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GROWTH PERFORMANCE, SOME BLOOD COMPONENTS, CARCASS TRAITS AND INTESTINE HISTOLOGY OF BROILER CHICKS AS AFFECTED BY STOCKING DENSITY

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ABSTRACT: The current investigation was conducted to evaluate the effects of stocking density on growth performance, some blood parameters, carcass characteristics and intestine histology of Evian broiler chicks under Sharkia Governorate conditions. A total number of 234 unsexed one day old Evian broiler chicks were randomly distributed into three treatment groups in completely randomized design to evaluate the influence of three stocking densities (10, 13 and 16 birds /m^2). The results of the present work could be summarized as follows: Stocking density significantly (P<0.05 and 0.01) changed body weight at 3 wks of age and daily weight gain, feed consumption and feed conversion ratio through 0-3 wks of age. Broilers kept at 10 birds /m^2 showed the heaviest (P<0.01) body weight at 3 wks of age in comparison with the other groups. Birds reared at stocking density of 13 birds /m^2 insignificantly gained more than the other densities during 3-6 and 0-6 wks of age. Broilers kept under stocking density of 10 birds /m^2 recorded the lowest feed intake and showed the best feed conversion ratio when compared with their counterparts during 0-3 wks of age. All of blood parameters studied were insignificantly changed due to stocking densities used in the present study. Weights of carcass after evisceration, liver and intestine as percentages were significantly changed due to the different stocking densities used in the current study. Broilers kept at 16 birds /m^2 had the highest (P<0.05) percentage of weight after evisceration and the lowest (P<0.05) percentages of liver and intestine in comparison with the other groups. Conclusively, it could be concluded that keeping Evian broilers at stocking density of 10 birds/ m^2 gave the most acceptable performance under Sharkia Governorate conditions.

Key words: Broilers, carcass, growth performance, blood parameters, stocking density.

INTRODUCTION

In today's poultry industry, practices regarding management are among the most important factors for poultry producers, especially in hot climates, because they have the potential to reduce the relative heat load **(Farghly *et al*., 2018)** and due to the high cost of breeding **(Abd El-Hack *et al*., 2019)**.

Broiler contribution in meat production has increased markedly in the last few decades, and this is mainly due to improved genetic and management practices. Due to its low fat and high protein content, broiler meat is considered as a high quality food by consumers **(Kryeziu *et al*., 2018)**. The housing environment is extremely important and has an influence on broiler performance and welfare **(Farghly and Mahrose, 2017; Farghly *et al*., 2017)**.

Among the many factors that can affect broiler growth performance, stocking density is very important **(Abudabos *et al*., 2013; Qaid *et al*., 2016)**. Stocking density is necessary factor influencing poultry well-being, welfare, health and performance as well **(Mahrose *et al*., 2019)**. Stocking density can be expressed as a number

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of birds per unit area or body mass per unit area. According to previous researcher **(Estevez. 2007)**, stocking density can be different in various countries and husbandry systems **(Buijs *et al*., 2009; Mahrose *et al*., 2019)**. It is one of the most important non-genetic factors in poultry breeding and has critical implications for the broiler industry, as higher returns can be obtained as the number of birds per unit area increases. Increasing stocking density could make stress and deleterious impacts on poultry immunity and performance, especially during the growing period **(Askar and Assaf, 2004; Attia *et al*., 2012)**.

Different studies have been conducted on the effects of stocking density on broiler performance, but the results have been conflicting. Some studies showed no significant influence of stocking density on broiler performance **(Buijs *et al*., 2009; Rambau *et al*., 2016)** while others demonstrated adverse effects of high stocking densities **(Beg *et al.*, 2011; Tong *et al.*, 2012; Ligaraba *et al*., 2016; Siaga *et al*., 2017)**. Others, on the other hand, reported improved broiler performance with increased stocking density **(Feddes *et al*., 2002)**.

Broiler producers generally increase stocking density and sacrifice bird performance in an attempt to maximize returns per unit of floor area **(Madilindi *et al*., 2018)**. However, circumstances are changing owing to bird welfare considerations. In Europe, stocking density has been fixed at 30 kg BW/m^2 with an option to increase it to 39 or 42 kg BW/m^2, provided set standards are met **(European Commission, 2007)**.

Therefore, the current study aimed to investigate the effect of using different stocking densities (10, 13 and 16 birds /m^2) on growth performance, blood components, carcass characteristics and intestine histology of Evian broiler chicks under Sharkia Governorate conditions.

MATERIALS AND METHODS

The present experiment was carried out at a Private Poultry Farm, Sharkia Governorate, Egypt (during February to March, 2018). A total number of 234 unsexed one day old Evian broiler chicks were randomly distributed into three treatment groups (3 replicates per each) to evaluate the influence of three stocking densities (10, 13 and 16 birds/m^2) in completely randomized design.

Birds were received starter diet till three weeks of the age; finisher diet from the fourth to sixth weeks of the age. The basal experimental diets (starter and finisher) were formulated to cover the nutrient requirements of broiler chicks according to **NRC (1994)** from 0-6 weeks of age. Composition and calculated analysis of the experimented basal diet are presented in Table 1.

The experimental period was lasted for 6 weeks, and divided into three intervals: 0-3 (starter period), 3-6 (finisher period) and 0-6 (whole experimental period). All chicks were wing-banded and had free access to fresh drinking water. Chicks were provided with feed and water for *ad-libitum* consumption.

All chicks in each group were kept under similar managerial and hygienic conditions. Artificial light source was used, giving a total of 23L: 1D hours of light per day throughout the experimental period. Gas heaters were used to provide chicks with needed heat for brooding, where room temperature was about 32^{o}C for the first three days and then decreased 3^{o}C daily until reaching 24^{o}C thereafter to the normal temperature. Electric fans were used to achieve a regular circulation of air up to 35 days of chick's age in all treatment groups. Vaccination and medical program were done according to the different stages of the age under supervision of a veterinarian in the farm.

Investigated Measurements

Live body weight

Chicks were individually weighed at the initial (one day old), 3 weeks of age and final of the experimental period (6 weeks of the age).

Daily body weight gain

Daily body weight gain for each period (0-3, 3-6 and 0-6 weeks of age) was calculated by subtracting the average initial live body weight from the average final body weight and divided by the number of days within the same period.

Table 1. Composition and calculated analysis of the experimental basal diet

Item	Basal diet	
	Starter	Finisher
Ingredient (%)		
Yellow corn	57.03	60.49
Soybean meal (44%)	31.65	27.15
Corn gluten meal (62%)	6.50	6.10
Di calcium phosphate	1.70	1.50
Limestone	1.24	1.15
Vit-min premix*	0.30	0.30
NaCl	0.30	0.30
DL-Methionine	0.15	0.01
L-Lysine	0.13	0.15
Soybean oil	1.00	2.85
Total	100	100
Calculated analysis**		
CP (%)	22.80	20.89
ME (Kcal/kg diet)	2948.00	3115.00
Ca (%)	1.00	0.90
P (Available) (%)	0.45	0.40
Lysine (%)	1.20	1.10
M+C (%)	0.93	0.73
CF (%)	3.55	3.31

* Growth vitamin and Mineral premix: Each 2.5 kg consists of: Vitam. A1200,000 IU; Vitam. D_3, 2000,000 IU; Vitam. E 10 g; Vitam. K_3 2 g; Vitam. B_1 1000 mg; Vitam. B_2 49 g; Vitam. B_6 105 g; Vitam. B_{12} 10 mg; pantothenic acid, 10 g; Niacin 20 g; Folic acid 1000 mg; Biotin 50 g; Cholin Chloride 500 mg; Fe 30 g; Mn 40 g; Cu 3 g; Co 200 mg; Si 100 mg.
** Calculated according to **NRC (1994)**.

Feed Consumption

At the beginning of the experimental period, a certain amount of each experimental diet was weighed. At the end of the certain period, the residuals were weighed and subtracted from the offered amount to obtain the total feed during the period, which was divided by number of chicks in order to obtain the average amount per chick.

The following equation was applied to obtain the amount per chick:

$$\text{Average feed intake/chick/period} = \frac{\text{Feed consmed (g) during a given period}}{\text{Number of chicks during the same period}}$$

Feed conversion ratio

Feed conversion ratio was estimated as units of grams of feed required to produce one gram of gain, during a certain period as follows:

$$\text{Feed conversion ratio} = \frac{\text{Average feed (g) during a given period}}{\text{Average weight gain (g) during the same period}}$$

Blood parameters

At the end of the experimental period (6 weeks of age), blood samples were randomly collected at slaughtering from nine birds per each group into sterilized tubes that closed with rubber stoppers as blood specimens were used for the different determinations. Blood samples were centrifuged at 3500 rpm for 20 minutes and serum was analyzed for total proteins (g/dl), albumin (g/dl), total cholesterol (mg/dl), AST (U/I), ALT (U/I) and creatinine using the available commercial kits (purchased from Bio-diagnostic, Egypt) according to the manufacturers' instructions. Plasma globulin concentration was calculated by the difference between total protein and albumin.

Carcass Characteristics

At the termination of the experimental period (6 weeks of age), three representative birds from each treatment were deprived of food for 12 hours after which they were individually weighed the assigned birds were slaughtered to complete bleeding followed by plucking the feather. After the removal of head, viscera, shanks, gizzard, liver, heart, and reproductive organs, the rest of the body was weighed to determine the dressed weight. The total edible parts included the dressed weight offered to table and the edible organs (*i.e.* heart, empty gizzard and liver), then dressing percentage was calculated on the basis of live weight.

Histological Examinations

Specimens from the broiler intestine and thymus collected and immediately fixed in 10% buffered neutral formalin solution for 48 hours, dehydrated in gradual ascending ethanol (70, 80, 95, 95 and 100%), cleared in xylene, and embedded in paraffin. Five-micron thick paraffin were sliced using a microtome (Leica RM 2155, England). The sections were prepared and then routinely stained with hematoxylin and eosin stains and examined microscopically (**Suvarna *et al*., 2013**). A hepatic alteration was observed. Morphometric analysis were done by camera microscope Am Scope® software as the following: Villus height measured (μm) from the tip to the base of villus and diameter. Muscular thickness, submucosa layer thickness as well as number of goblet cells per area of epithelium layer, intraepithelial leukocytes were also calculated.

Statistical Analysis

Data collected were subjected to analysis of variance of completely randomized design by applying the General Linear Models Procedure of SAS software **(SAS, 2009)** according to **Snedecor and Cochran (1982)**. The following model was adopted:

$X_{ij} = \mu + T_i + e_{ij}$ Where:

X_{ij} = An observation,

μ = Overall mean

T_i = Stocking density effect (i = 10, 13 and 16) and e_{ij} = Experimental error.

All means were tested for significant differences using Duncan's multiple range procedure **(Duncan, 1955)**. The percentages of carcass and organs were transformed to Arcsine values then re-transformed to the original values after analysis.

RESULTS AND DISCUSSION

Growth Performance

Results of growth performance are presented in Table 2. Stocking density significantly ($P<0.05$ and 0.01) affected on body weight and daily weight gain at 3 wks of age and feed consumption and feed conversion ratio through 0-3 wks of age. Broilers kept at 10 birds /m^2 showed the heaviest body weight in comparison with the other groups. Birds reared at stocking density of 13 birds/m^2 gained more than the other densities at 3-6 and 0-6 wks of age. Broilers kept under stocking density of 10 birds /m^2 recorded the lowest feed and showed the best feed conversion ratio when compared with their counterparts.

These results indicated that high stocking density reduced significantly body weight gain and market weight. However, the extent of reduction or improvement depended on how high the particular density was. Reduced body weight gain at high stocking densities could be attributed partly to decreased feed consumption, owing to physical competition for access to feeders **(Madilindi *et al*., 2018)**. Also, increasing stocking density could make stress and deleterious impacts on poultry immunity and

Table 2. Growth performance ($\overline{X}$ ±SE) of broilers as affected by stocking density

Trait	Stocking density			
	10 birds/m²	**13 birds/m²**	**16 birds/m²**	**Sig.**
Body weight (g)				
0 weeks	50.91± 00.271	49.94± 0.34	50.71 ± 0.38	NS
3 weeks	911.68^{a}±14.71	876.42^{b}± 6.93	856.64^{b}± 9.69	**
6 weeks	2432.44±30.50	2486.53± 43.78	2439.64± 18.36	NS
Daily weight gain(g/day)				
0-3 weeks	40.98^{a}± 0.70	39.36^{b}± 0.32	38.38^{b}± 0.47	**
3-6 weeks	72.41± 1.28	76.67± 2.02	75.38± 0.72	NS
0-6 weeks	56.70± 0.73	58.02± 1.04	56.88± 0.43	NS
Feed consumption(g/day)				
0-3 weeks	53.54^{b}± 0.78	56.61^{a}± 0.98	54.26^{ab}± 0.63	*
3-6 weeks	135.73± 1.50	134.34±0.93	134.51± 0.91	NS
0-6 weeks	94.63± 0.92	95.48± 0.69	94.39± 0.52	NS
Feed conversion ratio (g feed/g gain)				
0-3 weeks	1.31^{b}± 0.02	1.44^{a}± 0.03	1.42^{a}±0.02	**
3-6 weeks	1.88±0.03	1.76±0.05	1.79±0.01	NS
0-6 weeks	1.67± 0.03	1.64± 0.03	1.66± 0.01	NS

Means in the same raw with different letters, differ significantly (P<0.05).
NS= Not significant, * = P≤0.05 and ** = P≤0.01.

performance, especially during the growing period (**Asker and Assaf, 2004; Attia *et al.*, 2012**).

The current findings are in agreement with those observed by **Yakubu *et al*. (2010), Beg *et al*. (2011), Rambau *et al*. (2016), Siaga *et al*. (2017) and Mahrose *et al*. (2019)** who found that high stocking density negatively affected growth performance.

Mahrose *et al*. (2019) indicated that quail reared at stocking density of 100 cm^2 /bird (15 birds/cage) showed statistically (P≤ 0.01) higher body weight (6 wks) and daily body weight gain (3-6 and 1-6 wks) than those kept under 75 cm^2/ bird. However, quail reared at stocking density of 75 cm^2/ bird (20 bird /cage) had significantly (P≤ 0.01) lowest averages of consumed feed at all periods studied and significantly (P≤ 0.01) best values of feed conversion at 1-6 weeks of the age. **Madilindi *et al*. (2018)** found a progressive reduction in feed intake with increasing stocking density, but stocking density did not influence feed conversion ratio.

Blood Parameters

All of blood parameters studied were insignificantly changed due to stocking densities used in the present study as presented in Table 3.

Globulin is considered as a part of total serum proteins and indicates the immunological status **(Ismail *et al.*, 2002)**. The albumin synthesis takes place in the liver, while globulin in the lymphatic tissues **(Jones and Bark, 1979)**, thus the change in the albumin level is considered an evidence of a change in liver function **(Azoz and El-Kholy, 2005)**.

Contradicting results were obtained by **El-Tarabany (2015)** who confirmed an inverse relation between stocking density and globulin concentration in quail. The same author indicated that quail group that kept at 200 cm^2/ bird had significantly higher total proteins (4.63 g/dl, p = 0.001) and albumen concentrations (1.81 g/dl, p = 0.029) than those kept at 143 cm^2/bird group (3.61 and 1.32 g/dl respectively).

Carcass Characteristics

Table 4 shows the results of carcass characteristics as affected by different stocking densities. Dressing, giblets and intestine as percentages were significantly (P<0.05) changed due to the different stocking densities used in the current study. Broilers kept at 16 birds/m^2 had the highest (P<0.05) percentage of dressing and the lowest (P<0.05) percentages for each of giblets and intestine in comparison with the

Table 3. Blood parameters (within the normal range) of broilers ($\overline{X}$ ±SE) as afected by stocking density

Trait	Stocking density			
	10 birds/m^2	13 birds/m^2	16 birds/m^2	Sig.
Total protein (g/dl)	3.24± 0.14	3.61± 0.17	3.11± 0.01	NS
Albumin (g/dl)	1.29± 0.04	1.31± 0.05	1.27± 0.01	NS
Total cholessterol (mg/dl)	110.77± 4.71	118.88± 5.22	111.22± 3.55	NS
Globulin (g/dl)	1.94± 0.14	2.29±0.21	1.84± 0.06	NS
ALT (U/ I)	4.78± 0.32	4.82± 0.25	4.91± 0.23	NS
AST (U/ I)	330.66± 17.33	316.00± 13.89	307.55± 15.98	NS
Creatinin (mg/dl)	0.22± 0.02	0.16± 0.01	0.19±0.01	NS

NS= Not significant.

Table 4. Carccas characteristics of broilers ($\overline{X}$ ±SE) as afected by stocking density

Trait	Stocking density			
	10 birds/m^2	13 birds/m^2	16 birds/m^2	Sig.
Carcass (%)	92.67	93.64	93.91	NS
Dressing (%)	70.09^c	72.74^b	74.70^a	*
Giblets (%)	4.23^b	4.67^a	4.20^b	*
Spleen (%)	0.17	0.17	0.17	NS
Intestine (%)	6.38^a	6.36^a	5.18^b	*
Intestine Length	7.02	7.20	6.83	NS

Means in the same raw with different letters, differ significantly (P<0.05).
NS= Not significant and * = P≤0.05.

other groups. On the other hand, spleen and intestine length were not significantly changed due to stocking density (Table 4).

Stocking density affected liver percentage significantly, and this is probably because at high stocking densities overcrowding causes birds to consume feed quickly. **Ligaraba *et al.* (2016), Rambau *et al.* (2016) and Siaga *et al.* (2017)** reported reversed observations that stocking density had no effect on heart percentage.

These results are in line with those obtained by **Mailindi *et al.* (2018)** who showed that stocking density significantly influenced carcass parts percentage. On the other hand, **Seker *et al.* (2009), Attia *et al.* (2012), El-Gogary *et al.* (2015) and Mahrose *et al.* (2019)** demonstrated that carcass traits did not influence by stocking density.

Histological Examinations

Histological examinations of broilers kept under different stocking densities are found in Figs. 1, 2 and 3. Figure 1 shows photomicrograph of broiler intestine of control group with 10 birds/m^2 showing apparently normal tall and thin intestinal villi. H and E stain X100. Figure 2 shows photomicrograph of broiler intestine of group fed on basal diet with 16 bird /m^2 showing destructed and shorter villi (star), H&E stain X100. Fig. 3 show photomicrograph of broiler intestine of group treated with 13 birds /m^2 showing tall separate villi with mild fusion (star) H&E stain X100.

In conclusion, it could be concluded that the keeping Evian broilers at stocking density of 10 birds/ m^2 gave the most acceptable performance under Sharkia Governorate conditions.

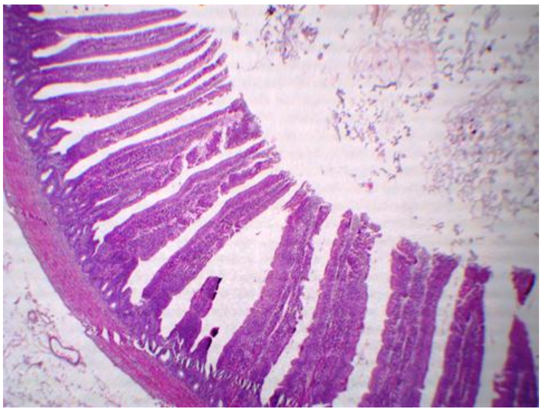

Fig. 1. Photomicrograph of broiler intestine of control group with 10 birds/m^2 showing apparently normal tall and thin intestinal villi. H&E stain X100

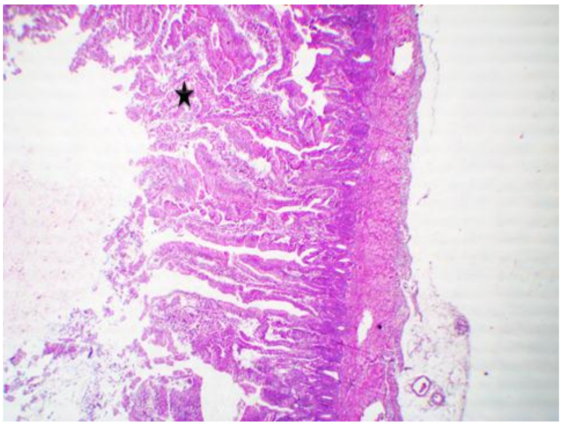

Fig. 2. Photomicrograph of broiler intestine of group fed on basal diet with 16 bird/m^2 showing destructed and shorter villi (star). H&E stain X100

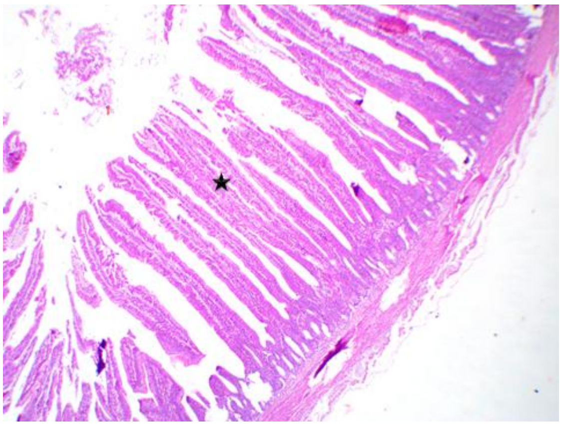

Fig. 3. Photomicrograph of broiler intestine of group treated with 13 birds/m^2 showing tall separate villi with mild fusion (star) H&E stain X100

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أداء النمــو وبعض مكــونات الــدم وصفات الذبيحة وهســتولــوجيــا الأمعــاء لكتاكيت التســـمين وتأثرها بكثافة القطيع

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أجريت هذه الدراسة لتقييم تأثير كثافة التسكين على أداء النمو، بعض قياسات الدم، مواصفات الذبيحة لدجاج التسمين تحت ظروف محافظة الشرقية، مصر، استخدم عددًا إجماليًا قدره ٢٣٤ كتكوتًا غير مجنسًا عمر يوم من دجاج ايفيان وزعت عشوائيا على ثلاث مجموعات تجريبية (٣ مكررات في كل مجموعة) في تصميم عشوائي تام لتقييم تأثير ثلاث مستويات من كثافات التسكين (١٠، ١٣، ١٦طائر/م^{٢}) يمكن تلخيص نتائج التجربة على النحو التالي: أدت كثافة التسكين عند معنويات (٠.٠٥، ٠.٠١) إلى زيادة في وزن الجسم عند ٣ أسابيع من العمر، وزيادة الوزن اليومية واستهلاك العلف ونسبة التحويل الغذائى عند عمر الفقس وحتى ٣ أسابيع من العمر وأظهرت الطيور عند كثافة ١٠ طائر/م^{٢} أعلى معدل وزن للجسم بالمقارنة مع المجموعات الأخرى، أظهرت الطيور التي تربى بكثافة تسكين ١٣ طائر/م^{٢} معدل زيادة وزنية من المجموعات الأخرى عند عمر٣ - ٦ أسابيع من العمر وأيضا عند عمر يوم – ٦ أسابيع من العمر مقارنة بالمجاميع التجريبية الأخرى، سجلت كثافة تسكين ١٠طائر/م^{٢} اقل استهلاك علف وأظهرت أفضل معامل تحويل غذائى عند مقارنتها بالمجموعات الأخرى خلال الفترة من الفقس وحتى ٣ أسابيع من العمر. مقاييس الدم التي تمت دراستها لم تتأثر معنويا بسبب كثافات التسكين المستخدمة في هذه الدراسة، تأثرت أوزان الذبيحة بعد التجويف والكبد والأمعاء كنسب مئوية معنويا بسبب كثافات التسكين المختلفة المستخدمة في الدراسة الحالية، سجلت الطيور عند كثافة تسكين ١٦ طائر/م^{٢} أعلى نسبة وزن ومعنوية عند ٥% وذلك بعد إزالة الأحشاء وأيضًا اقل عند مستوى ٥% معدل وزن من الكبد والأمعاء وبشكل قاطع، فإن الفروق كانت غير معنوية ويمكن تربية دجاج التسمين تحت كثافة تسكين حتي ١٠ طائر/م^{٢} تحت ظروف محافظة الشرقية.

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