EFFECT OF STOCKING DENSITY ON PERFORMANCE OF BROILER CHICKENS

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ABSTRACT
A study was conducted to investigate the effect of stocking density on growth performance of broiler chickens reared at five stocking densities (i.e., 10, 12, 14, 16 and 18 birds/m^2) up to 35 days of age in an open-sided house at the University farm. A total of 180 Ross 308 broiler chicks were obtained from a commercial hatchery and raised together on deep litter for 35 days. At 2 weeks of age birds were randomly assigned to five stocking densities in a Completely Randomized Design (CRD) experiment. Each treatment group of birds was replicated four times and kept in pens measuring 1 m × 1 m. Parameters studied were body weight (BW), body weight gain (BWG), feed intake, feed conversion ratio (FCR) and mortality rate. Results showed that generally BW, BWG and feed intake were significantly (P<0.05) influenced by stocking density while mortality and FCR were not affected. Higher BW, BWG and feed intake values were found for birds reared at 10 and 12 birds/m^2, indicating that these stocking densities gave desirable results. These results indicate that increasing the stock density beyond 12 birds/m^{2}has negative effects on the growth performance of commercial broiler chickens.

Key words: Body weight, broilers, feed conversion ratio, feed intake, stocking density

INTRODUCTION

Stocking density is one of the factors mostly considered in the broiler industry when dealing with the welfare of birds, broiler performance, uniformity and product quality (Ranvindranet al., 2006). According to Dozier et al. (2005), stocking density is the number of birds per unit area. Stocking density may also be defined as weight per floor surface area (Berg and Yngvesson, 2012). Nowadays, broilers are reared to target high body weight (BW) and as such the meaning of stocking density has been developed to be defined as mass per unit of space (Dozier et al.,2005). Overstocking elevates the environmental pressures on the broilers, thus compromising their welfare and reducing efficiency within the company (Toplu, 2011).

High stocking density has a negative impact on the well-being of poultry such as foot pad lesions (Dozier et al., 2005). Occurrence of foot pad lesions, breast and hock lesions are associated with wet litter which results from high stocking densities (Azum and Toplu, 2013). The negative effects of high stocking density include depressed feed intake, BW (Estevez, 2007; Azum and Toplu, 2013), deterioration of feed conversion ratio (FCR), and greater incidences of foot dermatitis, scratches, bruising, poorer feathering, carcass condemnations and high mortalities related to heat stress (Estevez, 2007). Increased stocking densityleads to reduction in space use, decreased movement of broilers and high incidences of disturbances which might lead to chickens having scratches and a decline in carcass quality (Dozier et al., 2005). It also decreases breast muscle as the birds are crowded and unable to grow to their full potential.

Most people are shifting from eating red meat to eating white meat because of health concerns giving rise to increased demand of white meat. Due to increased demand of broiler meat, poultry farmers tend to increase stocking density with the aim of increasing profits. There is limited information on stocking density for broilers in Botswana; hence the need for this study. The objective of this study was to investigate the effect of stocking density (i.e., 10, 12, 14, 16 and 18 birds/m^2) on growth performance of broilers reared up to 35 days of age in an open-sided house.The research hypothesis that stocking density will improve performance of broiler chickens was tested.

MATERIALS AND METHODS

Study site

The study was carried out at the Guinea Fowl Unit of the Botswana University of Agriculture and Natural Resources (BUAN), Content Farm, Sebele, Gaborone from February to March 2016, i.e., autumn. The BUAN is situated at 24º 33 S, 24º 54 E at an altitude of 994 m above sea level (Aganga and Omphile 2000). The ambient temperature during the study period averaged 28.0°C and ranged from 16.2 to 36 °C.

Experimental design

A total of 300 one-day-old Ross 308 broiler chicks were obtained from a commercial hatchery and used in this experiment. Chicks were brooded for 14 days in an electrically heated deep litter house. At 2 weeks of age, birds were randomly assigned to five stocking densities (i.e., 10, 12, 14, 16, and 18 birds/m^2) in a Completely Randomized Design experiment. Each treatment group of birds was replicated 4 times and raised in pens measuring 1m × 1m.

Bird management and parameters measured

Chicks were fed commercial broiler diets in accordance with industry practice.Broiler pre-starter diet was fed from 0-9 days, broiler starter (10-19 days), broiler grower diet (20-28 days) and broiler finisher diet from 28 to 35 days. Feed and water were provided *ad libitum* throughout the study.Parameters measured included BW, body weight gain (BWG), feed intake, FCR and mortality rate. Mortality was recorded as it occurred while other parameters were measured on weekly basis.Birds were vaccinated against Newcastle disease, infectious bronchitis and infectious bursal disease (IBD) at one-day-old, 10 days and 21 days, respectively. Vaccines were administered orally via water.

Chicks were weighed at day 1 using electronic scale with a precision of 0.0001, and their BW recorded. The first BW values were used to determine coefficient of variation (CV) between birds using the following formula: Standard deviation (g)/average body weight (g) x100 (Cobb-Vantress 2011). Thereafter, an average BW of five chickens from each replicate was taken on a weekly basis. Birds were weighed in the morning when their crops were empty. Data on feed intake were obtained by the difference between the quantity of feed offered and the quantity left after seven days. Feed conversion ratio was computed as total feed divided by total BWG (Ratsakaet al., 2012). Mortality was calculated as the ratio between the number of the dying birds and the initial total number of birds in the flock multiplied by 100 (Gabanakgosiet al., 2014).

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using Statistical Analysis Software system (SAS) appropriate for the CompletelyRandomized Design. The statistical model, $Y_{ij} = \mu + a_i + \varepsilon_{ij}$ was used to evaluate the effect of stocking density on feed intake, BW, BWG and FCR. Where;

Yij= the response variables from each individual pen.

μ = the overall mean.

a_i = treatment (density).

ε_{ij} = the experimental unit error (replication). The experimental error was used to test the effects of stocking density (Azum and Toplu,2013).

Treatment means were separated using Duncan's multiple range test.

RESULTS AND DISCUSSION

Body weight

The means and standard errors of performance parameters such as BW, BWG, feed intake, FCR and mortality rate of broiler chickens are presented in Table 1. Stocking density had no (P>0.05) effect on BW of chickens reared at 10 and 12 birds/m^2 at 2 weeks of age. However, at 5 weeks of age BW of birds on stocking densities of 10 birds/m^{2}was significantly (P<0.05) higher than other treatments (Table 1).During the same period, BW of birds on 10, 12 and 18 birds/m^2 was significantly different from each other, whereas BW of birds reared at stocking densities of 14, 16 and 18 was not significantly (P>0.05) different. In agreement with the present results, Azum and Toplu (2013) reported decreased BW of chickens due to increased stocking density (i.e., 18 birds/m^2). The authors attributed the decrease in BW to heat stress, the main factor of growth depression in cases of high stocking density. Similarly, Ali Abouelenienet al. (2016) reared broilers at four stocking densities and reported that birds raised at stocking density of 10 and 14 birds/m^2 had significantly higher BW than those reared at stocking density of 17 and 20 birds / m^2.Similarly, Kim and Kang (2020) investigated the effects of five stocking densities (14, 15, 16, 18, and 22 birds/m^2) on performance of Korean native chickens and found that increasing stock density to 22 birds/m^2 had some negative effects on the growth performance and meat quality.According to Feddeset al. (2002), an increase in stocking density results in decreased BW as birds are more crowded and unable to grow to their full potential. In disagreement with the current results, El-Deek and Ai-Harthi (2004), Tayeb et al. (2011) and Gupta et al. (2017) found no significant effect of stocking density on BW of broiler chickens.

Body weight gain

Body weight gain of birds was not affected (P>0.05)by different stocking densities at 2 weeks of age probably because during this period birds were still young and hence had enough space and increased movement compared to the later stages of growth. Nahashonet al. (2011) observed that at early age (1-2 weeks of age), birds reared at floor densities of 18 and 15.6birds/m^{2}exhibited significantly higher (P < 0.05) BWG than those reared at 13.6 and 12 birds/m^2, however, as the birds grew older (5-8 weeks of age) the BW of birds reared at 13.6 and 12 birds/m^{2}was higher. In this study, BWG of birds on stocking densities of 16 and 18 birds/m^2 at 3 weeks of age was not significantly (P>0.05) different. However, birds on stocking density of 18 birds/m^2 had significantly (P<0.05) lower BWG compared to those reared at stocking densities of 10, 12 and 14 birds/m^2. The higher BWG of birds at these floor densities could be ascribed to increased feed intake. Again, at 5 weeks of age birds reared at 10 birds/m^2 had significantly (P<0.05) higher BWG compared to other stocking densities. This finding corroborates with the finding ofGabanakgosiet al. (2014) who observed that family chickens reared at the stocking density of 13 birds/m^2 had higher BWG compared to those reared at 17 birds/m^2. It is evident from Table 1 that BWG decreased as stocking density increased from 3 to 5 weeks of age. Dozier et al. (2005) stated that the depression in BWG due to stocking density was related to a reduction in feed intake. It is argued (Škrbićet al., 2020) that high stocking densities has negative effects not only on production performances and quality parameters, but also on indicators of broiler health and welfare.However, Tong et al. (2012) observed no difference in daily weight gain even though there was reduction in feed intake due to increased stocking density.

Feed intake

At 2 weeks of age, birds reared at stocking densities of 10 and 12 birds/m^2 consumed significantly (P<0.05) more feed than other treatments. However, feed intake for birds on stocking densities of 14, 16 and 18 birds/m^2 during the same period was not significantly (P>0.05) different. Feed intake of birds reared at stocking densities of 10, 12, 16 and 18 birds/m^2 was significantly (P<0.05) different from each other at 3 weeks of age. However, feed intake of birds on 10 and 14 birds/m^2 during the same period was not significantly (P>0.05) different. At 4 weeks of age, feed intake of birds reared at 10 birds/m^2 was significantly (P<0.05) higher than those reared at 18 birds/m^2. However, feed intake of birds reared at 10 and 12 birds/m^2 was not significantly (P<0.05) different during the same period. Birds reared at 10 birds/m^2 consumed significantly (P<0.05) higher amount of feed while birds on the highest stocking density (i.e., 18 birds/m^2) consumed the least amount of feed. Birds on 18 birds/m^2 consumed less feed due to limited physical access to feeders and drinkers, and competition between birds. In line with the present results, Beget al. (2011) and Abudaboset al. (2013) observed that feed intake declines with increasing stocking density. Similarly, Tong et al. (2012) found that feed intake decreased drastically when stocking density increased from 25 birds/m^2 to 35 birds/m^2 and 45 birds/m^2, respectively. In the present study, from3 to 5 weeks of age, feed intake of birds reared at 10 and 12 birds/m^2 was not significantly (P>0.05) affected by stocking density, indicating that birds efficiently utilized feed at these stocking densities.

Feed conversion ratio

The FCR of birds reared at 10/m^2 and 14/m^2 stocking densities were significantly (P<0.05) different at 2 weeks of age (Table 1). However, FCR for birds on stocking densities of 12, 14, 16 and 18 was not significantly different from each other. From 3 to 5 weeks of age stocking density had no significant influence on FCR. In line with the current results, Feddeset al. (2002) and Abudaboset al. (2013) found no influence of stocking density on FCR. Similarly, Tayebet al. (2011) reported that FCR was not significantly affected by different stocking densities. However, Beget al. (2011) found that birds reared at lower stocking density (8 and 10 bird/m^2) had high average FCR values compared to those reared at high stocking densities (12 and 14 bird/m^2). On the contrary, Nahashonet al. (2009) indicated that FCR was adversely affected by increasing stocking densities of broilers at 35 days of age. In disagreement with the current result, Dozier et al. (2005) and Lalloet al. (2012) reported that high stocking density gives better FCR.

Mortality

Stocking density had no influence on mortality (Table 1). In agreement with this result, Beget al. (2011) found no effect of different stocking densities (i.e., 8, 10, 12, 14 birds/m^2) on mortality of broiler chickens. Similarly, Feddeset al. (2002), Gabanakgosiet al. (2014) and Gupta et al. (2017) found no significant effect of stocking density on mortality of broiler and family chickens, respectively. Similarly, Buijset al. (2009) also investigated the effects of different stocking densities (i.e., 6, 15, 23, 33, 35, 41, 47, and 56 kg BW/m^2) on broiler welfare and found no influence of stocking density on mortality. Škrbićet al. (2009) argued that it is possible that in conditions of high stocking density mass hysterical behaviour of chickens occurs with harmful effects on their vitality, which is does not occur in experimental conditions.In disagreement with the present results, Tayeb et al. (2011) investigated the effect of stocking density on broiler performance and reported that birds stocked at density of 8.66 birds/m^2 showed the lowest percentage of mortality compared to birds on stocking densities of 10.41 and 13.36 birds/m^2. This indicates that stocking density has influence on mortality.

CONCLUSION

Birds reared at lower stocking densities (i.e., 10 and 12 birds/m^2) had the highest BW compared to other treatments. Also, birds reared at 10 birds/m^2 gained more BW than those reared at 18 birds/m^2. Feed conversion ratio and mortality were not affected by stocking density. Further studies on the effect stocking density on broiler performance should be conducted in summer and winter.

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Table 1: Means and standard errors of performance parameters of broilers reared at varying stocking densities from week 2 to 5 weeks of age

Parameters	**Density**	**Age in weeks**			
	(birds/m^2)	**2**	**3**	**4**	**5**
Body weight, g	10	347.91±5.68^a	688.45±8.03^a	1285.64±13.23^a	1944.35±79.77^a
	12	341.66±6.38^a	685.58±8.63^a	1239.20±45.83^a	1697.70±34.49^b
	14	354.02±10.18^a	687.90±29.30^a	1150.71±37.66^{ab}	1542.26±29.05^{bc}
	16	346.30±11.01^a	646.68±5.63^a	1171.78±55.93^{ab}	1545.24±73.73^{bc}
	18	357.58±15.87^a	637.55±13.97^a	1048.41±46.35^b	1417.75±64.19^c
Body weight gain, g	10	58.84±4.52^a	340.54±11.20^{ab}	597.19±15.12^a	658.71±70.50^a
	12	74.46±14.34^a	343.92±10.53^a	553.62±41.42^{ab}	458.58±35.27^b
	14	95.45±12.82^a	333.88±20.23^{ab}	462.81±31.66^{bc}	391.55±62.04^b
	16	86.63±22.40^a	300.39±13.67^{cb}	525.10±55.80^{abc}	373.46±39.25^b
	18	88.45±26.20^a	279.97±7.60^c	410.86±46.31^c	369.34±44.37^b
Feed intake, g	10	344.59±19.63^a	350.37±9.83^a	908.30±31.66^a	1009.81±65.96^a
	12	281.81±14.51^a	309.32±14.53^{bc}	836.93±37.53^{ab}	751.08±226.79^{ab}
	14	179.98±32.30^b	327.49±2.61^{ab}	760.91±24.24^{bc}	823.37±15.71^{ab}
	16	208.20±23.42^b	299.10±5.22^{cd}	706.08±18.91^{cd}	731.55±5.72^{ab}
	18	192.12±7.91^b	277.78±0.00^d	664.88±1.80^d	628.32±33.05^b
Feed conversion ratio	10	6.035±0.78^a	1.0325±0.04^a	1.5250±0.08^a	1.5700±0.14^a
	12	4.203±0.75^{ab}	0.9025±0.05^a	1.5275±0.09^a	1.7525±0.55^a
	14	1.965±0.43^b	0.9925±0.06^a	1.6650±0.12^a	2.2450±0.30^a
	16	3.225±1.26^{ab}	1.0025±0.06^a	1.3975±0.16^a	2.0225±0.20^a
	18	3.388±1.57^{ab}	0.9925±0.03^a	1.7000±0.24^a	1.7750±0.23^a
Mortality, %	10	0.2500±0.25^a	0.0000±0.00^a	0.2500±0.25^a	0.2500±0.25^a
	12	0.0000±0.00^a	0.2500±0.25^a	0.0000±0.00^a	0.0000±0.00^a
	14	0.0000±0.00^a	0.2500±0.25^a	0.0000±0.00^a	0.0000±0.00^a
	16	0.2500±0.25^a	0.0000±0.00^a	0.2500±0.25^a	0.5000±0.29^a
	18	0.0000±0.00^a	0.7500±0.49^a	0.2500±0.25^a	0.2500±0.25^a