Supplementation of Amla (Emblica officinalis) Fruit Powder Modulate Growth and Reduce Heat Stress in Broiler Chickens

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ABSTRACT

Heat stress is a significant environmental challenge that impairs broiler production, negatively impacting growth, feed intake, nutrient absorption, and gut ecology. Various methods exist to mitigate heat stress such as genetic and nutritional approaches, air conditioning, ventilation, and antibiotic growth promoters but they are often expensive and not always adequate. Keeping this view in mind, research has been focused on medicinal herbs which are available, cheap and safer to use. Amla fruit possesses antioxidant, antimicrobial, and anti-stress properties that could mitigate heat stress’s harmful effects on broilers. Therefore, this study was conducted to evaluate the impact of amla fruit powder on growth performance, gut microbiota and blood lipid profile of broilers under ambient temperature and heat stressed condition. A total of 126 broiler chicks were divided into two major groups, one group kept under ambient temperature and another group exposed to heat stress. Each major group was split into 3 subgroups with 3 replications having 7 chicks per replication. In case of each major groups, first sub groups were kept as a control and latter two groups were supplemented with 0.5% and 1.0% amla fruit powder, respectively. Total duration of the experiment was 35 days, where treatments were given with basal diet from 12 days. All the experiment birds were maintained with the similar management except the experimental diets. The results showed that body weight and body weight gain at the end of the experiment were higher in amla treated group than in the control group at both temperatures. Supplementation of amla fruit powder also improved feed conversion ratio (FCR) and dressing percentage than the control groups. Additionally, amla powder reduced TC, TAG and LDL levels and slightly increased HDL content. Amla fruit powder decreased pathogenic bacterial population such as Escherichia coli and Salmonella spp. concentration in the gut and increased probiotic bacterial concentration such as Lactobacillus spp. under both rearing temperatures. Taken together, it can be concluded that, amla fruit powder could be used as an alternative tool to improve broiler performance and mitigate the deleterious effects of heat stress on broiler chickens.

Keywords: Antioxidant, body weight, FCR, heat stress.

1. Introduction

The consistent increase in global temperature caused by climate change and various environmental and man-made factors poses a significant threat to farm animals. Among them, broiler birds are particularly vulnerable to heat stress [1] due to their rapid growth rate, high body weight, and efficient feed conversion, all of which generate a substantial amount of heat energy [2]. This hampers their ability to adapt to adverse thermal conditions [3]. Heat stress adversely affects broiler performance by decreasing feed intake, feed conversion efficiency, and retarding growth. Prolonged exposure to heat stress has long-lasting negative effects on broilers. It leads to an increase in the fat content of meat, a reduction in the protein content of
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Kazal et al.

2. Materials and Method

2.1. Collection and Preparation of Amla Fruit Powder

Fresh Amla fruits were collected from Bangladesh Agricultural University campus, Mymensingh, Bangladesh. The fruits were washed with water, fleshes were separated from the seeds, chopped into small pieces and dried. Dried fleshes were then processed into powder. To achieve the ideal particle size of 0.5 mm, the powder was sieved through a mesh. The resultant amla powder (AP) was stored in an airtight container under dry conditions at 4 °C until further use in feeding trial.

2.2. Housing and Management of Broilers

After a clean water wash, the experimental shed was disinfected with TH4 (Century Agro Ltd., Bangladesh). The feeders and drinkers were washed with 1% bleached water and sun-dried. A total of 126-day-old broiler chicks were purchased from a reputed company. Placed them in the experimental shed. Vitamin C, glucose and electrolyzed Energy G were supplied to the chicks to prevent transportation stress. The chicks were kept in the same compartment for 7 days at a standard brooding temperature (35 °C for the first 3 days, then gradually decreased by about 3 °C per day until 21 °C was reached). Then the birds were reared at a temperature of 21 °C and relative humidity of 50%–60% during the remaining experimental period.

2.3. Experimental Design

Broiler chicks were randomly and equally divided into 2 major groups. Each group was again divided into 3 subgroups having 3 replications and 7 chicks per replication. One of the major group was exposed to heat at above 36 °C from 12–35 days of age using temperature adjusted heaters while the temperature of another subgroup was kept under ambient temperature (25 °C). First major group under ambient temperature (25 °C) contains three sub groups such as normal temperature (NT) without amla supplementation, normal temperature + 0.5% amla fruit powder (NT + 0.5% AP), normal temperature + 1.0% amla fruit powder (NT + 1.0% AP). Another major group under high temperature (36 °C) was also divided into 3 subgroups such as high temperature (HT) without amla administration,
high temperature + 0.5% amla fruit powder (HT + 0.5% AP), high temperature + 1.0% amla fruit powder (HT + 1.0% AP).

2.4. Experimental Diet

First 12 days all experimental groups were offered commercial starter feed and fresh drinking water. After wards, hand-mix feed was provided from 13 to 35 days. All feed ingredients were purchased from the registered supplier in the Mymensingh city. Amla fruit powder was supplemented with basal diet in 3 different combinations. Two doses (0.5% and 1.0%) of amla supplementation were incorporated with the normal diet and were provided to the birds reared under both ambient and high temperature.

2.5. Growth Performance

On the 12th day, before the start of treatment, the initial body weight of each chick was recorded. Feed consumption was measured for each experimental group on daily basis (from day 12 to 35). The leftover feed (if any), was subtracted from the initial feed offered. Then the average amount of feed consumed by each bird over the course of the treatment was calculated. At the end of the experiment, the final body weight, as well as their body weight gain and dressing percentage was recorded accordingly.

The feed conversion ratio (FCR) was calculated using the following formula:

\[
\text{Feed conversion ratio (FCR)} = \frac{\text{Average feed intake from day 13 to 35}}{\text{Body weight gain from day 13 to 35}}
\]

2.6. Blood Collection and Determination of Biochemical Parameters

The blood samples were collected via the wing veins using sterile needles and syringes. Then the blood-containing tubes were centrifuged at 4000 rpm for 10 min at 4 °C (Gyrozen 1580R Multi-Purpose High-Speed Refrigerated Centrifuge, Gangnam-gu, Seoul, Korea). After centrifugation, the supernatant serum without unwanted blood cells was collected in a new tube. Lipid profile studies involved analysis of parameters such as total cholesterol determined by CHOD-PAP method [14] triacylglycerols (TAG) level determined by GPO-PAP method [15]; HDL cholesterol level determined by CHOD-A method [16]. Huma Tex febrile antigen test kit (Human Diagnostic, Wiesbaden, Germany) was used and the absorbance of all the tests was determined using Humalyzer, Mode No-S000 (Human GmbH. Wiesbaden, Germany). Serum LDL cholesterol concentrations were calculated using the Friedewald equation as follows:

\[
\text{LDL cholesterol (mg/dl)} = \frac{\text{Total cholesterol}}{\text{HDL cholesterol}} - \frac{\text{Cholesterol}}{5}
\]

2.7. Analysis of Microbial Status in the Cecum

At the end of the study, five birds were randomly selected from each replicate, and approximately 2 grams of fresh fecal samples were collected with swab sticks and placed in sterile sample bottles for determination of microbial load. About 1 g of gut content from each bird was diluted with 9 ml of sterilized physiological saline solution and thoroughly mixed and a serial dilution up to 10⁻⁹ was done. From each dilution, 1 ml of aliquot was spread on the appropriate selective agar plates and incubated at 37 °C for 24 hours. The total bacterial count, Salmonella count, and E. coli count were determined using plate count agar, Salmonella shigella agar (SSA), and Eosin methylene blue agar, respectively. After incubation, the colonies were counted and expressed as the number of colony forming units (cfu) per gram of gut content.

2.8. Statistical Analysis

All statistical analyses were performed using Prism 5 (GraphPad Software. CA). All data were displayed as mean ± SEM. Data were analyzed using one-way ANOVA followed by Tukey’s post-hoc test was employed to justify the significant differences among groups of treatment. The p < 0.05 was set as a significant value for all analyses.

Fig. 1. Amla fruit powder supplementation attenuated the decrease in body weight of broiler under heat stress condition. All data were expressed as mean ± SEM. Data were analyzed using one-way ANOVA followed by Tukey’s post-hoc test. Mean values with distinct alphabetic superscripts indicate significant differences from each other at a significance level of \(P < 0.05\).
3. Results

3.1. Body Weight

The body weight of the experimental birds was similar during the second and third weeks of age. Supplementation of amla fruit powder tended to increase the body weight of birds regardless of the rearing temperature. Birds subjected to heat stress had lower body weights compared to those raised at ambient temperature (Fig. 1).

However, this weight loss was reversed by the supplementation of amla fruit powder. After four weeks of the treatment, though it was not statistically significant, the body weights of the amla fruit powder supplemented groups (1016.3 g for the HT + 0.5% AP group and 1012.1 g for the HT + 1.0% AP group) were slightly higher than the control group under heat stress condition. Similarly, at the end of the 5th week, the body weights of the amla fruit powder supplemented groups were comparatively higher than those of the control group under both rearing situations. But the values were statistically insignificant.

3.2. Body Weight Gain

The body weight gain (BWG) of birds at 2nd week of age was not significantly influenced by amla fruit powder supplementation as shown in Fig. 2. After 3 weeks of heat stress, high temperature decreased the BWG of the birds. However, supplementation of amla fruit powder improved the body weight gain. Under heat stress, amla fruit powder supplemented groups (0.5% & 1.0%) had slightly higher BWG than that of the control group at 3rd week of the treatment. However, BWG of birds reared under ambient temperature were almost similar. After four weeks of supplementation, BWG of amla fruit powder treated groups were significantly higher than that of the control group under ambient temperature. BWG of amla treated groups raised under heat stress were also higher than the control group but it was not statistically different. Similar trend of BWG was observed at 5th week of age.

3.3. Feed Intake

The total duration of the experimental period was 35 days and commercial starter feed was provided for the first 12 days. After that, hand mixed feed was provided as ad libitum basis up to 35 days of age. Feed intake was measured by deducting the amount of left-over feed from the amount supplied for the particular week. The results of the study revealed that the feed intake of amla fruit powder treated groups raised under heat stress was insignificantly lower than that of the control group at 3rd week of the feeding trial (Fig. 3). However, the feed intake of 1.0% amla fruit supplemented birds reared under ambient temperature was slightly higher than the control group. Under ambient temperature raising circumstances, 0.5% amla fruit powder supplemented group at four weeks of age consumed considerably more feed than the respective control group. However, 0.5% amla powder supplemented group consumed less feed under heat stress condition while the 1.0% amla fruit treated group consumed the same amount of feed as the control group. At the end of the feeding trial, the groups treated with amla fruit powder consumed significantly more feed than the control group in the ambient temperature-raising environment. On the other hand, under heat stress conditions, only 1.0% of the amla fruit supplemented group had a substantially higher feed intake than the control group.

3.4. Feed Conversion Ratio (FCR)

We also measured the FCR to evaluate the effect of amla fruit powder supplementation on feed efficiency. The results demonstrated that, compared to the other groups, the heat stressed control group had a significantly (p < 0.05) higher FCR (Fig. 4). However, supplementation of amla fruit powder at the level of 0.5% and 1.0% alleviated the effect of heat stress and improved the FCR significantly (1.8 ± 0.24 for HT + 0.5% AP group and 1.9 ± 0.07 for HT + 1.0% AP group). In ambient temperature rearing condition, the FCR value was statistically insignificant among the groups but comparatively better FCR was observed in the NT + 1.0% AP group (1.60 ± 0.14) than the control group (1.69 ± 0.83). Overall, birds reared under high temperature condition had higher FCR values than the birds reared under ambient temperature.

3.5. Dressing Percentage (DP)

At the end of feeding trial, five birds per dietary treatment group were randomly selected for the evaluation of DP. The DP of different dietary treatments did not differ significantly between the supplemented and the control
groups (Fig. 5). Under ambient temperature, the 0.5% and 1.0% amla fruit powder supplemented groups had higher DP (54.60 ± 1.12 for NT, 56.70 ± 0.49 for NT+ 0.5% AP group and 56.70 ± 2.50 for NT+ 1.0% AP group) than the control group. However, in case of high temperature condition, only the HT+0.5% AP group showed higher DP than the heat stress control group and the DP of the (HT+1.0% AP) group was almost similar when compared with the high temperature control group (HT). Overall, birds exposed to high temperature apparently showed higher DP, though they are not statistically significant, than the birds reared under normal temperature.

3.6 Liver Weight

The effect of amla fruit powder on the liver weight of birds is presented in the Fig. 6. In comparison to birds raised under normal ambient temperature, heat stress reduced the relative weight of the liver in broiler chicks. Moreover, liver weight of birds was comparatively lower in the amla powder treated groups than the control group in heat stress condition. In normal temperature condition, 0.5% amla powder supplemented group had lower liver weight than the control group. However, 1.0% amla powder supplementation increased the liver weight remarkably than the control group in ambient temperature condition.

3.7 Serum Lipid Profile

In the ambient temperature rearing condition, the total cholesterol (TC) level was slightly lower in the amla fruit treated groups than the respective control group, whereas the triacylglycerols (TAG) level was slightly higher in the amla supplemented groups (Fig. 7). But the LDL content of blood was almost same between amla supplemented groups and the control group. Present findings revealed that heat stress increased the levels of TC and TAG.

However, supplementation with amla fruit powder decreased the TC and TAG levels, and a significant reduction was noticed in the amla fruit treated (0.5%) groups. Similarly, LDL content was significantly higher in the heat-treated control group in comparison to the amla supplemented groups, and administration of amla fruit substantially decreased the LDL level of blood. HDL level was slightly higher in the 1.0% amla fruit powder supplemented groups than the control groups under both rearing temperatures.

3.8 Gut Microbiota

The effect of amla fruit powder on the gut microbial population of broilers receiving different dietary treatments was also examined (Table I). The results showed that supplementation of amla fruit powder significantly decreased the total plate count and Salmonella in a dose dependent manner in both ambient and high temperature environment. In comparison to the 0.5% amla fruit supplemented group, 1.0% amla fruit powder supplemented group showed more decrease. Total Escherichia coli (log cfu/g) ranged from 5.83 (NT) to 2.20 (HT+1.0% AP) and significantly lowest value was observed in both NT+1.0% AP and HT+1.0% AP groups. Other experimental groups also showed reduction in E. coli count though values were non-significant. Similarly, log value for Salmonella (log cfu/g) ranged from 5.07 to 2.05 among different dietary treatment groups. Though the lactobacilli bacterial count

Fig. 4. Amla fruit powder supplementation improved FCR in broilers reared under heat stress condition. All data were expressed as mean ± SEM. Data were analysed using one-way ANOVA followed by Tukey’s post-hoc test. Distinguishing asterisks (*) indicate significant differences (p < 0.05) among groups.

Fig. 5. Amla fruit powder supplementation slightly modified the dressing percentage of broiler birds. All data were expressed as mean ± SEM. Data were analysed using one-way ANOVA followed by Tukey’s post-hoc test. Distinguishing asterisks (*) indicate significant differences (p < 0.05) among groups.

Fig. 6. Amla fruit powder supplementation did not remarkably influence the liver weight of broiler under heat stress condition. All data were expressed as mean ± SEM. Data were analyzed using one-way ANOVA followed by Tukey’s post-hoc test. Distinguishing asterisks (*) indicate significant differences (p < 0.05) among groups.
4. Discussion

The objective of the study was to evaluate the effectiveness of amla fruit powder on the growth performance, blood parameters, and gut microbiota of broiler birds raised under ambient temperature and heat stressed conditions. The findings of the study revealed that supplementation of amla fruit powder led to increased feed consumption, average body weight, and body weight gain compared to the control group in both rearing conditions. The supplemented group also exhibited significantly lower FCR compared to the control group. Additionally, the inclusion of amla fruit powder resulted in a significant reduction in total cholesterol, triglycerides, and LDL levels, while showing slightly higher HDL levels in the supplemented group compared to the control group, although the differences were not statistically significant. Furthermore, the supplementation of amla powder significantly decreased the presence of pathogenic bacteria such as *Escherichia coli* and *Salmonella* spp. in the gut and increased the population of beneficial *Lactobacillus* spp. when compared to the control group.

The current study indicates that AP supplementation increased the feed consumption of birds and at the end of the experiment significantly higher feed consumption was observed in the 1.0% AP supplemented groups in comparison to the control groups in both rearing temperatures. Similar findings were also reported in earlier studies by Patel *et al.* [17] those who concluded that amla when supplemented with aloe-vera, maximum feed consumption was observed. The improvement in feed consumption of broilers in association with the supplementation of amla fruit powder could be explained by the fact that amla is known to act as a stomachic [18] and good appetizer [17]. Moreover, broiler birds exposed to high temperatures showed a significant decrease in total feed intake when compared with birds kept at a normal temperature. The decrease in feed intake might be due to adverse effect of heat stress [19]. Heat stress decreases the gastrointestinal motility and prolongs gastric emptying, which in turn results in lowered feed intake [20]. The appetite stimulant and stomachic and carminative properties of amla fruits seem to account for the increased feed consumption in heat-stressed broiler chickens. Broiler birds exposed to heat stress influenced the body weight and body weight gain. The negative effects of heat stress include reduced feed consumption, daily body weight gain and feed utilization [21]. Poultry feed intake declines 1.5% for each degree rise in temperature when the temperature ranges from 21 °C to 30 °C, and the decline in feed intake will increase to 4.6% with a temperature range of 32 °C to 38 °C [22]. The reduction in feed intake is one of the major reasons for retarded growth of broilers. Moreover, heat stress induced

was non-significant (p > 0.05), however, lactobacilli number tend to increase with high inclusion of amla fruit powder. Highest lactobacilli count was observed in 1.0% amla fruit powder supplemented group than the control group in both normal and high temperature condition. The results indicates that high level of AP inclusion in the diet significantly decreased the harmful *E. coli* and *Salmonella* bacteria and increase the number of beneficial lactobacilli bacteria in the gastrointestinal tract of the broilers.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total plate count</th>
<th><em>E. coli</em></th>
<th><em>Salmonella</em></th>
<th><em>Lactobacillus</em> spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>8.27±0.12</td>
<td>5.83±0.19</td>
<td>5.07±0.12</td>
<td>5.79±0.42</td>
</tr>
<tr>
<td>NT+0.5% AP</td>
<td>6.08±0.25</td>
<td>5.06±0.23</td>
<td>3.15±0.29</td>
<td>5.71±0.21</td>
</tr>
<tr>
<td>NT+1% AP</td>
<td>4.40±0.25</td>
<td>4.26±0.21</td>
<td>2.04±0.08</td>
<td>6.81±0.37</td>
</tr>
<tr>
<td>HT</td>
<td>8.08±0.43</td>
<td>5.96±0.47</td>
<td>5.07±0.28</td>
<td>6.06±0.41</td>
</tr>
<tr>
<td>HT+0.5% AP</td>
<td>5.95±0.08</td>
<td>4.86±0.19</td>
<td>3.08±0.14</td>
<td>5.94±0.39</td>
</tr>
<tr>
<td>HT+1% AP</td>
<td>3.94±0.49</td>
<td>2.20±1.10</td>
<td>2.05±0.25</td>
<td>6.92±0.24</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;0.001</td>
<td>0.003</td>
<td>&lt;0.001</td>
<td>0.122</td>
</tr>
</tbody>
</table>

Note: All data were expressed as mean ± SEM. Data were analysed using one-way ANOVA followed by Tukey’s post-hoc test. Distinct alphabetic superscripts indicate significant differences from each other at a significance level (P < 0.05).
the secretion of stress hormones, which alter the chickens’ neuroendocrine system by activating the hypothalamic-pituitary-adrenal axis and thereby increasing the plasma corticosterone levels [23]. Corticosterone is associated with a higher degree of body protein breakdown which affects the digestive system, nutrient utilization, and digestibility and retarded the growth of birds [24]. Furthermore, heat stress has been shown to increase the production of free radicals and other reactive oxygen species (ROS) in body fluids and tissues. Overproduction of ROS causes damage to the protein, lipid, and DNA, which reduces mitochondrial energy production efficiency and increasing the oxidative stress of the body [25]. However, antioxidants such as polyphenols, flavonoids, tannin, gallic acid etc. can ameliorate the detrimental effects of heat stress by enhancing the expression of stress response protein (e.g., heat shock protein) and antioxidant protein (e.g., CAT, SOD, GSH-Px) [25]. Amla is an herbal plant and a richest source of natural antioxidant such as vitamin C, gallic acid, tannin, saponin, and flavonoids etc. The improvement in body weight of the birds observed in the present study may be due to the presence of these bioactive compounds. Previous study also reported that amla fruit powder supplementation improves the body weight of birds due to the anabolic and antioxidant effects of ascorbic acid, gallic acid, and tannic acids present in *E. officinalis* [26]. Our findings are in agreement with Kumari et al. [27] and Patil et al. [28] who reported significant improvement of body weight of broiler when supplemented with amla fruit.

In our present findings, highest FCR was observed in the heat stress control group than the other groups. Supplementation of AP significantly improved the FCR value. This finding is similar to the previous reports by Gaikwad et al. [29] and Islam et al. [30]. Amla fruit has potential antioxidant, anti-inflammatory [31] and antimicrobial properties [32]. Phyto-nutrients present in amla may help to reduce oxidative stress, immune function, nutrient absorption and utilization in broilers, leading to better growth and FCR. Additionally, amla fruit may have a positive effect on the gut microbiota in broilers, which could further improve their nutrient absorption and FCR value. Dressing percentage of broilers did not show a significant difference between the AP supplemented groups and the control groups. However, addition of AP slightly improved the dressing percentage in both rearing temperatures. Our results are in consistent with those of Ansari et al. [33] who found improved dressing percentage in broilers fed with diets containing amla and turmeric powder. Additionally, Kurkure et al. [34] reported that broilers given an herbal premix containing amla as an integral part had better dressing percentages.

In the present study, we observed that broilers raised under heat stress had lower liver weight than the birds raised under ambient temperature. When birds are exposed to heat stress, they experience a significant decrease in total lipid and triglycerides in liver which could lead to lower liver weight [35]. Moreover, AP supplementation further decreased the liver weight of birds raised under heat stress due to its antioxidant properties such as gallic acid, saponin which prevent lipid accumulation and oxidative damage. Gallic acid and saponin found in amla have been shown to have various beneficial effects, including reducing lipid accumulation and oxidative damage, inhibiting inflammation, suppressing cholesterol and triglyceride synthesis, decrease mitogen-activated protein kinase (MAPK) phosphorylation levels and promoting fatty acid beta-oxidation and autophagy to improve fatty liver conditions [36].

In the present study, total cholesterol (TC), triacylglycerols (TAG), and low-density lipoprotein (LDL) levels of birds reared under heat stress were significantly higher in the control group which were attenuated by the administration of AP. The high-density lipoprotein (HDL) levels of birds did not differ significantly between the AP-supplemented groups and the control birds under both temperatures. Fallah and Rezaei [37] reported that birds reared at high ambient temperatures increased their serum cholesterol levels. In another study, the authors concluded that exposure of broilers to high ambient temperatures significantly increased the levels of triglycerides and VLDL in plasma, as well as the levels of total cholesterol, acetyl-CoA carboxylase (ACC), and fatty acid synthase (FASN) in the liver and the mRNA expression levels of carbohydrate response element-binding protein (ChREBP) and microsomal triglyceride transfer protein (MTTP) [38]. Tannoid compounds are known for their significant hypolipidemic properties that work by directly influencing the sympatho-adrenal axis, reducing the production of corticosterone, and enhances the clearance of endogenous cholesterol, according to Sai Ram et al. [39]. The reason behind the decrease in cholesterol levels observed in the groups treated with amla fruit may be attributed due to the active tannoid compounds present in *Emblica officinalis*.

The gut microbial population of birds are highly susceptible to heat stress. Several studies have shown that heat stress significantly affects the intestinal microbial composition and structure both in broilers and layers [40]. Some particular abnormalities that have been documented includes lowers the numbers of beneficial bacteria and increase the number of harmful bacteria [41]. In the present study, we found that the number of *Escherichia coli*, *Salmonella* and total viable bacteria count were higher in the birds reared under heat stress. But supplementation of amla fruit powder significantly decreased the number of *Escherichia coli*, *Salmonella* and total viable bacterial count than the control group. Moreover, though supplementation of amla fruit powder increased the number of *Lactobacillus* count than that of the control groups in both rearing environment but the values were statistically insignificant. Our results are in agreement with Bostami et al. [32] who reported that amla fruit supplementation significantly suppressed the pathogenic *E. coli* and increased the number of non-pathogenic *Lactobacillus* count. Similarly, Islam et al. [30] reported that administration of amla fruits and aloe vera significantly decreased *E. coli* and *Salmonella* population. Medicinal herbs contain phytochemical compounds such as saponins, alkaloids, flavonoids, tannins, and aromatic compounds that serve as defence mechanisms against microorganisms and herbivores [42]. The qualitative analysis of phytochemicals in amla fruits reveals the presence of various compounds such as alkaloids, tannins, saponins, cardiac glycosides, steroids,
phensols, glycosides, and flavonoids [43]. These compounds exhibit antimicrobial activity through their hydrophobicity and ability to enter bacterial cell membranes, leading to cell death [44]. Furthermore, antibacterial action of amla on gram-negative bacteria and favourable effects on gram-positive bacteria enhance the production of lactic acid by lactobacilli, enhancing intestinal villi growth and nutrient absorption [13]. Based on the above findings, it can be concluded that amla fruit powder may be used as a feed supplement to mitigate the harmful effects of heat stress on broilers. However, as it was short-term research, further study is needed to fully explore the beneficial role of amla fruit powder on broiler performance before field application.

5. Conclusion

The findings of the present study demonstrate that incorporating amla fruit powder into the feed as a supplement led to improve in feed consumption, body weight gain, and feed conversion efficiency. It also showed an increase in the number of beneficial bacteria and a decrease in the number of harmful bacteria, both in ambient temperature and heat stress conditions. This suggests that inclusion of amla fruit powder as a feed supplement may alleviate the negative effects of heat stress. However, further study is recommended to investigate the impact of amla fruit powder on the biochemical and meat quality indices in broiler birds.

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Conflict of Interest

The authors declare that they have no conflicts of interest pertaining to the publication of this paper.

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