RESEARCH ARTICLE

Impacts of Stocking Density on Broiler Chicken Performance Stress Reaction and Mortality in Broiler Chicken

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Abstract

The present study investigated the effect of stocking density on growth performance, stress reaction, and mortality in broiler chickens. Two hundred and forty (240) day-old straight run commercial broiler chicks (Vencob) were divided into two batches having 120 chicks each and further subdivided into three equal groups (G1, G2, G3) representing different stocking densities (20, 25, and 30-meter square/ bird) having 40 chicks in each group. It was evident that, after the 2nd week, body weight gain of G3 group was significantly ($p<0.01$) higher than G2 and G1. In 4th week, body weight gain of G2 and G3 groups was significantly ($p<0.01$) higher than G1. After completion of 35 days of the trial, the last week's body weight gain of G2 (577.15 ± 28.78 g) was found significantly ($p <0.01$) higher than G1 (554.07 ± 28.78 g) and G3 (517.35 ± 28.78 g). During 1st week, the FCR of broiler chicken of G1 (1.96 ± 0.02) group was found to be significantly ($p <0.01$) higher than G2 (1.83 ± 0.02) and G3 (1.82 ± 0.02). During 3rd week, FCR of G1 (1.94 ± 0.02) group was significantly ($p<0.01$) higher, while at 4th week, the FCR of G3 (1.81 ± 0.03) was found significantly ($p<0.01$) higher than other groups. The least square means of H/L ratio were significantly higher in G1 and G3 groups as compared to the G2 group. During the experimental period, 2.5 % mortality was observed in G1 and G2 groups, whereas 5% in group G3.

Keywords: Body weight, Body weight gain, Broilers, Feed conversion ratio, and Heterophil-lymphocyte ratio.

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Introduction

The poultry sector in India has valued at about Rs. 80,000 crores (2015-16), which is broadly divided into two sub-sectors – one with a highly organized commercial sector with about 80% of the total market share of Rs. 64,000 crore and the other being unorganized with about 20% of the total market share of Rs. 16,000 crore (National Action Plan for Egg and Poultry-2022). Broiler farming is a practicable business activity and has a huge scope for growth in India. The poultry industry is about Rs. 600 billion, about 0.77 % of the national GDP and 10 % of the livestock GDP of over five million people in the country (CARI vision 2050, 2013). Modern broiler houses are managed in extreme controlled environment. Birds should be provided with proper ventilation, temperature, and humidity at higher densities. Increasing stocking density without adversely affecting growth performance, feed conversion, meat quality, and welfare is a management technique used to reduce labor, housing, fuel, and equipment costs. With higher stocking densities, the profit per chicken decreases. The total production of meat per unit of floor surface increases, which results in higher profit. However, most farmers do not know adequate stocking density (Muniz *et al*., 2006; Adebiyi *et al*., 2011).

Stocking density is very important in broiler production (Tablante *et al*., 2003). In an earlier study, feed conversion ratio, feed intake, and body weight gain were increased at high stocking density (Estevez, 2007). Environmental temperature, humidity, and ammonia concentration can all disturb broiler growth (Yi *et al*., 2016; Zhou *et al*., 2019).

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The effect of stocking density on feed conversion ratio and mortality has remained a debatable issue (Singh *et al.,* 2018). A decrease in growth performance and survivability of broiler chickens after an increase in ambient temperature has already been recognized (Gous and Morris 2005). Singh *et al.* (2017) recorded a higher frequency of foot pad lesions with higher stocking density in broiler chickens. When stocking density increases, it causes physiological stress in the birds. Stress causes the release of hormones and reorients the

body's reserves, including energy and protein at the cost of decreased growth, reproduction, and health (Estevez, 2007). Stress is an important cause of reduced performance and increased susceptibility to disease (Imaeda, 2000). Hence, the present study was conducted with the objective of examining the effect of stocking density on growth performance, stress reaction, and mortality in broiler chickens.

Materials and Methods

The present investigation was carried out at the Poultry Unit of Livestock Farm Complex, College of Veterinary Science and Animal Husbandry, ANDUAT, Kumarganj, Ayodhya, UP (India). Two hundred and forty (240) day-old straight run commercial broiler chicks (Vencob) were divided into two batches having 120 chicks each. Each batch was subdivided into three equal groups representing different stocking densities, with 40 chicks in each group. Stocking density was provided based on the body weight of the bird per meter square. Three groups were Group 1 (20 kg/m^2), Group 2 (25 kg/m^2) and Group 3 (30 kg/m^2). Floor space (m^2) for each group was provided at the start of each progressive week, as mentioned in Table 1.

Body Weight, Body Weight Gain, and Mortality

On 1st day, the body weight (gm) of all chicks was recorded with a digital weighing machine. After that, the weekly body weight of all chicks was measured, and weekly body weight gain (gm) was calculated. Daily mortality of birds was recorded in the morning hours in each pen and each batch. The mortality rate was presented weekly.

Feed intake and Feed Conversion Ratio

During the experiment, every group was offered an equal amount of feed for a week. At the start of a new week, feed consumption was calculated by subtracting the residual feed from the total feed offered during the previous week. Average feed intake gm per bird was calculated by dividing the total feed intake by the number of birds taking into account mortality, if any, in the particular group. The bird's feed conversion ratio (FCR) was calculated by dividing the feed intake by average body weight gain.

Table 1: Weekly floor space provided to different experimental groups having different stocking density

Week	*G1 (20 kg/m^2)*	*G2 (25 kg/m^2)*	*G3 (30 kg/m^2)*
2nd	0.84	0.79	0.74
3rd	1.00	0.80	1.10
4th	2.28	1.90	1.70
5th	3.20	2.70	2.30

Heterophyl and Lymphocyte Ratio

The blood samples were collected on the 35th day of the study. A total of 5 randomly selected chickens from each group were gently removed from pens, and blood samples (0.5 mL) were collected from the wing vein for heterophil (HET), and lymphocyte (LYM) counts. Blood smears were prepared and stained with May-Grunwald–Giemsa stain. To assess the H:L ratios, 100 leucocytes were counted. H:L ratios were calculated by dividing the number of heterophils by the number of lymphocytes counted (Gross and Siegel, 1983).

Statistical Analysis

The analysis of data was done by using IBM SPSS Statistics® (20) software. The data obtained were subjected to analysis of variance, and means were compared using Duncan's multiple range test. A probability value of less than 0.01 ($p<0.01$) was considered significant.

Results and Discussion

Results of different stocking densities on growth performance, stress reaction, and mortality of broiler chickens have been shown in Tables 2-4.

Body Weight Gain

The least-square means of weekly body weight gain of broiler chickens during the 2nd, 4th, and 5th week of life under stocking densities of 20, 25, and 30 kg/m2 varied significantly (Table 2). However, there was no significant difference in body weight gain of chicks at 1st & 3rd week. In the 2nd week, body weight gain of G3 group was found to be significantly ($p<0.01$) higher than G2 and G1. In 4th week, it was found to be significantly ($p < 0.01$) higher in G2 and G3 groups than in G1. After completion of 35 days of the trial, last week's body weight gain of G2 (577.15±28.78) was found significantly ($p<0.01$) higher than G1 (554.07±28.78) and it was significantly depressed in higher stocking density group G3 (517.35±28.78). Shakeri *et al.* (2014) reared chickens under the stocking densities of 0.100 and 0.067 m2 /bird on a deep litter system and showed significantly lower final weight gain under the higher stocking density group. Singh *et al.* (2015) also found a significant difference in body weight performance under

Table 2: Least squares means of weekly body weight gain (g) of broiler birds under three different stocking densities

Week	*GI*	*G2*	*G3*	*Significance*
1st	128.88 ± 1.14	130.05 ± 1.14	130.29 ± 1.14	NS
2nd	298.05 ± 3.78^b	307.99 ± 3.78^b	330.82 ± 3.78^a	$p < 0.01$
3th	436.00 ± 27.79	443.86 ± 27.79	440.02 ± 27.79	NS
4th	454.34 ± 22.95^b	489.29 ± 22.95^a	498.95 ± 22.95^a	$p < 0.01$
5th	554.07 ± 28.78^b	577.15 ± 28.78^a	517.35 ± 28.78^c	$p < 0.01$

N=10 under each record; means having different superscripts within the row expressively differed ($P < 0.01$), NS- Non-significant.

Table 3: Least squares means of weekly FCR (g) of broiler birds under three different stocking densities

Week	*GI*	*G2*	*G3*	*Significance*
1st	1.96 ± 0.02[a]	1.83 ± 0.02[b]	1.82 ± 0.02[b]	p < 0.01
2nd	1.88 ± 0.04	1.81 ± 0.04	1.78 ± 0.04	NS
3th	1.94 ± 0.02[a]	1.83 ± 0.02[b]	1.79 ± 0.02[b]	p < 0.01
4th	1.73 ± 0.03[b]	1.72 ± 0.03[b]	1.81 ± 0.03[a]	p < 0.01
5th	1.84 ± 0.05	1.76 ± 0.05	1.89 ± 0.05	NS

N = 10 under each record; means having dissimilar superscripts within the row expressively differed (p < 0.01), NS- Non-significant

three stocking densities on days 14, 28, and 42. Silas *et al.* (2014) had significantly different results on the body weight gain concerning different stocking densities. Adeyemo et al. (2016) reported significantly increased body weight with respect to high stocking densities, while Henrique et al. (2017) reported a decline in weight gain in the last week of the experiment with respect to high stocking density.

Effect of Stocking Density on FCR

The least-square mean**s** of feed conversion ratio of broiler chicken under three different stocking densities presented in Table 3 revealed that at 1st week, FCR of G1 group (1.96±0.02) was significantly (p<0.01) higher than G2 (1.83±0.02) and G3 (1.82±0.02) groups. In the second week, no significant difference was found in FCR among the three groups. During the 3rd week, feed conversion ratio of G1 (1.94 ± 0.02) group was significantly (p<0.01) higher than G2 (1.83 ± 0.02) and G3 (1.79 ± 0.02). In the 4th week, FCR of G3 group (1.81 ± 0.03) was found to be significantly (p<0.01) higher than G1 and G2 groups. During 5th week, no significant difference was detected in groups G1, G2, and G3. Similarly, Abudabos *et al.* (2013) found no effect of FCR on increasing the stocking density of broilers from 37.0 to 40.0 kg/m^2. Shakeri *et al.* (2014) reared chickens under the stocking densities of 0.100 and 0.067 m^2 /bird on a deep litter system and showed a significantly lower feed conversion ratio in low stocking density group. Adeyemo *et al.* (2016) reported significantly decreased FCR with high stocking densities, while Henrique *et al.* (2017) did not find a significant effect of stocking density on FCR during the last week of the experiment.

Ratio of Heterophil and Lymphocyte

Table 4 shows that the least square mean of H/L ratio was significantly higher in the G1 (00.59±0.007) and G3 (00.57±0.007) groups in comparison to the G2 (00.52±0.007) group of broiler chickens. Singh *et al.* (2018) reported a high H:L ratio under high stocking density. Zulkifli *et al.* (2004) reported that the H: L ratio is a reliable indicator of avian stress, and summer stress increased H: L ratio. Turkyilmaz *et al.* (2008) found no significant difference in H:L ratio between different stocking densities in broiler breeders.

Mortality Rates

Table 4: Least squares means of DLC count and H: L ratio of broiler birds at 5th week in three different stocking densities

DLC%	*G1*	*G2*	*G3*	*Significance*
Heterophil	30.39 ± 0.389[b]	30.78 ± 0.389[b]	35.22 ± 0.389[a]	p < 0.01
Lymphocyte	51.56 ± 0.568[C]	58.71 ± 0.568[b]	61.57 ± 0.568[a]	p < 0.01
Monocyte	4.28 ± 0.48	4.12 ± 0.48	4.74 ± 0.48	NS
Eosinophil	3.72 ± 0.405	3.98 ± 0.405	4.09 ± 0.405	NS
Basophil	00±0.050	00±0.050	00±0.050	NS
H:L ratio	00.59 ± 0.007[a]	00.52 ± 0.007[b]	00.57 ± 0.007[a]	p < 0.01

N=5, under each record; means having dissimilar superscripts within the row expressively differed (p < 0.01), NS-non-significant

During the experimental period, mortality was not more than 5%. No more difference was observed in mortality between the three stocking densities in groups G1, and G2. Mortality was 2.5, and in-group G3, it was 5 %. If stocking density is increased, mortality can be explained by decreased animal welfare, such as bad air and litter quality, poor feed intake and increased stress reaction. In the present study, stocking density in broilers had no significant effect on mortality, similar to Adeyemo *et al.* (2016) and Singh *et al.* (2018).

Conclusion

The present stocking density investigation showed no significant difference in body weight gain of broiler chicks at the first and third weeks. Body weight gain and FCR of 25 kg/m^2 (G2) stocking density group were significantly higher than both 20 and 30 kg/m^2 groups. The H/L ratio was found to be significantly higher in 20 and 30 kg/m^2 groups compared to the 25 kg/m^2 density group. The mortality rate was found within 5% in all groups.

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