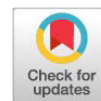


Research Article



Effect of Dietary Dried *Stevia rebaudiana* Leaf Powder on Growth Performance, Antioxidant Status, and Heat Stress Tolerance in Ross 308 Broiler Chickens

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Abstract | Heat stress is a significant limitation to broiler production, particularly in hot climates, where growth performance, oxidative balance, and physiological stability is affected. This study assesses the effects of graded dietary levels of dried *Stevia rebaudiana* leaf powder on growth performance, antioxidant status and tolerance to heat stress in Ross 308 broilers. Three hundred one-day old chicks were randomly assigned to five dietary treatments (0, 0.75, 1.50, 2.25 and 3.00 g/kg). The treatments were designed on a completely randomized design and replicated three times. On day 35, birds were subjected to acute heat stress (42°C). A significant difference ($P \leq 0.05$) was observed in final body weight, body weight gain, and feed conversion ratio in broilers fed diets supplemented with stevia leaves compared with the control group, with the 2.25 g/kg supplementation level showing the most favorable results. Moreover, supplementation with stevia leaves substantially increased ($P \leq 0.05$) the activities of superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH), while decreasing malondialdehyde (MDA) levels. Stevia fed birds under heat challenge had a lower ($P \leq 0.05$) body temperature, respiratory rate and heterophil-to-lymphocyte ratio which are indicative of improved thermoregulation and stress tolerance. Health and performance of birds were unaffected at all levels of supplementation because significant improvements in performance and antioxidant status were reported. The results indicate that a dietary inclusion of dried *Stevia rebaudiana* leaf powder at the level of 2.25 g/kg may be safely used as an effective phytogetic tool for improving growth efficiency and heat stress tolerance of broiler chickens raised under hot ambient temperatures.

Keywords | *Stevia rebaudiana*, Broiler chickens, Oxidative stress, Thermoregulation, Phytogetic feed additives, Performance efficiency

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INTRODUCTION

Heat stress is a huge barrier to broiler productivity and is especially marked in tropical and subtropical climates. High levels of heat drift are very damaging to a broiler's ability to maintain proper physiological balance, reduce their ability to consume feed, grow and as a result produce large quantities of low-cost meat, and cause the

bird to produce excess amounts of free radicals causing a decline in profitability (Lara and Rostagno, 2013; El-Sabrou et al., 2023). One example of the susceptibility of rapid growing genetically selected birds such as Ross 308 to thermal stress is due to their high metabolism resulting in proportionally high rates of metabolic heat production.

Overproduction of reactive oxygen species (ROS) induced

by heat stress results in oxidative damage and reduced productive and immune capabilities of animals. As such, there has been a growing interest in implementing nutritional interventions to support the antioxidant defense systems of poultry (Akbarian *et al.*, 2016; Surai, 2020).

The use of phytogetic additives in animal feeds has grown tremendously in popularity over the last several years due to their various positive effects on animal health and performance. This is especially true of *Stevia rebaudiana* which has many different bioactive compounds including steviol glycosides as well as phenolic and flavonoid compounds which have the ability to offer both antioxidant as well as metabolic regulatory effects (Gasmalla *et al.*, 2014; Alagawany *et al.*, 2018; Chatsudthipong and Muanprasat, 2021). A number of studies have demonstrated that the inclusion of stevia into poultry diets produces positive results among birds with regard to growth rates, antioxidant status and immune performance (Shehata *et al.*, 2020; Hussain *et al.*, 2022). Despite these benefits, very few studies have evaluated what the best inclusion level for dried stevia leaf is in poultry diets during times of heat stress.

Therefore, the present study evaluated the effects of varying levels of dried Stevia leaves on growth performance, antioxidant status, and physiological indicators of heat stress, as well as their combined effects on heat-stress tolerance in Ross 308 broiler chickens exposed to heat-stress conditions.

MATERIALS AND METHODS

ANIMALS AND EXPERIMENTAL DESIGN

A total of 300 unsexed Ross 308 broiler chicks were randomly assigned to the experimental treatments. Random allocation was applied to ensure a comparable distribution of male and female birds among treatment groups and to minimize the potential influence of sex-related variation on the measured parameters. Upon arrival, chicks were individually weighed and randomly allocated to five dietary treatments according to a completely randomized design (CRD). Each treatment consisted of three replicates with 20 birds per replicate.

Birds were reared under floor housing conditions using fresh litter material and provided *ad libitum* access to feed and water throughout the 35-day experimental period. Standard management and vaccination programs were applied according to commercial broiler production guidelines. Environmental conditions were maintained according to Ross 308 management recommendations during the thermoneutral phase.

All experimental procedures were conducted in accordance with institutional guidelines for animal care and welfare.

TREATMENTS

Five dietary treatments were established to evaluate the effect of dried *Stevia rebaudiana* leaf powder supplementation in broiler diets. The control group received a basal diet without any supplementation, while the remaining four experimental groups were fed the basal diet supplemented with dried *Stevia rebaudiana* leaf powder at graded levels of 0.75, 1.50, 2.25, and 3.00 g/kg feed.

The dried stevia leaves were finely ground to ensure uniform mixing and incorporated into the diets at the expense of an equivalent proportion of the basal feed ingredients to support nutrient balance across treatments. All experimental diets were formulated to be isocaloric and isonitrogenous and were prepared in mash form. Dried *Stevia rebaudiana* leaf powder was obtained from a commercial supplier and used as a dietary supplement. According to the manufacturer's specifications and published literature, stevia leaves have steviol glycosides (primarily stevioside and rebaudioside A), phenolic compounds, flavonoids, dietary fiber, and natural antioxidants, which are considered responsible for their biological and antioxidant activities (Gasmalla *et al.*, 2014; Chatsudthipong and Muanprasat, 2021).

The supplementation levels were selected based on preliminary trials and published literature indicating the efficacy of phytogetic feed additives within this inclusion range for improving antioxidant status, physiological responses, and productive performance without adversely affecting feed intake or nutrient use (Shehata *et al.*, 2020; Hussein *et al.*, 2022; Alagawany *et al.*, 2018).

DIET FORMULATION

The basal diets were formulated to meet or exceed the nutrient requirements of broiler chickens as recommended by the National Research Council (NRC, 1994). Three feeding phases were adopted throughout the experimental period: starter (1–10 days), grower (11–24 days), and finisher (25–35 days). Diets were formulated to be isocaloric and isonitrogenous across all treatments.

Dried *Stevia rebaudiana* leaf powder was incorporated into the basal diet at graded levels of 0.75, 1.50, 2.25, and 3.00 g/kg feed at the expense of an equivalent amount of the basal diet to maintain nutrient balance. The control group received the basal diet without stevia supplementation.

All diets were prepared in mash form and mixed thoroughly to ensure homogeneity. Ingredient composition and calculated chemical analysis of the experimental diets are presented in Table 1. The vitamin–mineral premix supplied adequate levels of fat- and water-soluble vitamins as well as essential trace minerals to satisfy broiler nutritional requirements during the experimental period.

Table 1: Ingredient and calculated chemical composition of the experimental diets (% as-fed basis).

Item	Starter (1–10 d)	Grower (11–24 d)	Finisher (25–35 d)
Ingredients (%)			
Yellow corn	43.80	44.60	46.50
Wheat	14.00	15.40	16.00
Soybean meal (48% CP)	32.70	29.10	26.00
Protein concentrate ¹	5.00	5.00	5.00
Sunflower oil	2.20	3.50	4.40
Limestone	1.10	1.50	1.30
Dicalcium phosphate	0.70	0.40	0.30
Sodium chloride	0.30	0.30	0.30
Vitamin–mineral premix ²	0.20	0.20	0.20
Total	100.00	100.00	100.00
Calculated chemical composition³			
Crude protein (%)	23.03	21.53	20.27
Metabolizable energy (kcal/kg)	3005.83	3105.47	3193.20
Lysine (%)	1.30	1.22	1.13
Methionine + cysteine (%)	0.88	0.84	0.80
Calcium (%)	0.86	0.93	0.82
Available phosphorus (%)	0.52	0.46	0.44
Crude fiber (%)	3.62	3.47	3.31
Ether extract (%)	5.09	6.35	7.24
Ash (%)	5.68	5.54	5.37

¹Protein concentrate was included at 5% of the diet and supplied essential amino acids, vitamins, and trace minerals according to the manufacturer's specifications. ²Vitamin–mineral premix supplied per kilogram of diet: vitamin A, vitamin D₃, vitamin E, vitamin K₃, thiamine, riboflavin, pyridoxine, cyanocobalamin, niacin, folic acid, biotin, pantothenic acid, choline chloride, Fe, Zn, Mn, Cu, I, and Se. ³Calculated nutrient composition was based on feed ingredient nutrient matrices and formulated according to NRC (1994) recommendations for broiler chickens.

GROWTH PERFORMANCE MEASUREMENTS

Body weight and feed intake were recorded on a weekly basis throughout the 35-days experimental period. Birds were weighed collectively per replicate using a calibrated digital scale, and feed intake was calculated by subtracting the residual feed from the total feed offered.

Body weight gain (BWG) was calculated as the difference between final and initial body weight:

$$BWG = \text{Final body weight (g)} - \text{Initial body weight (g)}$$

Feed conversion ratio (FCR) was calculated using the following equation:

$$FCR = \text{Feed intake (g)} / \text{Body weight gain (g)}$$

Mortality was recorded daily, and any mortality-corrected adjustments were applied to feed intake and feed conversion ratio calculations when necessary.

Growth performance parameters evaluated included final body weight, body weight gain, feed intake, and feed conversion ratio for the overall experimental period (1–35 days).

HEAT STRESS CHALLENGE

At 35 days of age, birds were subjected to an acute heat stress challenge to evaluate thermotolerance. Prior to heat exposure, broilers were maintained under thermoneutral environmental conditions according to Ross 308 management recommendations. For the heat stress test, ambient temperature was gradually increased to 42 °C for 3 hrs and maintained for a defined exposure period under controlled conditions.

Immediately after heat exposure, physiological parameters were recorded to assess thermoregulatory response. Cloacal temperature was measured using a digital thermometer inserted approximately 2–3 cm into the cloaca. Respiratory rate was determined by counting thoracic movements (breaths per minute). These measurements were conducted on randomly selected birds from each replicate.

ANTIOXIDANT ASSAYS

At 35 days of age, blood samples were collected from randomly selected birds in each replicate via wing vein puncture using sterile syringes. Samples were allowed to clot at room temperature and then centrifuged at 3000 rpm for 10 minutes to separate serum. The obtained serum was stored at –20 °C until biochemical analysis.

Antioxidant status was evaluated by determining the activities of superoxide dismutase (SOD) and catalase (CAT), as well as the concentration of reduced glutathione (GSH) and malondialdehyde (MDA). SOD and CAT activities were measured using standard spectrophotometric methods based on their ability to inhibit superoxide radical formation and decompose hydrogen peroxide, respectively. Reduced glutathione was determined according to its reaction with 5,5'-dithiobis-(2-nitrobenzoic acid), whereas MDA concentration, as an indicator of lipid peroxidation, was measured using the Thio barbituric acid reactive substances (TBARS) method.

All measurements were performed using a UV–visible spectrophotometer following the manufacturer's instructions of the commercial diagnostic kits.

STRESS INDICATOR

Physiological stress response was assessed by determining

the heterophil-to-lymphocyte (H/L) ratio, a widely recognized hematological indicator of stress in poultry (Gross and Siegel, 1983; Maxwell, 1993). Immediately after the heat stress challenge, blood samples were collected from randomly selected birds in each replicate. Thin blood smears were prepared on clean glass slides, air-dried, and stained using the Wright–Giemsa staining method.

Differential leukocyte counts were performed under a light microscope at 1000× magnification using immersion oil. A total of 100 leukocytes were counted per slide to determine the proportions of heterophils and lymphocytes. The H/L ratio was calculated using the following equation:

$$H/L \text{ ratio} = \text{Number of heterophils} / \text{Number of lymphocytes}$$

The H/L ratio was used as a physiological stress biomarker because increases in this ratio are closely associated with activation of the hypothalamic–pituitary–adrenal (HPA) axis, elevated corticosterone secretion, and chronic heat stress responses in broiler chickens. Previous studies have demonstrated that the H/L ratio is a reliable and practical indicator of thermal stress and welfare status in poultry (Gross and Siegel, 1983; Maxwell, 1993; Cotter, 2015).

STATISTICAL ANALYSIS

All data were analyzed according to a completely randomized design (CRD) using the General Linear Model (GLM) procedure of SAS software (SAS Institute Inc., Cary, NC, USA).

The statistical model used was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where; Y_{ij} = observed value of the dependent variable, μ = overall mean, T_i = effect of dietary treatment ($i = 1-5$), e_{ij} = random error.

Replicate was considered the experimental unit for growth performance parameters, whereas individual birds were considered the experimental unit for blood biochemical and physiological measurements.

When significant treatment effects were detected, means were separated using Tukey's multiple range test. Differences among treatments were considered statistically significant at $P \leq 0.05$. Results are expressed as means $\pm$ standard error (SE).

RESULTS AND DISCUSSION

GROWTH PERFORMANCE

Dietary supplementation with dried *Stevia rebaudiana*

leaf powder significantly influenced growth performance parameters of Ross 308 broilers during the experimental period (Table 2). Final body weight and body weight gain increased progressively with increasing stevia inclusion levels up to 2.25 g/kg, where the highest values were recorded ($P \leq 0.05$). Birds receiving 2.25 g/kg exhibited superior growth compared with the control and other supplemented groups. However, no further improvement was observed at 3.00 g/kg, suggesting a dose-dependent response with an optimal inclusion level. Feed intake was not significantly affected by dietary treatments ($P > 0.05$), indicating that stevia supplementation did not alter diet palatability. In contrast, feed conversion ratio (FCR) was significantly improved in stevia-fed groups, particularly at 2.25 g/kg, reflecting enhanced feed efficiency rather than increased consumption. The improvement in growth performance may be attributed to the bioactive components present in *Stevia rebaudiana*, including Steviol glycosides, phenolic compounds, and flavonoids. These compounds are known to enhance digestive enzyme activity, improve nutrient absorption, and modulate gut microbiota composition (Upadhya and Kim, 2017; Hussein et al., 2022). Enhanced gut health reduces metabolic energy losses associated with immune activation and intestinal inflammation, thereby allowing greater nutrient allocation toward muscle accretion. The absence of additional benefits at the highest supplementation level (3.00 g/kg) may be explained by the concept of hormesis, where moderate doses of phytochemical additives exert optimal biological effects, whereas excessive inclusion may lead to metabolic saturation or reduced bioavailability of active compounds (Hashemi and Davoodi, 2011; Lillehoj et al., 2018). Overall, the present findings confirm that dietary stevia supplementation enhances growth efficiency in broilers without negatively affecting feed intake, with 2.25 g/kg identified as the most effective level under the present experimental conditions. One limitation of the present study is the absence of gut microbiome analysis. Since phytochemical feed additives may influence intestinal microbial populations and gut health, future studies should evaluate the effects of *Stevia rebaudiana* supplementation on gut microbiota composition, microbial diversity, and intestinal health parameters under heat stress conditions. Such investigations may help explain the mechanisms responsible for the observed improvements in growth performance and physiological responses. The improvement in growth performance observed in stevia-supplemented birds may be attributed to the presence of steviol glycosides, phenolic compounds, and flavonoids. These bioactive compounds can reduce oxidative damage induced by heat stress, thereby preserving cellular integrity and metabolic efficiency. Furthermore, stevia has been reported to improve nutrient utilization and energy metabolism, which may enhance growth and feed efficiency under stressful environmental conditions. The reduction

in the heterophil-to-lymphocyte ratio suggests an attenuation of the physiological stress response. This effect may be associated with the antioxidant activity of stevia-derived phenolic compounds, which can reduce oxidative stress and modulate activation of the hypothalamic–pituitary–adrenal axis. Consequently, lower corticosterone-associated responses may contribute to improved immune and physiological stability during heat stress.

Table 2: Effect of dietary dried *Stevia rebaudiana* leaf powder on growth performance of Ross 308 broilers (1–35 days).

Treat- ment	Final body weight (g)	Body weight gain (g)	Feed intake (g)	Feed conver- sion ratio	SE	P value
Control	1980 ^c	1935 ^c	3450	1.78 ^a	24.6	0.001
0.75 g/kg	2055 ^{bc}	2010 ^{bc}	3470	1.73 ^{ab}	26.1	0.012
1.50 g/kg	2130 ^{ab}	2085 ^{ab}	3485	1.67 ^{bc}	27.3	0.004
2.25 g/kg	2235 ^a	2190 ^a	3490	1.59 ^c	28.4	<0.001
3.00 g/kg	2165 ^{ab}	2120 ^{ab}	3480	1.65 ^{bc}	25.8	0.006

Values are means ± SE. Different superscripts within the same column indicate significant differences at $P \leq 0.05$.

ANTIOXIDANT STATUS

Dietary supplementation with dried *Stevia rebaudiana* leaf powder significantly influenced serum antioxidant parameters in Ross 308 broilers (Table 3). Activities of superoxide dismutase (SOD) and catalase (CAT), as well as reduced glutathione (GSH) concentration, increased progressively with increasing stevia inclusion levels up to 2.25 g/kg ($P \leq 0.05$). Conversely, malondialdehyde (MDA) concentration, an indicator of lipid peroxidation, decreased significantly ($P \leq 0.05$) in stevia-supplemented groups compared with the control.

Table 3: Effect of dietary dried *Stevia rebaudiana* leaf powder on serum antioxidant status of Ross 308 broilers.

Treat- ment	SOD (U/mL)	CAT (U/mL)	GSH (mg/dL)	MDA (nmol/mL)	SE	P value
Control	82.5 ^c	45.2 ^c	18.4 ^c	5.62 ^a	2.8	0.002
0.75 g/kg	89.6 ^{bc}	49.8 ^{bc}	20.1 ^{bc}	5.02 ^{ab}	3.0	0.015
1.50 g/kg	95.3 ^{ab}	53.7 ^{ab}	22.3 ^{ab}	4.41 ^{bc}	3.2	0.004
2.25 g/kg	102.8 ^a	58.9 ^a	24.8 ^a	3.86 ^c	3.5	<0.001
3.00 g/kg	97.1 ^{ab}	55.1 ^{ab}	23.1 ^{ab}	4.23 ^{bc}	3.1	0.007

Values are means ± SE. Different superscripts within the same column indicate significant differences at $P \leq 0.05$.

The highest antioxidant enzyme activities and lowest MDA levels were observed in birds receiving 2.25 g/kg stevia, indicating enhanced redox balance and improved oxidative stability. The improvement in antioxidant status may be attributed to the high content of phenolic compounds, flavonoids, and steviol glycosides present in

Stevia rebaudiana. These bioactive compounds are known to function as free radical scavengers by donating hydrogen atoms or electrons, thereby interrupting lipid peroxidation chain reactions and protecting cellular membranes from oxidative damage (Surai *et al.*, 2019; Zhang *et al.*, 2022).

Furthermore, polyphenolic compounds have been reported to activate intracellular antioxidant defense mechanisms through modulation of the nuclear factor erythroid 2–related factor 2 (Nrf2) signaling pathway, leading to upregulation of endogenous antioxidant enzymes (Saleh *et al.*, 2021). Although molecular analyses were not conducted in the present study, the significant increases in SOD, CAT, and GSH activities suggest stimulation of endogenous antioxidant systems in stevia-fed birds.

Broiler chickens are particularly susceptible to oxidative stress due to their rapid growth rate and high metabolic activity, which elevate mitochondrial production of reactive oxygen species (Akbarian *et al.*, 2016). Improved antioxidant capacity therefore plays a crucial role in maintaining cellular integrity, immune competence, and productive performance. The present findings demonstrate that dietary stevia supplementation enhances systemic antioxidant defense, thereby contributing to improved physiological resilience.

Overall, inclusion of dried *Stevia rebaudiana* leaf powder at 2.25 g/kg provided the most consistent improvement in antioxidant status, supporting its potential as a natural phytogetic additive to mitigate oxidative stress in broiler production systems. The enhancement of antioxidant status may be related to the high concentration of phenolic compounds and flavonoids present in *Stevia rebaudiana*. These compounds are capable of scavenging reactive oxygen species and may stimulate endogenous antioxidant defense systems, including superoxide dismutase, catalase, and glutathione-related pathways, thereby reducing oxidative damage under heat stress conditions.

HEAT STRESS TOLERANCE

Exposure of broiler chickens to acute heat stress (42°C) significantly affected physiological stress indicators (Table 4). Birds in the control group exhibited the highest cloacal temperature, respiratory rate, and heterophil-to-lymphocyte (H/L) ratio compared with stevia-supplemented groups ($P \leq 0.05$). Dietary inclusion of dried *Stevia rebaudiana* leaf powder significantly improved thermoregulatory responses, particularly at 2.25 g/kg, where the lowest body temperature and respiratory rate were recorded.

The reduction in cloacal temperature and respiratory rate suggests improved thermotolerance and metabolic stability in stevia-fed birds. Heat stress typically increases

mitochondrial electron leakage, leading to excessive production of reactive oxygen species (ROS) and disruption of cellular homeostasis (Akbarian *et al.*, 2016; Surai, 2020). Enhanced antioxidant defense observed in stevia-supplemented groups likely contributed to maintaining cellular integrity and minimizing oxidative damage during thermal challenge.

Table 4: Effect of dietary dried *Stevia rebaudiana* leaf powder on heat stress indicators of Ross 308 broilers.

Treatment	Body temperature (°C)	Respiratory rate (breaths/min)	H/L ratio	SE	P value
Control	43.1 ^a	154 ^a	0.92 ^a	0.08	0.001
0.75 g/kg	42.6 ^{ab}	145 ^{ab}	0.81 ^{ab}	0.07	0.014
1.50 g/kg	42.2 ^{bc}	136 ^{bc}	0.69 ^{bc}	0.06	0.003
2.25 g/kg	41.9 ^c	128 ^c	0.61 ^c	0.05	<0.001
3.00 g/kg	42.1 ^{bc}	132 ^{bc}	0.66 ^{bc}	0.06	0.006

Values are means ± SE. Different superscripts within the same column indicate significant differences at $P \leq 0.05$.

The heterophil-to-lymphocyte ratio, a well-established indicator of physiological stress in poultry, was significantly lower in birds receiving stevia compared with the control. Elevated H/L ratios are associated with activation of the hypothalamic–pituitary–adrenal (HPA) axis and increased corticosterone secretion under stress conditions (Quinteiro-Filho *et al.*, 2010). The reduction in H/L ratio in stevia-treated birds indicates improved immune balance and reduced stress load.

The most pronounced improvement in heat stress tolerance was observed at 2.25 g/kg supplementation level, supporting the dose-dependent response identified in growth and antioxidant parameters. The lack of additional benefit at 3.00 g/kg may reflect metabolic saturation or limited bioavailability of active phytochemicals at higher inclusion levels, consistent with previous reports on phytogetic additives under thermal stress conditions (Hassan *et al.*, 2020; Chand *et al.*, 2021).

Overall, these findings demonstrate that dietary supplementation with dried *Stevia rebaudiana* leaf powder enhances thermoregulatory efficiency, stabilizes immune response, and improves resilience to acute heat stress in broiler chickens, with 2.25 g/kg identified as the optimal inclusion level under the present experimental conditions. The present study provides valuable information about the effects of dietary *Stevia rebaudiana* supplementation on broiler chickens under heat stress conditions. However, several limitations should be acknowledged. The study was conducted using unsexed birds, which may have introduced some biological variation in growth and stress responses.

In addition, the composition of the stevia powder was not analyzed under laboratory conditions, and no molecular or gut microbiome analyses were performed to further elucidate the underlying mechanisms of action. Another limitation of the present study was the absence of molecular analyses to investigate the mechanisms underlying the observed responses. Furthermore, an economic evaluation of stevia supplementation was beyond the scope of the present investigation. Future studies should address these aspects to provide a more comprehensive assessment of stevia use in commercial broiler production. Moreover, future studies should also evaluate the expression of genes associated with heat stress response, antioxidant defense, and immune regulation, such as HSP70, SOD, CAT, and GPx, to provide a more comprehensive understanding of the biological effects of *Stevia rebaudiana* supplementation in broiler chickens.

CONCLUSION

The present study revealed that supplementation of dried *Stevia rebaudiana* leaf powder in the diet significantly enhanced the growth performance, antioxidant status and heat stress tolerance of Ross 308 broiler chickens. Diets supplemented with a moderate level of stevia leaf powder improved body weight gain and feed conversion efficiency without significantly affecting feed intake, indicating enhanced nutrient utilization. The stevia altered the antioxidant status at the systemic level as reflected in the increased activities of SOD, CAT and GSH, and reduced lipid peroxidation levels. Under acute heat stress situation, stevia fed birds exhibited improved thermoregulatory behavior and lower physiological stress indicators as compared with that of controls, especially at the inclusion level of 2.25 g/kg. Overall, dried *Stevia rebaudiana* leaf powder at 2.25 g/kg is a safe and effective phytogetic feed additive to improve productivity traits and physiological resilience of broilers reared at higher ambient temperature. Although *Stevia rebaudiana* supplementation improved several productive and physiological parameters, the economic feasibility of its use was not evaluated in the present study. Future investigations should incorporate economic efficiency indicators, including feed cost per kilogram of body weight gain, net profit, and return on investment, to assess its practical value under commercial production conditions.

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This is the first study that combines growth performance, systemic antioxidant defense and physiological thermotolerance assessment under an acute thermal hurdle model in broiler chickens fed dried *Stevia rebaudiana* leaf powder. The results suggest an optimal functional level of 2.25 g/kg that improved redox state, immune balance and productive performance parameters under circumstances.

AUTHOR'S CONTRIBUTION

AHDA conceived and conducted the experiment, collected data, and drafted the initial manuscript. ASAH supervised the study, analyzed the statistics, and interpreted the data and manuscript. Both authors read and approved the final manuscript.

GENERATIVE AI AND AI ASSISTED TECHNOLOGY STATEMENT

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

STATEMENT OF CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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