Jurnal Kajian Veteriner
ISSN: 2356-4113
E-ISSN: 2528-6021
Vol.14 No. 1: 74-86 (2026)
DOI: https://doi.org/10.35508/jkv.v14i1.24932

Hepatoprotective Effects of Durian Seed Extract on Broiler Chickens: Evaluation of Serum SGPT and SGOT Levels

(Efek Hepatoprotektor Ekstrak Biji Durian terhadap Ayam Broiler: Evaluasi Kadar SGPT dan SGOT)

Suriansyah[1]*, Hikmawaty[2], Andi Citra Septaningsih[3] , Hendro Sukoco[4] , Adriany Ris[5], Korbinianus Feribertus Rinca[6]

[1, 2,3,4,5] Program Studi Peternakan, Universitas Sulawesi Barat, Majene
[6] Program Studi Kedokteran Hewan, Universitas Nusa Cendana, Kupang
*Korespondensi Email: suriansyah@unsulbar.ac.id

ABSTRAK

Tujuan dari penelitian ini adalah untuk menentukan kadar enzim Serum Glutamic Oxaloacetic Transaminase (SGOT) dan Serum Glutamic Pyruvate Transaminase (SGPT) pada ayam broiler yang diberi ekstrak biji durian (Durio zibethinus L.) di bawah kondisi cekaman panas. Ekstrak biji durian diketahui mengandung senyawa bioaktif seperti flavonoid, fenol, polifenol, tanin, saponin, dan alkaloid, serta vitamin C, vitamin E, dan mineral esensial. Kandungan tersebut berfungsi sebagai antioksidan alami dan sumber multivitamin yang mampu mendukung sistem imun, menjaga fungsi fisiologis, serta meningkatkan ketahanan tubuh unggas. Penelitian ini menggunakan Rancangan Acak Lengkap (RAL) dengan lima kelompok perlakuan dan lima ulangan. Kelompok perlakuan terdiri atas: P0 yaitu ayam broiler yang dipelihara dalam kondisi cekaman panas dengan pemberian 0,0 mL/L ekstrak biji durian; P1 yaitu cekaman panas dengan 1,0 mL/L ekstrak biji durian; P2 yaitu cekaman panas dengan 1,5 mL/L ekstrak biji durian; P3 yaitu cekaman panas dengan 2,0 mL/L ekstrak biji durian; dan P4 yaitu cekaman panas dengan 2,5 mL/L ekstrak biji durian. Sampel darah diambil setelah periode perlakuan, dan kadar SGOT serta SGPT diukur di laboratorium. Hasil penelitian menunjukkan bahwa pemberian ekstrak biji durian tidak berpengaruh signifikan terhadap kadar SGPT ayam broiler (P>0,05). Namun, kadar SGOT bervariasi antar kelompok, dengan nilai tertinggi terdapat pada P0. Hal ini menunjukkan bahwa ekstrak biji durian tidak bersifat hepatotoksik dan dapat digunakan sebagai alternatif antioksidan dan multivitamin. Temuan ini mendukung pemanfaatan ekstrak biji durian sebagai sumber antioksidan alami dan multivitamin yang berperan dalam mengurangi ketergantungan pada multivitamin sintetis tanpa memberikan dampak negatif pada fungsi hati
***Keywords**: antioksidan; broiler; cekaman panas; ekstrak biji durian, SGOT; SGPT*

INTRODUCTION

Broiler chickens are a vital poultry commodity for meeting the demand for animal protein due to their high growth rate and efficient

feed conversion. However, their productivity is highly sensitive to environmental stressors, particularly high temperatures in tropical regions. Heat stress has been identified as one of the major challenges in poultry production, leading to reduced feed intake, impaired growth, poor feed efficiency, metabolic disturbances, and even higher mortality rates (Oluwagbenga *et al*., 2023; Oke *et al*., 2024; Attia *et al*., 2022). A recent review also emphasized that heat stress induces systemic physiological and biochemical changes, which directly compromise animal welfare and performance (Oke *et al*,, 2024).

Oxidative stress is considered the key mechanism underlying the detrimental effects of heat stress. Excessive production of reactive oxygen species (ROS) overwhelms the endogenous antioxidant defense system, resulting in cellular damage, impaired metabolism, and organ dysfunction (Azad *et al.*, 2018; Habibu *et al.*, 2020). The liver, being the central metabolic and detoxification organ, is particularly vulnerable to oxidative damage. Elevated activities of Serum Glutamic Oxaloacetic Transaminase. (SGOT/AST) and Serum Glutamic Pyruvate Transaminase (SGPT/ALT) in blood serum are widely recognized as biochemical markers of hepatocellular injury (Moriles and Fyrst, 2024; Habibu *et al*., 2020).

To counteract oxidative stress, nutritional strategies involving natural feed additives with antioxidant and multivitamin properties have gained increasing attention. Among various plant-based resources, durian seed extract (*Durio zibethinus* L.) has shown promising potential. Several studies reported that durian seeds and other by-products contain high levels of phenolics, flavonoids, tannins, saponins, and alkaloids, in addition to vitamin C, vitamin E, and essential minerals, all of which contribute to strong antioxidant capacity (Akinmoladun *et al.*, 2021; Lim *et al.*, 2021; Ginting *et al*., 2024). Moreover, antioxidant and anti-inflammatory activities from durian pulp, seed, and peel extracts have been validated in vitro, suggesting their potential application in animal nutrition (Nurul *et al*., 2021; Rahmawati *et al*., 2023) durian seed extract in broiler chickens is still very limited, particularly under heat stress conditions. Previous broiler work on durian seed extract under heat stress has mainly evaluated growth performance, carcass traits, organ development, and intestinal morphometry, but has not specifically examined biochemical indicators of liver function such as SGOT and SGPT. In

Despite these promising bioactive properties, the utilization of durian seeds as a functional feed additive in poultry remains limited. Most research has focused on laboratory-scale assays of antioxidant and anti-inflammatory activity, while evidence for practical application in poultry is still scarce (Charoenphun *et al*., 2022). To date, quantitative evidence regarding the *in vivo* use of

addition, heat stress itself is known to impair hepatic status and increase serum AST in broilers, indicating that liver-related biomarkers are relevant endpoints in heat-stress studies (Tang *et al*., 2022). Considering the abundance of durian seeds as an underutilized agro-industrial by-product, their incorporation into poultry feed could provide dual benefits: enhancing poultry health and performance while promoting waste valorization and sustainability. Therefore, the present study was designed to evaluate the effect of durian seed extract supplementation on SGOT and SGPT levels in broiler chickens exposed to heat stress. The novelty of this study lies in the *in vivo* evaluation of durian seed extract as a natural antioxidant feed additive in heat-stressed broilers, with specific emphasis on liver function biomarkers. This approach is relevant because nutritional supplementation with plant-derived bioactives has been widely recognized as a promising strategy to alleviate heat stress in chickens, yet evidence specifically using durian seed extract and SGOT–SGPT responses remains unavailable or very limited (Mahasneh *et al*., 2024; Kim *et al*., 2025). The outcomes are expected to provide new insights into the role of durian seed extract as a safe and effective natural antioxidant and multivitamin source, supporting sustainable broiler production systems in tropical environments.

The outcomes are expected to provide new insights into the role of durian seed extract as a potential natural antioxidant-rich feed additive for broilers reared under heat stress conditions. Previous studies have shown that durian seed and other durian by-products possess measurable antioxidant and anti-inflammatory activity, supporting their potential as functional bioresources (Charoenphun and Klangbud, 2022). In poultry production, oxidative stress is widely recognized as a major factor that impairs growth, immunity, and physiological function, particularly under environmental challenges such as high ambient temperature (Oke *et al*., 2024). Nutritional supplementation with plant-derived bioactives has therefore been increasingly proposed as a practical strategy to improve antioxidant status, immunity, and intestinal health in heat-exposed chickens (Mahasneh *et al*., 2024; Kim *et al*., 2025). Experimental evidence also shows that chronic heat stress at 35 ± 2°C for 8 h/day can increase serum AST, elevate hepatic MDA, alter SOD activity, and induce liver injury in broilers, confirming that liver-related biomarkers are relevant indicators in heat-stress studies (Tang *et al*., 2022). In addition, recent work with phytogenic antioxidants demonstrated that plant flavonoids can alleviate cyclic heat stress-induced liver injury in broilers through regulation of the Keap1–Nrf2 pathway and antioxidant genes such as HO-1, NQO1, and SOD-1 (Yuan *et al*., 2025). Therefore, the present

study is relevant because it extends this line of research to durian seed extract, an underutilized agro-industrial by-product whose specific effects on SGOT and SGPT responses in heat-stressed broilers remain unavailable or still very limited.

MATERIALS AND METHODS

The extraction of durian seeds was carried out using a modified standard method described by Heinrich (2022) and recent studies on the utilization of durian seeds as a source of bioactive compounds. Fresh durian seeds (*Durio zibethinus* L.) were obtained from local markets, thoroughly washed under running water to remove adhering impurities, and air-dried under shade to avoid direct sunlight exposure in order to preserve their phytochemical stability. Once dried, the seeds were ground into a fine powder using an electric grinder. A total of 500 g of seed powder was placed in a tightly sealed glass container to prevent contamination.

To induce heat stress, broiler chickens were exposed to an ambient temperature of 34 ± 1°C for 8 hours daily (09:00–17:00) from day 22 to day 35 of the experimental period. Relative humidity was maintained at 70 ± 5% during the heat exposure period, and both temperature and humidity were recorded twice daily using a digital thermo-hygrometer. The Temperature Humidity Index (THI) was calculated to confirm the heat stress condition, and the average THI during the treatment period was classified as indicative of heat stress in broiler chickens. These environmental conditions were maintained consistently to ensure that the heat stress model could be replicated and validly applied throughout the study.

Maceration was carried out using 70% ethanol as the extraction solvent. A total of 500 g of durian seed powder was mixed with 2500 mL of 70% ethanol at a ratio of 1:5 (w/v). The mixture was placed in a clean glass container, tightly sealed to prevent solvent evaporation and contamination, and wrapped with aluminum foil to minimize light exposure and protect the stability of bioactive compounds during extraction. The maceration process was conducted at room temperature for 7 days, during which the mixture was stirred periodically to improve solvent penetration and enhance the dissolution of phytochemical constituents from the durian seed powder. After the extraction period, the macerate was filtered to separate the liquid extract from the residue, and the filtrate was collected for further processing. The resulting mixture was filtered through Whatman No. 1 filter paper to obtain the filtrate. The filtrate was then concentrated using a rotary evaporator at 50–55 °C until a viscous durian seed extract was obtained. The

viscous extract was prepared as a stock solution at 100% concentration, and subsequently diluted with distilled water to obtain the experimental concentrations of 1.0 mL/L, 1.5 mL/L, 2.0 mL/L, and 2.5 mL/L. The selection of these concentration ranges was based on previous reports indicating that durian seed extract exhibits strong antioxidant activity due to the presence of flavonoids, polyphenols, tannins, saponins, vitamin C, and vitamin E.

The experiment was conducted in an elevated cage system raised 1 m above ground level. The cage was divided into five compartments, each measuring 200 × 150 × 100 cm. Each compartment was assigned to one treatment group and housed 20 broiler chickens under intensive management, with standard feeders and drinkers provided in each compartment. Thus, a total of 100 broiler chickens were used in the experiment. However, only 10 birds from each treatment group were randomly selected for blood collection and serum biochemical analysis of SGOT and SGPT levels.

Before the treatment period, the broilers underwent a 14-day adaptation phase to acclimatize to the experimental environment. Following adaptation, the birds were provided with commercial broiler feed (corn–concentrate based) and drinking water ad libitum. Durian seed extract was administered daily through the drinking water using gallon containers, with concentrations adjusted according to the assigned treatment groups (P0–P4). Administration was carried out consistently at the same time each day to ensure treatment uniformity.

Blood samples were collected from the brachial vein of the broilers using a sterile 3 mL syringe and immediately transferred into vacutainer tubes without anticoagulant for serum preparation (Bounous and Stedman, 2000; Kaneko *et al*., 2008). To maintain sterility and avoid cross-contamination, a new syringe was used for each bird. The average blood volume collected was approximately 2.5–3 mL per bird, following standard procedures. After collection, the blood was allowed to clot at room temperature before centrifugation to obtain the serum for SGOT and SGPT analysis.

The blood samples were centrifuged at 3000 rpm for 15 minutes to separate the serum from the cellular components (Kalas *et al*., 2021). The obtained serum was then transferred into sterile microtubes and stored at –20 °C until further analysis (Habibu *et al*., 2020). The activity of the liver enzymes, namely Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvate Transaminase (SGPT), was measured at the Animal Science Laboratory, Universitas Sulawesi Barat. Biochemical analysis was performed using the kinetic enzymatic method with a commercial diagnostic kit according to the manufacturer's protocol, and

absorbance was read with a spectrophotometer at 340 nm (Talli *et al*., 2025; Moriles and Fyrst, 2024). The results were expressed in U/L (Units per Liter).

The quantitative data obtained, consisting of SGOT and SGPT values from the serum of broiler chickens, were statistically analyzed using Analysis of Variance (ANOVA) to determine treatment effects, followed by Duncan's Multiple Range Test (DMRT) for mean comparison among treatments (Wu and Hamada, 2021; Wu and Hamada, 2021). Statistical analyses were conducted using SPSS version 25, with the level of significance set at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Table 1 presents the results of the quantitative analysis of Serum Glutamic Pyruvate Transaminase (SGPT) levels in broiler chickens supplemented with durian seed extract under heat stress conditions, analyzed using Duncan's Multiple Range Test (DMRT). The results indicate that the administration of durian seed extract at various concentrations did not significantly affect ($P>0.05$) the serum SGPT levels.

As shown in Table 1, the mean SGPT levels of the treatment groups (P1–P4) were lower than that of the control group (P0). This trend suggests that durian seed extract did not induce hepatotoxic effects, as SGPT is widely recognized as a sensitive biomarker of hepatocellular injury (Kalas *et al*.,2021).

SGPT is an enzyme synthesized predominantly in hepatocytes, and elevated serum SGPT levels are typically associated with liver cell membrane damage. In this study, the relatively lower SGPT levels in broilers supplemented with durian seed extract indicate that the bioactive compounds such as flavonoids, tannins, saponins, and vitamins C and E may have played a role in protecting hepatocytes from oxidative stress. In this study, the SGPT values observed in broilers supplemented with durian seed extract ranged from 0.70 to 0.94 U/L. For comparison, published reference values for chickens indicate that ALT/SGPT is commonly reported at approximately 9–14 U/L and AST/SGOT at 90–226 U/L (Arzour-Lakehal *et al*., 2021). More recent reference-interval data in 35-day-old broilers also showed wider normal ranges, with ALT at 0.0–0.4 µkat/L (approximately 0–24 U/L) and AST at 1.4–5.7 µkat/L (approximately 84–342 U/L) (Zálešáková *et al*., 2025). Therefore, the SGPT values obtained in the present study appear lower than commonly reported literature values and should be interpreted cautiously, particularly with respect to analytical method, unit conversion, and reference standards used.

SGPT is an enzyme localized

predominantly in hepatocytes, and increased serum SGPT activity is a recognized indicator of hepatocellular membrane damage and liver cell injury (Moriles and Fyrst, 2024; Lala *et al*., 2023). In this study, the lower SGPT levels observed in broilers supplemented with durian seed extract indicate that the extract did not cause hepatocellular damage under the conditions tested. This finding is consistent with published evidence showing that durian seed contains antioxidant-associated bioactive compounds, particularly flavonoids, saponins, and phenolic compounds, with demonstrated antioxidant activity (Charoenphun and Klangbud, 2022; Aisyah *et al*., 2024). Nevertheless, because oxidative stress markers were not analyzed, the present study confirms the absence of adverse biochemical effects on SGPT, but does not directly confirm the antioxidant mechanism itself.

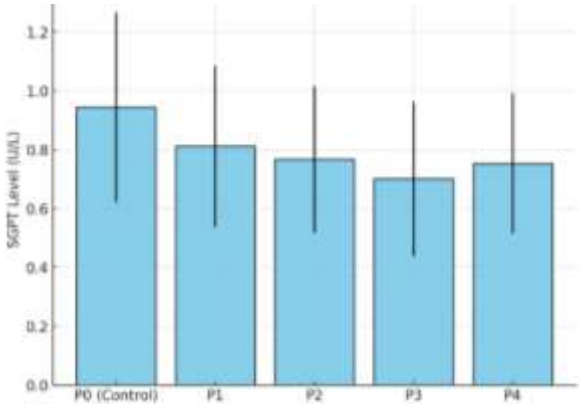

Figure 1. SGPT Levels of Broiler Chickens after Durian Seed Extract Supplementation under Heat Stress

Figure 1. The bar chart shows the SGPT levels (U/L) of broiler chickens under heat stress after supplementation with durian seed extract at various concentrations. The control group (P0) recorded the highest SGPT value, while treatment groups (P1–P4) exhibited lower mean values, ranging from 0.70 to 0.82 U/L. Despite these numerical differences, Duncan's test revealed that the variations were not statistically significant ($P>0.05$). The results suggest that supplementation with durian seed extract did not induce hepatocellular damage, as reflected by stable SGPT values across treatments. In poultry, alanine aminotransferase (ALT/SGPT) and aspartate aminotransferase (AST/SGOT) are still used as biochemical indicators to assess liver status, especially under environmental or metabolic stress conditions. Recent studies in broilers have shown that heat stress can increase serum AST activity and cause liver injury, supporting the relevance of transaminase evaluation in poultry research. Therefore, the lower SGPT values observed in the supplemented groups compared with the control indicate that durian seed extract supplementation did not produce adverse biochemical changes associated with hepatocellular injury

under the conditions of this study. However, because oxidative stress biomarkers were not measured, this finding should be interpreted as evidence of biochemical safety rather than direct confirmation of an antioxidant hepatoprotective mechanism (Tang *et al*., 2022; Ballo *et al*., 2022; Zálešáková *et al*., 2025).

Furthermore, the downward trend in SGPT values in the groups receiving durian seed extract should be interpreted cautiously. Recent evidence shows that durian contains diverse bioactive compounds, including phenolics, flavonoids, tannins, and vitamins, and its by products have potential for functional valorization (Khaksar *et al*., 2024). In heat stressed broilers, supplementation with plant derived extracts has also been reported to improve blood biochemistry, antioxidant related responses, and physiological resilience, as shown for oregano and rosemary leaf extracts (Madkour *et al*., 2024) and dietary rutin (Hafez *et al*., 2025). Similarly, antioxidant supplementation has been reported to reduce lipid peroxidation and improve antioxidant defense-related responses in poultry exposed to heat stress (Pasri *et al*., 2025). Therefore, the relatively stable SGPT values observed in the present study indicate that durian seed extract did not produce adverse biochemical changes associated with hepatocellular damage under the tested conditions. However, because oxidative stress markers were not measured, the present findings should be interpreted as evidence of biochemical safety and discussed in comparison with previous phytogenic studies, rather than as direct confirmation of an antioxidant hepatoprotective mechanism.

Tabel 1. Duncan's test outcomes for SGPT levels in broiler chickens after durian seed extract supplementation

Group	Mean ± standard deviation
P0	0.945 ± 0.322
P1	0.812 ± 0.274
P2	0.768 ± 0.249
P3	0.701 ± 0.263
P4	0.754 ± 0.238

Table 2 outlines the SGOT enzyme levels in broiler chickens after supplementation with durian seed extract under heat stress. The highest SGOT value was found in P0 (control, 218.55 U/L), while the lowest value appeared in P1 (1.0 mL/L durian seed extract, 165.32 U/L). Intermediate values were observed in P2 (1.5 mL/L; 178.46 U/L), P3 (2.0 mL/L; 187.29 U/L), and P4 (2.5 mL/L; 193.74 U/L). Although numerical differences were observed among groups, the statistical analysis showed that these differences were significant ($P<0.05$).This indicates

that the inclusion of durian seed extract at these concentrations did not elicit hepatotoxic responses in the broilers under heat stress.

SGOT is an enzyme found in the liver as well as in other tissues such as heart and kidneys, which reduces its specificity as a sole marker of hepatic damage (Ballo *et al.*, 2022). In this study, the lack of a significant change in SGOT further supports the notion that durian seed extract is biochemically safe when used in broiler diets under thermal challenge. Furthermore, the antioxidant properties of durian seed extract documented in recent research showing strong radical scavenging activity and phenolic/flavonoid content (Charoenphun *et al*., 2022) may contribute to hepatoprotection, counteracting oxidative stress that often elevates transaminase levels in heat-stressed poultry.

Table 2. Duncan's test results on SGOT levels in Broiler chickens

	Group	**N**	**Mean ± SD (U/L)**	**Duncan's Notation**
	P0	10	218,55±0,31	d
	P1	10	165.32±0.27	a
Duncan	P2	10	178.46±0.26	b
	P3	10	187.29±0.28	bc
	P4	10	193.74±0.25	c

Values with different superscripts in the same column are significantly different (P<0.05)

The findings of this study demonstrate that the bioactive compounds in durian seed extract such as tannins, saponins, flavonoids, and other secondary metabolites did not elevate SGPT or SGOT levels. The absence of significant effects on these parameters can be explained by the fact that SGOT, although primarily derived from the liver, is also expressed in extrahepatic tissues such as muscle, kidney, and heart, whereas SGPT is more specific to hepatocytes (Tang *et al*., 2022). Therefore, SGOT alone cannot be regarded as a sole biomarker of hepatic impairment, but concurrent increases in both SGOT and SGPT usually signify hepatocellular injury. In this study, the stable levels of both enzymes across treatments indicate that durian seed extract did not disrupt liver cell integrity or metabolism.

Liver dysfunction typically results from hepatocyte damage, which alters membrane permeability and transport functions, thereby facilitating the leakage of intracellular enzymes such as SGOT and SGPT into the bloodstream (Tang *et al*., 2022). The lack of significant enzyme elevation in this study may suggest that durian seed extract did not negatively influence liver function in broilers exposed to heat stress. Any assumption regarding its antioxidant

or hepatoprotective activity should still be treated cautiously, as such interpretation is mainly supported by previous studies and not directly demonstrated in the present experiment. Because oxidative stress indicators, including MDA, SOD, and CAT, were not evaluated, the underlying antioxidant mechanism cannot yet be confirmed. Thus, under the conditions of this study, durian seed extract may be viewed as a potentially safe feed additive, while its specific functional effects require further investigation.

CONCLUSION

The oral administration of durian seed extract in broilers did not result in significant changes in the SGOT and SGPT parameters measured in this study.

ACKNOWLEDGMENTS

The authors would like to sincerely thank the BIMA Research Grant Program, the Ministry of Science and Technology, and the Research and Community Service Institute (LPPM), Universitas Sulawesi Barat (UNSULBAR) for their financial support and the research facilities provided during the course of this study.

REFERENCES

Aisyah, S., Harioputro, D.R. and Nurwati, I. (2024). The potential of durian seed (*Durio zibethinus* Murr.) as natural resources with antioxidant activity and total flavonoid content', *NST Proceedings*, Pp 14-19. https://doi.org/10.11594/nstp.2024.4303

Akinmoladun, F. O., Komolafe, T. R., Farombi, E. O., & Olaleye, T. M. (2021). Phytochemical constituents and antioxidant potential of *Durio zibethinus* seeds. *Journal of Food Biochemistry, 45*(6), e13748. https://doi.org/10.1111/jfbc.13748

Arzour-Lakehal, N., Mehedi, M.Y., Iraqui, H.M., Martínez-Pastor, F. and Ain Baziz, H. (2021).Biochemical reference intervals in broiler chickens according to age and strain', *Veterinarski Arhiv*, 91(2), pp. 207–219.

Attia, Y. A., Hassan, S. S., & Al-Harthi, M. A. (2022). The detrimental impacts of heat stress on poultry health and performance and potential mitigation strategies. *Animals*, *12*(15), 1939.

https://doi.org/10.3390/ani12151939

Ballo, A., Rasyid, H. and Abdullah, M. (2022). Evaluation of serum aminotransferase activity as indicators of liver function in poultry under environmental stress', *Veterinary World*, 15(7), pp. 1874–1882. https://doi.org/10.14202/vetworld.2022.1874-1882

Charoenphun, N. and Klangbud, W.K. (2022). Antioxidant and anti-inflammatory activities of durian (*Durio zibethinus* Murr.) pulp, seed and peel flour', *PeerJ*, 10, e12933. https://doi.org/10.7717/peerj.12933

Ginting, C. N., Hasibuan, R., & Lubis, Z. (2024). The potential of durian seed (*Durio zibethinus* Murr.) as natural resources with antioxidant activity and total flavonoid content. *IOP Conference Series: Earth and Environmental Science, 1260*, 012032. https://doi.org/10.1088/1755-1315/1260/1/012032

Habibu, B., Ghazali, M., & Shukor, M. Y. (2020). Heat stress in poultry: Mechanisms and management. *Pertanika Journal of Tropical Agricultural Science, 43*(4), 451–466.

Hafez, M.H., Ashoura, N.R., Khatab, S.A., Waheeb, T.S., Saad, H.M. and Esmail, K.A. (2025). Heat stress relief for broiler chickens: Dietary rutin improved growth performance, immunity, antioxidant capacity, histopathologic picture and gene expression profile', *Research in Veterinary Science*, 181, 105782.

Heinrich, M., Jalil, B., Abdel-Tawab, M., Echeverria, J., Kulić, Ž., McGaw, L.J., Pešic, M., Williamson, E.M. and Potterat, O. (2022). Best practice in the chemical characterisation of extracts used in pharmacological and toxicological research—The ConPhyMP guidelines', *Frontiers in Pharmacology*, 13, 953205. https://doi.org/10.3389/fphar.2022.953205

Kalas, M.A., Chavez, L., Leon, M. and Taweesedt, P.T. (2021). Abnormal liver enzymes: A review for clinicians', *World Journal of Hepatology*, 13(11), pp. 1688–1698.

Khaksar, G., Assatarakul, K., Sirikantaramas, S. and Techawongstien, S. (2024). Durian (*Durio zibethinus* L.): Nutritional composition, bioactive compounds, and valorization potential', *Horticulturae*, 10(4), 342.

Kim, Y.B., Yeom, G.L., Park, J.Y., Lee, H.N., Park, G.Y., Shin, J.W., Lee, S.Y. and Kim, J.H. (2025). Nutritional strategies to alleviate heat stress in

broiler chickens and laying hens: role of functional nutrients', *Journal of Animal Science and Technology*, 67(5), pp. 949–981. https://doi.org/10.5187/jast.2500205.

Lala, V., Goyal, A. and Bansal, P. (2023). Liver Function Tests', in *StatPearls*. Treasure Island (FL): StatPearls Publishing.

Lim, T. K., Phan, C. W., & Sabaratnam, V. (2021). Antioxidant and anti-inflammatory activities of durian (*Durio zibethinus* Murr.) pulp, seed, and peel flour. *Journal of Food Science and Technology*, *58*(7), 2647–2656. https://doi.org/10.1007/s13197-020-04806-w

Madkour, M., Alagawany, M., Taha, A.E., Saadeldin, I.M. and Reda, F.M. (2024). Growth performance, blood biochemistry, and mRNA expression of heat shock proteins in heat-stressed broiler chickens fed oregano and rosemary leaf extracts', *Journal of Thermal Biology*, 120, 103760.

Mahasneh, Z.M.H., Abuajamieh, M., Abedal-Majed, M.A., Alqaisi, O., Alsmadi, F., Al-Ghadi, M.Q., Al-Fataftah, A.-R. and El Sabry, M.I. (2024). Effects of medical plants on alleviating the effects of heat stress on chickens', *Poultry Science*, 103(3), 103391. https://doi.org/10.1016/j.psj.2023.103391

Wu, C.F.J. and Hamada, M. (2021) *Experiments: Planning, Analysis, and Optimization*. 3rd edn. Hoboken, NJ: Wiley.

Moriles, K.E. and Fyrst, H. (2024). Alanine Aminotransferase (ALT) Test', in *StatPearls*. Treasure Island (FL): StatPearls Publishing.

Nurul, H., Rahman, S., & Karim, R. (2021). Exploration of antibacterial and antioxidative activity of *Durio zibethinus* seed and peel extracts. *Journal of Food Processing and Preservation*, *45*(5), e15662. https://doi.org/10.1111/jfpp.15662

Oke, O.E., Akosile, O.A., Oni, A.I., Opowoye, I.O., Ishola, C.A., Adebiyi, J.O., Odeyemi, A.J., Adjei-Mensah, B., Uyanga, V.A. and Abioja, M.O. (2024). Oxidative stress in poultry production', *Poultry Science*, 103(9), 104003. https://doi.org/10.1016/j.psj.2024.104003

Oluwagbenga, E.M., Ojediran, T.K. and Fafiolu, A.O. (2023). Heat stress and poultry production: a comprehensive review', *Poultry Science*, 102(12), 103265

Pasri, P., Tamtibunyers, T., Hanan, N. and Bunchasak, C. (2025). Alleviating heat stress on broiler breeder hens: Effect of either organic selenium or

phytogenic antioxidants on productive performance, oxidative stress, and offspring quality', *Research in Veterinary Science*, 179, 105661.

Rahmawati, N., Sari, R. P., & Utami, T. (2023). Phytochemical profile and antioxidant properties of durian seed extract for potential application in functional foods. *Food Research, 7*(2), 133–141. https://doi.org/10.26656/fr.2017.7(2).713

Talli, I., Marchioro, L., Zaninotto, M., Cosma, C., Pangrazzi, E., Artusi, C., Padoan, A. and Plebani, M. (2025). Measurement of AST and ALT with Pyridoxal-5′-Phosphate according to IFCC: A decades-long gap seems to be filled', *Clinica Chimica Acta*, 569, 120158.

Tang, L. P., Chen, Z. H., Zhao, Y. X., & Zhang, Y. (2022). Heat stress in broilers: Effects on liver injury and the protective role of natural antioxidants. *Poultry Science, 101*(9), 101874. https://doi.org/10.1016/j.psj.2022.101874

Yuan, J., Li, Y., Miao, J., Zhang, X., Xiong, Y., Ma, F., Ding, J. and He, S. (2025). Bamboo leaf flavonoids ameliorate cyclic heat stress-induced oxidative damage in broiler liver through activation of Keap1-Nrf2 signaling pathway', *Poultry Science*, 104(4), 104952. https://doi.org/10.1016/j.psj.2025.104952

Zálešáková, D., Novotný, J., Řiháček, M., Horáková, L., Mrkvicová, E., Šťastník, O. and Pavlata, L. (2025). The blood biochemical parameters intervals and dynamics in modern broiler chickens', *Veterinary and Animal Science*, 29, 100465. https://doi.org/10.1016/j.vas.2025.100465.