Effect of Amla *(Emblica officinalis*) powder on the performance of broiler chicken under different stocking density

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Abstract: An experiment was conducted with amla powder supplementation under different stocking densities to study the performance of broiler (Cobb-400) chickens. The investigation was conducted with 108 numbers of three-week-old broiler birds using a split plot design. Two stocking densities, one bird per cage (S0) and two birds per cage (S1), with three dietary treatments, 0 (F0), 20 (F1), and 50g (F2) of amla powder per kg of feed, were provided. Stocking density showed a non-significant effect on body weight, weight gain, and feed efficiency and a significant effect on feed intake. On the other hand, amla powder supplementation significantly impacted body weight, weight gain, and feed intake. However, the difference between F0 and F1 for the above parameters was found to be non-significant. Feed efficiency was unaffected by amla supplementation. The interaction of amla powder supplementation with stocking density showed significantly ($P<0.05$) higher body weight in group S0F1 and the least in S0F2, with significant differences among the

treatment means. The interaction effect of stocking on weight gain and feed conversion efficiency was found to be non-significant. In contrast, feed intake was significantly ($P<0.05$) higher for basal diet group S1F0 and the least in S1F2. The liveability percentage was recorded at 100 percent in all the groups. The best performance index (362.06) was observed in S0F1 and the least in S1F2. Stocking density, amla supplementation, and their interaction had non-significant effects on the dressing percentage, organ weights, RBC, WBC, and haemoglobin values.

Key words: Broiler, Amla powder, stocking density, Hematological, carcass.

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1. Introduction

Poultry farming is one of the most profitable ventures which has transformed from a mere backyard activity involving zero input to a highly intensive and commercialized industry. Today, poultry is one of the fastest growing segments of the agriculture sector in India. According to[1]**,** India is one of the world's top egg producer ranking 3rd in egg production and 5th in chicken meat production with an annual growth rate of 6 to 7% and 8-10% in layer and broiler, respectively as compared to the growth rate of agriculture as a whole which is 2.5%. Further, the present per capita availability of egg is 68 and 2.5 kg chicken meat against ICMR recommendation of 180 eggs and 10.8 kg poultry meat / person / year [8]. Broiler production is a dynamic as well as the most rapidly expanding segment of the poultry industry in the country.

Profitability in poultry industry is determined by the availability, utilization and cost of feed. Over a period of time, extensive efforts have been taken to lower down the cost of production by lowering the expenses on feed and through technological and nutritional interventions. For instance, originally, antibiotics were predominantly used as growth promoters in animal feeds particularly under intensive farming which in turn had positive impact on feed conversion efficiency. However, due to the threat of antibiotic residue and build up of resistance, use of antibiotics in broilers feeds has been ban in the European Union and many other regions of the world. As a result, more emphasis is being given on products which are safe, having beneficial properties and cost effective. A manipulation of gut function and microbial habitat of domestic animal with feed additives has been recognized as an important tool for improving growth performance, feed efficiency, disease resistance and obtain maximum returns in shortest possible time. Consequently, use of herbal feed additives is on the rise as a useful resource for improving productivity of broilers particularly due to its non residual effect especially under the intensive management systems. Both health status and general performance can be supported by plant extracts. The positive impact on animal's health and performance could be achieved through the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune response and antiviral, antioxidant and antihelminthic actions [17].

Poultry industry is facing several constraints today of which availability space is one of the major challenges .Since available land is shrinking day by day, optimum and efficient utilization of the resources in hand is of utmost importance. Higher density stocking is opted to maximize profit per unit of space hence increasing space allowances may have a major negative economic impact which increases linearly with density. With drastic changes in the environmental temperature due to climate change, stress related problems are increasingly becoming a challenge under high stocking density. Heat stress is known to be one of the major problems facing broiler industry in the tropical and subtropical areas. This

is because broilers can only attain the desired economic market weight in a stress-free environment. Heat stress may occur at 27ºC and above [10]. Researchers have carried out several studies on the deleterious effect of heat stress on the performance and profitability of broilers and have found that broiler feed intake, weight gain, water intake, feed conversion ratio and dressing percentage and profitability were significantly higher in heat free group as compared to heat stress group [7 and18]. High ambient temperature accompanied with high stocking densities can create a poor environment and affect the production and performance of broilers. Overcrowding may reduce the welfare of birds and cause discomfort due to low exchange of fresh air and increased ammonia level.

Amla *(Emblica officinalis*) is one of the richest sources of ascorbic acid or vitamin C, minerals, amino acids, tannins, and phenolic compounds, which is a very potent antioxidant [23] and is one such herbs which has potential to boost broiler production as it is extensively cultivated all over India. [19] Affirmed that in the last decade, herbal feed additives have attracted the attention of scientists as useful resource for improving productivity which does not have any side effects like residues in meat products. They advocated that amla (*Emblica officinalis*) fruit powder is one of the herbs which have potential to boost broiler production. Owing to its nutritive and therapeutic value, amla have become an important fruit. The fruits of the plants are used in Ayurveda as rasayana called Chyawanprash (revitalizes and biological response modifiers). It has been used as anti-stress factors for many years in human and animal medicines with proven results [21]. Phyto-chemical analysis of amla fruit powder also provided evidence of presence of the medicinally important bioactive compounds which can be exploited beneficially to improve productivity in broilers [19] also advocated that amla fruit powder as feed additive possess antis tress, adaptogenic, immunogenic and growth-stimulating properties resulting in better performance of broiler. Amla promotes growth, stimulate the immune system, improves feed conversion efficiency [20] and results in higher net profit per bird [19]. In addition, [24] ascertained the anti stress effect of herbal formulations containing amla and observed haematological alterations such as increase in haemoglobin and leukocyte.

In Nagaland, amla grows naturally and is widely available. Considering the benefits of amla and its availability, there is great potential to exploit and to popularize its use in poultry feed among the resource poor farmers particularly living in the remote areas of the state. This will help to ameliorate the deleterious effect of heat stress in poultry birds and thereby help to improve its overall performance and productivity. Nutritional interventions through exploitation of locally available herbal products not only increase efficiency and productivity but it is affordable and safe. In order to find out whether significant effect on the performance of commercial broiler chickens and cost effective production benefits could be derived or not through supplementation of amla (*Emblica officinalis*) powder.

2. Materials and Methods

The experiment was conducted in the poultry unit of the Instructional Animal Farm of the department of Livestock Production and Management, School of Agricultural Science and Rural Development, Nagaland University, Medziphema Campus, Nagaland. Day old, straight run, commercial broiler chicks of Cobb-400 strain from a single hatch were procured for the study from reliable source M/S Dilip, Poultry Feeds and Chicks, Khatkhati, Assam. Fresh amla fruit grown locally were procured from a single source. The berries were then washed, sliced and sun dried without the seed. After proper drying it was

crushed and powdered using a grinder and stored in clean dry airtight container.

The experiment was conducted in Split Plot Design. One hundred and eight numbers (108) of three weeks old broilers were divided into two main groups (stocking density) and three sub groups (amla powder supplementation). Altogether there were six treatments with four replicates in each group.

Table 1. The experimental birds were designated as under:

Treatment Groups	Treatment	Total No. of birds
S_OF_O	Single bird + basal diet	12
S_OF_1	Single bird + 20g amla powder / kg feed	12
SoF_2	Single bird + 50g amla powder /kg feed	12
S_1F_O	Two birds + basal diet	24
S_1F_1	Two birds + 20g amla powder /kg feed	24
S_1F_2	Two birds + 50g amla powder /kg feed	24
	Total	**108**

After weighing individually, the birds were randomly allocated to the designated cages in single and in pairs as described below:
Main plot factor: Stocking density – 2 levels Sub plot factor: Amla powder – 3 levels

i. Stocking density:
   a. S_0: 1 bird per cage
   b. S_1: 2 birds per cage
ii. Amla feed:
   a. F_0: Basal diet
   b. F_1: 20 g of amla powder per kg diet.
   c. F_2: 50 g of amla powder per kg diet.
iii. Total treatment combination: 6
iv. Replication:
   a. R = 4
   b. Each replication consisted of 4 rows having 3 individual cages
   c. Total cages used = 72 cages

After 21 days of brooding, the experimental birds were weighed individually and were randomly allocated to the designated cages in single and in pair. After completion of 42 days, blood samples were collected from three birds of each treatment. Two (2) ml of blood was collected from each sample from the wing vein inside the elbow joint using sterile disposable syringe and following standard hygienic measures. The blood was discharged immediately into collection tube with anticoagulant for RBCs, WBC, and Hb of the blood analysis. The economics of feeding diet supplemented with amla powder under different stocking density was calculated on the basis of overall cost of inputs, i.e. the cost of chicks, feeds, labour, medicines and other miscellaneous cost. Final live weight of the bird was considered for calculating the gross return per bird and net profit per bird. The collected experimental data was subjected to Statistical analysis using split plot analysis method described by [26] in order to interpret the result and to see the effect of the treatment against the various parameters so as to derive at a conclusion.

3. Results and Discussion

The results of the effect of feeding different levels of amla on the growth performance on 42nd day in broilers chicken were presented in Table 2-11, respectively. There was significant difference ($P \leq 0.05$) in body weight, feed intake and feed conversion ratio and no significant difference ($P > 0.05$) in survivability (%) of birds in the groups fed with different level of amla compared to the control group at the end of the experiment.

3.1 Body Weight and Weight Gain

The average body weight and gain in weight from fourth to sixth weeks of age observed under different stocking densities are presented in table 2. While the average body weight and weight gain as a result of amla powder supplementation at different levels from fourth to sixth weeks are summarized in table 3. The interaction effect of stocking density and amla powder supplementation on the average body weight and weight gain respectively is given in table 2 and table 5.

Table 2: Effect of stocking density on body weight and weight gain (g/bird/week) of broiler chicken.

Stocking Density	Body Weight			Weight Gain		
	4th	5th	6th	4th	5th	6th
S_0 (one bird/ cage)	1270.00	1881^{b}.00	2447.00^{a}	0.548^{bc}	0.611^{a}	0.566^{b}
S_1 (Two birds/cage)	1230.00	1832^{c}.00	2390.00^{a}	0.544^{bc}	0.602^{a}	0.557^{b}
SEM	18.773	25.85	20.36	0.014	0.013	0.011
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

From the data given in the table 2 (a), the average weekly body weight of the broilers from 4th to 6th week of age was 1270.00, 1881.00 and 2447.00 g per bird, respectively for the birds kept at lower stocking density. At the corresponding age, the average weekly body weight of the birds kept at higher stocking was 1230.00, 1832.00 and 2390.00 g per bird, respectively. Statistical analysis had revealed non- significant effect of stocking density on the body weight.

The weekly body weight gain of broilers from 4th to 6th week of age at lower stocking density (S_0) was 0.548, 0.611 and 0.566 g per bird, respectively. At the corresponding age, the values at higher stocking (S_1) were 0.544, 0.602 and 0.557 g per bird, respectively. Numerically, the values for weight gain were observed to be higher at lower stocking density (S_0) however, statistical analysis revealed non- significant difference in weight gain due to different stocking densities. The results was in close agreement with the findings of [27] who had also reported that weight gain was unaffected when broilers were kept under similar stocking density. Stocking density used in the present study might have been optimum as reported by [5] and which was not high enough to affect the body weight and weight gain.

Table 3. Effect of Amla (*Embilca officinalis*) powder on the body weight and weight gain (g/bird/week) of broiler chicken.

Amla Supplementation	Body Weight			Weight Gain		
	4th	5th	6th	4th	5th	6th
F_0 (Basal diet)	1311^{a}.00	1951^{a}.00	2565^{a}.00	0.591^{a}	0.640^{a}	0.614^{a}
F_1 (Basal diet + 20 g amla/kg feed)	1258^{ab}.00	1868^{ab}.00	2449^{a}.00	0.550^{ab}	0.610^{a}	0.582^{cb}
F_2 (Basal diet + 50 g amla/kg feed)	1181^{bc}.00	1752^{ac}.00	2241^{a}.00	0.497^{ab}	0.571^{a}	0.489^{b}
SEM	22.54	37.04	38.66	0.015	0.017	0.021
CD (P=0.05)	**81.60**	**134.11**	**139.99**	**0.053**	**0.062**	**0.076**

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

From the data given in Table 2 (b), the average body weights obtained at the 4th week of age were 1311.00, 1258.00, and 1181.00 g per bird for the groups F0, F1, and F2, respectively. At the

5th week, it was recorded to be 1951.00, 1868.00, and 1752.00 g per bird for the respective groups. The corresponding values at the 6th week were 2565.00, 2449.00, and 2241.00 g per bird, respectively. Statistical analysis revealed that amla powder supplementation had a significant effect on body weight. From the 4th to the 5th week, significantly (P<0.5) higher body weight was observed in groups fed with a basal diet, followed by group F1 (20g amla/kg diet), and the least in group F2 (50g amla/kg feed). However, the difference in body weight between F0 and F1 was found to be non-significant. Body weight was negatively affected at higher levels of amla powder. Contrary to the results of the present study, [9 and 19] have reported significantly higher body weight in birds that were fed a diet supplemented with amla. The variation in the result might be due to differences in the level of amla used, the system of rearing, or other environmental factors.

The average gain in body weight at 4 weeks of age was 0.591, 0.550, and 0.497 g per bird for F0, F1, and F2, respectively, and at 5 weeks, it was 0.640, 0.610, and 0.571 g per bird for the respective groups. Finally, at the 6th week, the corresponding values were 0.614, 0.582, and 0.489 g per bird, respectively. Analysis of variance showed significantly (P<0.05) higher weight gain in group F0, followed by group F1, and the least in group F2, with a similar trend at the 5th and 6th weeks. However, the weight gain between F0 and F1 was found to be non-significant. It is apparent that broilers fed with a basal diet performed better than the groups fed with an amla-supplemented diet at a higher level.

Table 4. Interaction effect of amla (*Emblica officinalis*) powder and stocking density on the body weight (g/bird/week) of broiler chicken.

Interaction	Weeks						
	Day 1	1st	2nd	3rd	4th	5th	6th
S_0F_0	45.00	149.00	373.00	716.50	1294.50^{ab}	1922.^{50ab}	2546.75^{b}
S_0F_1	46.21	150.96	374.12	752.25	1330.75^{b}	1988.75^{b}	2598.50^{b}
S_0F_2	44.87	148.79	373.11	696.50	1184.75^{a}	1732.50^{a}	2196.00^{a}
S_1F_0	45.12	149.04	373.01	724.00	1328.25^{b}	1979.25^{d}	2583.00^{b}
S_1F_1	44.56	148.76	372.60	664.25	1185.25^{a}	1746.50^{e}	2299.75^{a}
S_1F_2	44.24	147.45	372.16	671.50	1177.25^{a}	1771.25^{a}	2285.75^{a}
SEM					36.80	60.49	63.14
CD(P=0.05)					**133.26**	**219.01**	**228.61**

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

From the data given in table 2 (c), it was revealed that, body weight was in the range of 44.24 to 46.21, 147.45 to150.96, 372.16 to 374.12, 664.25 to 752.25, 1177.25 to 1330.75, 1746.50 to 1988.75 and 2196.00 to 2598.50 g per bird from day old to 6th week of age, respectively.

The average body weight of broilers at 4th week of age due to the interaction of stocking density and amla powder supplementation for the treatment groups S_0F_0, S_0F_1, S_0F_2, S_1F_0 S_1F_1 and S_1F_2 was 1294.50, 1330.75, 1184.75, 1328.25, 1185.25 and 1177.25 g per bird. At 5th week of age, the corresponding values in the different treatment group were 1922.50, 1988.75, 1732.50, 1979.25, 1746.50 and 1771.25 g per bird, respectively. During the final week, the body weight recorded was 2546.75, 2598.50, 2196.00,

2583.00, 2299.75 and 2285.75 g per bird for the respective groups.

The interaction of amla powder supplementation with stocking density had a significant (P<0.05) effect on the body weight of the birds. Higher body weight was observed in the birds kept at a lower stocking density supplemented with a lower level of amla (S0F1) from the 4th to the 6th week of age. The least body weight was recorded in groups kept at a higher stocking density supplemented with a higher level of amla powder (S1F2) at the 4th week and S0F2 at the 5th and 6th weeks of age, which was indicative that a higher level of amla at a higher stocking density had a negative impact on the body weight. Similar findings were also reported by [13 and16], who stated that birds at lower stocking densities, received anti-stress preparations and polyherbal preparations containing amla, respectively. However, the present findings were contradictory with the findings of [28 and 12], who did not observe any significant differences in body weight due to the supplementation of amla either alone or in combination with probiotics or multi-enzymes, respectively. Variation in results might be due to species/strain differences, systems of rearing, agro-climatic differences, differences in levels of amla powder and seasons, etc.

Table 5. Interaction effect of amla (*Emblica officinalis*) powder and stocking density on weight gain (g/bird/week) of broiler chicken.

Treatment	Weeks					
	1st	2nd	3rd	4th	5th	6th
S_0F_0	104.00	224.00	343.50	578.00	628.00^{ab}	624.25
S_0F_1	104.75	223.16	378.13	578.50	658.00^{b}	609.75
S_0F_2	103.92	224.32	323.39	488.25	547.75^{a}	463.50
S_1F_0	103.92	223.97	350.99	604.25	651.00^{b}	603.75
S_1F_1	104.20	223.84	291.65	521.00	561.25^{e}	553.25
S_1F_2	103.21	224.71	299.34	505.75	594.00^{a}	514.50
SEM				0.024	0.028	0.034
CD(P=0.05)				NS	0.101	NS

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The body weight gain was in the range of 103.21 to 104.75, 223.16 to 224.71, 291.65 to 378.13, 488.25 to 604.25, 547.75 to 658.00 and 514.50 to 624.25 g per bird from 1st week to 6th week of age, respectively. The average weekly gain in the body weight at 4th week of age as a result of stocking density and amla powder supplementation for the treatment groups S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 was 578.00, 578.50, 488.25, 604.25, 521.00, and 505.75 g per bird, respectively. At 5th week, the corresponding values were 628.00, 658.99, 547.75, 651.00, 561.25 and 594.00 g per bird for the respective groups. Similarly, at 6th week, body weight gain recorded was 624.25, 609.75, 463.50, 603.75, 553.25 and 514.50 g per bird, respectively for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2.

From the perusal of the data, it was observed that at 4th and 6th week of age interaction of stocking density and amla powder supplementation on weight was found to be non - significant. However, at 5th week, body weight gain was significantly (P<0.05) higher for treatment group S_0F_1 followed by S_1F_0, S_0F_0, S_1F_2, S_1F_1 and the least was observed in S_0F_2. Similar findings were also reported by [13 and 20], who reported significant increase in weight gain due to amla supplementation.

3.2 Feed Intake and Feed Conversion Efficiency

The effect of stocking density on the overall mean feed intake and feed conversion efficiency are presented in Table 6. The effect of amla powder supplementation on overall mean feed intake and feed conversion efficiency on the treatment groups can be inferred from table 7. The observations on interaction effect of stocking density and amla powder supplementation on the average weekly feed intake and feed conversion

efficiency is presented in table 8 and 9, respectively.

Table 6. Effect of stocking density on the overall mean feed intake (g/bird/week) and feed conversion efficiency of broiler chicken.

	Feed Intake			Feed Conversion Efficiency		
Stocking Density	4th	5th	6th	4th	5th	6th
S_0 (one bird/cage)	124.21	151.55	162.83^{b}	0.229	0.250	0.295
S_1 (Two bird/cage)	125.50	148.89	157.83^{ab}	0.232	0.248	0.284
SEM	1.715	1.573	1.002	0.005	0.004	0.01
CD(P=0.05)	NS	NS	5.916	NS	NS	NS

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The overall mean feed intake from 4th to 6th week of age at the lower stocking density (S_0) was 124.21, 151.55 and 162.83 g per bird/ week, respectively while the corresponding values at higher stocking density (S_1) was 125.50, 148.89 and 157.83 g per bird, respectively. Analysis variance of variance revealed significant effect of stocking density on feed intake at 6th week of age. The value for feed intake was higher at lower stocking density (S_0) as compared to (S_1) however, the difference in feed intake between the groups was found to be non – significant which was comparable with the findings of [4 and 3], (2005) who also reported significant effect of stocking density on feed intake. The reason might be due to high competition of birds for the feed and water due to lesser space allowance which made it difficult for them to reach the feeders and drinkers freely as compared to the single birds and more so with increase in size as the age advanced which consequently resulted in reduction of feed intake. The overall mean feed conversion efficiency from 4th to 6th week of age at the lower stocking density (S_0) was 0.229, 0.250 and 0.295, respectively. The corresponding weekly feed efficiency at higher stocking density (S_1) was 0.232, 0.248 and 0.284, respectively. Analysis variance of variance did not reveal any significant difference in feed efficiency in the treatment groups due to the effect of stocking density. The results can be generalized with the findings of [22], who did not find significant effect on the feed efficiency when broilers were subjected to different stocking densities.

Table 7. Effect of amla powder on the overall feed intake (g/bird/week) and feed conversion efficiency of broiler chicken.

Amla supplementation	Feed Intake			Feed Conversion Efficiency		
	4th	5th	6th	4th	5th	6th
F_0	130.19^{b}	155.21	170.53^{b}	0.220^{a}	0.244	0.278
F_1	123.18^{cb}	149.42	159.94^{c}	0.225^{ba}	0.246	0.275
F_2	121.20^{ac}	146.02	150.52^{ac}	0.246^{c}	0.256	0.316
SEM	2.351	2.857	2.753	0.005	0.003	0.013
CD(P=0.05)	8.511	NS	9.968	0.018	NS	NS

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The overall mean feed intake at 4th week of age due to amla powder supplementation for the treatment group F_0, F_1 and F_2 was 130.19, 123.18 and 121.20 g per bird, respectively. At the 5th

week, the corresponding values were 155.21, 149.42 and 146.02 g per bird, respectively. The overall mean feed intake at 6th week of age was 170.53, 159.94 and 150.52 g/bird for F_0, F_1 and F_2, respectively. The inferences that could be drawn from table 3 (b) was that feed intake decreased progressively in birds fed with amla supplementation as the trend of feed intake was observed to be higher in groups fed with basal diet alone (F_0) followed by F_1 and the least was in F_2 at 6th week of age. The statistical analysis also indicated significant effect of amla powder on the feed intake particularly at 4th and 6th week of age. However, these results were contradictory to the findings of [21], who observed higher feed intake in broilers on amla supplemented diet either alone or in combination over the groups fed with basal diet. These variations in the findings probably might have been due to the level of amla used, change in palatability of feed as a result of amla, rearing systems and other environmental factors.

The overall mean feed efficiency at 4th week of age for the treatment group F_0, F_1 and F_2 was 0.220, 0.225 and 0.246, respectively. At the 5th week, the corresponding values were 0.244, 0.246 and 0.256, respectively. The overall mean feed conversion efficiency at 6th week was 0.278, 0.275 and 0.316 for the respective groups. Except at 4th week, effect of supplementation of amla on feed conversion efficiency was found to be non-significant. At 4th week, the best feed conversion efficiency was observed for the treatment group F_0 followed by F_1 and F_2. These findings were in agreement with several researchers who reported better feed conversion efficiency due to amla supplementation [20, 6 and 14].

Table 8. Interaction effect of amla powder and stocking density on the feed intake (g/bird/week) of broiler chicken.

Treatment	Weeks						Total
	1st	2nd	3rd	4th	5th	6th	
S_0F_0	113.04	321.60	501.17	881.33^{b}	1019.67^{b}	1201.08^{ab}	4037.89
S_0F_1	114.12	322.17	502.24	929.41^{c}	1058.91^{c}	1185.33^{a}	4112.18
S_0F_2	109.56	320.73	500.31	830.08^{d}	943.41^{c}	1081.50^{a}	3785.59
S_1F_0	115.31	322.48	502.64	941.41^{c}	1053.33^{dc}	1207.79^{a}	4142.96
S_1F_1	112.96	320.86	501.03	827.79^{ad}	945.63^{ab}	1078.87^{a}	3787.14
S_1F_2	113.25	321.76	499.63	866.37^{d}	1000.67^{f}	1063.54^{b}	3865.22
SEm				3.839	4.665	4.496	
CD(P=0.05)				**13.899**	**16.890**	**16.277**	

. a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The overall feed intake at the end of the trial period for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups was 4037.89, 4112.18, 3785.59, 4142.96, 3787.14 and 3865.22 g per bird, respectively. The average feed intake due to the interaction of stocking density and amla supplementation for the groups S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 was 881.33, 929.41, 830.08, 941.41, 827.79 and 866.37 g per bird, respectively at 4th week. At 5th week, the corresponding values were 1019.67, 1058.91, 943.41, 1053.33, 945.63, 1000.67 g per bird, respectively. At 6th week of age the values for the respective groups were 1201.08, 1185.33, 1081.50, 1207.79, 1078.87 and 1063.54 g per bird. The interaction effect of stocking density and amla on feed intake at 4th week of age was significantly (P<0.05) higher for S_1F_0 followed by S_0F_1, S_0F_0, S_1F_2, S_0F_2 and the least was in S_1F_1. However,

there was non- significant difference between the treatment groups S_0F_2 and S_1F_1 and between S_1F_0 and S_0F_1. The above findings indicated higher feed intake in broilers fed with basal diet while feed intake decreased significantly for the groups at higher stocking density and with increase level of amla powder. The results corroborated with the findings of [6 and 14], who had also reported lower feed intake in broilers fed with diet supplemented with amla powder. Contrary to the present findings, [21 and 13] reported higher intake of feed due to supplementation of amla. The variation in result might be due to species/strain differences, different levels of amla powder, system of reading, agro-climatic difference, seasons etc.

Table 9. Interaction effect of amla powder and stocking density on the feed conversion efficiency of broiler chicken.

Treatment	Weeks					
	1st	2nd	3rd	4th	5th	6th
S_0F_0	1.09	1.44	1.46	1.52	1.62	1.92
S_0F_1	1.09	1.44	1.33	1.61	1.61	1.94
S_0F_2	1.05	1.43	1.55	1.70	1.72	2.33
S_1F_0	1.11	1.44	1.43	1.56	1.62	2.00
S_1F_1	1.08	1.43	1.72	1.59	1.68	1.95
S_1F_2	1.10	1.43	1.67	1.71	1.68	2.07
SEm				0.008	0.006	0.020
CD (P=0.05)				**NS**	**NS**	**NS**

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The mean feed conversion efficiency from 1st to 6th week of age was in the range of 1.52 to 1.92, 1.61 to 1.94, 1.70 to 2.33, 1.56 to 2.00, 1.59 to 1.95 and 1.68 to 2.07 for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups, respectively. The interaction of stocking density and feed (with or without amla powder) on feed conversion efficiency was found to be non significant which was similar to the findings of [16], who reported non-significant differences in feed conversion efficiency when broilers were subjected to different stocking density and provided antis tress preparation containing vitamin C. [19], also observed non-significant difference among the treatment groups fed with diet containing amla powder for feed intake and feed conversion efficiency.

3.3 Mortality and Liveability (%) and Performance Index of Broiler Birds in Different Treatment Groups.

Irrespective of all the groups, the mortality percentage of broiler birds at six weeks of age was zero percent. Similar findings were observed by [11], who reported low level of mortality due to amla powder supplementation. Liveability percentage was recorded to be 100 percent in all the groups which might be attributed to the amla used, favorable climatic condition, good quality feed and proper management practices. Similar findings were observed by [13], who reported increased liveability due to supplementation of amla powder. The performance index for the treatment groups S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 was calculated as 354.18, 362.06, 280.89, 355.10, 307.93 and 298.05. Best performance index was observed in birds subjected to lower stocking with lower level of amla powder while the least was observed at higher stocking density with higher level of amla.

3.4 Dressing percentage, Carcass yield and Organ weight

The interaction effect of stocking density and amla powder on the carcass traits and organ weight are presented in Table 10.

Table 10. Effect of stocking density and amla powder on dressing percentage, carcass yield and organ weight.

Treatment Group	Dressing %	Carcass Weight(kg)	Organs			
			Gizzard (g)	Heart (g)	Liver (g)	Spleen (g)
S_0F_0	83.87	2101	42.65	11.25	54.04	3.49
S_0F_1	80.29	1988	35.35	11.06	49.90	3.28
S_0F_2	78.46	1700	36.62	10.92	47.54	2.88
S_1F_0	79.28	2049	42.25	10.45	48.12	2.91
S_1F_1	78.76	1825	32.60	10.40	40.73	2.42
S_1F_2	78.47	1749	39.09	10.17	41.29	2.31
SEM	2.34		3.45	0.66	4.60	0.44
C.D (P=0.05)	**NS**		**NS**	**NS**	**NS**	**NS**

a,b,c Means in column bearing different superscript differ significantly (P<0.05)

The average dressing percentage of broiler birds at the end of 6th week for the treatment groups S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 was 83.87, 80.29, 78.46, 79.28, 78.76 and 78.47, respectively. Numerically, higher dressing percentage was recorded for the group S_0F_0 followed by S_0F_1, S_1F_0, S_1F_1, S_1F_2 and least was in S_0F_2 group. However, statistical analysis revealed non -significant effect of either stocking density, amla supplementation or their interaction effect on the dressing percentage. The average carcass weight of the broiler birds in different experimental groups was 2101, 1988, 1700, 2049, 1825 and 1749 g per bird for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups, respectively. The average gizzard weight was 42.65, 35.35, 36.62, 42.25, 32.60 and 39.09 g for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups, respectively. The average heart weight for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups was 11.25, 11.06, 10.92, 10.45, 10.40 and 10.17 g, respectively. The average liver weight recorded was 54.04, 49.90, 47.54, 48.12, 40.73 and 41.29 g for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups, respectively. Likewise the average spleen weight was 3.49, 3.28, 2.88, 2.91, 2.42 and 2.31 g for S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 groups, respectively. Statistical analysis revealed that dressing percentage and organ weights were unaffected by supplementation of amla and stocking density.

3.5 Blood Parameters

The effect of supplementation of amla powder and stocking density on RBC, WBC and haemoglobin in broilers are presented in table 11.

Table 11. Average RBC, WBC and Haemoglobin of broilers on basal diet and amla powder under different stocking density.

Treatments	RBC (10^3cumm)	WBC (10^4cumm)	Haemoglobin (g/dl)
S_0F_0	3.60	25.54	7.43
S_0F_1	3.73	25.18	7.68

S_0F_2	3.87	25.62	7.12
S_1F_0	3.68	25.98	7.67
S_1F_1	3.57	25.27	8.69
S_1F_2	3.78	25.81	8.87
SEM	0.120	0.261	0.071
C. D (P=0.05)	**NS**	**NS**	**NS**

The average RBC (10^3 /cumm) values observed for the treatment groups S_0F_0, S_0F_1, S_0F_2, S_1F_0, S_1F_1 and S_1F_2 was 3.60, 3.73, 3.87, 3.68, 3.57 and 3.78 , respectively. The corresponding values for WBC **(**10^4cumm) were 25.54, 25.18, 25.62, 25.98, 25.27 and 25.81, respectively. The values for haemoglobin (g/dl) with respect to the treatment groups were 7.43, 7.68, 7.12, 7.67, 8.69 and 8.87 g/dl. Statistically, the RBC, WBC and haemoglobin values were not influenced by either stocking density, amla powder supplementation or their interaction. Similar findings were also reported by [21], who reported that herbal preparation containing amla either alone or in combination did not influence the constituents of blood. The values for RBC and WBC observed in the present study were within the range as reported by [2] in broilers fed with amla stating that their mean values did not differ significantly among the supplemented and control group. Supplementation of amla powder might have maintained the normal values as reported by [13].

4. Conclusion

Based on the above findings on the performance of broilers fed with different levels of amla powder and reared under different stocking density with respect to the parameters such as body weight, gain in weight, feed intake and feed efficiency, mortality and liveability percent, dressing percentage and carcass traits, performance index, blood parameters and economics of rearing.

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