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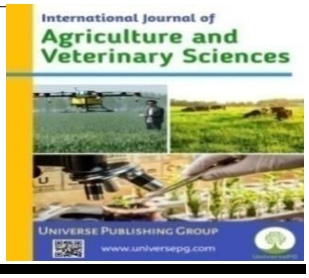

Efficacy of Star Gooseberry (*Phyllanthus acidus L.*) Feed Additive on the Performance of Broilers with Serum Biochemical Profile

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ABSTRACT

A study was done to find out how star gooseberry (*Phyllanthus acidus* L.*)* Fruit juice affected commercial broiler live weight gain, feed consumption, feed conversion ratio, carcass quality, and lipid profiles. A total of 210day-old broiler chicks (Cobb 500) were divided into five dietary treatment groups. The collected data were analyzed by using ANOVA with SPSS version 25. These groups were T_0 (control diet), T_1 (5 ml/L in water), T_2 (7 ml/L in water), T_3 (9 ml/L in water), T_4 (11 ml/kg in feed), T_5 (13 ml/kg in feed), and T_6 (15 ml/kg in feed). The T_5 group consumed the most feed overall (2829.15±19.85 g), while the T_0 group consumed the least feed overall (2767.25±17.55 g). At 5 weeks of age, the T_5 group had the highest body weight (2193.33±15.18g), followed by the T_6 group (2146.00±17.51g), T_2 (2088.00±11.15g), T_1 (2031.33±20.12 g), and T_0 (1871.67± 13.02g), all in that order. The FCR was discovered to be lowest in T_5 (1.31) and greatest in T_0 (1.51), whereas the FCR of T_1, T_2, T_3, T_4, and T_6 was 1.41, 1.38, 1.36, 1.35, and 1.32, respectively. The amount of star gooseberry juice has a big impact on the meat's quality. However, there were alterations that were significant ($P<0.05$) in the carcass weight, breast meat, drumstick meat, wing, shank weight, gizzard, head, liver, lung, skin, thigh bone, and drumstick bone. Only abdominal fat ($P>0.05$) was not significant. However, there were significant ($P<0.05$) changes in total cholesterol, triglycerides, HDL, and LDL. According to the findings, star gooseberry juice can be utilized as a cost-efficient and effective natural feed addition at a rate of 13 ml per kilogram of feed to enhance the broiler chicken's overall performance.

Keywords: Star Gooseberry, *Phyllanthus acidus,* Broiler, Carcass, Feed additive, and Performance.

INTRODUCTION:

The star gooseberry is a significant source of minerals, amino acids, ascorbic acid, tannins, and phenolic compounds. According to Indian research (Shivaji *et al.,* 2012) 100 mg of the most popular synthetic vitamin C is equivalent to 8.75 mg of natural vitamin C complex from the star gooseberries. As feed supplements, star gooseberries have been used to increase growth, save feed costs by increasing feed efficiency, and improve immunity (Ghavate *et al*., 2009). As stated by Janick and Paull, (2008) a 100-gram serving of the Star Gooseberry fruit contains 91.7% water, 28 kcal, 0.7% protein, 0.52% fat, 6.4% carbohydrate, 0.6% fiber, 0.51% ash, 5 mg of calcium, 0.4 mg of iron, 23 mg of

phosphorus, 8 mg of the ascorbic acid, 0.01 mg of thiamine, and 0.05 mg of riboflavin. As reported by Layek *et al*. (2023), biochemical parameters included the following: total soluble solid (TSS) content of 5.75 0Brix, total sugar (2.5%), reducing sugar (1.29%), non-reducing sugar (1.21%), and vitamin C content of 4.89 mg per 100 g edible pulp. Inflammation, diabetes, asthma, bronchitis, cephalgia, opthalmopathy, colic, jaundice, emaciation, cardiac disorder, the intermittent fever, hepatopathy, haemorrhage, menorrhagia, and skin diseases are treated with the fruit of star gooseberry (Anjaria *et al*., 2002; Sharif *et al*., 2019).

Tiwari *et al.* (2016) investigated the effects of the probiotic and herbal supplements on the features of commercial broiler growth and immunocompetence. In 2009, Ghavate *et al*. conducted an experiment to determine the impact of feeding broilers various amounts of star gooseberry on their ability to the perform well. Supplementation had a considerable impact on the broilers' body weight gain. Star gooseberry (*Phyllanthus acidus*) juice with a high antioxidant content lowers hepatic injury, purifies chemicals, and has an anti-inflammatory action that improves carcass quality, according to (Manikandan *et al*., 2017; Nguyen *et al*., 2017; Jain *et al*., 2010; Leeya *et al*., 2010). In order to assess the nutritional impact of star gooseberry juice as a feed additive on the performance of commercial broiler chickens and its cost-benefit analysis in broiler production, the current study was established. This research is based on the following objectives

1) To investigate the effect of star gooseberry fruit extract on the productive performance and the economic broiler production
2) To evaluate the serum biochemical lipid profile after treatment with star gooseberry
3) To determine the optimal star gooseberry fruit extract dosage for improving broiler performance.

MATERIALS AND METHODS:

Experimental site and duration

The experiment was conducted to ascertain the effects of supplementing with star gooseberry juice on the performance and meat yield traits of broilers (Cobb 500) during the summer season from October 20 to November 25, 2021, at the poultry farm of HSTU, Dinajpur.

Experimental birds

The 210day-old broiler chicks (Cobb 500) had been purchased for the experiment through local suppliers from the Kazi Farm hatchery.

Layout of the experiment

The chicks were randomly assigned to one of seven nutritional treatment groups (T_0, T_1, T_2, T_3, T_4, T_5, and T_6), each of which consisted of three replications with ten birds each. The following are the treatments: T_0 = Control, T_1 = Control + 5ml star gooseberry juice/ litter water, T_2 = Control + 7ml star gooseberry juice/ litter in drinking water, T_3 = Control + 9ml star gooseberry juice/litter water, and T_4 = Control + 11ml star gooseberry juice/kg feed, T_5 = Control + 13ml star gooseberry juice/kg feed, and T_6 = Control + 15ml star gooseberry juice/kg feed.

Collection and preparation of Star gooseberry & feed

The HSTU Botanical Garden provided the star gooseberry fruit for collection. These were cleaned with clean water after collection to remove any dirt. The fruit of the star gooseberry was then ground into juice using a grinder machine.

Managemental practices

Housing, litter, feed (CP Feed Co. Ltd. broiler pre-starter: 1-7, broiler starter: 8-14, broiler grower: 15-35), water; Lighting, sanitization, and vaccination are all necessities provided. Adequate precautions were implemented throughout the study period.

Fig. 1: Star Gooseberry.

Calculation

1. Total gain in weight = final weight – initial weight
2. Dressing percentage = (dressed weight ÷ body weight) x 100

3. Total feed consumption = total feed offered – total left-over
4. Feed efficiency = total feed consumed / total gain in weight
5. Mortality rate (%) = no. of dead chickens / total no. of birds as a group × 100

Hematological Analysis

A vacutainer tube (BD vacutainer SST Gel-5 ml) was inserted via the wing vein puncture tubes to collect blood samples at random from 6 birds in each group (2 birds/replication) at the end of 5 weeks. Then they were kept at room temperature (25°C) for an hour to allow the blood to coagulate. Serum was recovered from the blood sample after centrifuging it for 15 minutes at 2000 rpm. Separated, unhaemolyzed serum samples were kept in clean, dry Eppendorf tubes and kept at -20°C in the deep freezer until needed. The serum cholesterol concentration was measured using a suitable industrial analytical kit produced by German cholesterol agent producer Randof. As directed in the manufacturer's leaflet, the assay was carried out on a Merck Microlab 300 biochemistry analyzer.

Fig. 2: Star Gooseberry Juice.

Statistical analysis

According to the Complete Randomized Design (CRD) principles, data on feed consumption, growth performance, carcass characteristics, and hematobiochemical data were examined using SPSS version 25 software and the one-way ANOVA approach. Every result was shown as the mean SEM±, and the significance was determined at P<0.05. The Duncan test was used to compare the means of the treatment groups.

RESULTS AND DISCUSSION:

Performance of broiler of experimental birds

In this experiment, the effects of the different dietary doses of the Star Gooseberry juice on broilers' feed consumption, feed conversion ratio, live weight gain, bird mortality, the hemato-biochemical characteristics, cost effectiveness, heat stress, and carcass features were examined. The findings are presented in several tables and discussed in the sections below.

Body weight, feed intake and the Feed Conversion Ratio (FCR)

Table 1 provides information on average body weight at the end of five weeks, feed consumption, and feed conversion ratio (FCR). The results of the experiment showed that although there was the no significant difference in initial body weight (g/broiler) between the food groups, there was a significant difference in final body weight (g/broiler) and body weight gain (P<0.05). The 5th week of age saw the highest feed intake in the T_5 group and the lowest in the T_0 group, whereas the fifth week saw the highest FCR in the T_0 group and the lowest in the T_5 group, according to **Table 1**. The findings of the present study's feed intake were similar to those of (Begum *et al*., 2019; Ghavate *et al*., 2009; Patel *et al*., 2016; Tiwari *et al.,* 2016; Yadav *et al.,* 2014). The results of the present study, however, disagreed with those of (Sanjyal and Sapcota, 2011; Patil *et al*., 2012; Kumar *et al*., 2013; Gaikwad *et al*., 2016) who found that broiler chickens in the control group consumed more feed than those in the star gooseberry-treated group. The fact that the gooseberry is known to act as a stomachic (Bhandari *et al.,* 2012) and a nice appetiser (Patel *et al*., 2016) could account for the increase in feed intake in the Star Gooseberry-fed group. In comparison to the control group, the broiler chicken's feed conversion ratio gradually increased as a result of the addition of star gooseberry juice to the base diet, indicating efficient feed use by lowering stress. Ghavate *et al*. (2009), Patil *et al.* (2012), Shivaji, (2012), Kumar *et al.* (2013), Gaikwad *et al*. (2016), and Mandal *et al.* (2017) in broiler chicks came to the similar conclusions. The T_5 group had the highest body weight (2193.33±15.81). Similar results were also attained by (Patel *et al.,* 2016; Tiwari *et al.,* 2016; Ghavate *et al*., 2009; Begum *et al.,* 2019; Shivaji, 2012; Ghavate, 2009). The ascorbic

acid, gallic acid, and tannic acid found in *E. officinalis* may have anabolic and antioxidant effects that explain the increased body weights seen in the star gooseberry-supplemented groups (Mcdowell, 1989). Due to the addition of star gooseberry juice to the base meal, the feed conversion ratio of the broiler chickens steadily increased in the comparison to the control group, indicating efficient feed use by lowering stress. In broiler chicks, similar findings were reached by (Patil *et al.*, 2012; Shivaji, 2012; Kumar *et al.*, 2013; Gaikwad *et al.,* 2016; Mandal *et al.,* 2017).

Table 1: Body weight, feed intake and Feed Conversion Ratio (FCR).

Characteristics	Dietary Treatment Groups							Level of Significant
	T_0	T_1	T_2	T_3	T_4	T_5	T6	
Initial body	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	NS
body weight (7th days)	193.25 ±5.69	193.25± 5.69	194.12± 4.16	187.52± 11.59	196.10± 4.93	192.67±11. 05	200.67± 8.35	NS
Final body weight (35 days)	1871.67^{a} ±13.02	2031.33^{b} ±20.12	2088.00 ^{c}±11.15	2112.39 ^{d}±16.71	2125.45 ^{d}±20.02	2193.33^{e}±1 5.81	2146.00^{d}± 17.51	*
Weight gain (gm/bird)	1830.67^{a} ±09.49	1991.33^{b} ±12.84	2048.0^{c} ±9.16	2072.39 ^{d}±14.57	2085.45 ^{d}±14.26	2153.33^{e}±1 4.85	2106.0^{d}±1 4.70	*
Feed intake (gm/bird)	2767.25 ±17.55	2809.45± 18.69	2820.42 ±15.04	2824.66 ±21.05	2808.65 ±18.22	2829.15±19 .85	2778.51± 25.16	NS
FCR	1.51e±0.01	1.41 ^{d}±0.03	1.38 ^{c} ±0.01	1.36b±0 .01	1.35 ^{b}±0.01	1.31a ^{a}±0.01	1.32a ^{b}±0.02	*

Values are Mean±SEM, ^{abcd} means within a row without common superscripts differ significantly; NS-non significant; statistically significant difference are the expressed as *(P<0.05).

Where, T_0 = Control, T_1 = Control + 5ml star gooseberry juice / litter water, T_2 = Control + 7ml star gooseberry juice / litter in drinking water, T_3 = Control + 9ml star gooseberry juice /litter water, & T_4 = Control + 11ml star gooseberry juice /kg feed, T_5= Control +13ml star gooseberry juice /kg feed & T_6= Control +15ml star gooseberry juice /kg feed.

Effect of star gooseberry carcass quality of Broiler

The tabulated results show that star gooseberry juice levels significantly influenced the qualities of the meat. However, there were changes in carcass weight, breast meat, drumstick meat, wings, shank weight, gizzard, head, liver, lung, skin, thigh bone, and drumstick bone that were significant (P<0.05). Only abdominal fat was nonsignificant (P>0.05). Our findings demonstrated that supplementing with Star Gooseberry juice at a dose of the 13 ml considerably (P<0.05) increased dressing percentage. The results were in contradiction to the findings of Mukhtar *et al.* (2012), who noticed no significant differences between all the treatments regarding carcass dressing percentages in response to the dietary citrus feed. Also, the results of substituting sweet orange fruit peel with maize up to 20% level had no negative impact on the growth traits and carcass quality in the broilers (Agu *et al.,* 2010; Abbasi *et al.,* 2015). Similar findings were documented in rabbits (Hon *et al.,* 2009; Manikandan *et al.,* 2017; Nguyen *et al.,* 2017; Jain *et al.,* 2010; Leeya *et al.,* 2010) reported that star gooseberry (*Phyllanthus acidus*) juice with a high antioxidant level reduces hepatic injury, purifies compounds, and has an anti-inflammatory effect that increases carcass quality.

Table 2: Effect of Star Gooseberry on meat yield parameters of broiler chicken.

Characteristics	Dietary Treatment Groups							Level of Significant
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	
Final body weight (35 days)	1871.67^{a} ±13.02	2031.33^{b} ±20.12	2088.00^{c}± 11.15	2112.39^{d}± 16.71	2125.45^{d}± 20.02	2193.33 ^{c}±15.81	2146.00^{d}± 17.51	*
Carcass weight	1402± 2.51^{a}	1576± 3.26^{b}	1595± 3.53^{c}	1664± 4.22^{d}	1673± 2.49^{de}	1702± 2.79^{f}	1691± 2.12^{e}	*

Breast	420.67 ±25.53 [a]	545.07±5 .24 [b]	561.67± 5.33 [b]	568.58± 3.84 [b]	559.83± 3.82 [b]	576.88± 3.29 [b]	562.55± 4.34 [b]	*
Thigh	202.50± 14.57 [a]	246.45± 2.35[b]	249.67± 3.94 [b]	255.03± 4.67 [c]	266.27± 2.77 [d]	288.72± 1.47 [f]	273.57± 2.71 [e]	*
Drum stick meat	108.33± 4.67 [a]	17.27±1. 88 [b]	122.00±3. 60[c]	124.10±1. 57[bc]	127.87±2. 14[bc]	139.63± 2.38[e]	132.47±1.7 6[d]	*
Wing	55.77± 3.42 [a]	80.42± 2.91[c]	71.23± 1.30 [b]	72.97± 1.53 [b]	71.68± 2.69 [b]	74.82±1 .68[bc]	73.40±2.36 [bc]	*
Shank weight	31.90± 0.26[a]	33.38± 0.73[b]	35.40± 0.38[c]	38.5± 0.71[e]	35.20± 0.58[d]	38.00± 0.81[e]	41.20± 0.68[f]	*
Gizzard	52.37±2. 16 [a]	63.95± 3.33[bc]	60.40± 2.97 [b]	65.37± 1.21[bc]	69.12± 1.64 [c]	69.25± 3.24 [b]	70.40± 1.40 [c]	*
Head	61.75± 2.39 [a]	72.65± 1.64 [b]	75.00± 1.06 [b]	72.87±1.7 0 [b]	78.26± 2.05 [b]	73.30± 2.52 [b]	73.81± 2.77 [b]	*
Liver	56.32± 2.9 [a]	72.78± 3.14 [b]	73.75± 2.31[b]	76.21± 2.02 [b]	76.37± 2.46 [b]	77.68± 2.06 [b]	70.17± 2.98 [b]	*
Lung	8.22 ±1.11 [a]	14.47± .34 [b]	14.35± .35 [b]	14.15± .47 [b]	14.17± .35 [b]	14.08± .23 [b]	14.85± .35 [b]	*
Abdominal fat	21.82± 3.50	22.47± 1.50	22.95± .09	20.37± .94	20.80± 0.85	20.6± 1.14	20.87± 1.24	NS
Skin	169.33± 4.70 [a]	247.20± 2.42 [d]	235.17± 5.58[cd]	229.00± 5.70[bc]	220.5± 3.85 [b]	218.83± 2.41 [b]	220.5± 3.44 [b]	*
Thigh bone	33.39± 2.57[b]	33.63± 1.54 [b]	29.16± .94 [ab]	27.47± 1.04[a]	27.13± .66 [a]	26.75± 1.01 [a]	20.88± .37 [ab]	*
Drum stick bone	45.75± 1.80 [b]	45.43± 1.20 [b]	43.48± 1.40 [ab]	39.22± 1.10[a]	40.30± 2.04 [a]	39.90± 1.43 [a]	42.22± 1.36 [ab]	*

Values are Mean±SEM, [abcd] means within a row without common superscripts differ significantly; NS-non significant; the statistically significant difference are expressed as *(P<0.05).

Impact of Star Gooseberry Serum biochemical properties in broiler

The influence of Star Gooseberry on broilers' lipid profiles is seen in **Table 3**. However, there were changes that were significant (P<0.05) in total cholesterol, triglycerides, HDL, and LDL. The treatment group T_0 had the greatest level of cholesterol (mg/dl), and the treatment group T_6 had the lowest level, both significantly (P<0.05). The dietary treatment group's HDL (mg/dl) levels were substantially higher (P <0.05) in treatment group T_6 and lower (P <0.05) in treatment group T_0. The dietary treatment group's LDL (mg/dl) levels were substantially higher (P<0.05) in treatment group T_0 and lower (P<0.05) in treatment group T_6. Triglycerides (mg/dl) were non-significantly (P<0.05) highest in treatment group T_0 and lowest in treatment group T_6, respectively, in the dietary therapy group. The experiment's Star Gooseberry supplement group had higher HDL mg/dl blood levels. Blood LDL levels were considerably lowered with star gooseberry. These findings were in line with those of Nobakht (2013), who discovered that dried citrus pulp can reduce blood cholesterol and bad cholesterol called LDL (Hong *et al.,* 2012) (**Table 3**). Abbasi *et al.* (2015) reported reduced blood cholesterol, LDL, and triglyceride in broilers in response to dietary treatment with star gooseberry and hypothesized that vitamin C and other elements found in the pulp of citrus fruits may be to blame for the altered blood metabolites. The findings of this study and those of (Dalal *et al*., 2018; Alzawqari *et al.,* 2015) which revealed that increasing amounts of natural supplementation led to a decrease in blood cholesterol & that star gooseberry supplementation produced the best outcomes, are the likely related.

Cost-effectiveness of broiler production

Star Gooseberry Juice's effect on the broiler's profit margin was evident from the amount that was employed in the diet.

Table 3: Serum biochemical properties in broiler.

Lipid profile (mg/dl)	Dietary Treatment Group							Level of significance
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	
Total Cholesterol	175.14± 2.23^{g}	164.00± 1.53^{f}	157.43±0.97^{e}	145.14± 1.64^{d}	138.14± 0.91^{c}	135.56±1.67^{b}	128.35±0.85^{a}	*
Triglyceride	72±0.27^{g}	43±0.07^{f}	45.63±0.31^{e}	47.16 ±0.2^{d}	40.26± 0.12^{c}	38.43±0.72^{b}	35.68±.05^{a}	*
HDL	32.13 ±0.71^{f}	40.83±0.47^{e}	42.73±0.39^{d}	43.84±0.28^{d}	45.31±0.54^{c}	47.73±0.42^{b}	49.32±0.22^{a}	*
LDL	77.42± 0.36^{g}	53.04±0 .33^{f}	51.16± 1.11^{e}	48.09± 0.52^{d}	45.51± 0.64^{c}	34.39±0.14^{b}	28.85±36^{a}	*

Values are Mean±SEM, ^{abcd} means within a row without common superscripts differ significantly; NS-non significant; the statistically significant difference are expressed as *(P<0.05).

The most recent research supports Zafar and Fatima's, (2018) statement that chickens consume more organic mineral sources than the inorganic ones. Due to their increased the bioavailability and effectiveness, they are expected to reduce feed costs by reducing dose rates without negatively compromising performance. Abdallah *et al*. (2009) contend that an organic mineral diet benefits the economy. By swap-ping organic minerals for the inorganic ones, it was discovered that this increased bird performance and the immunological responses of chicks.

Table 4: Economics of broiler production kept different treatment groups from day old chick to 35 days of age.

Parameters (Tk.)	Dietary Treatment groups with Star Gooseberry							
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	L.S
Chick cost	41±0.00	41±0.00	41±0.00	41±0.00	41±0.00	41±0.00	41±0.00	NS
Litter cost / bird	4.5±0.00	4.5±0.00	4.5±0.00	4.5±0.00	4.5±0.00	4.5±0.00	4.5±0.00	NS
Vaccine + medicine	13.8±0.00	13.8±0.00	13.8±0.00	13.8±0.00	13.8±0.00	13.8±0.00	13.8±0.00	NS
Average Feed Consumed (kg/bird)	2767.25± 17.55	2809.45± 18.69	2820.42± 15.04	2824.66± 21.05	2808.65± 18.22	2829.15± 19.85	2778.51± 25.16	NS
Feed price (tk / kg	55±0.00	55±0.00	55±0.00	55±0.00	55±0.00	55±0.00	55±0.00	NS
Feed cost / broiler production	152.18± 0.08^{a}	154.49± 0.06^{b}	155.1± 0.09^{c}	155.32± 0.06^{c}	154.44± 0.03^{b}	155.6± 0.031^{c}	152.8± 0.07^{a}	*
Miscellaneous cost	5±0.00	5±0.00	5±0.00	5±0.00	5±0.00	5±0.00	5±0.00	NS
Total cost/broiler	211.48± 0.04^{a}	213.79± 0.68^{c}	214.4± 0.052^{d}	214.62± 0.05^{d}	213.74±0.05^{c}	214.9±0.09^{d}	212.1±0.08^{b}	*
Average live weight/broiler (Kg)	1871.67^{a}± 13.02	2031.33^{b}± 20.12	2088.00^{c}± 11.15	2112.39^{d}± 16.71	2125.45^{d}± 20.02	2193.33^{c}± 15.81	2146.00^{d}± 17.51	*
Sale price Tk./kg	145±0.00	145±0.00	145±0.00	145±0.00	145±0.00	145±0.00	145± 0.00	NS
Sale price / broiler	271.29± 0.07^{a}	294.49±0.06^{b}	302.76±0.03^{c}	306.24±0.08^{d}	308.12±0.08^{e}	318.05±0.06^{g}	311.17± 0.07^{f}	*
Net profit Tk./ broiler	59.81± 0.08^{a}	80.7±0.06^{b}	88.36±0.06^{c}	91.62± 0.06^{d}	94.38±0.06^{e}	103.15± 0.08^{f}	99.07± 0.09^{g}	*
Benefit over control/broiler	0.00±0	20.89±0.08^{a}	28.55±0.04^{b}	31.81±0.06^{c}	34.57±0.05^{d}	43.34± 0.06^{f}	39.26±0.08^{e}	*
Profit Tk./kg live weight	31.96± 0.06^{a}	39.73±0.05^{b}	42.31± 0.02^{c}	43.38± 0.0^{d}	44.41± 0.04^{e}	47.03± 0.0^{g}	46.16±0.06^{f}	*

CONCLUSION:

The experiment's findings showed that using star gooseberry juice as a feed supplement improved the feed intake, average body weight gain, feed conversion ratio, and yielded better gross profits in the production of commercial broilers. Feeding broiler chickens with star gooseberry at a rate of 13 ml per kg of feed produced the highest production results in

terms of body weight gain and feed conversion ratio among the various treatment groups, which in turn generated financial gains. As a result, the consumption of star gooseberry juice may have significant effects on commercial broiler production.

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CONFLICTS OF INTEREST:

The authors declare that there are no conflicts of interest.

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