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The effect of stocking density on the production performance and Carcass characteristics of Ross 308 broiler chickens

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I. Abstract

This study aimed to investigate the effect of stocking density on growth performance and carcass characteristics of Ross 308 broiler chickens. 188-day-old chicks were raising for 35 days of age. Four stocking density treatments (9, 10, 13, and 15 birds/m^2) were applied. The results showed no significant differences in body weight at 1 day and 5 weeks of age, and a significant decrease in body weight for density treatments T4, T3, and T2 (P≤0.05) compared to treatment T1 (control) at 3 weeks of age. The results also revealed a significant decrease in weight gain rate for density treatments T4, T3, and T2 (P≤0.05) compared to T1 treatment (control) during the period (0-3) weeks, while the treatments did not differ in weight gain rates during the periods (3-5) and (0-5) weeks. No significant differences were observed between the treatments in feed consumption rates for the period (0-3) weeks. Treatments T4 and T3 significantly superior (P≤0.05) in feed consumption compared to treatment T2 and treatment T1 (control) during the periods (3-5) and (0-5) weeks. The results indicated that there was no significant difference between treatments in feed conversion ratio of birds during the period (0-3) weeks, while treatments T2, T3 and T4 showed the best feed conversion ratio compared to treatment T1 (control) during the periods (3-5) and (0-5) weeks. Treatment T3 recorded the highest carcass weight significantly (P≤0.05) compared to the other treatments. While the treatments did not differ significantly (P≤0.05) in the average weight of breast and thigh cuts, their relative weights, average weight of pectoralis major muscle and dressing percentage. No significant(P≤0.05) differences were observed between treatments in color indices and cutting strength. T4 treatment significantly superiority (P≤0.05) in sarcomere length compared to other treatments.

Keywords: Stocking density, growth, meat quality, color indices, Ross 308

II. Introduction:

Poultry meat is a rich source of proteins, vitamins, and minerals with a low saturated fat content, making it a healthy food choice with a higher nutritional value compared to red meat (Ahmad et al., 2022). It is also low in cholesterol, calories, and fat, and is less expensive than other meats (Sujiwo et al., 2018; Ikusika et al., 2020; Shirshaab and Jassim 2021). Stocking density is an important management factor in the poultry industry that can increase production returns by increasing the number of birds raised per unit area (Adeyemo et al., 2016; Ibrahim et al., 2018). It also negatively impacts bird welfare, production performance, and health (Mahrose et al., 2019). At early ages, broiler chicks can be raised in larger numbers without stress, while birds' exposure to stress due to high stocking density increases with age during the rapid growth phase. High stocking density has been shown to have negative effects on broiler chickens (Ghosh et al., 2012; Xiong et al., 2020). Studies have varied regarding the effects of stocking density, with some indicating that higher stocking densities reduce broiler chickens' production performance during the growth phase compared to lower densities (Chegini et al., 2018; Abdelgaber et al., 2023), while other studies reported that stocking density had no effect on growth performance (Nogueira et al., 2013; Silas et al., 2014). In this regard, a study by Kryeziu et al., (2018) showed that raising broiler chickens at a density ranging from 14 to 18 chicks/m^2 up to the age of (6) weeks is considered permissible and profitable in broiler projects. In another study conducted on Ross 308 broiler chickens, the results showed no significant

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differences in the weights of the breast and thigh parts for stocking densities of 10, 15, 20, 25, and 30 birds/m^2 (Thema et al., 2022). Regarding the effect of density on meat color, Goo et al., (2019), a study conducted on Ross 308 broiler chickens reared at densities of 9 and 18 birds/m², indicated a higher L* index value for meat slices from carcasses treated with a stocking density of 9 birds/m² compared to those treated with a stocking density of 18 birds/m². Meat tenderness and juiciness were also observed to be affected by stocking density, with an inverse correlation with intramuscular fat content (Skřivanova et al., 2017). On the other hand, Son et al., (2022), a study conducted on Ross 308 broiler chickens using different stocking densities, indicated significant differences in the cutting force values of breast muscle slices, with the highest cutting force values being achieved at low stocking densities compared to high stocking densities. Therefore, the present study aims to know the effect of stocking densities (15, 13, 10, 9 birds/m^2) on productive performance, carcass characteristics, meat color indices, cutting force and sarcomere length of the breast segment muscle of Ross 308 broiler chickens.

III. Materials and Methods:

Experimental Birds and Experimental Treatments:

The experiment was conducted in the broiler stocking hall of the Animal Production Department at the University of Basra. 188 unsexed one-day-old Ross 308 broiler chicks were used in the study, supplied by the Fadak Hatchery in Basra Governorate, Iraq. The birds were reared from one day old to five weeks old in a broiler stocking hall with dimensions of 10 x 7 m², divided into wire-floored cages with dimensions of 1.20 x 80 m². The hall was equipped with oil heaters to maintain the temperature at 33-35°C during the first week of life. The temperature was then reduced at a rate of 2°C per week, reaching 24-27°C at the third week of life and continuing until the end of the experiment. The birds were fed ad libitum throughout the experiment. Manual round plastic feeders were used for feeding, and a nipple system was used to provide drinking water for the birds. A continuous 24-hour lighting program was used for the first three weeks of life, after which the lighting hours were reduced by half an hour for every three hours per day until the end of the experiment. One-day-old field experimental birds were distributed into four treatments for stocking densities, with four replicates (cages) for each treatment, as follows:

1- Treatment T1: 9 birds/m² per replicate (control treatment).
2- Treatment T2: 10 birds/m² per replicate.
3- Treatment T3: 13 birds/m² per replicate.
4- Treatment T4: 15 birds/m² per replicate.

Production Traits

Chickens were weighed collectively at one day of age for each replicate according to the experimental treatments using a sensitive digital balance at an average weight of 50 g. Weights were recorded weekly at ages (1, 3, and 5) weeks. Weight gain rates for birds were calculated for weekly periods (0-3), (3-5), and (0-5) by calculating the weight gain rates for birds for weekly periods (0-3), (3-5), and (0-5) for replicates of all treatments based on the difference between live body weight at the end of the weekly period and live body weight at the beginning of the weekly period. Feed consumption (g) for weekly periods (0-3), (3-5), and (0-5) was calculated based on the difference between the amount of feed added to the feeders and the amount of feed remaining at the end of the period. The feed conversion ratio for weekly periods (0-3), (3-5), and (0-5) was calculated by dividing the amount of feed consumed during a given period by the average weight gain during the same period.

The production index is calculated using the following equation:

$$\text{Production index} = \frac{Average\ body\ weight\ (g)\ x\ Vitality\ ratio}{\text{Number of days of stocking x Feed conversion ratio x 10}}$$

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Vitality ratio = 100 - number of deaths
Number of days of stocking x Feed conversion ratio x 10
Vital ratio = 100 - Number of deaths

Carcass characteristics:

Carcass Weight and Cuts (g):

At the age of (5) weeks, (3) males were randomly selected from each replicate (12 birds per treatment) to measure carcass specifications. The birds were weighed before slaughter, then slaughtered by cutting the jugular vein. After the bleeding process was completed, the feathers were plucked using a plucking machine. The carcasses were then transported to the laboratory for cleaning and removing edible and inedible entrails. The hot carcass weight was recorded, and the dressing percentage (%) was calculated based on the weight of the cleaned hot carcass. The carcass was cut into the two main cuts: the breast and the thigh. Their weights were recorded using a scale sensitive to two decimal places. Their relative weights were calculated according to the equation:

$$\text{Cut \%} = \frac{\text{Cut weight (g)}}{\text{Carcass weight (g)}} \times 100$$

After completing the skin removal process from the breast, the pectoralis major muscle was separated from the minor muscle, then weighed using a sensitive scale.

Morphological Characteristics of the Pectoralis Major Muscle:

Analysis of Color Indices of Pectoralis Major Meat Slices

The study was conducted in the Chemistry and Meat Technology Laboratory, Department of Food Sciences, College of Agriculture, University of Basrah. Color indices were measured from 16 pectoralis major meat slice samples (three readings per sample) according to the measurement method described by (Al-Hilphy et al., 2022). This was done using a developed computer system consisting of a computer, an HD camera, and four LED lamps. To determine the color indices (L, a, b), a version of the (Image J) program was used to determine these indices from the pectoralis major meat slice samples from the experimental treatments. The values (L, a, b) were corrected to (L*, a*, b*) using the following equations (Yam et al. 2004; Wasnik et al. 2019).

$$L^* = \frac{L}{255} \times 100 \quad , a^* = \frac{240a}{255} - 120 \quad , \quad b^* = \frac{240b}{255} - 120$$

The degree of color clarity (chroma) was determined based on the C value (color degree) using the equation mentioned by (Bermudez et al. 2009), where:

$$C = \sqrt{a^2 - b^2}$$

Cutting Force of Large Pectoralis Muscle Steaks

Cutting force was measured in the central laboratory of the College of Pharmacy, University of Basrah. 16 large pectoralis muscle steaks were randomly selected, with four samples per treatment. The cutting force was measured using a British-made (AT-XT-plus texture analyzer), equipped with three cutting blades. The device is directly connected to a computer for data analysis. The dimensions of the steak slice for all samples with different treatments were (1 length x 1 width x 1 height) cm^3. Each steak was placed on the base of the device and a force was applied using a sharp lever. The process was repeated twice, perpendicular to the muscle fibers, and the maximum cutting force was recorded in Newtons.

Sarcomere Length

Tissue sections were prepared for the experimental treatment samples, with 16 samples (4 samples per treatment). Sections were photographed using a light microscope at a magnification of (100X) by calibrating the lens of an ocular micrometer containing a graduated ruler from (0-100) with a glass slide. Each graduation of this lens is equivalent to 0.01 of the slide using the following equation:

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$$\text{Ocular unit}=\frac{\text{Number of the matched stage units} \times 0.01 \times 1000}{\text{Number of the matched ocular units}}$$

The sarcomere length was read and recorded after matching the number (0) of the ruler with the beginning of the tissue section prepared for reading to the end of the tissue section.

Statistical Analysis:

Data related to production traits, carcass specifications, color indices, cutting force, and sarcomere length were entered into Excel and analyzed using IBM SPSS Statistics for Windows 10, Version 29.0 (IBM Corp Armonk, NY, USA). The least significant difference (LSD) test was used to compare experimental treatments at a significance level of ($P \leq 0.05$).

IV. Results and Discussion

Productive Traits

Body Weight and Weight Gain

Table (1) shows a significant effect of stocking density ($P \leq 0.05$) on average body weight at 3 weeks of age and average weight gain during the period (0-3). Body weight and average weight gain decreased significantly ($P \leq 0.05$) for treatments T4, T3, and T2 compared to the control treatment (T1). However, body weights did not differ for all treatments at one day of age and 5 weeks of age, nor did weight gain rates during the periods (5-3) and (5-0) weeks. The reason for the decrease in the body weight rate at 3 weeks of age and the weight gain rate for the period (0-3) weeks for the density treatments T4, T3, T2 compared to the treatment (T1 control) may be due to the increase in the number of chicks per unit area (15, 13, 10) birds/m^2, which led to restriction of their movement and weakening of their ability, as well as their competition to reach the feeders during this early period of growth. The decrease in the body weight rate at 3 weeks of age and the weight gain rate for the period (0-3) weeks for the density treatments T4, T3, T2 was associated with the arithmetic decrease in the feed consumption rate compared to the control treatment (T1). These results are consistent with the findings of Erensoy et al., (2024), which showed a decrease in body weight rates of broiler chicks at 10 days of stocking. While the current results did not agree with the study of Shynkaruk et al., (2023) which showed no significant effect ($P \leq 0.05$) of the stocking density (14, 18, 20 birds/m2) on the body weights and weight gain rates for the period of (7-21) days in Ross 308 broiler chickens. The period of (3-5) weeks of broiler chicken stocking is considered a period of accelerated growth and muscle building, and competition between birds for feeders during this period leads to a reduction in the number of times heavy birds reach the feeders, and this behavior is associated with a decrease in the energy used by the bird in movement, which may lead to increased growth rates and increased body weights. Variation in body weight and weight gain across stocking densities is also influenced by careful daily handling of birds and the provision of appropriate management conditions, which is essential for improving production performance (Cengiz et al., 2015). Improved growth performance in broiler chickens may also be due to reduced intestinal permeability, indicating improved intestinal barrier function (Goo et al., 2019). The results of this study are consistent with Nogueira et al., (2013), which indicated no significant effect on growth rates in Ross broiler chickens reared at stocking densities of 10, 14, or 18 birds/m^2, while the results did not agree with those of Meena et al., (2022) when applying three stocking densities, 10, 8, and 12 birds/m^2, the highest body weight and weight gain rates were achieved at a density of 8 birds/m^2 compared to the other densities.

Table 1. Effect of stocking density on the average live body weight (g) and weight gain rate (g) of Ross 308 broiler chickens at different ages and weekly intervals.

Traits	Stocking Density Coefficients

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	Ages and Weekly Periods	1 Control	2	3	4	Significance Level
Live Body Weight	day age	4.30	2.38	3.56	1.47	.19
	weeks age	107.42^{a}	58.88^{b}	11.65^{b}	86.5^{b}	.004
	weeks age	148.15	171.75	146.56	083.68	.62
Weight Gain Rate	3-0)	053.12^{a}	06.5^{b}	58.09^{b}	35.03^{b}	.004
	5-3)	040.73	212.87	234.91	197.18	.14
	5-0)	093.85	119.37	093.0	032.21	.60

Different horizontal letters between treatments mean significant differences ($P\leq 0.05$). N.S: There are no significant differences between the treatments. T1: Control treatment 9 birds/m^2, T2: Density treatment (10 birds/m^2), T3: Density treatment (13 birds/m^2), T4: Density treatment (15 birds/m^2).

Feed Consumption and Feed Conversion Ratio:

Table (2) shows the results of the effect of stocking density on feed consumption (g) and feed conversion ratio (g feed consumed/g weight gain) for different Ross 308 broiler chicken treatments at the (3-0), (5-3), and (5-0) week intervals. Although there were no significant differences in feed consumption rates between treatments during the period (0-3) weeks, there was an arithmetic increase of 1498 g of feed consumed in treatment T1 (control) compared to the arithmetic decrease in feed consumption rate for treatments T4, T3, T2, which amounted to (1220.87, 1158.4, 1203.75) g, respectively. The results also indicate the presence of significant differences ($P\leq0.05$)) in the feed consumption rate during the periods (3-5) and (0-5) weeks, as feed consumption increased significantly ($P\leq0.05$)) for birds in treatment T1 (control) and treatment T2 during the period (3-5), while the feed consumption rate decreased significantly ($P\leq0.05$)) for birds in treatment T4. The birds of the two treatments T1 (control) and T2 were significantly superior in the rate of feed consumption ($P\leq0.05$) during the period (0-5) weeks compared to the decrease in feed consumption of the two treatments T3 and T4.

The results also indicate that there are no significant differences ($P\leq0.05$) between all density treatments in the feed conversion ratio during the period (0-3) weeks, while a significant decrease ($P\leq0.05$) is observed in the feed conversion ratio for treatments T4, T3, and T2 during the periods (0-5) and (3-5) weeks compared to treatment T1 (control). The results of the difference in feed consumption and feed conversion ratio may be due to the inability of birds to move freely and reach the feeders in the high density groups, which led to a decrease in feed consumption (Vargas et al., 2013). These results are consistent with the study by Yanai et al., (2018), which indicated the effect of stocking densities (10, 15, and 20 birds/m^2) on the feed consumption rate, as it decreased with increasing stocking density. On the other hand, the results of the study by Shynkaruk et al., (2023) showed significant differences in the feed consumption rate between low and high stocking density treatments, while the densities did not affect significantly on the feed conversion ratio during the period 0-34 days. The results of Karar et al., (2023) showed the negative effect of increasing the stocking density on the feed conversion ratio, as the stocking density (10 birds/m^2) showed the best feed conversion ratio at the ages of 4 and 5 weeks. Some researchers also reported that high stocking density causes a deterioration in the feed conversion ratio of the Ross 308 broiler chicken (Rambau et al., 2016 ; Ghanima et al., 2021;), while stocking density did not cause any difference in the feed conversion ratio of the Ross 308broiler hybrid at different stocking densities (Kim et al., 2021; Nasr et al., 2021). Table (2) and Figure (1) also indicate that the T3 stocking density treatment significantly ($p\leq0.05$) outperformed the production index as it reached 488.04 compared to the other treatments. This may be due to several factors, including flock size, bird density, and stress, which affect growth rate and feed consumption, which is reflected in the production index values (Esmail 2013). High production index values indicate a healthy flock, which positively impacts production performance (Bhamre et al., 2016). The current results are not consistent with the study of Kryeziu et al. (2018), as no

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significant differences (P≤0.05) were observed between the density treatments in the production index values. While (Gholami et al., 2020) reported that raising Ross broiler chickens at a density of 20 birds/m^2 led to a decrease in the European production index compared to flocks raised at densities of (10, 15 and 20 birds/m^2). On the other hand, (Ghosh et al., 2012) showed that raising at a high density is negatively related to the profit index and total revenues in broiler projects.

Table (2): Effect of stocking density on feed consumption rate (g) and feed conversion ratio (g feed/g weight gain) of the hybrid Ross 308 meat at different weekly intervals.

raits	ges an veekly periods	tocking Density 1 ontrol	 2	 3	 4	ignificance Level
eed Consumptior	3-0)	489	203.75	158.4	202.87	.15
	5-3)	787.85^a	2603.78	130.9^b	028.46^b	.0001
	5-0)	389.45^a	128.88^a	646.42^b	554.53^b	.001
eed Conversio atio	3-0)	.45	.33	.34	.44	.88
	5-3)	.73^a	.15^b	.72^c	.70^c	.0001
	5-0)	.62^a	.47^b	.26^c	.40^b	.014
roduction Index	5-0)	61.66^c	21.71^b	88.04^a	26.18^b	.015

Different horizontal letters between treatments mean significant differences (P≤ 0.05). N.S: There are no significant differences between the treatments. T1: Control treatment 9 birds/m^2, T2: Density treatment (10 birds/m^2), T3: Density treatment (13 birds/m^2), T4: Density treatment (15 birds/m^2).

Carcass Specifications

Table (3) show that treatment T3 significantly outperformed the average carcass weight (P≤0.05) compared to all other treatments. It is also evident that the treatments did not significantly differ (P≤0.05) in the weight of the breast and thigh portions, their proportions, the weight of the pectoralis major muscle, and the dressing percentage (%). This may be due to the potential effect of density on bird growth due to stress, which is more focused on growth rates than on tissue distribution in the body. Our results are consistent with the results of Henrique et al., (2017), which indicated a significant superiority in carcass weight for density treatments of 14, 12, and 10 birds/m² compared to the high density treatment (16 birds/m²), while the different densities had no significant effect on the relative weight of the breast and thigh (%). The results of the current study also agreed with the study of Kryeziu et al., (2018), which indicated that the stocking density had a significant effect on the average carcass weight, while it did not affect the dressing percentage.

While Astaneh et al., (2018) indicated that there was no significant effect of stocking density on carcass characteristics, it reported that stocking density did not significantly affect the weight of breast muscle segments and carcass quality. Lima et al., (2018) also showed, in their study on Ross 308 broiler chickens reared at two stocking densities (10 and 13 birds/m^2), no significant differences in the relative weight of the breast segment and the relative weight of the thigh segment. In the same context, Meena et al., (2022) indicated that the relative weights of the breast and thigh segments were not significantly affected by stocking densities of 8, 10, or 12 birds/m^2. The current results are consistent with the findings of Kaya and Dereli (2021), which showed a significant effect of stocking density on carcass weight gain when stocking at a density of 12 birds/m^2 compared to stocking densities of 15 and 18 birds/m^2. The results are not consistent with Gupta et al., (2017), which did not show a significant effect of stocking densities (8, 12, and 19 birds/m^2) on carcass weight gain. Elkolaly et al., (2019), when studying Ross 308 chickens, indicated a significant effect of stocking densities (10, 13, and 16 birds/m^2)

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on the dressing percentage (%). Studies have attributed the differences in carcass characteristics of broiler chickens to the genetic makeup of the strain (Skomorucha et al. 2009) and differences in experimental conditions (Ravindran et al., 2006).

Table 3. Effect of stocking density on average carcass weight (g), weights (g), their relative weight (%), large breast weight (g), their relative weight (%), and dressing percentage (%) for the hybrid Ross 308 meat at 5 weeks of age.

Carcass specifications	Stocking Density				Significance Level
	T1 control	T2	T3	T4	
Carcass weight (g)	1664.58^b	1612.08^b	1862.75^a	1697.08^b	0.02
Breast weight (g)	678.33	667.50	749.58	684.58	0.12
Thigh weight (g)	481.25	429.16	507.08	469.58	0.06
Pectoralis major muscle weight (g)	423.33	412.08	465.40	433.33	0.14
Relative weight of breast (%)	40.81	41.43	40.27	40.33	0.65
Relative weight of thigh (%)	28.87	26.68	27.14	27.61	0.28
Dressing percentage(%)	81.38	76.57	80.74	78.62	0.06

Different horizontal letters between treatments mean significant differences (P≤ 0.05). N.S: There are no significant differences between the treatments. T1: Control treatment 9 birds/m^2, T2: Density treatment (10 birds/m^2), T3: Density treatment (13 birds/m^2), T4: Density treatment (15 birds/m^2).

Color indices and cutting strength of breast meat slices:

Table (4) indicate no significant differences between experimental treatments in the values of breast muscle meat color indices (a*, b*, and L*). These results may be due to the lack of influence of stocking density on protein oxidation (Tong et al., 2012). The pigment myoglobin and its chemical state play a major role in determining meat color, and redness is related to its quantity and oxidative state (Mancini and Hunt 2005; Al-Hilphy et al., 2024). High stocking density has also been shown to cause oxidative stress in broiler chickens (Najafi et al., 2015). Stressful conditions such as high carbon dioxide concentrations and exposure to heat stress may also lead to increased L* luminosity values in chicken breast meat (Lu et al., 2017; Xu et al., 2018). In this study, stocking density up to15 birds/m^2 did not cause stress to the birds and thus did not lead to changes in muscle meat color indices.

High breast muscle meat color values are also often associated with muscle pathologies such as dull meat and tough meat (Cai et al., 2018). Our results are consistent with the findings of Simitzis et al., (2012) on Cobb700 chickens at two stocking densities (6, 13 birds/m^2), as bird density did not show a significant effect on muscle color traits. However, this study did not agree with the findings of Costa et al., (2021) when broiler chickens were raised at two stocking densities (24 birds/m^2 and 30 birds/m^2), as breast muscle meat color was not affected by stocking density. These results did not agree with the findings of Kaya and Fidan (2023), which showed a significant effect of stocking density on breast muscle meat color of Ross 308 chickens raised at three stocking densities (12, 15, 18) birds/m^2, the high density recorded higher values for the L* color index compared to the other densities.

Table (4): Effect of stocking density on color parameters, cutting force rate (N), and sarcomere length rate (μm) of the Ross 308 meat hybrid at 5 weeks of age.

	Traits	tocking Density				Significance Level
		1 ontrol	2	3	4	
olor dicator	* ightness	6.06	7.34	4.55	7.36	.9

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* Redness	6.48	5.85	4.14	6.31	).85
* Yellowness	8.05	5.98	4.23	8.3	).6
Shear force	↓.25	↓.49	;.27	↓.20	).32
Sarcomere length	.68^{c}	.82^{b}	.90^{b}	:.15^{a}	).005

Different horizontal letters between treatments mean significant differences (P≤ 0.05). N.S: There are no significant differences between the treatments. T1: Control treatment 9 birds/m^2, T2: Density treatment (10 birds/m^2), T3: Density treatment (13 birds/m^2), T4: Density treatment (15 birds/m^2).

The results of Table (4) showed no significant differences in the cutting force of large breast muscle steaks between the experimental treatments. Tenderness, which represents the ease of chewing or cutting meat, is considered the most important factor for consumers. The results of Table (4) showed no significant differences in the cutting force of large breast muscle steaks between the experimental treatments. These results are consistent with the findings of Henrique et al., (2017) conducted on Cobb500 broiler chickens at stocking densities of 10, 12, 14, and 16 birds/m^2, which indicated no significant differences in the cutting force values in the breast muscle of broiler chickens. While the results were not consistent with the study of Patria et al., (2016) conducted on Kampong chickens at three stocking densities (8, 10, 12 birds/m^2), the two densities (10 and 12 birds/m^2) showed a decrease in breast meat tenderness compared to the stocking density of 8 birds/m^2.

This variability in cutting force values may be attributed to the influence of several factors, including differences in the chemical properties of meat, whether fresh or frozen, as well as the condition of the meat before and after cooking (Tasoniero et al., 2016). Additionally, variability in cutting force measurement methods can lead to inconsistent readings (Bowker and Zhuang 2019). Furthermore, histological changes in muscle fibers and connective tissue accumulation may play a role in determining cutting force (Soglia et al., 2015; Aguirre et al., 2018). On the other hand, increased intramuscular fat content may adversely affect meat tenderness (Skřivanova et al., 2017). The results of Table (4) show significant differences in the average sarcomere length, as the average sarcomere length in chicken breast muscles ranged between 1.67 and 2.15 µm for treatments T1 and T4, respectively. While both density treatments T2 and T3 recorded similar length values, reaching 1.82 and 1.90 µm, respectively.

Stocking densities may affect muscle fiber structure, leading to muscle hypertrophy and, consequently, increased sarcomere length. Variation in sarcomere length may also be due to increased collagen content in the muscles or to necrosis, which may affect muscle fiber structure after slaughter (Tijare et al., 2016). In a study conducted to investigate the effect of scleroderma on the sarcomere structure of Ross508 broiler chickens, Soglia et al., (2020) observed a 13% difference in sarcomere length in steaks affected by myopathy compared to unaffected steaks, ranging from 1.91 to 1.69 µm, respectively. On the other hand, a study conducted on Ross 308 broiler chickens by Liu et al., (2020) showed no significant effect of myopathy on sarcomere length between normal breast meat and breast meat affected by scleroderma. Puolanne et al., (2021) study, which aimed to identify the effect of pectoralis major muscle sclerosis on the sarcomere length of Ross 308 broiler chickens, found an increase in the sarcomere length in the affected samples compared to the normal samples, reaching (1.93) and (1.88) µm, respectively.

Conclusions

The results showed that increasing stocking density to 15 birds/m² did not affect body weight or weight gain, while feed consumption and feed conversion ratio were affected by different density levels. Furthermore, color indices and cutting

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force were not significantly affected, while sarcomere length was affected by increasing stocking density to 15 birds/m². Broiler producers are recommended to increase stocking density to 15 birds/m² without any negative impact on bird performance.

V. Reference

Abdelgaber, A A Mohammed, A A Mahmoud, U T and Darwish, M H 2023 Effect of stocking density on broiler behavior and welfare indices. Assiut. Veterinary Medical Journal, 69(179), 1-13.

Adeyemo, G., Fashola, O., & Ademulegun, T. (2016). Effect of stocking density on the performance, carcass yield and meat composition of broiler chickens. *British Biotechnology Journal*, *14*(1), 1-7.

Aguirre, M. E., Owens, C. M., Miller, R. K., & Alvarado, C. Z. (2018). Descriptive sensory and instrumental texture profile analysis of woody breast in marinated chicken. *Poultry science*, *97*(4), 1456-1461.

Ahmad, R., Yu, Y. H., Hsiao, F. S. H., Su, C. H., Liu, H. C., Tobin, I., ... & Cheng, Y. H. (2022). Influence of heat stress on poultry growth performance, intestinal inflammation, and immune function and potential mitigation by probiotics. *Animals*, *12*(17), 2297.

Al-Hilphy, A. R., Al-Asadi, M. H., Khalaf, J. H., & Khaneghah, A. M. (2024). A Comprehensive Review of Modified Atmosphere Packaging for Poultry Meat: Effects on the Qualitative Characteristics and Shelf-Life Stability. *Basrah Journal of Agricultural Sciences*, *37*(1), 303-340.

Al-Hilphy, A. R., Ali, H. I., Al-IEssa, S. A., Lorenzo, J. M., Barba, F. J., & Gavahian, M. (2021). Refractance window (RW) concentration of milk-Part II: Computer vision approach for optimizing microbial and sensory qualities. *Journal of Food Processing and Preservation*, *45*(9), e15702.

Astaneh, I. Y., Chamani, M., Mousavi, S. N., Sadeghi, A. A., & Afshar, M. A. (2018). Effects of stocking density on performance and immunity in Ross 308 broiler chickens. *Kafkas Üniversitesi Veteriner Fakültesi Dergisi*, *24*(4).

Bhamre, K. S. (2016). Nutritive evaluation of cashew apple waste in broilers. Intern. J. Sci. Nat. 7, 629 632.

Bowker, B., & Zhuang, H. (2019). Detection of razor shear force differences in broiler breast meat due to the woody breast condition depends on measurement technique and meat state. *Poultry Science*, *98*(11), 6170-6176.

Cai, K., Shao, W., Chen, X., Campbell, Y. L., Nair, M. N., Suman, S. P., ... & Schilling, M. W. (2018). Meat quality traits and proteome profile of woody broiler breast (pectoralis major) meat. *Poultry science*, *97*(1), 337-346.

Cengiz, Ö., Köksal, B. H., Tatlı, O., Sevim, Ö., Ahsan, U., Üner, A. G., ... & Önol, A. G. (2015). Effect of dietary probiotic and high stocking density on the performance, carcass yield, gut microflora, and stress indicators of broilers. *Poultry science*, *94*(10), 2395-2403.

Chegini, S., Kiani, A., Parizadian Kavan, B., & Rokni, H. (2019). Effects of propolis and stocking density on growth performance, nutrient digestibility, and immune system of heat-stressed broilers. *Italian Journal of Animal Science*, *18*(1), 868-876.

Costa, H. D. A., Vaz, R. G. M. V., Silva, M. C. D., Rodrigues, K. F., Sousa, L. F., Bezerra, L. D. S., ... & Oliveira, M. F. D. (2021). Performance and meat quality of broiler chickens reared on two different litter materials and at two stocking densities. *British Poultry Science*, *62*(3), 396-403.

Elkolaly, A. M., El-Sayiad, G. A., Mahrose, K. M., & Ismail, I. E. (2019). Growth performance, some blood components, carcass traits and intestine histology of broiler chicks as affected by stocking density. *Zagazig Journal of Agricultural Research*, *46*(4), 1213-1222.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 671-683

https://iasj.rdd.edu.iq/journals/journal/issue/18682 *https://doi.org/10.54174/utjagr.v13i1.323*

Erensoy, K., Sarıca, M., Noubandiguim, M., & Karaçay, N. (2024). The effects of varying stocking densities during the first 10 days on the performance, welfare, slaughter and meat quality characteristics of broiler chickens in the subsequent period. *Tropical Animal Health and Production*, *56*(8), 286.

Esmail, S. H. (2013). Factors affecting feed intake of chickens. World Poultry 29:15-17.

Ghanima, M. M. A., Swelum, A. A., Shukry, M., Ibrahim, S. A., Abd El-Hack, M. E., Khafaga, A. F., ... & Younis, M. E. (2021). Impacts of tea tree or lemongrass essential oils supplementation on growth, immunity, carcass traits, and blood biochemical parameters of broilers reared under different stocking densities. *Poultry science*, *100*(11), 101443.

Ghosh, S Majumder, D and Goswami, R 2012 Broiler performance at different stocking density. Indian journal of animal research, 46(4), 381-384.

Gholami, M., Chamani, M., Seidavi, A., Sadeghi, A. A., & Aminafschar, M. (2020). Effects of stocking density and climate region on performance, immunity, carcass characteristics, blood constitutes, and economical parameters of broiler chickens. *Revista Brasileira de Zootecnia*, *49*, e20190049.

Goo, D., Kim, J. H., Choi, H. S., Park, G. H., Han, G. P., & Kil, D. Y. (2019). Effect of stocking density and sex on growth performance, meat quality, and intestinal barrier function in broiler chickens. *Poultry science*, *98*(3), 1153-1160.

Gupta, S. K., Behera, K., Pradhan, C. R., Acharya, A. P., Sethy, K., Behera, D., ... & Shinde, K. P. (2017). Influence of stocking density on the performance, carcass characteristics, hemato-biochemical indices of Vanaraja chickens. *Indian Journal of Animal Research*, *51*(5), 939-943.

Henrique, C., Oliveira, A. F. G., Ferreira, T. S., Silva, E. S., de Mello, B. F. F. R., de Freitas Andrade, A., ... & Bruno, L. D. G. (2017). Effect of stocking density on performance, carcass yield, productivity, and bone development in broiler chickens Cobb 500®. Semina: Ciências Agrárias, 38(4), 2705-2717.

Ibrahim, R. R., Khalil, F., Mostafa, A. S., & Emeash, H. H. (2018). Effects of probiotic on comfort and body care behaviors of broilers reared at different stocking densities. *Journal of Advanced Veterinary Research*, *8*(3), 60-65.

Ikusika, O. O., Falowo, A. B., Mpendulo, C. T., Zindove, T. J., & Okoh, A. I. (2020). Effect of strain, sex and slaughter weight on growth performance, carcass yield and quality of broiler meat. *Open Agriculture*, *5*(1), 607-616.

Karar, E M H Atta, A R M M Gharib, H B A and El, M A R A H 2023 Impact of prebiotic supplementation on productive performance, carcass traits, and physiological parameters of broiler chickens under high stocking density condition. Journal of World's Poultry Research, 13(1), 48-60.

Kaya, M., & Fidan, E. D. (2021). The effect of drinking water temperature and stocking density on some welfare parameters of broilers reared at high ambient temperature.

Kaya, M., & Fidan, E. D. (2023). The effect of drinking water temperature and stocking density on broiler performance, meat quality and some behavioral traits at high ambient temperature. *Journal of the Hellenic Veterinary Medical Society*, *74*(1), 5315-5324.

Kim, H. J., Jeon, J. J., Kim, H. S., Son, J., Kim, K. Y., You, A. S., ... & Kang, H. K. (2021). Effects of stocking density on the growth performance, immune status and breast meat quality of broiler. *Korean Journal of Poultry Science*, *48*(1), 13-22.

Kryeziu, A J Kamberi, M Muji, S Mestani, N and Berisha, S 2018 Carcass traits of broilers as affected by different stocking density and sex. Bulgarian Journal of Agricultural Science, 24(6).

Lima, R. C., Freitas, E. R., Gomes, H. M., Cruz, C. E. B., & Fernandes, D. R. (2018). Performance of broiler chickens reared at two stocking densities and coir litter with different height. *Revista Ciência Agronômica*, *49*(3), 519-528.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 671-683
https://iasj.rdd.edu.iq/journals/journal/issue/18682 https://doi.org/10.54174/utjagr.v13i1.323
Liu, J., Puolanne, E., Schwartzkopf, M., & Arner, A. (2020). Altered sarcomeric structure and function in woody breast myopathy of avian pectoralis major muscle. *Frontiers in physiology*, *11*, 287.

Lu, Z., He, X., Ma, B., Zhang, L., Li, J., Jiang, Y., ... & Gao, F. (2017). Chronic heat stress impairs the quality of breast-muscle meat in broilers by affecting redox status and energy-substance metabolism. *Journal of agricultural and food chemistry*, *65*(51), 11251-11258.

Mahrose, K. M., ELHACK, M. E., Mahgoub, S. A., & Attia, F. A. (2019). Influences of stocking density and dietary probiotic supplementation on growing Japanese quail performance. *Anais da Academia Brasileira de Ciências*, *91*, e20180616.

Mancini, R. A., & Hunt, M. (2005). Current research in meat color. *Meat science*, *71*(1), 100-121.

Meena, N. N., Waiz, H. A., Chavhan, D. M., & Tosawada, K. (2022). Impact of stocking density on broiler chicken performance, blood biochemisty, and carcass attributes in an intensive rearing system. *Iranian Journal of Applied Animal Science*, *12*(4), 803-812.

Mir, N. A., Rafiq, A., Kumar, F., Singh, V., & Shukla, V. (2017). Determinants of broiler chicken meat quality and factors affecting them: a review. *Journal of food science and technology*, *54*, 2997-3009.

Najafi, P., Zulkifli, I., Amat Jajuli, N., Farjam, A. S., Ramiah, S. K., Amir, A. A., ... & Eckersall, D. (2015). Environmental temperature and stocking density effects on acute phase proteins, heat shock protein 70, circulating corticosterone and performance in broiler chickens. *International Journal of Biometeorology*, *59*, 1577-1583.

Nasr, M. A., Alkhedaide, A. Q., Ramadan, A. A., Hafez, A. E. S. E., & Hussein, M. A. (2021). Potential impact of stocking density on growth, carcass traits, indicators of biochemical and oxidative stress and meat quality of different broiler breeds. *Poultry science*, *100*(11), 101442.

Nogueira, W. C. L., Velásquez, P. A. T., Furlan, R. L., & Macari, M. (2013). Effect of dietary energy and stocking density on the performance and sensible heat loss of broilers reared under tropical winter conditions. *Brazilian Journal of Poultry Science*, *15*, 53-57.

Patria, C. A., Afnan, R., & Arief, I. I. (2016). Physical and microbiological qualities of kampong-broiler crossbred chickens meat raised in different stocking densities. *Media Peternakan*, *39*(3), 141-147.

Rambau, M. D., Mudau, M. L., Makhanya, S. D., & Benyi, K. (2016). Effects of stocking density and daily feed withdrawal periods on the performance of broiler chickens in a semi-arid environment. *Tropical animal health and production*, *48*, 1547-1554.

Ravindran, V., Thomas, D. V., Thomas, D. G., & Morel, P. C. (2006). Performance and welfare of broilers as affected by stocking density and zinc bacitracin supplementation. *Animal Science Journal*, *77*(1), 110-116.

Shirshaab, A. J., & Jassim, J. M. (2021). Effect of Adding Different Levels of Portulaca oleracea L. Seeds and Leaves Powder to The Diet on Productive and Physiological Performance of Broiler Chickens (Ross 308). *Basrah Journal of Agricultural Sciences*, *34*(1), 38-48.

Shynkaruk, T., Long, K., LeBlanc, C., & Schwean-Lardner, K. (2023). Impact of stocking density on the welfare and productivity of broiler chickens reared to 34 d of age. *Journal of Applied Poultry Research*, *32*(2), 100344.

Siaga, R., Baloyi, J. J., Rambau, M. D., & Benyi, K. (2017). Effects of stocking density and genotype on the growth performance of male and female broiler chickens. *Asian J. Poult. Sci*, *11*(2), 96-104.

Silas, A. F., Ayorinde, A. O., Daisy, E., Mark, S. O., Bolanle, O. O., & Nwakaegh, E. G. (2014). Effect of stocking density and quantitative feed restriction on growth performance, digestibility, haematological characteristics and cost of starting broiler chicks. *J. Anim. Health Prod*, *2*(4), 60-64.

Skomorucha, I., Muchacka, R., Sosnówka-Czajka, E., & Herbut, E. (2009). Response of broiler chickens from three genetic groups to different stocking densities. *Annals of Animal Science*, *9*(2), 175-184.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 671-683

https://iasj.rdd.edu.iq/journals/journal/issue/18682 https://doi.org/10.54174/utjagr.v13i1.323

Simitzis, P E Kalogeraki, E Goliomytis, M Charismiadou, M A Triantaphyllopoulos, K

Skomorucha, I Muchacka, R Sosnówka-Czajka, E and Herbut, E 2009 Response of broiler chickens from three genetic groups to different stocking densities. Annals of Animal Science, 9(2), 175-184.

Skřivanová, V., Tůmová, E., Englmaierová, M., Chodová, D., & Skřivan, M. (2017). Do rearing system and free-range stocking density affect meat quality of chickens fed feed mixture with rapeseed oil? Original Paper. *Czech Journal of Animal Science*, *62*(4).

Soglia, F., Petracci, M., & Puolanne, E. (2020). Sarcomere lengths in wooden breast broiler chickens. *Italian Journal of Animal Science*, *19*(1), 569-573.

Son, J., Kim, H. J., Hong, E. C., & Kang, H. K. (2022). Effects of stocking density on growth performance, antioxidant status, and meat quality of finisher broiler chickens under high temperature. *Antioxidants*, *11*(5), 871.

Sujiwo, J., Kim, D., & Jang, A. (2018). Relation among quality traits of chicken breast meat during cold storage: correlations between freshness traits and torrymeter values. *Poultry science*, *97*(8), 2887-2894.

Tasoniero, G., Cullere, M., Cecchinato, M., Puolanne, E., & Dalle Zotte, A. (2016). Technological quality, mineral profile, and sensory attributes of broiler chicken breasts affected by White Striping and Wooden Breast myopathies. *Poultry science*, *95*(11), 2707-2714.

Thema, K. K., Mnisi, C. M., & Mlambo, V. (2022). Stocking density-induced changes in growth performance, blood parameters, meat quality traits, and welfare of broiler chickens reared under semi-arid subtropical conditions. *Plos one*, *17*(10), e0275811.

Tijare, V. V., Yang, F. L., Kuttappan, V. A., Alvarado, C. Z., Coon, C. N., & Owens, C. M. (2016). Meat quality of broiler breast fillets with white striping and woody breast muscle myopathies. *Poultry Science*, *95*(9), 2167-2173.

Tong, H. B., Lu, J., Zou, J. M., Wang, Q., & Shi, S. R. (2012). Effects of stocking density on growth performance, carcass yield, and immune status of a local chicken breed. *Poultry science*, *91*(3), 667-673.

Vargas-Rodriguez, L. M., Duran-Melendez, L. A., Garcia-Masias, J. A., Arcos-Garcia, J. L., Joaquin-Torres, B. M., & Ruelas-Inzunza, M. G. (2013). Effect of probiotic and population density on the growth performance and carcass characteristics in broiler chickens. *Int. J. Poult. Sci*, *12*, 390-395.

Xiong, X., Yang, Y., Jiang, X., Yu, C., Peng, H., Chen, J., ... & Yang, C. (2020). Effects of stocking density on performance, egg quality, reproductive hormones, and antioxidant capacity in egg-laying ducks. *Journal of Applied Animal Research*, *48*(1), 454-459.

Xu, L., Zhang, Y., Wang, Z., Li, G., & Yu, S. (2018). Comparison of combined laparoscopic ureterolithotomy and flexible ureteroscopy with percutaneous nephrolithotomy for removing large impacted upper ureteral stones with concurrent renal stones. *Laparoscopic, Endoscopic and Robotic Surgery*, *1*(2), 37-41.

Yam, K. L., & Papadakis, S. E. (2004). A simple digital imaging method for measuring and analyzing color of food surfaces. *Journal of food engineering*, *61*(1), 137-142.

Yanai, T., Abo-Samaha, M. I., El-Kazaz, S. E., & Tohamy, H. G. (2018). Effect of stocking density on productive performance, behaviour, and histopathology of the lymphoid organs in broiler chickens. *European Poultry Science/Archiv für Geflügelkunde*, *82*(247).

Yu, D. G., Namgung, N., Kim, J. H., Won, S. Y., Choi, W. J., & Kil, D. Y. (2021). Effects of stocking density and dietary vitamin C on performance, meat quality, intestinal permeability, and stress indicators in broiler chickens. *Journal of animal science and technology*, *63*(4), 815.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 671-683

https://iasj.rdd.edu.iq/journals/journal/issue/18682 *https://doi.org/10.54174/utjagr.v13i1.323*

Zabir, M., Miah, M. A., Alam, M., Bhuiyan, M. E. J., Haque, M. I., Sujan, K. M., & Mustari, A. (2021). Impacts of stocking density rates on welfare, growth, and hemato-biochemical profile in broiler chickens. *Journal of Advanced Veterinary and Animal Research*, *8*(4), 642.