Effect of Stocking Density and Feeding Regime on Performance of Broiler Chicken in Summer Season

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Abstract: A total of five-hundred and fifty (550) day-old Cobb-500 broiler chicks were used for a period of six weeks to study the effect of different stocking densities and feeding regime on the performance of broiler chicken. The treatments under stocking densities were D₁ (8 bird/m²), D₂ (10 bird/m²), D₃ (12 bird/m²) and D₄ (14 bird/m²). The form of feeds under feeding regime was F₁ (mash), F₂ (crumble) and F₃ (pellet) feeds. The study revealed that the lower stocking density D₁ consumed significantly (p<0.05) the highest amount of feed and in terms of feed form F₂ group consumed significantly (p<0.05) the highest amount of crumble feed and among the interaction between ‘density x feed’ D₂F₂ consumed significantly (p<0.05) the highest amount of feed. The average live weight of birds under stocking density D₁ was significantly (p<0.05) higher compared to other density groups; there was no significant difference (p<0.05) among the mash, crumble and pellet groups. The interaction between D₂F₂ was achieved significantly (p<0.05) highest live weight than other treatment groups. Irrespective of feed type, FCR value was significantly better in D₄ and D₅ (p<0.05) compared to others and the interaction group D₃F₂ showed significantly better (p<0.05) FCR compared to other combinations. The birds under lower stocking density D₁ consumed significantly (p<0.05) the highest amount of water; but the form of feeds (F₁, F₂ and F₃) had no significant (p<0.05) effect on water intake and the water intake was significantly higher (p<0.05) in D₃F₁ compared to other treatments. No significant difference (p<0.05) in mortality was found among different stocking densities, feeding regime and different interaction groups. The Benefit Cost Ratio (BCR)/m² under D₅ was significantly (p<0.05) higher compared to others; the F₁, F₂ and F₃ feeds had no significant effect on BCR and D₃F₂ group was significantly (p<0.05) profitable than other combinations. The dressing % of stocking density D₄ and D₅ were significantly (p<0.05) higher compared to D₁ and D₂. No significant difference (p<0.05) in dressing % was found among F₁, F₂ and F₃ feeds, similar results were observed in different carcass parts for stocking density and feed types. Significantly higher (p<0.05) abdominal fat deposition were found higher in D₃ and D₄. Lower stocking density showed higher dressing percent. The stocking density and feeding regimes had no significant effect on different carcass parts of broiler except higher abdominal fat deposition was found in higher stocking density groups. Finally, it can be concluded that during summer the stocking density 12 bird/m² feed on crumble feed may be profitable for commercial broiler production up to six weeks in Bangladesh condition.

Key words: Broiler, density, feed type, performance, summer, profit

INTRODUCTION

Broiler farming has been recognized as a profitable enterprise and seemed to be a much-preferred agro business than ruminants. It can be harvest for human consumption within a very short period of time. Broiler farming is a rapid income generating source for the rural women and un-employed youths. Per capita annual meat consumption of Bangladesh is 4.57 kg (standard 43.8 kg/year) which indicates a huge demand for increasing the production of broiler meat and its related industry (Rahman, 2003). Bangladesh is a tropical country with climatic variations which influence broiler production. Poultry husbandry in tropical and sub tropical countries are affected by stocking density and increased temperature (Beg, 1993). Research performed in open sided house shows that seasonal variation has significant effect on total body weight gain of broilers (Saleque and Rozen, 2007) where impact of stocking density and feeding system were ignored. There is few published literature concerning the influence of stocking density with feeding regimes in summer season. High environmental temperature impairs the growth and feed intake of broilers (Charles, 1986). Change in season and the season of rearing period, influences the growth performance of chicks. Yalcini et al. (1997) found that body weight and body weight gain of broilers reared...
during summer was lower as compared to those reared during winter. Deaton et al. (1989); Wabeck et al. (1994), Al-Ribdawi and Singh (1989) also reported lower body weight for broilers reared during summer. In addition, Imaeda (2000) reported lower body weight of broilers during summer irrespective of stocking density. Many countries have initiated programs aimed at improving small-scale poultry as a means of helping to bring socio-economic benefits to rural communities. Stocking density is reported using the number of birds per unit area or the amount of area per bird through out their life which reduces their opportunity for movement during the later stage of rearing. Stocking density 10 bird/m² is practiced in tropical countries (Hulzebosch, 2004). Farmers rear broilers ignoring stocking density in different seasons due to high price of construction materials and lack of knowledge. High stocking density creates health hazard in poultry shed. It might be hypothesized that farmers need to consider housing density with feed types to maximize profitability. Studies on stocking densities in broiler production have produced variable conclusions. Some studies show large benefits in reducing stocking density, while others show little or no differences. Biligili and Hess (1995) concluded that body weight, feed conversion, mortality, carcass scratches and breast meat yield were significantly improved when birds were given more space. Beg et al. (1994) found lower growth rate at higher density in open-sided house. In contrast, Feddes et al. (2002) demonstrated that when bird density was reduced, live body and carcass weights were also decreased.

In poultry industry mash, crumble and pellet feeds are generally used. Banerjee (1987) reported that feed intake is stimulated by granulation of the feed. Birds fed on pellets consumed their feed in a shorter time than birds fed on mash. The physical form of these three feeds is not same. Most of the farmers purchase ready made feed, while others use farm made mash feed. From a comparative study by Christopher et al. (2006) between mash and pellet feed indicates that there is no economic difference between using either mashes or pellet feed. Further it was recommended that poultry growers can use any one of these depending on their preference. The crumble form of feed is better than mash and pellet for the production of commercial broiler (Jahan et al., 2006). Broiler research in Bangladesh is focused mainly either on stocking density or feeding regime. However, in developed countries most of the broiler growers use environmental controlled house where stocking density can be compromised. Due to the environmental fluctuation, poultry production in tropical and sub-tropical countries suffers a lot. As about 99% commercial broilers are reared in simple open house; broiler rearing need appropriate management practice to improve its performance in Bangladesh (Saleque and Rozen, 2007). Broiler growers need summer stocking density and feeding regime of broiler chicken to increase production and profitability of the broiler farm. Keeping this idea in mind the present study was undertaken with the following specific objectives:

C To determine the effect of stocking density and feeding regime on performance broiler chicken.
C To identify the suitable stocking density and feeding regime of broiler chicken during summer.
C To evaluate the carcass characteristics of broiler reared in summer season.
C To analyze the Benefit Cost Ratio (BCR) of broilers reared under different densities and feeding regimes.

Table 1: Layout of the experiment

<table>
<thead>
<tr>
<th>Factors</th>
<th>Density of bird/m²</th>
<th>Feed</th>
<th>Replications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D₁ (8 bird/m²)</td>
<td>F₁ (Mash)</td>
<td>M8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₂ (Crumble)</td>
<td>C8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₃ (Pellet)</td>
<td>C8</td>
</tr>
<tr>
<td></td>
<td>D₂ (10 bird/m²)</td>
<td>F₁ (Mash)</td>
<td>M10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₂ (Crumble)</td>
<td>C10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₃ (Pellet)</td>
<td>P10</td>
</tr>
<tr>
<td></td>
<td>D₃ (12 bird/m²)</td>
<td>F₁ (Mash)</td>
<td>M12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₂ (Crumble)</td>
<td>C12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₃ (Pellet)</td>
<td>P12</td>
</tr>
<tr>
<td></td>
<td>D₄ (14 bird/m²)</td>
<td>F₁ (Mash)</td>
<td>M14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₂ (Crumble)</td>
<td>C14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F₃ (Pellet)</td>
<td>P14</td>
</tr>
</tbody>
</table>

M indicates Mash feed; C indicates Crumble feed; P indicates pellet feed; M8 indicates 8 birds fed on mash feed

MATERIALS AND METHODS
Broiler chicks and management: A total of five-hundred and sixty (560) day-old straight run Cobb 500 chicks were used and fed on mash, crumble and pellet. The experiment was conducted at the Sher-e-Bangla Agricultural University Poultry Farm, Dhaka, Bangladesh for a period of six weeks. The conditions and standards of care employed in this experiment were in accordance with standard guideline of poultry management. In the layout of the experiment (Table 1) there were two factors, one was stocking density and another was feeds. The stocking densities were D₁ (8 bird/m²), D₂ (10 bird/m²), D₃ (12 bird/m²) and D₄ (14 bird/m²) and feeding regime which were F₁ (mash), F₂ (crumble) and F₃ (pellet). The number of replication was four with 48 observations. The broiler chicks were housed in the open-sided south facing shed. To keep disease away from the broiler farm all bio-security measures such as Cleaning, washing, disinfection, common vaccination and medication were done. The experimental birds (528) distributed randomly inside the pens on the basis of stocking density and type of feeds. The size of each pen was 1 m² (1m x 1m x 0.46m). The mash and crumble feed were used as...
starter ration (ME kcal/kg 2998.48 and CP 22.82%) and mash, crumble and pellet feed as grower (ME kcal/kg 3088.59 and CP 21.05%) and finisher (ME kcal/kg 3287.53 and CP 20.21%) ration. Feed and drinking water were allowed ad libitum. Round plastic feeders and drinkers were used. The average summer temperature and humidity at bird level was 31.9°C and 78% respectively. Fresh, clean and sun dried rice husk was used as shallow litter on floor. Using electric brooders did brooding. There was provision of cross net wire ventilation in the broiler house to remove polluted air. Thick polythene sheet was used over the net to save the bird from rains and wind. Electric fans were used as per necessity to save the birds from the summer heat stress. At night-light was provided with four 40 watt tubes light to eat and drink for first 2 weeks. Rest of the weeks 1 h dark was allowed at night in two times.

**Data collection:** Data were collected for initial body weight, temperature, humidity, feed intake, water intake, body weight gain, mortality and final live weight and carcass parts: breast, thigh, drumstick, wings, back, giblet and abdominal fat weight.

**Dressing of broilers:** Two birds were picked up at random from each replicate and sacrificed to estimate dressing percent and weight of breast, thigh, drumstick, back, neck, wing, giblet and abdominal fat. All birds to be slaughtered were weighed and fasted for over night (12 h). Birds were slaughtered following Halal method (Singh and Sharma, 2003). As per procedure the birds were defeathered, eviscerated. Thereafter the eviscerated carcass cut into parts.

**Lab and economic analysis:** Commercial ready made mash, crumble and pellet feeds were collected from feed mill and analyzed in the Bangladesh Livestock Research Institute (BLRI) laboratory to determine its proximate component. The economics was analyzed to find out benefit cost ratio/m² of broiler chicken by considering stocking density and type of feeds. The capital expenditure, recurring expenditure and depreciation cost were considered to calculate replication wise total annual expenditure. Finally replication wise benefit cost ratio was found by deducting the total expenditure from the total income according to treatment wise.

Following formula were used to find out different parameters:

Feed intake (g/bird) = \( \text{Feed intake in a replication} / \text{No. of live birds in a replication} \)

Water intake (ml/bird) = \( \text{Water intake in a replication} / \text{No. of live birds in a replication} \)

\[
\text{FCR} = \frac{\text{Feed intake (g)/bird}}{\text{Live weight (g)/bird}}
\]

\[
\text{Mortality (%)} = \frac{\text{No. of death bird in a replication}}{\text{No. of initial birds in a replication}} \times 100
\]

\[
\text{BCR} = \frac{\text{Total income/m²}}{\text{Total cost of production/m²}}
\]

Dressing yield = Live weight - (blood + feathers + head + shank+ digestive system)

\[
\text{Dressing %} = \frac{\text{Dressing yield}}{\text{Live weight}} \times 100
\]

\[
\text{Percent carcass cut =} \frac{\text{Carcass cut weight (g)}}{\text{Eviscerated weight (g)}} \times 100
\]

Giblet weight = weight of liver + heart + gizzard + neck

**Statistical analysis:** Data were analyzed in factorial experiment with Randomized Completely Block Design (RCBD) for ANOVA table. MSTAT-C (Russel, 2004) computer package program was used for data analysis. Duncan Multiple Comparison Range Tests were done at 5% level of significant. Excel Program was practiced for preliminary data calculation.

**RESULTS AND DISCUSSION**

The average impartment performance parameters such as feed consumption, live weight, Feed Conversion Ratio (FCR), water consumption, mortality and Benefit Cost Ratio (BCR) data of 42 days of broiler chicken are presented in the Table 2, 3 and 4 respectively.

**Feed consumption:** The data of Table 2 shows the lower stocking density D₁ consumed significantly (p<0.05) highest amount of feed (4466 g/bird), where as the higher stocking density D₄ consumed least amount of feed (4307 g). There was a pattern of decreasing feed intake with the increasing of stocking density. This was due to less feeder space and immovability of birds within the pen and less ability of birds to express normal postural adjustments and to access feed. Several authors agreed that the feed consumption diminished with increasing stocking density (Scholtyseck and Gschwindt, 1983; Valdivie and Dieppa, 2002; Singh and Sharma, 2003; Thomas et al., 2004; Santos et al., 2005) which is similar to the present findings. The relationship between weekly feed intake and temperature is shown in Fig. 1. There was no remarkable change in feed intake with temperature up to 4 weeks, but at 5th week when temperature decreased then feed intake increased and at 6th week when temperature increased then feed intake decreased.
Table 2: Production performances of broiler chicken at different stocking densities in summer season

<table>
<thead>
<tr>
<th>Density (No. of Bird/m²)</th>
<th>Feed consumption (gm/bird)</th>
<th>Live weight (gm/bird)</th>
<th>Feed Conversion Ratio (FCR) (ml/bird)</th>
<th>Water consumption (ml/bird)</th>
<th>Mortality (%) (BCR)</th>
<th>Benefit Cost Ratio (BCR/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 (8 bird/m²)</td>
<td>4466⁵</td>
<td>2174⁴</td>
<td>2.09⁴</td>
<td>1410⁴</td>
<td>2.08⁴</td>
<td>1.06⁴</td>
</tr>
<tr>
<td>D2 (10 bird/m²)</td>
<td>4430⁵</td>
<td>2160⁵</td>
<td>2.08⁵</td>
<td>13340⁵</td>
<td>2.50⁵</td>
<td>1.05⁵</td>
</tr>
<tr>
<td>D3 (12 bird/m²)</td>
<td>4425⁶</td>
<td>2306⁶</td>
<td>1.95⁶</td>
<td>13160⁶</td>
<td>2.77⁶</td>
<td>1.13⁶</td>
</tr>
<tr>
<td>D4 (14 bird/m²)</td>
<td>4307⁷</td>
<td>2252⁷</td>
<td>1.94⁷</td>
<td>13030⁷</td>
<td>1.78⁷</td>
<td>1.12⁷</td>
</tr>
<tr>
<td>Means±SE</td>
<td>4406.83±19.69</td>
<td>2223.27±14.72</td>
<td>2.01±0.018</td>
<td>13383.52±26.17</td>
<td>2.28±1.285</td>
<td>1.09±0.0129</td>
</tr>
<tr>
<td>CV (%)</td>
<td>1.11</td>
<td>3.15</td>
<td>2.62</td>
<td>1.32</td>
<td>196.55</td>
<td>3.71</td>
</tr>
</tbody>
</table>

Means within a column with different superscripts are significantly different (p<0.05). SE = Standard Error, LSD = Least Significant Difference, CV = Coefficient of Variation, NS = Non Significant

Table 3: Production performances of broiler chicken at different feeding regime (Feed form) in summer season

<table>
<thead>
<tr>
<th>Feeding Regime (Form of feeds)</th>
<th>Feed consumption (gm/bird)</th>
<th>Live weight (gm/bird)</th>
<th>Feed Conversion Ratio (FCR) (ml/bird)</th>
<th>Water consumption (ml/bird)</th>
<th>Mortality (%) (BCR)</th>
<th>Benefit Cost Ratio (BCR/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 (Mash)</td>
<td>4342⁸</td>
<td>2224</td>
<td>2.02⁸</td>
<td>13430</td>
<td>2.29⁸</td>
<td>1.10</td>
</tr>
<tr>
<td>F2 (Crumble)</td>
<td>4462⁹</td>
<td>2248</td>
<td>1.97⁹</td>
<td>13320</td>
<td>2.44⁹</td>
<td>1.02</td>
</tr>
<tr>
<td>F3 (Pellet)</td>
<td>4417¹⁰</td>
<td>2197</td>
<td>2.04¹⁰</td>
<td>13400</td>
<td>2.11⁴</td>
<td>1.08</td>
</tr>
<tr>
<td>Means±SE</td>
<td>4406.83±12.22</td>
<td>2223.27±17.51</td>
<td>2.01±0.01369</td>
<td>13383.52±44.08</td>
<td>2.28±1.123</td>
<td>1.09±0.0111</td>
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<tr>
<td>LSD0.05</td>
<td>35.67</td>
<td>51.10⁹⁵</td>
<td>0.03997</td>
<td>128.71³⁵</td>
<td>3.27³⁵⁹</td>
<td>0.0328³⁵⁹</td>
</tr>
<tr>
<td>CV (%)</td>
<td>1.11</td>
<td>3.15</td>
<td>2.62</td>
<td>1.32</td>
<td>196.55</td>
<td>3.71</td>
</tr>
</tbody>
</table>

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Table 4: Production performances of broiler chicken at different ‘density x feed’ interaction groups in summer season

<table>
<thead>
<tr>
<th>Density x Feed (Interaction)</th>
<th>Feed consumption (gm/bird)</th>
<th>Live weight (gm/bird)</th>
<th>Feed Conversion Ratio (FCR) (ml/bird)</th>
<th>Water consumption (ml/bird)</th>
<th>Mortality (%) (BCR)</th>
<th>Benefit Cost Ratio (BCR/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 F1</td>
<td>4455¹⁰</td>
<td>2262¹⁰</td>
<td>1.98¹⁰</td>
<td>14230¹⁰</td>
<td>3.12¹⁰</td>
<td>1.11¹⁰</td>
</tr>
<tr>
<td>D1 F2</td>
<td>4484¹¹</td>
<td>2116¹¹</td>
<td>2.15¹¹</td>
<td>13930¹¹</td>
<td>3.12¹¹</td>
<td>1.03¹¹</td>
</tr>
<tr>
<td>D1 F3</td>
<td>4458¹²</td>
<td>2125¹²</td>
<td>2.15¹²</td>
<td>13860¹²</td>
<td>0.00¹²</td>
<td>1.06¹²</td>
</tr>
<tr>
<td>D1 F4</td>
<td>4394¹³</td>
<td>2178¹³</td>
<td>2.05¹³</td>
<td>13320¹³</td>
<td>2.50¹³</td>
<td>1.06¹³</td>
</tr>
<tr>
<td>D2 F1</td>
<td>4509¹⁴</td>
<td>2184¹⁴</td>
<td>2.10¹⁴</td>
<td>13170¹⁴</td>
<td>2.50¹⁴</td>
<td>1.06¹⁴</td>
</tr>
<tr>
<td>D2 F2</td>
<td>4386¹⁵</td>
<td>2119¹⁵</td>
<td>2.10¹⁵</td>
<td>13530¹⁵</td>
<td>2.50¹⁵</td>
<td>1.04¹⁵</td>
</tr>
<tr>
<td>D2 F3</td>
<td>4291¹⁶</td>
<td>2185¹⁶</td>
<td>1.99¹⁶</td>
<td>13140¹⁶</td>
<td>0.00¹⁶</td>
<td>1.10¹⁶</td>
</tr>
<tr>
<td>D2 F4</td>
<td>4495¹⁷</td>
<td>2432¹⁷</td>
<td>1.87¹⁷</td>
<td>13160¹⁷</td>
<td>4.10¹⁷</td>
<td>1.18¹⁷</td>
</tr>
<tr>
<td>D3 F1</td>
<td>4490¹⁸</td>
<td>2302¹⁸</td>
<td>1.98¹⁸</td>
<td>13170¹⁸</td>
<td>4.10¹⁸</td>
<td>1.12¹⁸</td>
</tr>
<tr>
<td>D3 F2</td>
<td>4228¹⁹</td>
<td>2252¹⁹</td>
<td>1.90¹⁹</td>
<td>13030¹⁹</td>
<td>3.50¹⁹</td>
<td>1.13¹⁹</td>
</tr>
<tr>
<td>D3 F3</td>
<td>4359²⁰</td>
<td>2262²⁰</td>
<td>1.95²⁰</td>
<td>13010²⁰</td>
<td>0.00²⁰</td>
<td>1.13²⁰</td>
</tr>
<tr>
<td>D3 F4</td>
<td>4332²¹</td>
<td>2243²¹</td>
<td>1.96²¹</td>
<td>13040²¹</td>
<td>1.78²¹</td>
<td>1.12²¹</td>
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<tr>
<td>Means±SE</td>
<td>4406.83±24.44</td>
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<td>13383.52±88.17</td>
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<td>102.2</td>
<td>0.07993</td>
<td>257.3</td>
<td>6.559³⁵⁹</td>
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<tr>
<td>CV (%)</td>
<td>1.11</td>
<td>3.15</td>
<td>2.62</td>
<td>1.32</td>
<td>196.55</td>
<td>3.71</td>
</tr>
</tbody>
</table>

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The type of feeds (Table 3) show that the F2 (4462 g) group of birds consumed significantly (p<0.05) highest amount crumble feed from the lowest F1 (4342 g) mash group and F3 (4417 g) was intermediate. The interaction between density x feed at 42 days broiler chicken is presented in the Table 4. It was observed that among different density x feed interaction group the D2F2 (4509 g) consumed significantly (p<0.05) highest amount of crumble feed from other treatment groups and the D1F3 (4228 g) consumed the lowest amount of mash feed. It is clear that the lower density consumed the highest amount of crumble feed and the highest density consumed the lowest amount of mash feed. Bolton and Blair (1977), Choi et al. (1986), Jahan et al. (2006), Golian and Mirghelenj (2009) studied the performance of mash, crumble and pellet feeds as broiler diet. They found that the crumble group showed high trend of feed consumption compared with others. Similar findings reported by Mutetwa (2001), Lemme et al. (2006), Amerah et al. (2007), Brickett et al. (2007) and Sundu et al. (2008) by comparing pellet with mash feed. The opinion of Bolukbası et al. (2005) was contrary that there was no effect of pellet and mash feed on feed consumption.
Fig. 1: Weekly relationship between summer temperature and feed intake

Fig. 2: Weekly relationship between feed intake and weight gain in summer

Live weight: Table 2 states that the stocking density D₁ (2306 g) was significantly (p<0.05) higher from the stocking density D₃ (2252 g), D₄ (2174 g) and D₅ (2160 g) respectively. The lower stocking density D₃ and D₄ didn't show significant difference at final live weight. The stocking density D₅, 12 birds/m² showed better performance in achieving the final market weight. This findings directly supported by Mizubuti et al. (2000), Skrbic et al. (2007) and reported that the 12 birds/m² density showed higher (p<0.05) means for average body weight. Feddes et al. (2002) reported that body weight increased as density increased. Valdivie et al. (2004) proposed higher stocking density in Cuba to get higher live weight. Dozier et al. (2005) got findings that body weight was adversely affected by increasing the placement density above 30 kg of BW/m² (12 birds/m²) of floor. Although El-Deek and Al-Harthi (2004) concluded that broiler chicks could be stocked up to 14 birds/m² without adverse effect on growth performance. The relationship between weekly feed intake and live weight gain is shown in Fig. 2. In 1st, 2nd and 3rd week minimum amount of feed was utilized to gain per unit live weight and at 4th, 5th and 6th week maximum amount of feed was utilized to gain per unit live weight.

According to type of feed (Table 3) no significant difference (p<0.05) was found among the F₁ (mash), F₂ (crumble) and F₃ (pellet) feed to achieve the final live weight 2224 g, 2248 g and 2197 g respectively, but F₃ (crumble) group of birds achieved the highest live weight. Table 4 indicates that the average live weight of different ‘density x feed’ interaction groups, among them D₃F₂ (2432 g) was significantly (p<0.05) higher from all other treatment groups. The D₁F₂ (2116 g) group was the lowest live weight achieved group. So here D₃F₂, 12 birds/m² fed on crumble feed was the best live weight gained group. McAllister et al. (2000) and Bölükbası et al. (2005) also noted that feed type has no effect on live weight. But Jahan et al. (2006), Golian and Mirghelenj (2009) found effect of feed type on live weight and observed higher live weight from crumble and crumb-pelleted feed.

Feed conversion ratio (FCR): The average FCR value in Table 2 shows that the stocking density D₁ (2.09) and D₂ (2.08) were significantly (p<0.05) higher from D₃ (1.95) and D₄ (1.94). The FCR value of density D₁ and D₂ were significantly better (p<0.05) in comparison with the density D₃ and D₄. The Figure 3 shows weekly FCR value in comparison with age. The figure indicates that the feed efficiency was decreased after three weeks of age. The Lower FCR value indicates positive performance. Birds of lower density groups got chance to intake more feed, this more feed is one type of wastage because they didn’t convert it into meat and finally unable to show better FCR value. It is evident from the result that feed conversion was better at the higher density than at the lower densities which is supported by Gonzalez et al. (1978a), Schollyssek and Gschwindt (1983), Ravindran and Thomas (2004), Valdivie et al. (2004) and Sreehari and Sharma (2010).

It is revealed from Table 3 that FCR was affected by feeding regime. The better FCR was found in F₁ (1.98) from F₁ (2.02) and F₃ (2.04). But no significant difference (p<0.05) of FCR value was found in between F₁ (2.02) and F₃ (1.98) and F₁ (2.02) and F₃ (2.04). The crumble feed showed better efficiency than mash and pellet. The FCR value of most of the ‘density x feed’ interaction groups differed significantly. Table 4 shows that the FCR value of D₃F₂ (2.15) group was significantly higher (p<0.05) from all other treatment groups. The FCR value of D₃F₂ (1.87) group was significantly lower (p<0.05) from all other treatment groups. The lowest FCR value of D₃F₂ indicates positive performance. The stocking density 12 birds/m² fed on crumble feed showed better feed efficiency. Reece et al. (1984), Jahan et al. (2006) carried out experiment on broiler feed and obtained better feed conversion ratio in crumble form of feed. Sarvestani et al. (2006) noted that pellet feed showed better FCR value than mash diet, similar findings reported by Golian and Mirghelenj (2009) who found better FCR in pellet feed compared to crumble-pellet and mash diet.
Fig. 3: Relationship between FCR with age in summer presented in Table 2, where the mean value of mortality.

Fig. 4: Weekly relationship between summer broiler flock. Table 4 indicates mortality of different temperature and water intake density x feed interaction groups where mean value is

Benefit Cost Ratio (BCR): The average Benefit Cost Ratio (BCR) data of different stocking density groups shown in Table 2, which varied from 1.05 to 1.13. The benefit cost ratio was affected by different stocking densities. Higher density showed maximum benefit. Although there was no significant (p<0.05) difference between higher density D_3 (1.13) and D_4 (1.12). The maximum benefit was found in the density of 12 birds/m². It is evident that the profit margins increased as stocking density increased and this findings agreed by Diego et al. (1995), Oliveira et al. (2000), Miragliotta et al. (2002) and Moreira et al. (2004).

Table 3 represents the average Benefit Cost Ratio (BCR) of broiler chicken in different feeding regimes. No significant (p<0.05) difference was found among the F_1 (1.10) F_2 (1.09) and F_3 (1.08) feeds. The BCR data of different "density x feed" interaction groups are presented in the Table 4. It is shown from the table that the BCR was significantly (p<0.05) affected by most of the density x feed interaction groups.

The BCR of D_3F_2 (1.18) was significantly (p<0.05) higher from all other treatment groups. The density D_3F_2 (1.03)
showed significantly (p<0.05) the lowest BCR value among all treatments. It is concluded that the density 12 bird/m² feed on crumble feed was the best profitable groups. Sreehari and Sharma (2010) also found best net profit in increased stocking density. Jahan et al. (2006) gave same statement that the crumble form of feed is better than mash and pellet form of feed. Koknaroglu and Atilgan (2007) reported that raising broiler in summer season is more sustainable that in winter.

**Carcass yield (%) of dressed broiler:** The average dressing percent and percent of important carcass parts such as breast weight, thigh weight, drumstick weight, wing weight, back weight, giblet weight and abdominal fat weight data of 42 days broiler chicken under different stocking densities is presented in the Table 5. The average dressing percent and percent of important carcass parts such as breast weight, thigh weight, drumstick weight, wing weight, back weight, giblet weight and abdominal fat weight data under different feeding regimes is presented in the Table 6.

**Dressing percent:** Table 5 shows the dressing percent of the stocking density D₁ (77.17%) and D₂ (76.08%) were significantly (p<0.05) higher from the density D₃ (74.83%) and D₄ (74.17%). The lower stocking density D₁ and D₂ showed higher dressing percent and higher stocking density D₃ and D₄ showed lower dressing percent. It is signified from the result that the dressing percentage was lower in the higher stocking density. Singh and Sharma (2003), El-Deek and Al-Harthi (2004) searched out same findings about dressing percent. Although Ravindran and Thomas (2004) reported that carcass characteristics were unaffected by stocking density.

Table 6 indicates that there was no significant difference (p<0.05) in dressing percent found among F₁ (75.25%), F₂ (75.69%) and F₃ (75.75%), but the F₄ (pellet) feed performed the highest dressing percent and F₁ (Mash) lowest. Golian and Mirghelenj (2009) conducted an experiment to assess the effect of feed form on broiler performance and noticed that weight of carcass characteristics was not affected by physical form of diets. On the other hand, Rajini et al. (1998) and Brickett et al. (2007) found better dressing percent in pellet feed than mash at 6 and 8 weeks of age (p<0.05).

**Breast weight percent:** The presented average breast weight values in Table 5 indicates that D₁ (32.50%), D₂ (33.00%), D₃ (32.42%) and D₄ (32.25%) had no significant (p<0.05) effect on breast meat production, but the highest breast weight percent was found in the lower stocking density D₃. Dozier et al. (2006) reported that increasing stocking density decreased breast tender weight. Many poultry scientists conducted experiment to find out the effect of stocking density on carcass characteristics of broiler and noted that stocking density had no effect on carcass characteristics of broiler.
chicken (Feddes et al., 2002; Ravindran and Thomas, 2004; Thomas et al., 2004; Makowski et al., 2005; Sreehari and Sharma, 2010). Table 6 shows that the breast weight percent of F1 (32.69%), F2 (32.31%) and F3 (32.63%) was not statistically significant (p<0.05), but mash feed showed the highest breast weight percent. Golian and Mirghelenj (2009) conducted an experiment to assess the effect of feed form on performance of broiler chicken and indicated that the breast weight was not affected by physical form of diets. Lemme et al. (2006) reported that breast meat production increased by mash and pelleted form of feed.

**Thigh weight percent:** In the Table 5 no significant difference (p<0.05) in thigh weight % was found among different stocking densities of D1 (15.67%), D2 (15.58%), D3 (15.83%) and D4 (15.50%), but the highest thigh meat % was found in the stocking density D2, 12 bird/m². It is evident that thigh weight % was not significantly affected by stocking density. Offiong et al. (2001), Ravindran and Thomas (2004), Thomas et al. (2004), Sreehari and Sharma (2010) also noticed that the carcass characteristics were not affected by stocking density. The Table 6 shows that thigh weight % was unaffected (p<0.05) by the feeding regimes F1 (15.56%), F2 (15.56%) and F3 (15.81%), but F3 (pellet) feed showed the highest thigh weight percent. Golian and Mirghelenj (2009) found that thigh weight was not affected by physical form of diets. Sarvestani et al. (2006) concluded that the carcass characteristics were improved in pellet diets.

**Drumstick weight percent:** It is evident from the Table 5 that there was no significant difference (p<0.05) in drumstick weight % found among different stocking densities of D1 (12.50%), D2 (12.42%), D3 (12.75%) and D4 (12.92%), but the highest drumstick weight was found in the stocking density D4 (14 bird/m²). Several authors reported that the various carcass characteristics were not influenced by stocking density (Offiong et al., 2001; Feddes et al., 2002; Ravindran and Thomas, 2004; Thomas et al., 2004; Makowski et al., 2005; Sreehari and Sharma, 2010). In Table 6 there was no significant difference (p<0.05) in drumstick weight % found among different feeding regimes of F1 (12.81%), F2 (12.69%) and F3 (12.44%), but the highest drumstick weight percent was found in the F1 (mash) feed. Golian and Mirghelenj (2009) stated that drumstick weight was not affected by feeds.

**Wing weight percent:** Table 5 shows the wing weight % at different stocking densities of D1 (10.17%), D2 (10.50%), D3 (10.25%) and D4 (10.25%) which were not statistically significant (p<0.05), but the highest wing weight % was found in stocking density D2 (10 bird/m²).

The wing weight was not affected by stocking density and similar result reported by Offiong et al. (2001); Ravindran and Thomas (2004); Thomas et al. (2004); Makowski et al. (2005); Sreehari and Sharma (2010).

In Table 6 the mean wing weight % at different feeding regimes of F1 (10.38%), F2 (10.19%) and F3 (10.31%) were not statistically significant (p<0.05), but the highest wing weight percent was found in feeding regime F1 (mash) feed. Golian and Mirghelenj (2009) found that carcass parts were not affected by physical form of diets.

**Back weight percent:** In Table 5 no significant difference (p<0.05) in back weight % was found among different stocking densities of D1 (17.08%), D2 (16.75%), D3 (16.67%) and D4 (16.58%), but the highest back weight % was found in stocking density D3 (8 bird/m²). Offiong et al. (2001); Ravindran and Thomas (2004); Thomas et al. (2004); Makowski et al. (2005); Sreehari and Sharma (2010) noted that various carcass characteristics were not influenced by stocking density. Table 6 shows no significant difference (p<0.05) in back weight % among different feeding regimes of F1 (16.63%), F2 (16.94%) and F3 (16.56 %), but the highest Back weight percent was found in feeding regime F2 (crumble) feed.

**Giblet weight percent:** The average giblet weight % presented in Table 5 at different stocking densities of D1 (9.58%), D2 (9.25%), D3 (9.66%) and D4 (9.58%) were not found statistically significant (p<0.05), but the highest giblet weight % was found in stocking density D3 (12 bird/m²). Yakubu et al. (2010), Jayalakshmi et al. (2009) reported same result that the giblets weight was not significantly (p<0.05) influenced by housing density. Offiong et al. (2001); Ravindran and Thomas (2004); Thomas et al. (2004) also found that stocking density had no effect on carcass yield percent.

The average giblet weight % shown in Table 6 at different feeding regimes of F1 (9.18%), F2 (9.68%) and F3 (9.68%) were not statistically significant (p<0.05), but the highest giblets weight was found in F3 (crumble) and F3 (pellet) feeds than mash. Golian and Mirghelenj (2009) found that carcass parts were not affected by pellet, crumble or mash. Rajini et al. (1998) got contrary result in giblet weight for pellet feed.

**Abdominal fat percent:** Abdominal fat weight percent in the stocking density D1 (2.08%) and D2 (2.08%) shown in Table 5, were significantly (p<0.05) lower from the density D3 (2.58%) and D4 (2.50%). Higher stocking density resulted more abdominal fat deposition and this was due to less locomotion of broilers at higher density pens. But contrary opinion was that the abdominal fat content was not affected by stocking density (Dozier et al., 2006; Alsobayel et al., 2007 and Jayalakshmi et al., 2009).
Table 6 indicates that there was no significant difference (p<0.05) in abdominal fat weight % found among different feeding regimes of F₁ (2.31%), F₂ (2.43%) and F₃ (2.18%). Golian and Mirghelenj (2009) observed no significantly (p<0.05) difference in abdominal fat weight by different form of feeds. Lemme et al. (2006) also observed decreasing fat accretion for all feed forms. The carcass yield % of different parts is presented in Fig. 5 and on the basis of % the carcass cuts can be ranked as 1. Breast (32.54%), 2. back (16.77%), 3. thigh (15.64%), 4. drumstick (12.64), 5. wing (10.29%), 6. giblet (9.5%) and abdominal fat (2.31).

The broiler chicken of lower stocking density group consumed the highest amount feed and water. But the birds of higher stocking density group fed on crumble feed showed better feed efficiency and achieved the highest live weight. The mortality was not affected either by density or feeds. The carcass parts were unaffected by stocking density and feeding regimes, but lower stocking density produced higher dressing percentage and lower abdominal fat. The highest profit margin was found in higher stocking density group fed on crumble feed. So, 12 birds/m² fed on crumble feed is suggestive for commercial broiler production in summer condition of Bangladesh rearing up to 6 weeks of age.

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