. Al wakeel. 2019. Role of gamma-aminobutyric acid in regulating feed intake in commercial broilers reared under normal and heat stress conditions. J. Therm. Biol. 84:164-175.

Fang, X. L., X. T. Zhu, S. F. Chen, Z. Q. Zhang, Q. J. Zeng, L. Deng, J. L. Peng, J. J. Yu, L. N. Wang, S. B. Wang, P. Gao, Q. Y. Jiang, and G. Shu. 2014. Differential gene expression pattern in hypothalamus of chickens during fasting-induced metabolic reprogramming: Functions of glucose and lipid metabolism in the feed intake of chickens. Poult. Sci. 93:2841-2854.

Fathi, M., S. Saeedyan, and M. Kaoosi. 2023. Gamma-amino butyric acid (GABA) supplementation alleviates dexamethasone treatment-induced oxidative stress and inflammation response in broiler chickens. Stress. 26:1.

Harn, V., J. M. A. Dijkslag, and M. M. Van Krimpen. 2019. Effect of low protein diets supplemented with free amino acids on growth performance, slaughter yield, litter quality, and footpad lesions of male broilers. Poult. Sci. 98:4868-4877.

Havel, P. J. 2001. Peripheral signals conveying metabolic information to the brain: short-term and long-term regulation of food intake and energy homeostasis. Biol. Med. 226: 963-977

He, L. W., Q. X. Meng, D. Y. Li, Y. W. Zhang, and L. P. Ren. 2015. Influence of feeding alternative fiber sources on the gastrointestinal fermentation, digestive enzyme activities and mucosa morphology of growing greylag geese. Poult. Sci. 94:2464-2471.

Heli, Z., C. Hongyu, B. Dapeng, T. Yee Shin, Z. Yejun, Z. Xi, and W. Yingying. 2022. Recent advances of γ-aminobutyric acid: Physiological and immunity function, enrichment, and metabolic pathway. Front. Nutr. 9:1076223.

Jacobs, L., S. Melick, N. Freeman, A. Garmyn, and F. A. M. Tuyttens. 2021. Broiler chicken behavior and activity are affected by novel flooring treatments. Animal. 11(10):2841.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC,
PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Jang, M., S. Y. Park, Y. W. Kim, S. P. Jung, and J. Y. Kim. 2017. Regulating hypothalamus gene expression in food intake: Dietary composition or calorie density. Diabetes. Metab. J. 41:121-127.

Jeong, S. B., Y. B. Kim, J. W. Lee, D. H. Kim, B. H. Moon, H. H. Chang, Y. H. Choi, and K. W. Lee. 2020. Role of dietary gamma-aminobutyric acid in broiler chickens raised under high stocking density. Anim. Nutr. 6:293-304.

Jin, Z., S. K. Mendu, and B. Birnir. 2013. GABA is an effective immunomodulatory molecule. Amino. Acids. 45:87-94.

Jonaidi, H., L. Abbassi, M. M. Yaghoobi, H. Kaiya, D. M. Denbow, Y. Kamali, and B. Shojaei. 2012. The role of GABAergic system on the inhibitory effect of ghrelin on food intake in neonatal chicks. Neurosci. Lett. 520:8-86.

Kidd, M. T., C. W. Maynard, and G. J. Mullenix. 2021. Progress of amino acid nutrition for diet protein reduction in poultry. J. Anim. Sci. Biotechnol. 12:45.

Kim, K., and H. Yoon. 2023. Gamma-aminobutyric acid signaling in damage response, metabolism, and disease. Int. J. Mol. Sci. 24:4584.

Kolodziejski, P. A., M. Sassek, D. Chalupka, N. Leciejewska, L. Nogowski, P. Mackowiak, D. Jozefiak, K. Stadnicka, M. Siwek, M. Bednarczyk, T. Szwaczkowski, and E. Pruszynska-Oszmalek. 2018. GLP1 and GIP are involved in the action of synbiotics in broiler chickens. J. Anim. Sci. Biotechnol. 9:1.

Leeson, Steven., and J. D. Summers. 2005. Commercial poultry nutrition. University Books.

Li, Z., X. Liu, P. Zhang, R. Han, G. Sun, R. Jiang, Y. Wang, X. Liu, W. Li, X. Kang, and Y. Tian. 2018. Comparative transcriptome analysis of hypothalamus-regulated feed intake induced by exogenous visfatin in chicks. BMC. Genomics. 19(1):249.

Lin Law, F., Z. Idrus, A. Soleimani Farjam, L. Juan Boo, and E. A. Awad. 2019. Effects of protease supplementation of low protein and/or energy diets on growth performance and blood parameters in broiler chickens under heat stress condition. Ital. J. Anim. Sci. 18:679-689.

Livak, K. J., and T. D. Schmittgen. 2001. Analysis of relative gene expression data using real- time quantitative PCR and the $2^{-\Delta\Delta CT}$ method. Methods. 25:402-408.

Lobley, G. E., G. Holtrop, G. W. Horgan, D. M. Bremner, C. Fyfe, and A. M. Johnstone. 2015. Responses in gut hormones and hunger to diets with either high protein or a mixture of protein plus free amino acids supplied under weight-loss conditions. Br. J. Nutr. 113:1254-1270.

Lorenzo, I., M. Serra-Prat, and J. Carlos Yébenes. 2019. The role of water homeostasis in muscle function and frailty: A review. Nutrients. 11:1857.

Lowry O. H., N. J. Rosebrough, A. L. Farr, R. J. Randall. 1951. Protein measurement with the folin phenol reagent. J. Biol. Chem. 193(1):265-75.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Luo, C., J. Wang, W. Jiang, D. Yin, G. Meng, J. Wang, J. Xu, and J. Yuan. 2025. Different starch sources and amino acid levels on growth performance, starch and amino acids digestion, absorption and metabolism of 0- to 3-week-old broilers fed low protein diet. Anim. Nutr. 20:277-290.

Luo, C., Y. Yu, G. Meng, and J. Yuan. 2025. Slowly digestible starch impairs growth performance of broiler chickens offered low-protein diet supplemental higher amino acid densities by inhibiting the utilization of intestinal amino acid. J. Anim. Sci. Biotechnol. 16:12.

Ma, X., Q. Sun, X. Sun, D. Chen, C. Wei, X. Yu, C. Liu, Y. Li, and J. Li. 2018. Activation of GABAA receptors in colon epithelium exacerbates acute colitis. Front. Immunol. 9:987.

Ma, S., K. Zhang, S. Shi, X. Li, C. Che, P. Chen, and H. Liu. 2023. Low-protein diets supplemented with isoleucine alleviate lipid deposition in broilers through activating 5′ adenosine monophosphate-activated protein kinase and janus kinase 2/signal transducer and activator of transcription 3 signaling pathways. Poult. Sci. 102:3.

Macelline, S. P., S. S. Wickramasuriya, H. M. Cho, E. Kim, T. K. Shin, J. S. Hong, J. C. Kim, J. R. Pluske, H. J. Choi, Y. G. Hong, and J. M. Heo. 2020. Broilers fed a low protein diet supplemented with synthetic amino acids maintained growth performance and retained intestinal integrity while reducing nitrogen excretion when raised under poor sanitary conditions. Poult. Sci. 99:949-958.

Maharjan, P., D. A. Martinez, J. Weil, N. Suesuttajit, C. Umberson, G. Mullenix, K. M. Hilton, A. Beitia, and C. N. Coon. 2021. Review: Physiological growth trend of current meat broilers and dietary protein and energy management approaches for sustainable broiler production. Animal. 15:100284.

Mahdavi, K., M. Zendehdel, and H. Zarei. 2024. The role of central neurotransmitters in appetite regulation of broilers and layers: similarities and differences. Vet. Res. Commun. 48(3):1313-1328.

Miah, M. Y., S. Saha, N. Koiri, A. Mahbub, M. Ashraful Islam, and G. Channarayapatna. 2022. Effects of dietary methionine and threonine on growth performance, carcass traits and blood metabolites of broilers in a hot environment. Eur. Poult. Sci. 86:1-13.

Miller, G. D. 2019. Appetite regulation: hormones, peptides, and neurotransmitters and their role in obesity. Am. J. Lifestyle. Med. 13:586-601.

Morrison, C. D., S. D. Reed, and T. M. Henagan. 2012. Homeostatic regulation of protein intake: In search of a mechanism. Am. J. Physiol. Regul. Integr. Comp. Physiol. 8:302.

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. 8:640968.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Musigwa, S., N. Morgan, R. A. Swick, P. Cozannet, S. K. Kheravii, and S. B. Wu. 2021. Multi-carbohydrase enzymes improve feed energy in broiler diets containing standard or low crude protein. Anim. Nutr. 7:496-505.

Ncho, C. M., A. Goel, C. M. Jeong, M. Youssouf, and Y. H. Choi. 2021. In ovo injection of gaba can help body weight gain at hatch, increase chick weight to egg weight ratio, and improve broiler heat resistance. Animals. 11:1364.

Ndazigaruye, G., D. H. Kim, C. W. Kang, K. R. Kang, Y. J. Joo, S. R. Lee, and K. W. Lee. 2019. Effects of low-protein diets and exogenous protease on growth performance, carcass traits, intestinal morphology, cecal volatile fatty acids and serum parameters in broilers. Animals. 9:226.

Oliveira, M. D., F. C. Sousa, J. O. Saraz, A. A. Calderano, I. F. F. Tinôco, and A. P. S. Carneiro. 2021. Ammonia emission in poultry facilities: A review for tropical climate areas. Atmosphere. 12:1091.

Onbaşılar, E. E. 2022. Effect of alternative litter materials on the behaviour of male broilers. Behav. Processes. 195:104566.

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

Pérez, M. Á., V. Peñaloza-Sancho, J. Ahumada, M. Fuenzalida, and A. Dagnino-Subiabre. 2018. N-3 polyunsaturated fatty acid supplementation restored impaired memory and GABAergic synaptic efficacy in the hippocampus of stressed rats. Nutr. Neurosci. 21:556-569.

Pezeshki, A., and P. K. Chelikani. 2021. Low protein diets and energy balance: mechanisms of action on energy intake and expenditure. Front. Nutr. 8:655833.

Pokoo-Aikins, A., J. R. Timmons, B. R. Min, W. R. Lee, S. N. Mwangi, and C. Chen. 2021. Effects of feeding varying levels of DL-Methionine on live performance and yield of broiler chickens. Animals. 11:2839.

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.

Prud'homme, G. J., Y. Glinka, and Q. Wang. 2015. Immunological GABAergic interactions and therapeutic applications in autoimmune diseases. Autoimmun. Rev. 14:1048-1056.

Rauglaudre, D. T., B. Méda, S. Fontaine, W. Lambert, S. Fournel, and M. P. Létourneau-Montminy. 2023. Meta-analysis of the effect of low-protein diets on the growth performance, nitrogen excretion, and fat deposition in broilers. Front. Anim. Sci. 4:1214076.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Selle, P. H., S. P. Macelline, M. Z. Wang, and S. Y. Liu. 2025. A perception that the feed grain basis of reduced-crude protein diets modifies the anabolic impact of insulin on the growth performance of broiler chickens. Anim. Nutr. 21:245-255.

Shao, D., Y. Shen, X. Zhao, Q. Wang, Y. Hu, S. Shi, and H. Tong. 2018. Low-protein diets with balanced amino acids reduce nitrogen excretion and foot pad dermatitis without affecting the growth performance and meat quality of free-range yellow broilers. Ital. J. Anim. Sci. 17:698-705.

Star, L., S. Tesseraud, M. van Tol, I. Minussi, E. Corrent, and W. Lambert. 2021. Production performance and plasma metabolite concentrations of broiler chickens fed low crude protein diets differing in Thr and Gly. Anim. Nutr. 7:472-480.

Such, N., L. Pál, P. Strifler, B. Horváth, I. A. Koltay, M. A. Rawash, V. Farkas, Á. Mezőlaki, L. Wágner, and K. Dublecz. 2021. Effect of feeding low protein diets on the production traits and the nitrogen composition of excreta of broiler chickens. Agriculture. 11:781.

Suzuki, T. 2020. Regulation of the intestinal barrier by nutrients: The role of tight junctions. Anim. Sci. J. 91:1-12.

Thennakoon, T. M. I. D., U. G. D. M. B. Udagedara, N. S. B. M. Atapattu, and D. Senaratne. 2024. Effects of Salvinia as a broiler litter material on growth performance, behavior, welfare parameters, litter characters, and ammonia emission. Poult. Sci. 103:103542.

Vosoughi, A., M. Zendehdel, and S. Hassanpour. 2024. Central effects of the serotoninergic, GABAergic, and cholecystokinin systems on neuropeptide VF (NPVF)-induced hypophagia and feeding behavior in neonatal broiler chicken. Neurosci. Lett. 818:137557.

Wang, Q. D., S. Li, K. Y. Zhang, Y. Zhang, S. P. Bai, X. M. Ding, J. P. Wang, H. W. Peng, G. Tian, Y. Xuan, Z. W. Su, and Q. F. Zeng. 2020. Protease supplementation attenuates the intestinal health damage caused by low-protein diets in Pekin ducks. Poult. Sci. 99:6630-6642.

Weatherburn, M. W. 1962. Phenol-hypochlorite reaction for determination of ammonia. Anal. Chem. 39(8):971-974.

White, B. D., F. Du, and D. A. Higginbotham. 2003. Low dietary protein in associated with an increase in food intake and a decrease in the in vitro release of radiolabeled glutamate and GABA from the lateral hypothalamus. Nutr. Neurosci. 6:361-367.

Woyengo, T. A., K. E. B. Knudsen, and C. F. Børsting. 2023. Low-protein diets for broilers: Current knowledge and potential strategies to improve performance and health, and to reduce environmental impact. Anim. Feed. Sci. Technol. 297.

Wu, Y., B. Li, L. Li, S. E. Mitchell, C. L. Green, G. D'Agostino, G. Wang, L. Wang, M. Li, J. Li, C. Niu, Z. Jin, A. Wang, Y. Zheng, A. Douglas, and J. R. Speakman. 2021.

UNIVERSITAS
GADJAH MADA
PENGARUH GAMMA AMINOBUTYRIC ACID DALAM PAKAN RENDAH PROTEIN TERHADAP EKSPRESI GEN NEUROPEPTIDERGIC, PRODUKTIVITAS, DAN TINGKAH LAKU BROILER
Randi, Dr. Ir. Muhsin Al Anas, S.Pt., IPP; Prof. Dr. Ir. Chusnul Hanim, M.Si., IPM., ASEAN Eng
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Very-low-protein diets lead to reduced food intake and weight loss, linked to inhibition of hypothalamic mTOR signaling, in mice. Cell. Metab. 33:888-904.

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

Zare, D., H. Jonaidi, and B. Sadeghi. 2019. Induction of hypothalamic GABA synthetic enzymes mRNA (Gad 1 and Gad 2) expression by negative energy balance in broiler and layer chicks. Neurosci. Lett. 712:134498.

Zhang, B., A. Vogelzang, M. Miyajima, Y. Sugiura, Y. Wu, K. Chamoto, R. Nakano, R. Hatae, R. J. Menzies, K. Sonomura, N. Hojo, T. Ogawa, W. Kobayashi, Y. Tsutsui, S. Yamamoto, M. Maruya, S. Narushima, K. Suzuki, H. Sugiya, K. Murakami, M. Hashimoto, H. Ueno, T. Kobayashi, K. Ito, T. Hirano, K. Shiroguchi, F. Matsuda, M. Suematsu, T. Honjo, and S. Fagarasan. 2021. B cell-derived GABA elicits IL-10+ macrophages to limit anti-tumour immunity. Nature. 599:471-476.

Zheng, J., L. Zhang, J. Liu, Y. Li, and J. Zhang. 2021. Long-term effects of maternal low-protein diet and post-weaning high-fat feeding on glucose metabolism and hypothalamic pomc promoter methylation in offspring mice. Front. Nutr. 8:657848.

Zheng, Z., Y. Zong, Y. Ma, Y. Tian, Y. Pang, C. Zhang, and J. Gao. 2024. Glucagon-like peptide-1 receptor: mechanisms and advances in therapy. Signal. Transduct. Target. Ther. 9:234.

Zulkifli, I., A. F. Akmal, A. F. Soleimani, M. A. Hossain, and E. A. Awad. 2018. Effects of low-protein diets on acute phase proteins and heat shock protein 70 responses, and growth performance in broiler chickens under heat stress condition. Poult. Sci. 97:1306-1314.