Effects of high stocking density on growth performance, blood metabolites and immune response of Broilers (ROSS 308)

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Abstract

This study was done to investigate the effects of different stocking densities on performance, blood metabolites and immune function in broilers. About 720 (male and female mixed) one-day-old broilers was used in a completely randomized design. Each pen measured 1.50×2.00 meter. Stocking density was calculated by subtracting 0.75 m^2 of unusable space (for feeder area) from the total floor area. On top of each pen two adjustable water nipple systems was installed. The experiment consisted of (five treatments with four replications in each treatment) different stocking densities of 10.6, 13.3, 16.0, 18.6 and 21.3 birds/m^2. The results showed that there was a significant difference between treatments for food intake during the experimental period (P<0.05). The comparison showed that the average body weight decreased by increasing stocking density. The total FCR was affected (P<0.05) by stocking density in which by increasing the density the FCR decreased considerably. Effect of different stocking densities on blood metabolites was not significant. The antibody titers against SRBC (sheep red blood cell), IgG and IgM significantly increased as well as increasing stocking densities (P<0.05). In conclusion, 16 birds per m^2 could be recommended to broiler producers without any adverse effects on bird's performance.

Keywords: Broilers; immune system; performance; stocking density.

Introduction

Stocking density plays an important role, especially during summer, in broiler production. Higher mortality, lower meat production, greater incidence of leg disorders, and cannibalism occur at higher stocking densities in broilers. Increasing stocking density of broilers is a management practice used for reducing cost associated with labor, housing and equipments. However, over-crowding of broilers can lead to reductions in performance (Shanawany, 1988). Broiler performance and health can be influenced by very high stocking density (Webster, 2004) thereby it is important to ensure that adequate floor space is available for each bird (Al-Homidan, 2001).

Previous recommendation was about 30-35 kg of poultry meat production per unit of area (meter square), but it seems it can be increased up to 40-50 kg of meat per unit of area, which is equivalent to 16-20 birds per square meter. Consequently the commercial stocking density for broilers is approaching 50 kg/m^2 (Shanawany, 1988; Grashorn & Kutritz, 1991) in some regions, which is roughly equivalent to 20 birds/m^2 if slaughtered at 2.5 kg of individual body weight. Stocking density has critical implications for the broiler industry because higher returns can be obtained as the number of birds per unit space increases (Shanawany, 1988). Assessing the stress level of broiler chickens could be taught by Immune response to a given antigen. In this context, researchers reported that there was a significant decrease in immune response with an increase in stocking density in broilers (Turkyilmaz, 2008). Therefore the purpose of this experiment was to study the performance and immune system of broilers which grow on different stocking densities up to 21 birds per m^2.

Materials and methods

This experiment was conducted in Nowshahr city (Mazandaran, North of Iran) and about 720 one day old chickens (Ross 308 strain) were used. Each pen for this experiment measured 1.50×2.00 meter. Stocking density was calculated by subtracting 0.75 m^2 of unusable space (for feeder area) from the total floor area. On top of each pen two adjustable water nipple systems was installed. Therefore the experiment consisted of (five treatments with four replications in each treatment) different stocking densities of 10.6, 13.3, 16.0, 18.6 and 21.3 birds per m^2. All treatments were fed 3 similar soybean meal- corn based diets for 7 to 14d, 15 to 28d and 28 to 45d. Diets contained 21.4% crude protein (CP) and 3010 kcal.Kg^{-1} metabolizable energy (ME), 19.6% CP and 3050 kcal.Kg^{-1} ME and 18.8% CP and 3100 kcal.Kg$^{-1,}$ for 7 to 14d, 15 to 28d and 28 to 42 d respectively (Table 1). The diets were provided *ad libitum* throughout the experiment in mash form. Food intake and average body weight gain were recorded weekly as well as feed conversion ratio. On d 36, eight birds per treatment were injected intravenously via the wing with 1 ml of 10 % SRBC suspension. Blood samples were collected in the 43d and hemagglutination titers were measured by hemagglutination test. SRBC was done according to (Ambrose and Donner, 1973; Heckert et al., 2002) and also IgG and IgM was measured according to SRBC method and microtiter was done using Mercaptoethanol for agglutination (Isakov et al., 2005). Pars Azmun test kits for measuring blood metabolites (Tehran, Iran) by autoanalyzer at classical model was made in Chalous, Iran.

Table 1. Ingredient of diets fed to experimental birds in different stocking densities.

Ingredient	Day of experiment		
	1-14	15-28	29-45
Corn grain	54.00	58.70	64.40
Soybean meal	39.50	32.00	29.00
Limestone	1.20	1.10	1.10
Dicalciumphosphate	1.85	1.65	1.55
Soybean oil	2.00	2.10	2.50
Salt	0.30	0.30	0.25
Choline chloride	0.05	0.05	0.05
Sodium bicarbonate	0.10	0.10	0.15
Methionine	0.27	0.25	0.23
Lysine	0.10	0.13	0.15
Mineral +vitamin supplement †	0.48	0.45	0.47
Coccidiostat	0.05	0.05	0.05

†The mineral and vitamin premix provided the following per kilogram of complete diet: Mn, 100 mg; Zn, 75 mg; Fe, 80 mg; I, 0.65 mg; Cu, 80 mg; Se, 0.35mg, retinyl acetate, 0.009 MIU; cholecalciferol, 0.002 MIU; vitamin E, 0.011MIU; vitamin K, 1.0 mg; thiamine, 1.2 mg; riboflavin, 5.8 mg; niacin, 66 mg; pantothenic acid, 10 mg; pyridoxine, 2.6 mg; biotin, 0.10 mg; folic acid, 0.7 mg; and vitamin B12, 0.012 mg

Statistical Analysis
The experiment was done with 5 treatments and 4 replicates in a completely randomized design. Data were analyzed using SAS statistical software (2001). Significant means were compared using the least square means method. Mean differences were considered significant at P < 0.05. Standard errors of means were calculated from the residual mean square in the analysis of variance

Results

Effect of stocking density on food intake in 1-14 d was significant (P<0.01, Table 2); the 10.6 density had the highest food intake compare to other treatments. There was no significant difference in food intake between treatments in 1-21 and 1-28 d. However significant difference was seen in 1-35 and 1-42d in food intake and treatments with high stocking densities had the lowest food intake (P<0.05).

Table 2. Effect of stocking densities on feed intake (g) of broilers during the experimental period

Experimental days					
Stocking density	1-14	1-21	1-28	1-35	1-42
10.6	597.00^{a}	1104.25	2109.50	2302.50^{a}	4735.00^{ab}
13.3	476.23^{b}	1103.00	2105.75	3247.50^{a}	4765.00^{a}
16.0	475.63^{b}	1107.50	2084.00	3125.00^{b}	4750.00 ^{b}
18.6	476.29^{b}	1105.25	2054.25	3045.00^{ab}	4775.00^{b}
21.3	475.98^{b}	1099.00	2116.75	2975.00^{c}	4750.00^{b}
SEM	2.06	12.99	40.08	56.83	28.14
P-value	<0.01	0.912	0.225	<0.01	0.047

SEM: Standard error of means

Table 3. Effect of stocking on body weight gain (g) during the experimental period

Experimental days					
Stocking density	1-14	1-21	1-28	1-35	1-42
10.6	471.25	891.50	147.50	2140.00	2960.75^{a}
13.3	455.75	975.50	1435.50	2062.50	2950.75^{a}
16.0	433.00	930.50	1431.50	1958.80	2839.25^{ab}
18.6	482.00	955.75	1355.00	2016.30	2722.00^{c}
21.3	453.50	931.50	1432.50	2038.80	2692.50^{c}
SEM	34.14	84.81	122.14	152.68	35.437
P-value	0.533	0.808	0.861	0.569	<0.01

SEM: Standard error of means

Table 4. Effect of stocking on feed conversion ratio (g) during the experimental period

Experimental days					
Stocking density	1-14	1-21	1-28	1-35	1-42
10.6	1.01	1.24	1.49	1.54	1.072^{c}
13.3	1.05	1.15	1.48	1.58	1.72^{c}
16.0	1.08	1.20	1.46	1.60	1.80^{b}
18.6	0.99	1.16	1.52	1.51	1.84^{a}
21.3	1.09	1.19	1.49	1.47	1.87^{a}
SEM	0.067	0.102	0.118	0.109	0.413
P-value	0.301	0.804	0.797	0.453	<0.0001

SEM: Standard error of means

Table 5. Effect of stocking density on immune response of broiler

Stocking density	SRBC*	IgG	IgM
10.6	8.80^{d}	4.75^{d}	4.10^{d}
13.3	9.95c	5.75^{dc}	4.70^{dc}
16.0	12.75^{b}	7.00^{bc}	5.20^{c}
18.6	14.50^{b}	8.00^{b}	6.80^{b}
21.3	16.75^{a}	9.50^{a}	7.90^{a}
SEM	0.707	0.836	0.56
P-value	<0.01	<0.01	<0.01

*Sheep red blood cell, SEM: Standard error of means

Effect of stocking density on body weight gain was not significant in 1-35d (Table 3). Significant differences was seen in 1-42d in body weight gain and treatments with high stocking densities had the lowest body weight gain (P<0.01). Effect of stoking density on feed conversion ratio was shown in Table 4. Effect of stocking density on feed conversion ratio was not significant in 1-35d. Although significant differences was seen in 1-42d in feed conversion ratio and treatments with high stocking densities had the highest feed conversion ratio ($P<0.01$).

The results showed that flock density had no effect on glucose, urea, uric acid, cholesterol, albumin, total protein, HDL, LDL and triglyceride concentrations. Effect of stocking density (Table 5) on SRBC, IgG and IgM titers was significant ($P<0.01$). In order to increase in stocking density, the immune responses include SRBC, IgG and IgM increased significantly ($P<0.01$). Birds in high stocking density had higher SRBC, IgG and IgM titers in compare to low stocking density.

Discussion

In the present study it was shown that the stocking density decreased food intake in high density treatments. Consistent with our findings, Shanawany (1988) showed a decline in average feed intake with increasing flock density. It may occur because of low feeder space for each bird. Accordingly the lower feed intake leads to lower body weight gain in high density treatments; although total kilogram produced per unit of space increased (Shanawany, 1988; Cravener et al., 1992, Verspecht et al., 2011), which may result in higher profits. Researchers in a study on broilers showed that kilograms produced per meters squared increased with increasing stocking density (Puron et al., 1995; Dozier et al., 2006). Consistent with the results for food intake and BWG, the FCR was affected by stocking densities and the highest FCR were seen in very high stocking densities.

It has been demonstrated that increasing stocking density inversely affect body weight gain and food intake and also suggested that high densities may induce birds in a competitive situation for food intake and possibly increase their activities (Shanawany, M. M. 1988; Thaxton et al., 2006; Martrenchar et al., 1997). Consistent to current results, increasing the density from 14 to 18 birds per square meter increased feed conversion ratio (Palizdar et al., 2016). In agreement to our results, Thaxton did not find any effects of density on serum glucose and cholesterol concentrations in broilers reared between 20 to 55 kg/m^2 or 8 to 22 birds per m^2 (Thaxton et al., 2006). Heckert et al., (2002) showed that increasing housing density may produce immunosuppression in broilers, which can be most easily and reliably assessed at slaughter by measuring the bursa weights and or the bursa to body weight ratios. Other parameters such as humoral immune response to SRBC, heterocite:lymphocyte ratios, or lymphocyte blastogenesis were not different across densities (Heckert et al., 2002); Although immune response to SRBC was affected by densities which this result was inconsistent to Heckert (Heckert et al., 2002). Palizdar also showed that by increasing the stocking densities up to 18 birds/m^2, the immune response to SRBC and IgG and IgM titers did not affected (Palizdar et al., 2016), which is not consistent to current results. Estevez (2007) suggested that the health and welfare of broilers can be achieved at a range of densities (rather than at a single density) most likely varying between 34 to 38 kg/m^2. This suggestion means that broiler producer should not exceed 15 birds/m^2, however in the current study showed that we can use higher densities in controlled environment. In addition Puron et al., (1995) recommended that the densities in which yield per unit of space reach to plateaus (17 birds/m^2 for males and 19 for females) are not far from the densities recommended to minimize the negative welfare impact and health. It seems producer can improve broiler rearing up to 16 birds per m^2 if they can maintain the precise environmental quality to preserve and ensure the health and welfare of birds raised in their facilities.

Conclusions Our results showed that under the condition of this study increasing stocking density up to 21 birds/m^{2,} reduce feed intake and weight gain but increased feed conversion ratio and antibody response against SRBC of broilers. In conclusion it can be recommended to broiler producers that increase broiler rearing up to 16 birds per m^2 without any adverse effects on bird’s performance.

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