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Original Article

Influence of population density on performance of two broiler strains

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Abstract
Production performance of livestock is mostly dependent on the breed, nutrition and management practices (stocking density). The experiment was carried out to evaluate the effect of population density on morphometric traits of Agrited and Amo broiler chickens. Performance traits considered were initial body weight, final body weight, body weight gain, average daily weight gain, average feed intake, average weekly feed intake and feed conversion ratio (FCR). Morphometric traits include thigh length, shank length, neck length, heart girth, body length, wing length and thigh circumference. While the cost-benefit analysis carried out include cost of feed/kg diet, cost per kg weight gain, total cost of feed per birth and cost of production per birth. Data generated were analyzed using ANOVA. Body weight gain was not significant (P>0.05). Agrited had high values for the average daily weight gain (42.91g), average total feed intake (5380.90g) and average weekly feed intake (768.70g). The body weight, shank length, and neck length were not affected (P>0.05) by stocking density in both strains. The cost per kg weight gain (₦726.35), total cost of feed per birth (₦1765.03) and cost of production per birth (₦2126.30) were less and best estimated in Amo strain. Hence, the two strains were not affected by stocking density in most traits measured.

INTRODUCTION

The optimal density of group housed broiler birds are still very limited (Dawkins *et al.,* 2004). Broiler producer especially in large scale commercialization always tempted of increase the number of broilers as a ways of reduced the cost of housing and management (Estevez, 2007). Poultry production is among the livestock animals which in many years create employment opportunity to the teeming youth due to short and fast return in their production cycle. The estimation of broiler chick production worldwide in 2018 was approximately 23 billion (Carys *et al.,* 2018). The social and economic development of the people in any country needs poultry production which is one of the important livestock productions (Oladeebo and Ambe-Lamidi, 2017). The economic traits in most poultry industries such as production traits cannot be over emphasized (Thu *et al.,* 2020). Characterizing of the genotype by

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integrating markers related to production traits served as good criteria for selection for efficient performance (Thu *et al.,* 2020). Homogenous populations are more susceptible to infections than a high genetic diver's population (Shapiro, 2017).

High productive exotic breeds of domestic animals have been more and highly favoured in breeding programs (Malomane *et al.,* 2021). Phenotypic traits have been reported to be central to both adaptation and productivity of chickens in their local surroundings (Daikwo *et al.,* 2018). Farmers tend to reduce the time duration and the stocking rate aiming to increase the profitability of broiler production (Smith, 2010). Housing in poultry management is a practice involving the allocation of a specific floor space to a bird to provide a comfortable environment for wellbeing and performance (Yakubu *et al*., 2010).

Broilers are usually kept at high stocking densities which vary considerably between countries. Stocking densities range between 22 - 42 kg /m^2 (5 - 9 lb/sq ft) or between about 11 to 25 birds per square meter (1.0 to 2.3/sq feet) in Europe (Turner *et al.,* 2005). Maintaining a high stocking density is a common practice in poultry industry because it allows for an increase of economic returns per unit of floor space (Yakubu *et al.,* 2010). Higher stocking densities are associated with increased dermatitis including foot pad lesions, breast blisters and soiled plumage (Bessei, 2006). Growth performance and development of birds depends on the breed, nutrition and management system (stocking density) (Bessei, 2006).

Optimal environmental conditions and thermal comfort must be provided for broilers to maintain constant body temperature and to achieve their genetic potential for superior growth (Feddes *et al*., 2002). Stocking density plays an important role, especially during summer, in broiler production (Türkyilmaz, 2008).

A significantly higher profitability and revenue was obtained from the sale of Arbor Acres compared to Anak Titans when stocking density was applied (Yakubu *et al.,* 2010). Stocking density has critical implications for the broiler production because higher returns can be achieved as the number of birds per unit space increases (Yakubu *et al.,* 2010). Poultry managers are interested in increasing the number of birds per space area, and reducing housing and labour costs per bird (Yakubu *et al.,* 2010). The aim of the study was to evaluate the population density on performance of two broiler strains.

MATERIALS AND METHODS

Study Area

The study was conducted at the Poultry Section of the Teaching and Research Livestock Farm of Federal College of Agriculture, Akure, Ondo State, Nigeria. The details description of weather pattern of the study area was as reported by (Arotolu *et al*., 2015).

Management of experimental birds

One hundred day-old broiler chicks of two strains (Agrited and Amo) of 50 birds each were sourced from a reputable hatchery in Ibadan, Oyo State, Nigeria. The birds were raised in wire cage system (battery cage). Prior to the arrival, cleaning, washing and fumigation of the brooding pen, cages, equipment and the surrounding were carried out using disinfectant (morigad and formalin solution). The brooding house was then covered with polythene nylon few days to the arrival of the chicks. Lighting bulbs (200 watt) for illumination were fixed. Litter materials of dry wood shavings were spread on the floor. The brooding pen was pre-heated few hours to the arrival of the chicks. The birds were fed with formulated broiler starter and finisher diets from one to three weeks and four to six weeks, respectively (Table 1). Lasota vaccine was given against Newcastle diseases on the first day, followed by other vaccination and medication schedules (Table 2).

Table 1. Experimental diets of the broiler chicken

Ingredient (kg)	Starter	Finisher
Maize	40.38	49.38
Full fat Soybean	17.00	18.00
Groundnut cake	19.00	18.00
Wheat offal	14.00	6.90
Fish meal	5.00	3.00
Bone meal	1.00	2.00
Grower premix	0.25	0.25
Salt	0.20	0.20
Lysine	0.12	0.12
Methionine	0.15	0.15
Palm oil	2.00	1.00
Limestone	0.90	1.00
Total	**100**	**100**
Calculated Analysis (%)		
Metabolizable energy (kcal/kg)	3000	3100
Crude protein	23.00	22.00
Calcium	1.05	1.32
Available phosphorus	0.76	0.81
Methionine	0.53	0.50
Limestone	1.29	1.10

Table 2. Experimental vaccination and medication schedule

Days	Vaccination	Mode of administration
1-7	1st Lasota vaccine	Oral
	Electrolyte vitalyte	Oral
14-18	1st Gomboro vaccine	Oral
21-24	2nd Lasota	Oral
	2nd Gomboro	Oral
28-32	Amprolium (anticoccidiosis)	Oral
32-44	Multivitamins	Oral

Experimental Design

The birds were randomly assigned to three treatments with different stocking density of five, seven and eleven birds replicated two times at three weeks of age for each strain (Agrited and Amo). The feeding trial lasted for seven weeks. The cages measured 59×37cm (length × width).

Treatment 1 (T1), R1, R2 = 5 birds per replicate

Treatment 2 (T2), R1, R2 = 7 birds per replicate

Treatment 3 (T3), R1, R2 = 11 birds per replicate

Data Collection

Performance traits considered were; initial body weight, final body weight, body weight gain, average daily weight gain, average feed intake, average weekly feed intake and feed conversion ratio (FCR). Morphometric traits were measured in centimeter (cm) includes; shank length (SL), neck length (NL), heart girth (HG), thigh length (THL), thigh circumference (THC), wing length (WL), and body length (BL) while the body weight (BW) was taken in kilogram (kg). While the cost-benefit analysis; cost of feed/kg diet, cost per kg weight gain, total cost of feed per birth and cost of production per birth.

Data analysis

Analysis of variance (ANOVA) using General Linear Model (GLM) of SAS (2002) was used to analyzed data obtained. While Duncan Multiple Range Test (DMRT) of SAS (Duncan, 1955) was used to separate significant means of the parameters measured.

The experimental model show below:

$Y_{ij} = \mu + B_i = S_j + (B \times S)_{ij} + E_{ijk}$

Where:

μ = Population mean, B_i = effect of the i^{th}

breed (Agrited and Amo), S_j = effect of the j^{th} stocking densities (5, 7 and 11 birds), $(B \times S)_{ij}$ = interaction effect of the i^{th} breed and j^{th} stocking densities.

RESULTS AND DISCUSSION

Performance of the broiler strains

Average daily weight gain 42.91±0.04g, average feed intake 5380.90±26.89g and average weekly feed intake 768.70±21.30g were significantly high in Agrited breed (Table 3). The difference could be as a result of genetic potential of the strain. Udeh, (2015) reported significant difference in body weight of Amo and Agrited at one to four weeks of age. The body weight 1.99±0.03kg Amo and 2.18±0.05kg Agrited were higher than 1.20 to 2.00 reported by Akanno *et al*. (2007) at 8 to 10 weeks. However, the no significant difference observed on final body weight contradicted the report of Yakubu *et al.* (2010) who observed variation between Anak Titan and Arbor Acre broiler chickens. Ajayi and Ejiofor (2006) documented variation of body weight when two genotypes were compared. The environmental influence may also be the cause of variation obtained here. Korver *et al.* (2004) reported that genotype may affect the body weight of poultry birds. The differences could be linked to the genetic makeup and environment (Abdullah *et al*., 2010). The present study revealed that average weekly feed intake is breed-dependent. This is similar to the report of Yakubu *et al.* (2010) who also observed variation in average weekly feed intake of two genotypes of broiler chickens whose average weekly body weight gain and feed conversion ratio were similar. The feed conversion ratio obtained here were higher than the 1.62 - 1.69 reported by Türkyilmaz (2008). However, Sudik *et al.* (2020) observed feed conversion ratio of 2.41, 2.41 and 2.42 in three genotypes of broiler chickens.

Table 3: Means (±SE) of growth performance of broiler chicken

Parameters	Amo	Agrited
Initial body weight (kg)	31.88±0.04	41.94±0.10
Final body weight (kg)	1.99±0.03	2.18±0.05
Body weight gain (kg)	1.96±0.11	2.14±0.11
Average daily weight gain (g)	23.71±0.04[b]	42.91±0.04[a]
Average feed intake (g)	4845.98±34.96[b]	5380.90±26.89[a]
Average weekly feed intake (g)	692.28±27.92[b]	768.70±21.30[a]
Feed conversion ratio (FCR)	2.43	2.46

Means with different superscript on the row are significantly (P<0.05) different. SE= standard error.

Table 4 shows the interaction effects of the stock density within a breed on broiler chicken. The following traits were significantly (P<0.05) affected by stock density include; thigh length, heart girth, body length and thigh circumference, while body weight, shank length, neck length and wing length were not affected by stock density in Amo strain. The body length of 35.12±1.14cm was high in stock density of five birds while thigh circumference was high in 11 birds' stock density. Traits were not significantly (P<0.05) affected by stock density except the heart girth, wing length and thigh circumference in Agrited breed. Although, the heart girth (34.62±0.78cm) and wing length (21.50±1.44cm) were high in eight birds' stock density while thigh circumference (20.84±6.05cm) was high in 11 birds per stock density.

Stocking density had no significant (P>0.05) effect on body weight, shank length (SL), neck length (NL) and wing length (WL) in Amo genotype. Thomas *et al*. (2004) claimed that mean body weights of broilers on day 35 were not affected by stocking density. Yakubu *et al.* (2010) observed no linear decrease with increasing population density especially between birds stocked at 11.1 and 14.3 birds per m^2.

Table 4. Interaction effects of stock density within a breed on broiler chicken

	Amo			Agrited		
	Stocking density			Stocking density		
Trait	5	7	11	5	7	11
BW	2.13±0.07	1.85±0.05	2.02±0.04	2.17±0.07	2.14±0.08	2.25±0.08
THL	12.62±O.99[b]	14.13±0.21[a]	13.14 ± 0.21[b]	11.73 ± 0.39	12.25±0.29	11.72 ±0.20
SL	7.16 ± 0.31	6.53± 0.18	7.21 ± 0.16	7.30 ± 0.14	7.00 ± 0.09	6.84 ± 0.12
NL	11.25 ± 0.83	10.06±0.20	9.95 ± 0.17	8.00 ± 0.14	8.75 ± 0.16	8.60 ± 0.12
HG	31.00± 0.50[a]	28.40±0.67[b]	30.95 ± 0.28[a]	31.57±0.93[b]	34.62±0.78[a]	32.08±042[b]
BL	35.12± 1.14[a]	31.00±0.52[c]	33.85 ± 0.31[b]	31.92 ± 0.48	30.81±0.56	30.08± 0.29
WL	18.75 ± 0.36	17.13±0.25	18.09 ± 0.28	19.50±0.57[b]	21.50±1.44[a]	19.45±0.27[b]
THC	11.37 ± 0.9[b]	10.73±0.50[c]	14.54 ± 0.32[a]	14.26 ±0.43[c]	16.06±0.55[b]	20.84±6.05[a]

Means with different superscript within the same breed on the same column are significantly ($P< 0.05$) different. BW= body weight, THL = Thigh length, SL = shank length, NL = neck length, HG = heart girth, BL = body length, WL = wing length and THC = thigh circumference.

Nielsen *et al.* (2003) observed differences in growth rate in different genotype of broiler chickens. Body weight was affected when stocking rate was increased from 30 to 45 kg of BW per m^2 of floor space (Dozier *et al*., 2005). Mtileni *et al.* (2007) attributed a significant effect to reduced floor space per body weight of adult broiler breeder hens. Although, the current findings is contrary with the report of Ravindran *et al.* (2006) who stated that stocking density had no effect on the weight gain of broilers over the 35-day trial period.

The significant effect of stocking densities on body weight, thigh length (THL), Shank length, Neck length and body length in Agrited contradicted the reports of Bessei (2006) who stated that the growth performance and development of birds depends on the stocking density. Yakubu *et al.* (2010) submitted that housing density affected the final body weight of broiler birds. The significant effect of stocking density on some of the traits measured could be as a result of difference in genetic makeup of the breed. Under stress condition animal system tends to activate some vital genes to fight against environmental change which is breeds dependent. This could be responsible for disparities in values observed between the stocking rates within a breed. Keeling and Duncan (1991) reported that aggressiveness was relatively higher in small flocks than in large flocks, as birds adopt strategies to avoid negative social interactions.

Cost analysis

Table 5 show the cost–benefit analysis of broiler chicken. High values were observed in Agrited strain, thus include; Cost per kg weight gain ₦781.10, total cost of feed per birth ₦1960.56 and cost of production per birth ₦2130.23. The high cost of feeding Agrited strain implies that the sales prices will increase with increase in production cost. This may be attributed to high body weight in the breed. The high production cost in Agrited may also be due to higher feed in take on the breed. Yakubu *et al.*, (2010) stated that significant higher

Table 5. Cost-benefit analysis of broiler chicken

Parameters	Amo	Agrited
Cost of feed/kg diet (₦)	365	365
Cost per kg weight gain (₦)	726.35[a]	781.10[b]
Total cost of feed per birth (₦)	1765.03[a]	1960.56[b]
Cost of production per birth (₦)	2126.30[a]	2130.23[b]

Means with different superscript in the same row are significantly ($P<0.05$) different.

profitability, profit margin and revenue were obtained from the sale of Arbor Acres compared to Anak Titans. Different strategies such as genotype, management system and stocking rate are imperative. As a result the cost of production is reduced, more income are generated thereby improve the livelihood of the farmer. Abdurofi *et al.* (2017) revealed that high cost of feed is considered as a major constraint of broiler production. Cosmas *et al.* (2015) reported ₦79.20 cost of feed per kg diet for broiler chicken. The cost analysis of assessment of a poultry business is usually determined by the level of risk to which the reared flocks are exposed to biosecurity measures (Vaillancourt, 2001).

CONCLUSION

In rural setting where space are major constraints affecting livestock production, farmers try to maximized available space for animal production. Increasing the stocking rate without any adverse effect on the performance of broiler chicken is important. However, the stocking density of five, seven and eleven of 59×37cm (length×width) space is beneficial thereby reduce the cost of production in Amo strain.

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