Stocking Density Effects on Growth Performance and Processing Yields of Heavy Broilers[1]

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ABSTRACT This study examined responses of male broilers during a 49-d production cycle to 4 placement densities in 2 trials. Trials were pooled because no treatment × trial interaction occurred. In each trial, 1,488 male chicks were randomly placed into 32 floor pens to simulate final densities of 30 (37 chicks/pen), 35 (43 chicks/pen), 40 (50 chicks/pen), and 45 (56 chicks/pen) kg of BW/m^2 of floor space based on a projected final BW of 3.29 kg. Growth rate and nutrient utilization were similar ($P \geq 0.05$) among the treatments from 1 to 32 d of age. From 1 to 49 d, BW gain ($P = 0.011$) and feed consumption ($P = 0.029$) were adversely affected by increasing the placement density from 30 to 45 kg of BW/m^2 of floor space. The reduction in cumulative BW gain due to placement density can be partially explained by less feed consumption as evidenced by 95.4% of the sums of squares of BW gain being attributable to feed consumption. Litter moisture content ($P = 0.025$) and foot pad lesion score ($P = 0.001$) increased linearly with increasing placement density. Upon processing, whole carcass and breast meat yields relative to BW were not affected ($P \geq 0.05$) as density increased from 30 to 45 kg/m^2. The proportion of whole carcasses with scratches, but not tears, on the back and thighs increased ($P = 0.021$) as density increased. These results indicate that increasing the density beyond 30 kg/m^2 elicited some negative effects on live performance of heavy broilers.

(*Key words*: growth performance, processing yield, broiler)

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INTRODUCTION

Animal welfare has generated concerns from the domestic and global market sectors. In the United States, the National Council of Chain Restaurants and the Food Marketing Institute are certifying auditors for their animal welfare audit program. The National Chicken Council has established a voluntary welfare audit program for broiler companies to follow so that welfare concerns are being addressed (National Chicken Council, 2005). Stocking density during grow out has been regarded as a concern to food retailers and wholesalers (Food Marketing Institute and National Council of Chain Restaurants, 2003). High stocking density has been reported to increase ammonia production, foot pad lesions, litter moisture, locomotion, heat stress, and preening (Murphy and Preston, 1988; Newberry and Hall, 1988; Lewis and Hurnik, 1990; Bessie and Reiter, 1992; Cravener et al., 1992). As a result, welfare specialists have suggested reducing stocking density from 43 to 30 kg of BW/m^2 when broilers are grown to heavy weights. The optimum density for broilers marketed to heavy weights is debated among broiler companies, contract growers, and welfare auditors.

Numerous studies have demonstrated that increasing placement density (of broiler chickens approximating 2.4 to 2.7 kg) adversely affects growth performance, carcass yield, and skin scratches and tears (Deaton et al., 1968; Shanawany, 1988; Stanley et al., 1989; Casteel et al., 1994; Bilgili and Hess, 1995; Puron et al., 1995; Feddes et al., 2002). Puron et al. (1995) reported the optimum stocking densities for males (2.7 kg) and females (2.2 kg) to be 17 and 19 birds/m^2, respectively, based on profit margins. Other research has shown that 2.7-kg male broilers exhibited lower 49-d BW, poorer cumulative 49-d feed conversion, and reduced breast fillet yield as placement density was increased from 10.5 to 13.2 birds/m^2 (Bilgili and Hess, 1995). In practice, optimum density based on profit margins typically ex-

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ceeds the recommendation based on welfare and bird performance (Shanawany, 1988; Puron et al., 1995). It appears that the adverse responses are not as pronounced with females when compared with male broilers. This difference probably relates to body mass because results with females correspond to a final BW of 2.2 kg (Bilgili and Hess, 1995; Puron et al., 1995).

Because body mass appears to affect bird performance more dramatically than number of birds, evaluating stocking density expressed as BW per floor space may be more appropriate for broilers grown to heavy weights (Shanawany, 1988; Bilgili and Hess, 1995; Puron et al., 1995; Feddes et al., 2002). Stocking density research reported in the literature is limited on production parameters, meat yield, and litter quality of broilers grown to BW of 3.0 kg. This study examined the effects of various stocking densities corresponding to 30, 35, 40, and 45 kg of BW/m^2 of floor space on live performance, processing yields, and carcass quality of heavy male broilers (i.e., based on a projected final weight of 3.29 kg). Measurements also included litter moisture, ammonia production, foot pad lesions, and gait scores.

MATERIALS AND METHODS

Husbandry Practices

In each of 2 separate trials, 1,488 male Ross[3] × Cobb[4] 500 chicks were obtained from a commercial hatchery and randomly distributed among 32 floor pens. Chicks were vaccinated for Marek's disease, Newcastle disease, and infectious bronchitis at the hatchery. Each pen was equipped with new shavings, one pan feeder, and a nipple drinker system having 9 nipples. The nipple spaces in each pen were 4.1, 4.8, 5.6, and 6.2 birds per nipple (flow rate = 60 mL/min), and the feeder pan spaces were 2.95, 2.54, 2.18, and 1.95 cm per bird as density was increased to 30, 35, 40, and 45 kg/m^2, respectively. Stocking densities did not exceed the manufacturer's recommendations on a bird basis for the pan feeder (75 birds/feeder) and nipple drinkers (13 birds/nipple) within each pen. A 3-phase feeding program was provided that met or exceeded NRC (1994) recommendations (starter, 1 to 17 d; grower, 18 to 32 d; and finisher, 33 to 49 d). The feed changes used were selected as convenient times to approximate industry practice. Starter feed was provided as crumbles, and subsequent feeds were fed as whole pellets. Ambient temperature was maintained at 33°C at the start of experimentation and was reduced as the birds progressed in age to ensure comfort with a final temperature set point of 21°C at 41 d and thereafter. The lighting schedule consisted of continuous lighting with an intensity of 20 lx from placement to 7 d, 19L:5D at 20 lx from 8 to 14 d, 20L:4D at 5 lx from 15 to 22 d, and continuous lighting at 3 lx from 23 to 49 d.

Treatments

Stocking densities of 30, 35, 40, and 45 kg BW/m^2 of floor space corresponding to 37, 43, 50, and 56 chicks per pen at 1 d of age were established. Stocking density was calculated based on an estimated final weight of 3.2 kg and a pen area of 4.18 m^2. The equation used to compute the number of birds per pen needed for the projected treatment densities is as follows: birds per pen = final treatment density (kg/m^2) × pen area (m^2)/projected final BW (kg). Each treatment was replicated with 8 pens.

Measurements

Temperature was measured by placing data loggers[5] in the north (one) and south (one) ends of the experimental facility. Each data logger was attached to the nipple drinker line in the pen. Birds and feed were weighed by pen at 17, 32, and 49 d of age for the computation of growth rate, feed consumption, and feed conversion. The incidence of mortality was recorded daily. Ammonia measurement was conducted at 45 d using a photoacoustic multigas analyzer.[6] Gas concentrations at time-zero and 1 min were used to estimate instantaneous ammonia flux from the litter. The flux box consisted of a cylindrical plastic container (35 cm high with a 14.3 cm radius) with a small electric fan mounted inside the bottom of the container. An analyzer was connected to the flux box by a 0.635 cm diameter tube with a length of 1.54 m. A flux box was inverted on the litter surface of each pen at a common site away from the feeder and waterer. Flux calculations were based on the difference between the sample ammonia concentrations and included application of the ideal gas law. The ideal gas law, using atmospheric pressure, room temperature, and the volume of ammonia, determines the number of moles of ammonia. To estimate the litter ammonia flux, the number of moles of ammonia was multiplied by the molecular weight of ammonia and then divided by the area of the litter measured (flux box area) and the time elapsed between an initial and final measurement at 0 and 60 s, respectively.

At 46 d, litter samples were collected from each pen. A 150-g sample of litter was obtained from 4 locations in each pen and placed in a drying oven for 24 h at 100°C for litter moisture determination (AOAC, 1996). In addition, 10 birds from each pen were scored for foot pad lesions following the procedure reported by Hess et al. (1999). Gait scoring was assessed on 10 birds from each pen based on a modification of the system of Garner et al. (2002) in trial 2. Birds were subjectively assigned 0 = for normal gait, 1 = abnormal movement, or 2 = lameness.

[3]Aviagen, Inc., Huntsville, AL.
[4]Cobb Vantress, Inc., Siloam Springs, AR.
[5]Onset Computer Corporation, Pocasset, MA.
[6]California Analytical, Orange, CA.

TABLE 1. Actual temperatures of the housing facility during experimentation

Days	Max[1]	Min[2]	Avg[3]	SD[4]
1 to 7	35.4	32.3	33.1	0.8
8 to 14	33.6	29.8	30.7	1.5
15 to 21	31.6	26.9	27.7	1.0
22 to 28	30.3	26.3	27.6	0.6
29 to 35	29.8	25.1	26.3	1.0
36 to 42	28.9	24.2	25.7	1.2
43 to 49	29.1	23.5	25.0	1.1

[1]Max = mean of the maximum value during each time interval.
[2]Min = mean of the minimum value during each time interval.
[3]Avg = mean of the average value during each time interval.
[4]SD of the daily average temperatures during each time interval.

At 49 d of age, 12 birds per pen were selected randomly for processing. Feed was removed from each pen 12 h prior to placing birds in transportation coops. Birds were manually processed, and carcass weight, abdominal fat weight, and the incidence of skin scratches and tears on the back and thighs of the whole carcasses were determined. Carcasses were split into front and back halves and chilled in ice for 24 h. The front halves were manually deboned to obtain weights of skinless, boneless breast fillets and tenders after a 24-h chill.

Statistics

Two trials were conducted as a randomized complete block design with 8 replicate blocks and 4 stocking density treatments. The following 3 analyses were conducted: 1) ANOVA followed by least significant difference test (Fisher, 1939) comparing stocking density means, 2) ANOVA using a linear trend to explain potential stocking density effects, and 3) feed consumption was added to the model in the second trend analysis as a covariant with BW gain as the dependent variable. In general, a quadratic trend was not significant ($P \geq 0.05$) for the variables measured in this study. The 2 trials were pooled in all 3 analyses with trial, replication within trial, and trial × treatment as random effects. Analyses were performed by PROC MIXED (SAS Institute, 2004). All mortality data were subjected to arc sine transformation. Statistical significance was established at $P \leq 0.05$.

RESULTS AND DISCUSSION

Stocking densities in this study were 27.0, 29.4, 33.8, and 36.8 kg/m^2 for the estimated treatments of 30, 35, 40, and 45 kg/m^2, respectively. In calculating the treatments, final BW of 3.29 kg was used based on a preliminary study conducted from February to May 2004. In the present study, the 2 trials were initiated in May and July 2004, and the summer conditions may have depressed growth rate, leading to lower final stocking densities than projected.

Weekly ambient temperature results are presented in Table 1. The outside ambient temperature exceeded 32.0°C, but the temperature inside the house was maintained at 25.5°C through the use of evaporative cooling pads from 33 to 49 d of age. Ambient temperature is paramount when interpreting stocking density results because stocking density influences feed consumption and heat production (Shanawany, 1988).

At 17 d of age, growth rate and feed conversion ratio improved as stocking density increased (Table 2), but growth differences were diminished from 1 to 32 d (Table 3). The reason for this increase in growth during the starter period is not understood; however, this improvement in growth may be related to metabolic heat production (Kuenzel and Kuenzel, 1977). Actual average temperatures from 1 to 14 d were in close agreement with the temperature set points (Table 1). The pens did not have brooders, and additional chicks at higher densities probably increased heat production, which, in turn, increased growth. Because chicks do not attain the homethermic condition until approximately 14 d of age (Whittow, 1986) and are poorly insulated during neonatal period, they are capable of using excess heat for growth (Davidson et al., 1980).

Depressed growth and feed consumption during the final period led to reduction in cumulative BW and feed consumption (Table 4). Feed conversion was not significantly affected ($P = 0.093$) by stocking density. Previous research has shown that high stocking density increases ($P \leq 0.05$) nutrient utilization (Puron et al., 1995; Feddes et al., 2002). In the present study, linear trend analysis showed that slopes for cumulative BW gain and feed consumption were –65 and –80, respectively. This indicates that an increase of 5 kg of BW/m^2 in stocking density above 30 kg/m^2 of BW corresponds to decreases in BW gain and feed consumption of 65 and 80 g, respectively. With cumulative feed consumption as a covariate and BW gain as the dependent variable, feed consumption represented 95.4% of the sum of squares attributable to the stocking density effect.

Rate of growth was more adversely affected as the birds progressed in BW (Tables 2, 3, and 4). For example, the slope for BW gain was –0.03 g, whereas the slope of growth rate from 1 to 49 was –64.1 g. The slopes did not differ ($P = 0.696$) for BW gain from 1 to 17 vs. 1 to 32 d of age. Conversely, the slope for BW gain from 1 to 49 d decreased at a greater rate than 1 to 17 and 1 and 32 d of age ($P = 0.0001$; $P = 0.0001$), respectively. The slope for BW gain from 1 to 49 d was significantly different from 1 to 17 d and 1 to 32 d, which implied that body mass influenced stocking density more than number of birds.

Shanawany (1988) reported a linear decline in feed consumption in 1.8-kg broilers as stocking density increased from 20 to 50 birds/m^2. Final BW was reduced by 13 and 21%, respectively, as stocking density increased from 40 to 50 birds/m^2. These stocking densities were much higher than typically used in the US broiler industry. In the current study, as stocking density was increased from 30 to 45 kg/m^2 (i.e., 9 to 13 birds/m^2), final BW and cumulative feed consumption were re-

TABLE 2. Live performance responses of male broilers from placement to 17 d of age subjected to various stocking densities[1]

Treatment[2]	BW (g)	BW gain (g)	FC[3] (g)	FG[4]	Mortality (%)
30 (kg/m^2)	577	532	690	1.298	1.5
35 (kg/m^2)	588	542	698	1.289	1.2
40 (kg/m^2)	588	543	694	1.280	0.7
45 (kg/m^2)	590	544	692	1.274	0.6
SEM	6	6	10	0.027	0.9
Probabilities					
Trend analysis					
Linear	0.012	0.014	0.917	0.001	0.408
Estimate					
Slope	3.9	3.8	0.23	–0.008	–0.3
SE of Slope	1.5	1.5	2.12	0.002	0.3
Least significant difference					
Critical values	10	10	22	0.021	3.9

[1]Values represent least squares means of 16 replicate pens. Average chick BW was 46 g at placement.

[2]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

[3]FC = feed consumption per bird.

[4]FG = feed conversion corrected for mortality.

duced by 7.0 and 4.4%, respectively. Bilgili and Hess (1995) reported a 3.6% reduction in BW at 49 d of age as stocking density increased from 10 to 13 birds/m^2 (2.7 kg). In another study, Puron et al. (1995) found 2.3 and 3.5% reductions in 49-d BW (2.6 kg) and cumulative feed consumption, respectively, as stocking density increased from 10 to 12 birds/m^2.

In the current study, the depression in BW gain due to stocking density was related to a reduction in feed consumption. Physical access to feeders was probably limited as stocking density, increased leading to reduced feed consumption. Nipple waterer density of 20 birds per nipple has been shown to support optimum growth for 2.0-kg broilers (Feddes et al., 2002). Apparently, the number of nipples per bird in the current study did not limit growth. Malone et al. (1980) reported improved cumulative feed conversion in 54-d-old broilers (2.1 kg) as feeder space was increased from 1.8 to 2.3 cm/bird. Some of the adverse affects of stocking density on growth performance could be ameliorated by increasing feeder space as broilers approach heavy weights. Performance may be improved if recommendations of feeder space are determined by expected bird mass, rather than solely on a per bird basis.

TABLE 3. Live performance responses of male broilers from placement to 32 d of age subjected to various stocking densities[1]

Treatment[2]	BW (g)	BW gain (g)	FC[3] (g)	FG[4]	Mortality (%)
30 (kg/m^2)	1,748	1,702	2,479	1.458	1.7
35 (kg/m^2)	1,769	1,723	2,507	1.455	2.1
40 (kg/m^2)	1,754	1,709	2,502	1.465	1.8
45 (kg/m^2)	1,753	1,707	2,491	1.459	0.8
SEM	30	30	21	0.022	1.1
Probabilities					
Trend analysis					
Linear	0.994	0.996	0.744	0.465	0.519
Estimate					
Slope	0.05	–0.03	2.9	0.001	–0.29
SE of slope	6.53	6.43	8.6	0.002	0.43
Least significant difference					
Critical values	73	72	83	0.019	4.4

[1]Values represent least squares means of 16 replicate pens.

[2]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

[3]FC = feed consumption per bird.

[4]FG = feed conversion corrected for mortality.

TABLE 4. Live performance responses of male broilers from placement to 49 d of age subjected to various stocking densities[1]

Treatment[2]	BW (g)	BW gain (g)	FC[3] (g)	FG[4]	Mortality (%)
30 (kg/m^2)	3,162	3,117	5,641	1.814	3.6
35 (kg/m^2)	3,096	3,051	5,563	1.825	7.8
40 (kg/m^2)	3,046	3,000	5,549	1.826	7.3
45 (kg/m^2)	2,966	2,920	5,392	1.847	7.5
SEM	63	63	83	0.026	2.3
Probabilities					
Trend analysis					
Linear	0.011	0.011	0.029	0.093	0.188
Estimate					
Slope	−63.9	−64.1	−76.1	0.010	1.13
SE of slope	16.6	16.6	25.9	0.005	0.73
Least significant difference					
Critical values	210	210	256	0.059	6.5

[1]Values represent least squares means of 16 replicate pens.

[2]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

[3]FC = Feed consumption per bird.

[4]FG = Feed conversion corrected for mortality.

Gradient increments of stocking density increased litter moisture, yet litter ammonia production was not affected (Table 5). Stocking density also altered foot pad scores, but the response was more pronounced as stocking density was increased to 40 and 45 kg of BW/m^2 of floor space. The increase in foot pad scores was probably a reflection of the poor litter quality associated with high stocking density. Sorensen et al. (2000) reported increased litter moisture and foot pad burns of broilers as stocking density increased from 622 to 455 cm/bird. In the current study, litter ammonia concentration was highly variable. The variability of ammonia content might have been attributable to the amount of caked litter in the pens. As stocking density increased, the amount of caked litter in the pens increased. The presence of caked litter could have served as a seal altering the production of ammonia. Also, caked litter corresponds to high litter moisture or areas where litter becomes anaerobic, which suppresses ammonia volatilization (Carr et al., 1990). In addition to litter

TABLE 5. Litter quality and foot quality measurements of male broilers at 45 and 46 d of age subjected to various stocking densities[1]

Treatment[2]	Litter moisture (%)	Ammonia[3] (mg/m^2 per h)	Pad lesion[4] score
30 (kg/m^2)	38.8	367	0.5
35 (kg/m^2)	39.3	470	0.6
40 (kg/m^2)	43.7	354	0.9
45 (kg/m^2)	46.6	405	1.0
SEM	9.5	97	0.1
Probabilities			
Trend analysis			
Linear	0.025	0.988	0.001
Estimate			
Slope	2.8	−0.36	0.18
SE of slope	0.8	21.57	0.03
Least significant difference			
Critical values	10.7	156	0.2

[1]Values represent least squares means of 16 replicate pens.

[2]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

[3]Measurement was obtained using a multigas analyzer. Ammonia was measured at 45 d of age.

[4]Values represent scoring the bottom of the feet (pads) as 0 = no lesions; 1 = lesion less than 1.5 cm; 2 = lesion greater than 1.5 cm. Foot pads were scored at 46 d of age.

TABLE 6. Carcass yield, skin scratches, and tears of male broilers at 50 d of age subjected to various stocking densities[1]

Treatment[2]	Carcass[3] (g)	Carcass yield[4] (%)	Fat weight[5] (g)	Fat yield[4] (%)	Scratches[6] (%)	Tears[6] (%)
30 (kg/m^2)	2,340	74.0	40	1.25	41.9	13.5
35 (kg/m^2)	2,337	74.7	35	1.12	51.4	15.5
40 (kg/m^2)	2,288	74.5	39	1.28	58.7	13.3
45 (kg/m^2)	2,257	74.6	37	1.23	53.5	14.5
SEM	44	0.3	2	0.05	4.3	6.3
Probabilities						
Trend analysis						
Linear	0.070	0.136	0.772	0.754	0.021	0.965
Estimate						
Slope	–30.2	0.158	–0.25	0.008	4.23	0.05
SE of slope	13.3	0.089	0.81	0.025	1.76	1.25
Least significant difference						
Critical values	103	0.5	6	0.08	10.9	15.5

[1]Values represent least squares means of 16 replicate pens with each providing 12 carcasses.

[2]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

[3]Carcasses without giblets and necks and removal of abdominal fat.

[4]Relative to BW.

[5]Amount of abdominal fat.

[6]Means represent the proportional of birds having defects on the back and thigh corresponding to scratched skin and torn skin.

quality assessment, gait scoring was conducted only in trial 2. There were no differences. Stocking density did not affect the proportion of birds observed having abnormal movement ($P = 0.651$) or lameness ($P = 0.181$).

Upon processing, stocking density did not influence carcass and abdominal fat yields relative to BW (Table 6). However, carcass weight decreased in a linear manner as stocking density increased ($P = 0.07$). The incidence of scratches on the back and thigh of the carcasses increased with progressive increments of stocking density, but occurrence of tears did not. Elfadil et al. (1996) found greater occurrence of scratches (23 vs. 53%; 12 vs. 30%) on the whole carcass as stocking density increased from 0.14 to 0.07 m^2/bird at 35 and 42 d of age, respectively. Bilgili and Hess (1995) also reported elevated incidence of scratches on the back and thigh of the whole

TABLE 7. Breast meat yield of male broilers at 50 d of age subjected to various stocking densities[1]

Treatment[5]	Fillet[2] Weight (g)	Fillet[2] Yield[4] (%)	Tender[3] Weight (g)	Tender[3] Yield[4] (%)
30 (kg/m^2)	518	16.4	112	3.55
35 (kg/m^2)	522	16.6	111	3.55
40 (kg/m^2)	508	16.5	110	3.56
45 (kg/m^2)	495	16.3	109	3.61
SEM	12	0.1	5	0.17
Probabilities				
Trend analysis				
Linear	0.079	0.720	0.198	0.129
Estimate				
Slope	–8.19	–0.019	–1.07	0.02
SE of slope	3.76	0.052	0.72	0.01
Least significant difference				
Critical values	42	3.2	9	0.08

[1]Values represent least squares means of 16 replicate pens.

[2]Pectoralis major breast muscles.

[3]Pectoralis minor breast muscles.

[4]Relative to BW.

[5]Stocking densities of 30, 35, 40, and 45 kg/m^2 were estimated by placing 37, 43, 50, and 56 birds, respectively, in floor pens of 4.18 m^2 at 1 d of age. The following equation was used in the calculation: birds per pen = [final treatment density (kg/m^2) × pen area (m^2)]/projected final BW (kg), where the final BW was considered to be 3.29 kg.

carcass as stocking density increased from 10 to 13 birds/m^2; however, the proportion of tears on carcasses was not affected by stocking density.

Stocking density did not lead to apparent differences in breast meat yield relative to BW (Table 7). Progressive increments of stocking density led to a linear reduction in absolute weight of the breast fillet that approached significance (P = 0.079). Increasing stocking density from 10 to 13 birds/m^2 has been shown to reduce breast fillet yield relative to BW, but breast tender and total white meat yields are not affected by stocking density (Bilgili and Hess, 1995).

In conclusion, these data indicate that increasing the stocking density from 30 to 45 kg of BW/m^2 of floor space influenced BW gain and feed consumption, but meat yields were not significantly altered. Cumulative BW gain decreased 64 g for a 5 kg of BW/m^2 unit increase in stocking density. Future research should address the interrelationships of feeder space and stocking density of broilers grown to heavy weights because the effects of stocking density on feed and water consumption are closely related.

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