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Effect of Stocking Density on Chick Performance, Internal Organ Weights and Blood Parameters in Broilers

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Abstract: In the present study, the effect of stocking density on chick performance, internal organ weights and blood parameters were investigated in broilers. A total of 327 Ross 308 broilers divided into 3 stocking density groups (9, 13 and 17 birds m^{-2}). The live weight gain of broilers grown at density of 13 birds m^{-2} was higher ($p<0.01$) than those at the other two densities during the 2nd and 3rd weeks ($p<0.01$). Birds in highest stocking density group (17 birds m^{-2}) had the lowest live weight gain of all three groups during the 4th, 5th and 6th weeks ($p<0.01$). The difference of livability among groups was not significant ($p>0.05$). The 17 birds m^{-2} stocking density group had better food conversion ratio than 9 and 13 birds m^{-2} stocking density groups between 21-42 days. The difference of food conversion ratio between stocking density groups was not significant between 0-21 and 0-42 days ($p>0.05$). The difference in carcass yield, pH, meat colors (E) and internal organ weights of stocking density groups was not significant ($p>0.05$). The plasma protein levels were significant among the density groups ($p<0.05$). In conclusion, 13 birds m^{-2} stocking density groups is more suitable than 9 and 17 birds m^{-2} stocking density groups in rearing conditions.

Key words: Stocking density, broiler performance, internal organ weights, blood parameters, rearing condition, Turkey

INTRODUCTION

Poultry production in the industrialized countries has changed significantly during the last 75 years. Due to genetic improvement and progress in nutrition and poultry management, broilers may exhibit very high growth rates and feed efficiency (Duclos *et al*., 2007). The time required to reach 1.5 kg live weight was reduced from 120 days in 1925 to 30 days in 2005 (Albers, 1998).

However, the major welfare concerns have occurred in the last two decade and it resulted in great social pressure to provide minimum welfare conditions (Vanhonacker *et al*., 2008). Welfare of broiler is to regulated by various intrinsic and extrinsic factors such as management, stress, nutrition, stocking density, poor ventilation, high intensity of light, immunosuppression and exposure to disease agents (Yakubu *et al*., 2009). Stress is an important cause of reduced performance and increased susceptibly to disease (Imaeda, 2000).

The stocking densities in broilers vary widely by countries, husbandry systems and final body weight. Although, the use of high stocking densities can diminish individual growth (El-Deek and Al-Harthi, 2004; Turkyilmaz, 2008; Skomorucha *et al*., 2009), total production of meat per unit of floor surface increases which results in higher profit because of the economic benefit, producers have not incentive to decrease stocking densities (Shanwany, 1988; Feddes *et al*., 2002). There was no consistent trend of stocking density on feed conversion rate. While this trait was improved (Shanawany, 1988; Grashorn and Kurtritz, 1991) or not significantly changed (El-Deek and Al-Harthi, 2004; Turkyilmaz, 2008), there was a significant deterioration (Ravindran *et al*., 2006; Skomorucha *et al*., 2009).

Although, high stocking density has been reported to increase the incidence of diseases and deaths (Shanawany, 1988), effect of density on mortality was not significant (Sekeroglu *et al*., 2001; Turkyilmaz, 2008; Ravindran *et al*., 2006; Buijs *et al*., 2009; Skomorucha *et al*., 2009). Broiler growth and performance, Heterophil to Lymphocyte ratio (H:L), leukocyte diversity are frequently used indicators of welfare in chickens

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(Gross and Siegel, 1983; Altan *et al*., 2000; Islam *et al*., 2004). Gross and Siegel (1983) suggested that reference values for the heterophil to lymphocyte ratio of about 0.2, 0.5 and 0.8 are characteristic of low, optimal and high degrees of stress, respectively.

Moreover, exposure of chickens to high temperatures causes a decrease in blood hematocrit values and proportion of leucocytes (Altan *et al*., 2000). Therefore, the aim of this study was to determine the effect of stocking density as a stress factor on production results, percentages of organ weights and blood parameters.

MATERIALS AND METHODS

This experiment was conducted at Poultry Unit of Faculty of Agriculture, Gaziosmanpasa University, Tokat, Turkey. Unsexed Ross 308 broiler chicks were raised in floor pens under similar managerial. One day old chickens (n = 327) were randomly placed into boxes of floor system of rearing in 3 stacking densities and 3 repetitions of each treatment. Treatment A (75 bird), treatment B (108 birds) and treatment C (144 birds) are designated for stocking density of 9, 13 and 17 birds m^{-2}, respectively. Chickens were reared 42 days of age and fed on *ad libitum* basis on 4-phase feeding program (1st phase: 1-11 day; 2nd phase: 12-21 day; 3rd phase: 22-35 day and 4th phase: 36-42 day). Water was given *ad libitum* and the photoperiod was 24 h day^{-1}. Birds in all 3 treatments were allocated with equal space of feeders and drinkers.

During the study, individual body weights of the birds and feed consumption in groups were recorded weekly to determine Feed Conversion Ratio (FCR). The incidence of mortality was recorded daily. The birds were raised according to a typical commercial management program from 1-42 days. Ambient temperature was 32°C on 1st day and gradually reduced by 1°C daily until the temperature of 22°C, after which temperature remained constant. At the end of study (42 day) on random sample of birds from treatment A (n = 6) , treatment B (n = 9) and treatment C (n = 12) were fasted for 8 h (had access to water only). After the fasting period, blood samples from the branchial vein was taken into heparinized syringes for analysis and birds were slaughtered. Blood samples were stored at +4°C until analyzed. The smears were stained using May-Grunwald and Giemsa stains (Gross and Siegel, 1983), One hundred leukocytes, including both granular and nongranular cell were counted microscopically. The Heterophil (H): Lymphocyte (L) ratios were determined by dividing the percentage of heterophils and the percentage of lymphocytes. Plasma protein concentrations were determined by reflectometer methods (Atago, SPR-N, Japon). Blood hematocrit values and hemoglobin were estimated by the method described by Merk (1974). After slaughter, birds were eviscerated and carcasses were cooled for 24 h to 4°C. Relative organ weight (liver, heart, kidney and gizzard) were determined according to Demir and Sekeroglu.

The color of the breast meat was determined with a colorimeter (Konica Minolta Chromameter model CR-300). The average of duplicate measurements was calculated and the results were reported in the CIELAB trichromatic system as lightness (L*), redness (a*) and yellowness (b*) values. According to this method, L* is the amount of incident light that a surface reflects; positive a* value represent the red colors and negative a* values represent the green one; positive b* values represent yellow and negative b* values represent blue. Also, meat colors (E value) were calculated by using the formula: E: $(L^{*2}+a^{*2}+b^{*2})^{1/2}$.

The lower the E value was the darker the colors. The initial pH of the breast meat that cooled +4°C was determined for 24 h post-mortem by the using a digital pH meter (Testo 205, Germany). Reading of breast color and pH values was made on the right side of breast meat with skin (Altan *et al*., 2000; Ingram *et al*., 2008). Statistical analysis was carried out by using the Generalized Linear Model Procedure of SPSS (Version 17.0).

Before the analyses, data distribution was tested for normality by Probity analysis and variance homogenity by Bartlett test. The significant differences among the mean values of treatment was determined by Duncan test.

RESULTS AND DISCUSSION

The effect of stocking density on performance of broiler chickens over the 42 days trial period is shown in Table 1. Stocking density had no effect on the body weight of birds at the age of 1 week ($p>0.05$). At the age of 2 weeks, birds raised at stocking density of 13 birds m^{-2} had significantly higher body weight than reared at stocking density of 9 and 17 birds m^{-2} ($p<0.01$). At 3 weeks age, the groups of 13 bird m^{-2} had significantly higher body weight than group of 17 birds m^{-2}. However, the group of 9 birds m^{-2} was in middle of each others ($p>0.05$). At 4-6 week of age, birds raised at stocking density 17 birds m^{-2} had significantly lower body weight than those of the other stocking density ($p<0.01$). Feed Conversion Ratio (FCR) was 1.6, 1.57 and 1.57; 1.9, 1.95 and 2.00 for 9, 13 and 17 birds m^{-2} at the 0-21 and 0-42 day, respectively (Table 1). No difference was found in the FCR between the 3 density groups at the age of 0-21 and 0-42 days ($p>0.05$). But stocking density had effect on the FCR at the age of 21-42 days ($p<0.05$). The difference of livability of stocking density groups was not significant ($p>0.05$).

Table 1: The effects of stocking density on growth performance, livability and feed conversion ratio

Variables	Stocking density 9 birds m^{-2}	13 birds m^{-2}	17 birds m^{-2}	Means	SEM	p-value
Cumulative bodyweight						
Initial body weight (g)	46.75	46.77	46.77	46.76	0.48	0.382
1 week body weight (g)	173.02	179.49	177.67	176.21	1.02	0.204
2 week body weight (g)	434.64^{a}	451.63^{b}	428.71^{a}	437.68	2.69	<0.001
3 week body weight (g)	843.77^{ab}	868.17^{b}	824.27^{a}	843.28	6.20	<0.008
4 week body weight (g)	1394.03^{b}	1412.40^{b}	1267.77^{a}	1342.94	11.39	<0.000
5 week body weight (g)	1992.52^{b}	2016.10^{b}	1853.79^{a}	1940.67	17.81	<0.000
6 week body weight (g)	2420.03^{b}	2398.91^{b}	2255.80^{a}	2343.12	23.16	<0.005
Livability %	89.33	89.81	84.72	87.96	2.33	0.121
Feed conversion ratio (g feed/g BW)						
0-21 day	1.56	1.57	1.57	1.57	0.02	0.922
21-42 day	2.02^{a}	2.03^{a}	2.21^{b}	2.10	0.03	<0.036
0-42 day	1.90	1.95	2.00	1.95	0.03	0.493

^{a,b}Different means in the same row; SEM: Standard Error of Mean; p: Probability

Table 2: The effects of stocking density on growth carcass parameters and relative organs

Variables	Stocking density 9 birds m^{-2}	13 birds m^{-2}	17 birds m^{-2}	Means	SEM	p-value
Carcass parameters						
Carcass yield (%)	74.17	75.19	74.35	74.59	0.37	0.531
Meat pH	6.05	6.17	6.22	6.16	0.06	0.627
Meat color (E)	69.01	66.33	69.73	68.44	1.24	0.493
Relative internal organ weights (g/100 g BW)						
Spleen	0.14	0.16	0.12	0.14	0.01	0.200
Liver	1.97	1.96	2.02	1.99	0.04	0.820
Hearth	0.68	0.63	0.65	0.65	0.02	0.615
Gizzard	2.75	2.30	2.35	2.42	0.09	0.174

SEM: Standard Error of Mean; p: Probability

Table 3: The effects of stocking density on hematocrit value, differential leucocytes counts and H:L ratio

Variables	Stocking density 9 birds m^{-2}	13 birds m^{-2}	17 birds m^{-2}	Means	SEM	p-value
Blood parameter						
Hematocrit (%)	35.67000	33.44000	32.73000	33.65000	0.62000	0.187
Total plasma protein (g dL^{-1})	3.53000^{a}	3.82000^{ab}	4.10000^{b}	3.87000	0.08000	<0.018
Haemoglobin (g dL^{-1})	14.10000	13.90000	12.97000	13.56000	0.26000	0.149
Erythrocyte (%)	3.02×10^{6}	3.13×10^{6}	2.81×10^{6}	2.97×10^{6}	0.08×10^{6}	0.245
Heterophil (%)	34.17000	34.78000	36.55000	35.38000	01.75000	0.855
Eosinophil(%)	2.67000^{a}	4.33000^{b}	3.18000^{ab}	3.46000	0.29000	0.073
Basophil (%)	4.67000	3.78000	3.82000	4.00000	0.31000	0.515
Lymphocyte (%)	54.67000	52.89000	52.55000	53.15000	1.79000	0.904
Monocyte (%)	3.83000	4.22000	3.91000	4.00000	0.27000	0.844
H:L ratio	0.66000	0.71000	0.74000	0.71000	0.06000	0.856

^{a,b}Different means in the same row; SEM: Standard Error of Mean; p: Probability

Effect of stocking density on carcass parameters of broiler chickens is shown in Table 2. Stocking density had no effect on any of the breast meat color and pH and carcass yield (p>0.05). There were no significant difference in liver, heart, kidney and gizzard (p>0.05) according to stocking density groups (p>0.05). Effect of stocking density on the haematological parameters of broiler chickens is shown in Table 3.

There was stocking density influence on total plasma protein contents (p<0.05) But there vas no stocking density influence on hematocrit, haemoglobin, erythrocyte, heterophil, eosinophil, basophil, lymphocyte, monocyte and H:L ratio. Some researchers have been reported that decreased individual body weight with increasing stocking density had not significant difference in stocking density groups (El-Deek and Al-Harthi, 2004; Ravindran *et al*., 2006; Turkyilmaz *et al*., 2008). But findings of this study are similar to some researchers have been reported that a linear decrease in individual body weights with increasing of population density had significant difference in stocking density groups (Bilgili and Hess, 1995; Feddes *et al*., 2002; Galobart and Moran, 2005; Dozier *et al*., 2006; Skrbic *et al*., 2009).

There was no significant effect of stocking density on FCR of broilers during 0-21, 0-42 days of age (p>0.05), except 21-42 days of age (p<0.05). Some studies have demonstrated that increasing stocking density of broiler chickens adversely affect FCR (Bilgili and Hess, 1995; Dozier *et al*., 2006; Ravindran *et al*., 2006).

The FCR found in the present study are in agreement with the findings of some researchers have been reported that there was no significant effect of stocking density on FCR of broilers (Feddes *et al*., 2002; El-Deek and Al-Harthi, 2004; Galobart and Moran, 2005; Turkyilmaz, 2008). Mortality was higher for stocking density 17 birds m^{-2} but was not significantly different.

Shanawany (1988) and Bilgili and Hess (1995), found an effect on livability of stocking density groups was significant. In contrast, the results are in agreement with observations of the other investigators reported that stocking density had no effect on livability (Feddes *et al*., 2002; El-Deek and Al-Harthi, 2004; Galobart and Moran, 2005; Dozier *et al*., 2006; Ravindran *et al*., 2006; Turkyilmaz, 2008). The weights of the lymphoid organs are known to decrease in response to increasing levels of stress. Because they can be easily recorded at slaughter, the lymphoid organ weights are commonly assessed as measures of immune status in poultry (Pope, 1991; Ravindran *et al*., 2006).

Also, the weight of liver weight increase in the stres period (Puvadolpirod and Thaxton, 2000). Therefore decreased lymphoid organ weights had been expected with increasing stocking density.

The relative internal organ weights that found in the present study are in agreement with the findings of some researchers reported that density had no significant influence on the relative internal organ weights of broilers (El-Deek and Al-Harthi, 2004; Buijs *et al*., 2009). Serum total protein has been reported to be directly responsive to protein intake and quality (Eggum, 1989). There was no difference between ratio of plasma protein and FCR in last 3 week. But FCR and plasma protein ratio were the highest on stocking density 17 birds m^{-2}. The H: L ratio, leukocyte change are recognized as a stress indicator (Gross and Siegel, 1983; Altan *et al*., 2000; Puvadolpirod and Thaxton, 2000; Islam *et al*., 2004). In general, birds respond to stress by decreasing the number of lymphocyte, heterofil, eosinophil and monocyte in circulation but there are increasing lymphocyte, haematocrit, basophil (Altan *et al*., 2000).

Gross and Siegel (1983) suggested that reference values for the heterophil to lymphocyte ratio of about 0.2, 0.5 and 0.8 are characteristic of low, optimal and high degrees of stress, respectively. However, stocking density was not a significant explanatory factor in haematocrit value and leukocyte components in the current investigation.

CONCLUSION

The study has shown that stocking density had no significant effect on breast meat color and pH and carcass yield, haematological parameters, livability, FCR (0-42 days of age) and internal organ weights. Conversely, stocking density significantly influenced body weights, FCR (21-42 days of age) and plasma protein. In conclusion, broiler chickens could be stocked up to 13 birds m^{-2} without negatively affect on growth performance, FCR and the physiological responses of birds.

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