Effects of Brown Seaweed Extract Nanoparticles on Liver Enzymes of Broiler Chickens

Faizal Andri[1,2], Nanung Danar Dono[3], Heru Sasongko[3], and Zuprizal Zuprizal[3](✉)

[1] Faculty of Animal Science, Universitas Gadjah Mada, 55281 Yogyakarta, Indonesia
[2] Faculty of Animal Science, Universitas Brawijaya, 65145 Malang, Indonesia
[3] Faculty of Animal Science, Universitas Gadjah Mada, 55281 Yogyakarta, Indonesia
zuprizal@ugm.ac.id

Abstract. This study investigated the effects of brown seaweed extract nanoparticles on liver enzymes of broiler chickens. The drinking water of broiler chickens were treated with no additive (negative control), zinc bacitracin (0.25 g/L; positive control), brown seaweed extracts (2.50 or 5.00 g/L), or brown seaweed extracts nanoparticles (25 or 50 mL/L). The safety of water additives was observed through the serum concentration of aspartate aminotransferase, alanine aminotransferase, and aspartate aminotransferase:alanine aminotransferase ratio as the biochemical marker for hepatocellular injury. Results showed that aspartate aminotransferase was significantly elevated ($P < 0.05$) in the chicks treated with zinc bacitracin, when compared to the negative control. Meanwhile, both brown seaweed extracts and brown seaweed extracts nanoparticles did not alter aspartate aminotransferase compared to negative control. Water additives showed negligible effects on alanine aminotransferase and aspartate aminotransferase:alanine aminotransferase ratio. It could be concluded that brown seaweed extract nanoparticles could be considered as a safe drinking water additive for broiler chickens.

Keywords: aspartate aminotransferase · brown seaweed · liver enzyme · nanoparticle · poultry

1 Introduction

Broiler chickens is currently recognized as one of the most important livestock commodities to fulfill national meat demand in Indonesia. According to DGLAH [1], broiler chicken population is increase from year to year, with the increment rate of 6.31% in the last five years. DGLAH [1] also reported that about 71.5% national meat production originate from broiler chickens. For these reasons, efforts to increase efficiency of broiler chicken production is highly essential to support the fulfillment of national meat demand.

Antibiotic growth promoters (AGP) have been used intensively to improve efficiency of broiler chicken production for over six decades [2]. However, the overuse of AGP led to the emergence of multi-resistant pathogenic microbes growth which threaten both animal and human health. [3–5] For this reason, the use of AGP is now prohibited in

E. Widodo et al. (Eds.): ICESAI 2022, ABSR 28, pp. 405–410, 2023.
https://doi.org/10.2991/978-94-6463-116-6_50

broiler production [3]. In Indonesia, the ban of AGP was started from 2018 [6]. In the absence of AGP, many problems in the growth and health conditions of the birds as well as increasing production cost were reported [7–10]. Therefore, finding safe alternatives for AGP is highly crucial for sustainable broiler chicken production.

Natural extract nanoparticles have recently emerged as promising alternatives to antibiotic growth promoters in the poultry industry. A meta-analysis study by Andri et al. [11] showed that nanoparticles inclusion improved body weight gain and reduced feed conversion ratio without any adverse effect on feed intake of broiler chickens. However, it should be noted that the use of nanoparticles products has potent cellular toxicity [12]. This is because nanoparticles can penetrate every part of the body easily and interact with intracellular metabolism [13]. Furthermore, the safety evaluation of nanoparticles products in broiler chickens is still very limited. Thereby, this study investigated the probable effects of brown seaweed extract nanoparticles on liver enzymes of broiler chickens.

2 Materials and Methods

2.1 Birds and Management

One hundred and ninety-two mixed sex broiler chickens were obtained from a commercial hatchery. Upon arrival, the birds were reared in an open-sided house using rice husk as floor material. On day 11, the birds were distributed into 24 pens representing six treatments with four replicates of eight chicks each.

2.2 Experimental Design

A completely randomized design with six treatments and four replicates was employed in this study. The drinking water of broiler chickens were treated with no additive (negative control), zinc bacitracin (0.25 g/L; positive control), brown seaweed extracts (2.50 or 5.00 g/L), or brown seaweed extracts nanoparticles (25 or 50 mL/L). The experimental treatment was lasted from day 11 up to day 42.

2.3 Liver Enzymes Examination

At the end of the experiment, one bird per replicate pen was chosen. Blood was collected from jugular vein and the serum was separated. Serum concentration of aspartate aminotransferase, alanine aminotransferase, and aspartate aminotransferase:alanine aminotransferase ratio were then examined. These variables were biochemical marker for hepatocellular injury thus observed to evaluate the safety of drinking water additives.

2.4 Statistical Analysis

Data were analyzed statistically using analysis of variance with $P < 0.05$ was considered as significant. Means in the variable with significant effect were separated using Duncan's test. Analyzed data were reported as means $\pm$ standard deviation. All statistical analyses were proceed using IBM SPSS Statistics 22.

3 Results and Discussion

The effects of drinking water inclusion with zinc bacitracin, brown seaweed extract, and brown seaweed extract nanoparticles on serum aspartate aminotransferase, alanine aminotransferase, and aspartate aminotransferase:alanine aminotransferase ratio of broiler chickens is presented in Table 1. The use of zinc bacitracin in drinking water elevated ($P < 0.05$) serum aspartate aminotransferase concentration, when compared to that of negative control. The increment of serum aspartate aminotransferase concentration in the chicks treated with zinc bacitracin was almost 1.5 times to that of negative control. On the other hand, both brown seaweed extract and brown seaweed extract nanoparticles did not alter aspartate aminotransferase compared to that of negative control. Drinking water additives showed a negligible effect on serum alanine aminotransferase concentration of broiler chickens. In the case of aspartate aminotransferase:alanine aminotransferase ratio, no subtantial alteration was observed on all drinking water treatments.

Serum concentration of aspartate aminotransferase, alanine aminotransferase, and aspartate aminotransferase:alanine aminotransferase ratio are indicators of hepatocyte damage induced by drugs metabolism in the liver [14]. In current study, the use of AGP increased serum aspartate aminotransferase concentration of broiler chickens. In agreement with this finding, Haque et al. [15] also reported that the use of ciproflox and renamycin as AGP in broiler chicken diets elevated serum aspartate aminotransferase concentration. Similarly, Lee et al. [16] also observed that aspartate aminotransferase concentration of broiler chickens was increased due to the use of enramycin as AGP. In another study, Erinle et al. [17] also found that the use of bacitracin methylene disalicylate as AGP tended to increase serum aspartate aminotransferase concentration in broiler chickens. It could be stated that the detoxification of antibiotics in the liver induced hepatocyte damage thus releasing aspartate aminotransferase to the circulatory system. This finding provided indication that the use of AGP impaired the liver health of broiler chickens.

The utilization of natural additives rich in bioactive compounds are currently received great attention as AGP alternatives [18–23]. Brown seaweed is one of the potential

Table 1. Effects of drinking water additions on serum concentration of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and AST:ALT ratio of broiler chickens

Treatments	AST	ALT	AST:ALT ratio
Control	193.00 ± 17.91^{a}	13.25 ± 0.50	14.56 ± 1.05
ZB (0.25 g/L)	283.00 ± 18.06^{a}	14.00 ± 0.82	20.27 ± 1.85
BSE (2.5 g/L)	215.50 ± 61.16^{a}	14.00 ± 0.82	15.59 ± 4.99
BSE (5 g/L)	217.75 ± 18.84^{ab}	13.25 ± 1.26	16.57 ± 2.29
BSEN (25 mL/L)	230.25 ± 33.93^{ab}	14.75 ± 1.50	15.79 ± 3.12
BSEN (50 mL/L)	236.25 ± 44.51^{b}	13.75 ± 0.96	17.32 ± 3.96

[ab] uncommon superscripts indicate significant different ($P < 0.05$)
ZB: Zinc Bacitracin, BSE: Brown Seaweed Extract, BSEN: Brown Seaweed Extract Nanoparticles.

resources which could be used as a natural antibacterial agent [24]. The main bioactive substance in brown seaweed extract was phenolic compounds [25, 26]. Nanoparticles technology could be employed to improve the antibacterial efficacy of brown seaweed extract [27]. In this study, the evaluation was focus on safety aspect of brown seaweed extract and brown seaweed extract nanoparticles. Results showed that both brown seaweed extract and brown seaweed extract nanoparticles did not alter serum aspartate aminotransferase concentration. This result probably because brown seaweed extract and brown seaweed extract nanoparticles were natural products so that they did not possess any harmful effect on the health of broiler chickens. In line with this finding, Erinle et al. [17] observed that the use of grape pomace which rich in phenolic compounds as AGP substitute did not alter serum aspartate aminotransferase concentration in broiler chickens. In a study by Adegoke et al. [28] the use of turmeric and cayenne pepper as source of dietary phenolic compounds also had no adverse effect on serum aspartate aminotransferase concentration of broiler chickens.

4 Conclusions

It could be concluded that brown seaweed extract nanoparticles could be considered as a safe drinking water additive for broiler chickens.

Acknowledgment. This study was financially supported by Indonesian Endowment Fund for Education, Ministry of Finance, Republic of Indonesia.

References

1. DGLAH (Directorate General of Livestock and Animal Health): Livestock and Animal Health Statistics 2021. Directorate General of Livestock and Animal Health, Ministry of Agriculture of the Republic of Indonesia. Jakarta (2021).
2. Nazeer, N., Uribe-Diaz, S., Rodriguez-Lecompte, J. C., Ahmed, M.: Antimicrobial peptides as an alternative to relieve antimicrobial growth promoters in poultry. British Poultry Science 62(5), 672-685 (2021).
3. Rahman, M. R. T., Fliss, I., Biron, E.: Insights in the development and uses of alternatives to antibiotic growth promoters in poultry and swine production. Antibiotics 11(6), 766 (2022).
4. Gupta, C. L., Blum, S. E., Kattusamy, K., Daniel, T., Druyan, S., Shapira, R., Krifucks, O., Zhu, Y. G., Zhou, X. Y., Su, J. Q., Cytryn, E.: Longitudinal study on the effects of growth-promoting and therapeutic antibiotics on the dynamics of chicken cloacal and litter microbiomes and resistomes. Microbiome 9(1), 1-19 (2021).
5. Andri, F., Huda, A. N., Marjuki, M.: The use of essential oils as a growth promoter for small ruminants: a systematic review and meta-analysis. F1000Research 9, 486 (2020).
6. Coyne, L., Arief, R., Benigno, C., Giang, V. N., Huong, L. Q., Jeamsripong, S., Kalpravidh, W., McGrane, J., Padungtod, P., Patrick, I., Schoonman, L., Setyawan, E., Sukarno, A. H., Srisamran, J., Ngoc, P. T., Rushton, J.: Characterizing antimicrobial use in the livestock sector in three South East Asian countries (Indonesia, Thailand, and Vietnam). Antibiotics 8(1), 33 (2019).

7. Winaya, I. B. O., Berata, I. K., Dwinata, I. M., Merdana, I. M.: Coccidiosis and hemorrhagic necrotic typhlitis in broilers fed without antibiotic growth promoter. Journal of Advanced Veterinary Research 12(5), 509-512 (2022).
8. Cardinal, K. M., Kipper, M., Andretta, I., Ribeiro, A. M. L.: Withdrawal of antibiotic growth promoters from broiler diets: Performance indexes and economic impact. Poultry Science 98(12), 6659-6667 (2019).
9. Belote, B. L., Tujimoto-Silva, A., Hümmelgen, P. H., Sanches, A. W. D., Wammes, J. C. S., Hayashi, R. M., Santin, E.: Histological parameters to evaluate intestinal health on broilers challenged with *Eimeria* and *Clostridium perfringens* with or without enramycin as growth promoter. Poultry Science 97(7), 2287-2294 (2018).
10. Kumar, S., Chen, C., Indugu, N., Werlang, G. O., Singh, M., Kim, W. K., Thippareddi, H.: Effect of antibiotic withdrawal in feed on chicken gut microbial dynamics, immunity, growth performance and prevalence of foodborne pathogens. PloS One 13(2), e0192450 (2018).
11. Andri, F., Dono, N. D., Sasongko, H., Zuprizal, Z.: Efficacy of nano-phytobiotics to improve growth performance of broiler chickens: Evidence from a meta-analysis. Journal of Advanced Veterinary Research 11(4), 195-202 (2021).
12. Liu, N., Tang, M.: Toxic effects and involved molecular pathways of nanoparticles on cells and subcellular organelles. Journal of Applied Toxicology 40(1), 16-36 (2020).
13. Kumar, V., Sharma, N., Maitra, S. S.: In vitro and in vivo toxicity assessment of nanoparticles. International Nano Letters 7(4), 243-256 (2017).
14. Salem, G. A., Shaban, A., Diab, H. A., Elsaghayer, W. A., Mjedib, M. D., Hnesh, A. M., Sahu, R. P.: Phoenix dactylifera protects against oxidative stress and hepatic injury induced by paracetamol intoxication in rats. Biomedicine & Pharmacotherapy 104, 366-374 (2018).
15. Haque, M. I., Ahmad, N., Miah, M. A.: Comparative analysis of body weight and serum biochemistry in broilers supplemented with some selected probiotics and antibiotic growth promoters. Journal of Advanced Veterinary and Animal Research 4(3), 288-294 (2017).
16. Lee, W. D., Kothari, D., Moon, S. G., Kim, J., Kim, K. I., Ga, G. W., Kim, Y. G., Kim, S. K.: Evaluation of non-fermented and fermented chinese chive juice as an alternative to antibiotic growth promoters of broilers. Animals 12(20), 2742 (2022).
17. Erinle, T. J., Oladokun, S., MacIsaac, J., Rathgeber, B., Adewole, D.: Dietary grape pomace– effects on growth performance, intestinal health, blood parameters, and breast muscle myopathies of broiler chickens. Poultry Science 101(1), 101519 (2022).
18. Cristo, A. B. D., Schmidt, J. M., Benito, C. E., Buzim, R., Pinto, L. A. D. M., Fernandes, J. I.: Effect of the supplementation of plant extracts based additive in broiler chicken diets on productive performance, carcass yield, and meat quality. Brazilian Journal of Poultry Science 24(3), eRBCA-2021–1528 (2022).
19. Redondo, E. A., Redondo, L. M., Bruzzone, O. A., Diaz-Carrasco, J. M., Cabral, C., Garces, V. M., Liñeiro, M. M., Fernandez-Miyakawa, M. E.: Effects of a blend of chestnut and quebracho tannins on gut health and performance of broiler chickens. Plos One 17(1), e0254679 (2022).
20. Dilawar, M. A., Mun, H. S., Rathnayake, D., Yang, E. J., Seo, Y. S., Park, H. S., Yang, C. J.: Egg quality parameters, production performance and immunity of laying hens supplemented with plant extracts. Animals 11(4), 975 (2021).
21. Rabelo-Ruiz, M., Ariza-Romero, J. J., Zurita-González, M. J., Martín-Platero, A. M., Baños, A., Maqueda, M., Valdivia, E., Martínez-Bueno, M., Peralta-Sánchez, J. M.: Allium-Based phytobiotic enhances egg production in laying hens through microbial composition changes in ileum and cecum. Animals 11(2), 448 (2021).
22. Edi, D. N., Habsari, I. K. Andri, F.: Effects of supplementing Mojosari ducks diet with fish oil or fish oil in combination with tomato powder on hatching egg quality during storage. Livestock Research for Rural Development 30, 29 (2018).

23. Habsari, I. K., Edi, D. N., Andri, F.: Economic evaluation of omega-3 fatty acid enriched duck egg production by feeding diet supplemented with Lemuru fish oil. Livestock Research for Rural Development 30, 44 (2018).
24. Andri, F., Dono, N. D., Sasongko, H., Zuprizal, Z.: The effects of dietary seaweed inclusion on growth performance of broiler chickens: a systematic review and meta-analysis. F1000Research 9, 1087 (2020).
25. Baek, S. H., Cao, L., Jeong, S. J., Kim, H. R., Nam, T. J., Lee, S. G.: The comparison of total phenolics, total antioxidant, and anti-tyrosinase activities of Korean Sargassum species. Journal of Food Quality 2021, 6640789 (2021).
26. Sobuj, M. K. A., Islam, M., Haque, M., Alam, M., Rafiquzzaman, S. M.: Evaluation of bioactive chemical composition, phenolic, and antioxidant profiling of different crude extracts of Sargassum coriifolium and Hypnea pannosa seaweeds. Journal of Food Measurement and Characterization 15(2), 1653-1665 (2021).
27. Madureira, A. R., Pereira, A., Pintado, M.: Current state on the development of nanoparticles for use against bacterial gastrointestinal pathogens. Focus on chitosan nanoparticles loaded with phenolic compounds. Carbohydrate Polymers 130, 429–439 (2015).
28. Adegoke, A. V., Abimbola, M. A., Sanwo, K. A., Egbeyale, L. T., Abiona, J. A., Oso, A. O., Iposu, S. O.: Performance and blood biochemistry profile of broiler chickens fed dietary turmeric (Curcuma longa) powder and cayenne pepper (Capsicum frutescens) powders as antioxidants. Veterinary and Animal Science 6, 95-102 (2018).