



RESEARCH ARTICLES

Effect of Amla Juice on Growth Performance, Carcass Characteristics, and Lipid Profile of Broiler

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ABSTRACT

This study was carried out to evaluate the effect of Amla juice on growth performance, carcass characteristics, and lipid profile of broiler. This 35-day study at HSTU, Dinajpur, evaluated the effects of Amla juice in drinking water on broilers. 120 chicks were divided into five groups (0%, 0.75%, 1%, 1.25%, and 1.5% Amla). The 1% group (T2) showed significantly higher body weight, better feed conversion ratio, and improved carcass traits. Lipid profiles improved with lower cholesterol and LDL, and higher HDL and triglycerides. T2 also yielded the highest net profit. Amla juice at 1% enhances growth, health, and profitability, making it a natural growth promoter in broiler production.

Keywords: Chicks, economic benefit, immunity, live weight, slaughter weight

INTRODUCTION

The poultry industry in Bangladesh has emerged as one of the fastest-growing segments of the agriculture sector, with a flourishing impact to provide a sustainable and cheap protein source. The livestock and poultry sector contributed 1.47% to GDP with a growth rate of 3.47%, the current price GDP volume was 43212 crore taka, and the current price share of livestock and poultry was 13.46 in 2018-2019. The livestock and poultry sector provided direct opportunity to 20% population and indirect opportunity to 50% population of the country in 2018-2019. The total number of poultry and chicken population was 3563.18 and 2966.02 lakh, respectively, in 2019-2020. Meat production in 2019-2020 was 74.76 lakh metric tons, and egg production was 1736 crores. The national population of poultry has gradually increased from 2788.06 lakhs in 2010-2011 to 6563.18 lakhs in 2019-2020; except in 2005, the number of chickens consistently increased from 2346.86 lakhs in 2010-2011 to 2966.02 lakhs in 2019-2020 (BBS, 2020).



Broiler farming is very much desired and liked industry among urban and rural farmers because of the very fast economic return. In present days, Bangladeshis are attracted to broiler chicken production because of the fast return and high demand. The condition of broiler production in Bangladesh is improving day by day. The success of the poultry industry depends upon its fast growth and low mortality during the first two weeks of life, which can be managed by good hygienic and feeding conditions. The production of safer poultry products without the use of any chemical or microbial residues is the demand of the day. Feed additives are one of the important tools used for improving feed conversion ratio, growth rate, and disease resistance. The additives that hold great promise in the feeding of poultry comprise antibiotics, coccidiostat, antioxidants, enzymes, hormones, probiotics, buffers, organic acids, mold inhibitors, herbal products, synthetic micronutrients, etc. Use of antibiotics has negative effects on animal health and its production, such as residues in tissues, withdrawal period, and development of resistance in microorganisms (Botsoglou and Fletouris, 2001). The nutritionists and researchers attempted other alternatives to enhance the performance of broiler chicken. Herbs, spices, and various plant extracts have received increased attention as a possible antibiotic growth promoter replacement. In this view, the plants identified with properties of secondary metabolites became interesting due to their antimicrobial, antioxidant effects, and their stimulating effects on animal performance and digestive enzymes. At present, there are large numbers of Natural Growth Promoters available in the market, including herbs, probiotics, prebiotics, and symbiotics etc. (Sapkota et al., 2006).

In the last decade, herbal feed additives have attracted the attention of scientists as useful resource for improving productivity with no drug residue and no side effect. Besides, these herbs are natural component and do not have any side effects like residues in meat products. Amla (*Emblica officinalis*) fruit powder is one of the herbs which have potential to boost broiler production. Amla is extensively cultivated all over Nepal. The fruits of the plants are used in Ayurveda as a potent rasayana (revitalizers, biological response modifiers), in which the Amla was added as an anti-stress agent. Phytochemical analysis of Amla fruit powder provided evidence of the presence of the medicinally important bioactive compounds, which can be exploited beneficially to improve productivity in broilers. Amla (*Emblica officinalis*) is one of the richest sources of ascorbic acid, minerals, amino acids, tannins, and phenolic compounds (Yokozawa et al., 2007). Rapid growth rate in commercial broilers accelerates the metabolic rate and makes them vulnerable to oxidative stress owing to increased free radical generation (Feng et al., 2012). Gallic acid and tannic acids are the phenolic acids present in *E. officinalis* that contribute to the antioxidant activity, in addition to ascorbic acid (Suresh et al., 2006). Therefore, the present study was conducted to evaluate the dietary addition of *E. officinalis* (Amla) juice in drinking water with the following objectives:



- 1) To determine the effects/potential of Amla juice on the growth performance and carcass characteristics of broiler;
- 2) To investigate the effects/potential of Amla juice on the lipid profile of broiler, and
- 3) To assess the cost and benefit.

MATERIALS AND METHODS

Experimental Site

The study was conducted at Hajee Mohammad Danesh Science and Technology University (HSTU) Poultry Shed, Dinajpur.

Experimental Birds

A total of one hundred twenty (120) active and healthy day-old broiler chicks (Cobb 500) were purchased from Kazi Farms Limited's local dealer, Sadar Dinajpur, Bangladesh. Immediately after the arrival of chicks, the chicks were weighed and brooded in a proper brooding, lighting, ventilation, and heating arrangement for 7 days.

Layout of the Experiment

The day-old chicks were reared at the brooder house to adjust to the environmental conditions for seven days. After seven days, chicks were randomly allocated into five treatment groups, each group having three replications.

Table 1. Layout showing the distribution of experimental broilers

Dietary Treatments		Number of broilers in each replication			Total
		R1	R2	R3	
Control (Only basal diet)	T0	8	8	8	24
Basal diet + 0.75% Amla juice	T1	8	8	8	24
Basal diet + 1% Amla juice	T2	8	8	8	24
Basal diet + 1.25% Amla juice	T3	8	8	8	24
Basal diet + 1.5% Amla juice	T4	8	8	8	24
Total no. of broilers		40	40	40	120

Preparation of the Amla Solution

The Amla solution of different compositions, i.e., 0.75%, 1%, 1.25% and 1.5% was made by the addition of 0.75 ml, 1ml, 1.25ml, and 1.5ml pure Amla juice in 100ml of drinking water, respectively. The chicks during the brooding period (seven days) were supplied only with clean, fresh drinking water and commercial diet. The Amla solution treatment was started from the 8th day to the treatment group: - T1 supplied 0.75% Amla solution, similarly, birds under treatment group T2, T3, and T4 fed 1%, 1.25% and 1.5% Amla solution, respectively, except the control group (T0).



RESULTS AND DISCUSSION

This experiment was conducted to evaluate the efficacy of Amla juice on production performance, including weekly body weight, final live weight gain, feed intake, feed efficiency, carcass characteristics, mortality rate, and lipid profile for a period of 35 days at the University poultry shed, HSTU, Dinajpur, Bangladesh. A total of 120 chicks were randomly assigned to 5 dietary treatment groups. During the study period, all the birds were provided with standard husbandry conditions required for broiler production. The treatments were T_0 (control group), T_1 (0.75%), T_2 (1%), T_3 (1.25%), and T_4 (1.5%) of Amla juice administered through drinking water. During the experimental period, data on feed intake were noted daily, the body weight of birds was noted weekly, and at the end of the study the carcass characteristics and lipid profile data were noted for further evaluation. All results are expressed as mean $\pm$ standard error mean (SEM). Some values had undergone one-way ANOVA, and then Duncan's t-test was used to determine whether there were any differences. Results were presented in different tables and discussed under the following subheadings.

Effect of Amla Juice on Feed Intake (g) of Broiler

Data on weekly and total feed intake of experimental birds are presented in Table 2. It was observed that T_4 consumed more amount of feed (3317.95 ± 40.93 g) followed by T_2 (3297.39 ± 13.44 g), T_3 (3290.16 ± 12.41 g), T_1 (3285.64 ± 13.16 g) and T_0 (3285.32 ± 14.21 g) which were statically non-significant ($P > 0.05$). The results of the current study revealed that there was no significant ($P > 0.05$) difference among the treatment groups in weekly and total feed intake throughout entire experimental period.

Table 2. Effect of amla juice on feed intake (g)

Feed intake (g)/bird (days)	Treatment Group					Level of significance
	T_0	T_1	T_2	T_3	T_4	
7 th	155.67 ± 0.88	154.00 ± 2.08	156.00 ± 1.53	155.67 ± 2.33	157.67 ± 1.76	NS
14 th	360.11 ± 3.64	363.09 ± 3.91	356.55 ± 3.90	360.11 ± 2.78	365.16 ± 2.47	NS
21 st	642.34 ± 2.65	640.56 ± 3.51	638.74 ± 3.57	640.66 ± 3.29	634.69 ± 3.48	NS
28 th	935.32 ± 2.89	929.81 ± 2.71	941.45 ± 1.10	933.88 ± 1.43	932.06 ± 2.68	NS
35 th	1191.88 ± 4.15	1198.18 ± 0.95	1204.65 ± 3.34	1199.84 ± 2.58	1228.37 ± 30.54	NS
Total feed intake	3285.32 ± 14.21	3285.64 ± 13.16	3297.39 ± 13.44	3290.16 ± 12.41	3317.95 ± 40.93	NS

Values are expressed as mean $\pm$ standard error of means (SEM). NS: Statistically not significant ($P > 0.05$).



Feed Intake

This study showed no significance difference ($P>0.05$) in weekly and total feed intake throughout entire experimental period (Table 2). Total feed intake was highest in T_4 (3317.95 ± 40.93 g) followed by T_2 (3297.39 ± 13.44 g), T_3 (3290.16 ± 12.41 g), T_1 (3285.64 ± 13.16 g) and T_0 (3285.32 ± 14.21 g) which were statically non-significant ($P>0.05$). The results of the current study revealed that there was no significantly difference ($P>0.05$) in weekly and total feed intake throughout the entire experimental period among all groups. Supplementation of Amla showed no adverse effect on feed intake of broiler may because of herbal products having negligible side effects. This study seemed closely related with the findings of Patel *et al.* (2016) in which 0.4% and 0.8% Amla powder supplemented group had no effect on feed intake and so as reported by Islam *et al.* (2020), Sanjyal *et al.* (2011). The results obtained in the study differ with the results of Gaikward *et al.* (2016) in which 0.5% and 1% Amla supplemented group consumed less amount of feed compared to control group. Similar findings were reported by Dalal (2018), Naik (2020) and Kumari (2012), they reported that Amla supplemented group consumed lower amount of feed compared to control. It may be due to the difference in the form of amula used i.e. Powder and liquid.

Growth Performance of Broiler

Live Weight (g) of Broiler

The results of the present study showed that there was no significant ($P>0.05$) differences in live weight (Table 3) on 7th day (first week) among all five groups of the experiment (T_0 , T_1 , T_2 , T_3 and T_4).

Table 3. Effect of amla juice on live weight (g) of broilers

Live weight (g)/ bird (days)	Treatment Group					Level of significance
	T_0	T_1	T_2	T_3	T_4	
Initial Body Weight	47.67 ± 0.33	46.67 ± 0.33	47.00 ± 0.58	47.33 ± 0.33	47.00 ± 0.58	NS
7 th	201.67 ± 1.45^a	207.00 ± 1.00^b	202.67 ± 1.20^a	199.00 ± 1.15^a	200.33 ± 0.88^a	*
14 th	515.00 ± 1.53^a	517.00 ± 4.58^a	541.00 ± 4.51^b	516.00 ± 7.09^a	508.67 ± 4.10^a	*
21 st	1017.67 ± 14.84^a	1007.33 ± 7.69^a	1068.00 ± 8.33^b	997.33 ± 8.67^a	1011.33 ± 8.88^a	*
28 th	1608.00 ± 26.91^{ab}	1582.67 ± 22.93^a	1725.67 ± 19.40^c	1660.33 ± 9.21^b	1589.00 ± 11.06^a	*
35 th	2255.67 ± 28.43^a	2334.67 ± 36.09^{ab}	2574.67 ± 10.73^c	2385.33 ± 33.78^b	2363.67 ± 35.03^b	**

Values are expressed as mean $\pm$ standard error of means (SEM). NS: Statistically not significant ($P>0.05$).

^{a b c d e} means having different superscript in the same row differed significantly ($P<0.05$) *indicates 5% level of significance, and **indicates highly significant

The live weight was differed significantly ($P<0.05$) from 14th to 28th days and highest significant different ($P<0.01$) was recorded on 35th days of the experiment



among groups (T_0 , T_1 , T_2 , T_3 and T_4) where, lowest body weight was observed in T_0 (2255.67 ± 28.43 g) and T_2 group gained highest body weight (2574.67 ± 33.78 g) followed by T_3 (2385.33 ± 33.78), T_4 (2363.67 ± 35.03) and T_1 (2334.67 ± 36.09), respectively.

Live Weight Gain

The results of the present study showed that there was no significant ($P > 0.05$) differences observed in live weight gain (Table 4) on 7th, 14th and 21st days among all treatment group (T_0 , T_1 , T_2 , T_3 and T_4). The significant ($P < 0.05$) differences was observed in live weight gain on 28th and 35th days of experiment among all groups (T_0 , T_1 , T_2 , T_3 and T_4) where, T_2 recorded significantly highest live weight gain (657.67 ± 12.35 g) and (849.00 ± 29.96 g) on 28th and 35th days of experiment respectively. Significant difference ($P < 0.05$) in average live weight gain was also recorded at end of the study (35th days) where, T_0 recorded significantly lowest live weight gain (2208 ± 59.25 g) and T_2 recorded significantly highest live weight gain (2527.67 ± 56.96 g) followed by T_3 (2338 ± 83.3 g), T_1 (2321.32 ± 80.66 g) and T_4 (2316.67 ± 61.07 g), respectively.

Table 4. Effect of amla juice on weight gain

Live weight gain (g)/ bird (days)	Treatment Group					Level of significance
	T_0	T_1	T_2	T_3	T_4	
7 th	154.00 ± 1.73	160.33 ± 0.88	155.67 ± 0.67	151.67 ± 1.20	153.33 ± 1.45	NS
14 th	313.33 ± 2.85	313.00 ± 5.13	338.33 ± 3.38	317.00 ± 7.00	308.33 ± 3.28	NS
21 st	502.67 ± 13.59	492.33 ± 11.98	527.00 ± 10.60	481.33 ± 15.45	502.67 ± 12.68	NS
28 th	590.33 ± 14.31 a	579.33 ± 30.38 ^a	657.67 ± 12.35 ^b	663.00 ± 17.39 ^b	577.67 ± 10.20 ^a	*
35 th	647.67 ± 26.77 a	779.33 ± 32.13 ^{bc}	849.00 ± 29.96 ^c	725.00 ± 42.34 ^{ab}	774.67 ± 33.46 ^b c	*
Total weight gain	2208 ± 59.25 ^a	2321.32 ± 80.66 b	2527.67 ± 56.96 d	2338 ± 83.38 ^{bc}	2316.67 ± 61.0 7 ^b	*

Values are expressed as mean $\pm$ standard error of means (SEM). NS: Statistically not significant ($P > 0.05$).

^{a b c} means having different superscript in the same row differed significantly ($P < 0.05$); * indicates 5% level of significance.

The study shows no significance difference ($P > 0.05$) in live weight gain on 7th, 14th and 21st days among all treatment groups (Table 4). Significance difference ($P < 0.05$) were recorded in live weight gain on 28th and 35th days among all five group. Significance difference ($P < 0.05$) in average live weight gain was recorded on 35th days where, T_0 registered significantly lowest average live weight gain (2208 ± 59.25 g) and T_2 gained highest (2527.67 ± 56.96 g) followed by T_3 (2338 ± 83.38) T_1 (2321.32 ± 80.66) and T_4 (2316.67 ± 61.07).



The study showed that Amla supplementation had no significant effect on live weight gain from 7th to 21st days while, Amla supplementation showed significant effect on live weight gain on 28th and 35th days. Also, Amla supplementation had significant effect on total average live weight gain at the end of experiment (35th days). The results of the study reveals that significantly higher live weight was recorded in Amla treated groups compared to control where, 1% Amla supplement recorded highly significant highest live weight. This study seems closely related with the findings of Gaikward *et al.* (2016) who found highest live weight gain in 1% Amla treated group than 0.5% Amla supplement and control group. Naik *et al.* (2020), found highest live weight in 1% Amla supplement than 0.5% and 2% Amla powder supplement group. The obtained results is comparable with previous findings of Patel *et al.* (2016) who recorded significantly higher live weight gain in 0.8% and 0.4% Amla powder supplemented group; Patil *et al.* (2012) recorded significantly higher live weight gain in 1.5% and 2% Amla powder supplemented group; Tiwari *et al.* (2016), recorded highest body weight in 10% Amla powder supplement group. Aljumaily *et al.* (2019), recorded highest live weight in 0.1% Amla supplement.

Effect of amla juice on feed conversion ratio (FCR)

The results of the current study showed that there was no significance ($P>0.05$) difference in FCR (Table 5) on 7th, 14th and 21st days among all treatment groups (T_0 , T_1 , T_2 , T_3 and T_4) and significantly different ($P<0.05$) FCR was observed on 28th and 35th days of treatment. Amla supplemented group showed better FCR than control group where, T_2 recorded significantly improved FCR (1.30 ± 0.24) than T_3 (1.41 ± 0.15), T_1 (1.42 ± 0.16), T_4 (1.43 ± 0.67), and T_0 (1.49 ± 0.24), respectively.

Supplementation of Amla showed a significantly beneficial effect on FCR which may be because of enhancement of intestinal activities of trypsin, lipase, and amylase (Lee *et al.*, 2004) and improved gut morphological characteristics (Jamroz *et al.*, 2003). The beneficial influence of the phytogetic feed additives on improved performance and feed conversion ratio could be also explained due to the antioxidant activity of bioactive compounds such as carvacrol, thymol, cineol and pinene (Hazzit *et al.*, 2006) as well as from improved enzyme activity in the alimentary tract, stimulation of useful and inhibition of pathogenic microflora which eventually resulted in improved absorption and utilization of nutrients (Windisch *et al.*, 2008). This study seems closely related with the findings of Gaikward *et al.* (2016), in which 1% Amla supplement resulted lowest FCR and 0.5% Amla supplement resulted better FCR than control; Dalal *et al.* (2018), who recorded best FCR in 1% Amla supplemented group, Aljumaily *et al.* (2019) also recorded higher FCR in 1% Amla supplemented group; Kumar *et al.* (2013) recorded highest FCR in 1% Amla treated group. The results of this study is comparable with previous findings of Patel *et al.* (2012) who, recorded



lower FCR in 1.5% and 2% Amla supplement group and Naik *et al.* 2020 recorded higher FCR in 0.5% Amla powder supplement.

Table 5. Effect of amla juice on feed conversion ratio (FCR)

FCR (days)	Treatment Group					Level of significance
	T ₀	T ₁	T ₂	T ₃	T ₄	
7 th	1.01±0.02	0.98±0.01	1.00±0.01	1.03±0.02	1.03±0.00	NS
14 th	1.15±0.02	1.16±0.03	1.15±0.02	1.14±0.03	1.18±0.00	NS
21 st	1.28±0.03	1.30±0.04	1.21±0.03	1.33±0.04	1.26±0.03	NS
28 th	1.59±0.04 ^b _c	1.61±0.09 ^c	1.43±0.03 ^a _b	1.41±0.04 ^a	1.62±0.03 _c	*
35 th	1.85±0.08 ^b	1.54±0.07 ^a	1.42±0.05 ^a	1.67±0.10 ^a _b	1.59±0.07 _a	*
Final FCR	1.49±0.24 ^b	1.42±0.16 ^a _b	1.30±0.24 ^a	1.41±0.15 ^a _b	1.43±0.67 _{ab}	*

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05).

^{a b c} means having different superscript in the same row differed significantly (P<0.05); *indicates 5% level of significance.

Effect of amla juice on carcass yield characteristics of broiler

Live weight, slaughter weight and carcass weight

Final live weight, slaughter weight and carcass weight and carcass characteristics data are presented in Table 6. From Table 5 it is observed that T₂ gained higher live weight (2574.67±10.73 g), slaughter weight (2492.80±37.64 g) and carcass weight (2574.67±10.73 g) compared to T₀ live weight (2574.67±10.73 g), slaughter weight (2492.80±37.64 g) and carcass weight (2574.67±10.73 g). T₃ (2385.33±33.78 g), T₄ (2363.67±35.03 g) and T₁ gained (2334.67±36.09g) live weight On 35th days of the experimental period; T₃ (2272.57±34.41 g), T₄ (2263.33±33.20g) and T₁ gained (2231.00±38.81 g) slaughter weight on 35th days of the experiment and T₃ (1643.33±45.04 g), T₄ (1637.20±33.43 g) and T₁ gained (1620.33±18.01 g) slaughter weight on 35th days of the experiment.

Weight of thigh, drumstick, breast, wings, abdominal fat, liver and heart

Data on weight of thigh, drumstick, breast, wings, abdominal fat, and liver and on heart 35th days are presented in table 6. Thigh weight was significantly (P<0.05) differed among all the treatment groups, T₂ recorded higher thigh weight (394.67±2.96 g) compared T₀ (350.67±7.69 g), T₁ (359.33±6.33 g), T₄ (360.47±7.99 g) and. T₃ (364.23±7.03g) on 35th days of the experiment respectively. Non-significant (P>0.05) differences were recorded in drumstick weight where, T₀ (242.33±0.88 g), T₁ (235.33±8.09 g), T₂ (240.00±3.06 g), T₃ (595.70±14.23 g) and



T₄ (235.80±3.37 g) respectively. Although high drumstick weight was non-significant but higher drumstick weight was observed in T₂ (240.00±3.06 g) and lower in T₀ (242.33±0.88g) groups. Breast weight was significantly (P<0.05) differed among the all treatments groups. In T₀ breast weight was (566.67±18.68 g), T₁ (602.33±17.61 g), T₂ (659.00±10.50 g), T₃ (595.70±14.23 g) and T₄ (607.27±17.69 g), where higher breast weight was observed in T₂ group. Wings weight was also differed significantly (P>0.05) T₀ recorded 118.00±5.86 g, T₁ gained (116.67±6.23) g, T₂ (144.67±2.19 g), T₃ (132.10±9.07 g) and T₄ (128.33±9.94g) respectively. Higher drumstick weight was recorded in T₂ (144.67±2.19 g) and lower in T₁ (116.67±6.23 g) during 35th days of experiment. No significant (P>0.05) differences were recorded in abdominal fat weight. Abdominal fat in T₀ was (48.83±1.74 g), T₁ (49.17±1.59 g), T₂ (46.67±3.53 g), T₃ (44.67±3.18 g) and T₄ (39.17±0.44 g) respectively. Increasing the inclusion level of Amla resulted decreasing in abdominal fat weight. Significant (P<0.05) differences were observed in liver weight. Liver weight was 49.33±1.86 g in T₀, T₁ (53.33±1.45 g), T₂ (58.00±0.58 g), T₃ (52.83±2.09 g) and T₄ (53.67±0.33 g) respectively, where, T₂ recorded higher and T₀ recorded liver weight among all treatment groups. Significant (P<0.05) differences were also shown in heart weight. Heart weight was (13.33±0.33 g) in T₀, T₁ (12.67±0.33 g), T₂ (14.17±0.17 g), T₃ (12.53±0.26 g) and T₄ (13.20±0.20 g) respectively, where, T₂ recorded (14.17±0.17 g) higher and T₃ recorded lower heart weight among all treatment groups.

Cost effectiveness on production

Data on cost benefit analysis of the present study are presented in table 7. It is observed that chick cost was non-significant (P>0.05) among the treatment groups. All treatment groups recorded similar chick cost that 57.00Tk/chick. Average feed consumption per bird was non-significant (P>0.05). Price of concentrate per kg was also non-significant (P>0.05), all treatment groups recorded similar feed price (56.8 TK/kg). Amla juice supplemented group was not significantly (P>0.05) differed. Total feed consumed cost was non-significant (P>0.05).

Amla juice cost was non-significant (P>0.05). Miscellaneous cost /bird registered non-significant (P>0.05). Total cost of production per bird was little bit similar with another groups. Sell price per kg live of broiler was similar 145 Tk/kg which is non-significant (P>0.05). Sell price per broiler of Amla supplemented group was significant (P<0.05), lowest sell price per broiler (TK 327.07±4.12) was recorded in T₀ whereas, highest sell price per broiler (TK 373.33±1.56) was recorded in T₂ followed by T₃ (TK 345.87±4.90), T₄ (TK 43.38±5.06) and T₄ (TK 338.53±5.23), respectively. Net profit/ broiler was significantly different (P<0.05) among treatment groups, lowest net profit (TK 35.53±5.07) was recorded in T₄ whereas, highest net profit (TK 74.77±1.57) was recorded in T₂ followed by T₁ (TK 60.42±21.50) T₃ (TK 43.38±5.06) and T₀ (TK 38.56±4.11), respectively.



Table 6. Carcass yield characteristics

Parameter	Treatment Group					Level of sign.
	T ₀	T ₁	T ₂	T ₃	T ₄	
Live wt.	2225.00±9.07 ^a	2334.67±36.0 ₉ ^b	2574.67±10.73 ^c	2385.33±33.78 ^b	2363.67±35.03 ^b	**
Slaughter wt.	2110.33±7.54 ^a	2231.00±38.8 ₁ ^b	2492.80±37.64 ^c	2272.57±34.41 ^b	2263.33±33.20 ^b	**
Carcass wt.	1441.33±15.30 ^a	1620.00±18.0 ₁ ^b	1758.00±3.46 ^c	1643.33±45.04 ^b	1637.20±33.43 ^b	**
Thigh	350.67±7.69 ^a	359.33±6.33 ^a	394.67±2.96 ^b	364.23±7.03 ^a	360.47±7.99 ^a	*
Drum stick	242.33±0.88	235.33±8.09	240.00±3.06	234.67±4.41	235.80±3.37	NS
Breast	566.67±18.68 ^a	602.33±17.61 ^a	659.00±10.50 ^b	595.70±14.23 ^a	607.27±17.69 ^a	*
Wings	118.00±5.86 ^a	116.67±6.23 ^a	144.67±2.19 ^c	132.10±9.07 ^b	128.33±9.94 ^b	*
Abdominal fat	48.83±1.74	49.17±1.59	46.67±3.53	44.67±3.18	39.17±0.44	NS
Liver	49.33±1.86 ^a	53.33±1.45 ^{ab}	58.00±0.58 ^b	52.83±2.09 ^a	53.67±0.33 ^{ab}	*
Heart	13.33±0.33 ^{ab}	12.67±0.33 ^a	14.17±0.17 ^b	12.53±0.26 ^a	13.20±0.20 ^a	*

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant ($P>0.05$).

^{a b c} means having different superscript in the same row differed significantly ($P<0.05$); *indicates 5% level of significance.

Data on cost benefit analysis of the study are presented in table 7. The study showed no significant difference ($P>0.05$) in chick cost, feed cost, total feed cost, average feed consumed per bird, Amla cost, miscellaneous cost, total cost of production per broiler and sell price per kg live broiler among all treatment group. Significance difference ($P<0.05$) was recorded in average live weight of broiler where, T₀ registered the lowest average body weight (2.22±0.03 g) and T₂ registered the highest average body weight (2.57±0.01 g) followed by T₃ (2.39±0.03), T₄ (2.36±0.04 g) and T₁ (2.33±0.04 g) on 35th day. Significance difference ($P<0.05$) was recorded in sell price of per broiler among all group where, T₀ recorded lowest sell price per broiler (TK 327.07±4.12) and T₂ recorded highest sell price per broiler (TK 373.33±1.56) followed by T₃ (TK 345.87±4.90), T₄ (TK 342.73±5.08) and T₁ (TK 338.53±5.23).

Significant difference ($P<0.05$) was recorded in net profit per broiler among all group where, T₄ recorded lowest net profit per broiler (TK 35.53±5.07) and T₂ recorded highest net profit per broiler (TK 74.77±1.57) followed by T₁ (TK 60.42±21.50), T₃ (TK 60.42±21.50) and T₀ (TK 38.56±4.11). The study reveals that significantly higher selling price per broiler and net profit were achieved with



Amla juice supplementation. 1% Amla juice supplemented group achieved highest net profit and sold price of per broiler chicken whereas T₃ and T₄ recorded lowest net profit because of high dose of Amla cost. This study seems closely related with the findings of Gaikward *et al.* (2016), who gained highest economic profit in 1% Amla treated group. The result seems comparable with the findings of Patel *et al.* (2016), who gained highest profit in 0.4% Amla supplement followed by 0.8% Amla supplement. Patil *et al.* (2012) gained slightly lower profit in Amla treated group than control.

Table 7. Cost Benefit Analysis

Description	Treatment Group					Level of signi
	T ₀	T ₁	T ₂	T ₃	T ₄	
Cost / chick (TK)	57.00±0.00	57.00±0.00	57.00±0.00	57.00±0.00	57.00±0.00	NS
Avg. feed consumed (kg/bird)	3.28±0.00	2.95±0.33	3.26±0.00	3.28±0.00	3.32±0.00	NS
Feed cost /Kg (TK)	56.80±0.00	56.80±0.00	56.80±0.00	56.80±0.00	56.80±0.00	NS
Total Feed cost (TK)	186.51±0.02	167.71±18.90	185.36±0.02	186.49±0.19	188.41±0.03	NS
Cost of Amla juice (TK)	0.00±0.00	8.40±0.00	11.20±0.00	14.00±0.00	16.80±0.00	NS
Miscellaneous cost (Tk/ bird)	45.00±0.00	45.00±0.00	45.00±0.00	45.00±0.00	45.00±0.00	NS
Total cost /bird (Tk)	288.51±0.02	278.11±18.90	298.56±0.02	302.49±0.19	307.21±0.03	NS
Average live weight (kg)	2.22±0.03 ^a	2.33±0.04 ^{ab}	2.57±0.01 ^c	2.39±0.03 ^b	2.36±0.04 ^b	*
Sell price / kg live wt. (Tk)	145.00±0.00	145.00±0.00	145.00±0.00	145.00±0.00	145.00±0.00	NS
Sell price /broiler (Tk)	327.07±4.12 ^a	338.53±5.23 ^{ab}	373.33±1.56 ^c	345.87±4.90 ^b	342.73±5.08 ^b	*
Net profit / broiler (Tk)	38.56±4.11 ^a	60.42±21.50 ^{ab}	74.77±1.57 ^b	43.38±5.06 ^a	35.53±5.07 ^a	*

Values are expressed as mean ± standard error of means (SEM). NS: Statistically not significant (P>0.05).

^{a b c} means having different superscript in the same row differed significantly (P<0.05); *indicates 5% level of significance.

Effect of amla juice on lipid profile

Effect of Amla juice on lipid profile of broiler are presented in table 8. Total cholesterol was significantly (P< 0.01) differed among the treatment groups where, T₀ recorded higher level of cholesterol 151.00±0.58 mg/dl blood and lower level of cholesterol (101.33±0.88 mg/dl blood) was in T₃ group. Triglycerides were also statistically significant (P< 0.01) where, T₂ recorded higher level of blood triglyceride 87.00±1.00 mg/dl and T₁ recorded level amount of blood



triglyceride (42.33 ± 0.33 mg/dl). High density lipoprotein (HDL) was statistically significant ($P < 0.01$) where, T_4 recorded higher value (43.33 ± 0.88 mg/dl) and T_0 recorded lower value (36.00 ± 0.58 mg/dl) of blood. Low density lipoprotein (LDL) was also statistically significant ($P < 0.01$) where, T_0 recorded higher value 99.00 ± 0.58 and T_3 recorded lower value 49.00 ± 0.58 mg/dl blood. Amla treated group was lower in LDL compared to control group.

Data on lipid profile are presented in table 8. The study recorded statistically significant lipid profile parameter among all treatment groups. Total cholesterol was statistically significant ($P < 0.05$) where, T_3 recorded lower level of cholesterol (101.33 ± 0.88 mg/dl) and T_0 recorded higher level of cholesterol (151.00 ± 0.58 mg/dl) of blood followed by T_1 (145.00 ± 1.15 mg/dl), T_2 (121.67 ± 0.88 mg/dl) and T_4 (105.00 ± 0.58 mg/dl) respectively. Triglyceride was also statistically significant ($P < 0.05$) where, and T_1 recorded lowest blood triglyceride (42.33 ± 0.33 mg/dl) and T_2 recorded higher blood triglyceride (87.00 ± 1.00 mg/dl) followed by T_0 (71.33 ± 0.88 mg/dl), T_3 (54.00 ± 0.58 mg/dl) and T_4 (48.00 ± 0.58 mg/dl). High density lipoprotein (HDL) was also statistically significant ($P < 0.05$) where, T_0 recorded lowest HDL 36.00 ± 0.58 mg/dl blood and T_4 recorded highest HDL (43.33 ± 0.88 mg/dl) followed by T_2 (40.67 ± 0.88 mg/dl), T_3 (40.67 ± 0.88 mg/dl) and T_1 (38.00 ± 0.58 mg/dl). Low density lipoprotein (LDL) was also statistically significant ($P < 0.05$) where, T_3 recorded lower value (49.00 ± 0.58 mg/dl) and T_0 recorded higher value 99.00 ± 0.58 mg/dl followed by T_1 recorded 88.67 ± 0.88 mg/dl, T_2 recorded (67.33 ± 1.20 mg/dl) and T_4 recorded (53.00 ± 1.00 mg/dl). Amla treated group registered significantly lower blood cholesterol compared to control group.

The results of the current study revealed that Amla supplement had significantly beneficial effect on blood cholesterol, the increasing level of Amla supplement gradually decreased cholesterol level of blood. Amla supplement showed significantly beneficial effect on blood triglyceride; 1% Amla supplement recorded highest triglyceride 87.00 ± 1.00 mg/dl of blood. Amla supplement had significantly beneficial effect on blood HDL.

Table 8. Effect of amla juice on lipid profile of broiler

Lipid profile (mg/dl)	Treatment Group					Level of sign
	T_0	T_1	T_2	T_3	T_4	
Total cholesterol	151.00 ± 0.58^c	145.00 ± 1.15^d	121.67 ± 0.88^c	101.33 ± 0.88^a	105.00 ± 0.58^b	*
Triglyceride	71.33 ± 0.88^d	42.33 ± 0.33^a	87.00 ± 1.00^c	54.00 ± 0.58^c	48.00 ± 0.58^b	*
HDL	36.00 ± 0.58^a	38.00 ± 0.58^a	40.67 ± 0.67^b	40.67 ± 0.88^b	43.33 ± 0.88^c	*
LDL	99.00 ± 0.58^c	88.67 ± 0.88^d	67.33 ± 1.20^v	49.00 ± 0.58^a	53.00 ± 1.00^b	*



Values are expressed as mean $\pm$ standard error of means (SEM). NS: Statistically not significant ($P > 0.05$).

^{a b c d e} means having different superscript in the same row differed significantly ($P < 0.05$); ** indicates 1% level of significance.

1.5% Amla supplemented group recorded higher level of HDL mg/dl of blood. Amla had significantly beneficial effect on blood LDL, the increasing the level of Amla supplement gradually decreased LDL of blood in all treated group may be because of Amla fruits are a rich source of ascorbic acid and acts as an antioxidant to prevent the oxidation of LDL and cholesterol (Mathur *et al.* 1996), thus slows atherogenesis. This study seems closely related to the findings of Dalal *et al.* (2018), who recorded an increasing level of Amla supplementation caused decreased serum cholesterol, and gained the best result in 1% Amla supplement. They also recorded an increasing level of Amla supplemented resulted in decreased serum HDL (mg/dl) and higher. The result seems comparable with the findings Aljumaily *et al.* (2019), who found 0.1% Amla supplement recorded lower triglyceride than control; Dalal *et al.* (2018), recorded Amla supplement had similarity with control group serum triglyceride (mg/dl), they also recorded similarity in LDL (mg/dl) with control group.

CONCLUSION

The feeding value of Amla on broiler (Cobb 500) was evaluated in the poultry shed, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. The phytogetic properties of Amla as an antioxidant, anti-stress, antimicrobial, metabolism enhancer, gut microflora manipulation, and better digestion could be the reason for higher production performance, lower serum cholesterol, lower LDL higher and higher HDL, and in Amla Amla-treated group than control group. The higher live weight, better FCR and higher profit can be achieved with 1% Amla juice supplement. So, it can be concluded that Amla juice can be effectively used as an alternative to growth promoters, prebiotics, probiotics and heat stress minimizer in poultry diet. The beneficial influence of the Amla on improved performance and feed conversion ratio could also be explained due to the antioxidant activity of bioactive compounds.

In a nutshell, feeding Amla to broilers seems too good in many aspects. Mainly, it controls heat stress, lipid level, mortality, and boosts up immunity and gut health. Feeding of Amala with 1% of drinking water showed better results than 0.75%, and 1.5% under a managed broiler production system.



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