Growth performance, carcass yield and gait score of Marshal broiler chicken reared on intensive and semi intensive management systems

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Abstract

The rearing system used in highly productive farms is often subjected to harsh criticism, one of the reasons being its failure to provide adequate welfare. A number of attempts have been made to introduce new technologies in rearing poultry for meat production aiming at improving rearing conditions, protecting the environment and enhancing the quality of poultry products. Given the above, one hundred and sixty eight unsexed 14-day old Marshall broiler chicks were used in a completely randomized design study to compare the effect of management systems (intensive and semi intensive) on the growth performance, carcass characteristics and gait score of broiler chickens. The experiment lasted for 42 d. Data were collected on weight gain, feed intake, feed conversion ratio, carcass yield and gait score. Result showed that birds on the intensive management system recorded higher weight gain ($P < 0.05$; 1.83 vs 1.37 kg) while feed conversion ratio was significantly higher in birds on the semi intensive management system ($P < 0.05$; 2.32 vs 2.15). Dressing and thigh weight percentages were higher in birds on the intensive management system ($P > 0.05$; 66.94%, 11.44%) than those in semi-intensive system (54.55%, 10.92%, respectively). For the gait score broiler birds on semi intensive management system recorded reduced number of cases of severe and slight leg problems ($P < 0.05$, 25.76% vs 49.3%). It was concluded that broiler birds should be reared on intensive management system for better growth performance and carcass yield. However, birds reared on semi intensive management system had fewer leg problems compared to birds reared on intensive management system. The fewer severe leg problems observed in birds on semi intensive management system will help improve their market value thereby making birds more profitable to rear on semi intensive management system.

Key words: Growth performance, management systems, carcass yield, intensive and semi intensive

Introduction

The management system used in highly productive farms is often subjected to harsh criticism, one of the reasons being its failure to provide adequate welfare (Katarzyna and Joanna, 2011). In many countries, this has led to the production of poultry under less intensive rearing conditions (Onyango *et al.*, 2006). Animal welfare is increasingly viewed as a factor affecting production and the quality of animal products while being an important tool of marketing strategy (Katarzyna and Joana, 2009). Research findings have shown improved welfare in chickens having access to free range. This is

reflected in the behaviour of free-range chickens, which more often express their natural instincts compared to confined birds (Sosnówka-Czajka *et al.,* 2007). As a result, systems and technologies that ensure access to free range, low stocking density, and natural lighting are attracting increasing interest among poultry producers.

Animals raised on extensive system enjoy a much "higher quality of life" than those confined within factory farms. When raised on open pasture, animals are able to move around freely and express their natural behaviours. The ability of birds to express their natural instinct and behaviour is reduced to the barest minimum if not impossible to achieve in industrialized farms, where thousands of animals are crowded into confined facilities - a stressful condition which pre-disposes birds to allergies and tissue injury, damage and microbial infection (Robinson, 2000). Research has also found out that confined birds are subjected to high incidence of respiratory diseases and breast blister due to high ammonia (NH_3) concentration in the confined system (SCAHAW, 2000).

Free-range broiler production has increased substantially as a result of the greater demand for the so-called natural products (Silva *et al*., 2001; Dawkins *et al*., 2003). This may represent a profitable alternative for small producers and offer better broiler welfare (Bastianelli, 2001; Heier *et al*., 2002; McInerney, 2004). The semi intensive system minimizes the effect of stressing factors and contributes to bird welfare (Sundrum, 2001). Birds can stay longer in the grazing area when provided in the semi intensive system. They have greater mobility and bird welfare and productivity will be improved without compromising economic profitability. However, there is dearth of detailed information on semi intensive poultry production system as an alternative production technique on the Nigerian eco-system and this necessitated this study. Therefore, this study was conducted to compare the growth performance, carcass characteristics and gait score of Marshal broiler chickens reared on intensive and semi intensive management systems.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry Unit of the Directorate of University farms of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. This area is situated in the rainforest vegetation zone of south-western Nigeria on Latitude 7°13°49.46" N, Longitude 3° 26°11.98" E and altitude of 98 m above sea level. The climate is humid with a mean annual rainfall of 1003 mm and annual mean temperature and humidity range from 31.9° - 34.8^{0}C and 79.7- 90.1%, respectively.

Experimental birds and management

A total of 168 unsexed day-old Marshal strain broilers chicks were purchased from a reputable hatchery in Abeokuta, South West Nigeria for this study. The chicks were brooded together intensively for 14 d. The birds were allocated randomly to 2 treatment groups of 84 birds each of 3 replicates with 28 birds per replicate. Routine and occasional management practices in poultry were carried out as at when due. Feeders and drinkers were cleaned daily and fresh feed and water were supplied daily. Litters were changed twice a week in both systems. Recommended vaccination and medication were applied. Sanitation of the environment was maintained throughout the experimental period. The birds were placed on commercial starter and finisher diets formulated to meet the nutrient requirements of the birds. After 2

wk of brooding, the chicks were randomly divided into 2 groups of management systems: intensive and semi intensive. Replicates in both management systems were housed separately. The birds in the intensive system were fed a known quantity of feed recommended for the age (Aduku, 1993) while birds in semi-intensive system were given 70% percent of the quantity of the feed given to those in intensive management system (Savory *et al.*, 2000). For the semi intensive system a quadrant of 1 m^2 was tossed 5 times in each replicate and available scavengeable plants were determined and expressed in average terms, this was done at the beginning and at the end of the experiment. The difference between the initial plant population and the final plant population was recorded as the semi intensive system scavenged feed resources following the method of Kirsopp-Reed (1994).

Housing

The intensive housing system with deep-litter was a concrete floor with dwarf wall of about 0.7m from floor level with wire mesh at the upper side for cross ventilation. The roof was made of corrugated zinc sheets. Birds under intensive system were stocked at 0.18m^2/bird. The semi-intensive system with deep-litter run was a moveable cage type made of wood with wooden floor and dwarf wall of 0.7 m in height.

Table 1: Percentage composition of experimental diets

Ingredients	Starter (%)	Finisher (%)
Maize	50.00	65.00
Soya bean meal	22.00	20.00
Wheat offal	6.00	0.00
Groundnut cake	12.00	7.00
Fish meal (72%)	5.00	3.00
Bone meal	2.50	2.50
Oyster shell	1.50	1.50
*Broilers Premix	0.25	0.25
Salt	0.25	0.25
Lysine	0.25	0.25
Menthionine	0.25	0.25
Total	100	100
Determined Analysis		
Crude protein (%)	23.71	19.63
ME (MJ/kg)	11.75	12.46

*Mineral Premix based on 2.5 kg per ton (Micro Mix®)
Vit. A 12,500,000.00 IU, Vit. D_3 2,500,000.00 IU, Vit. E 40,000.00 mg Vit. K 32,000.00 mg, Vit. B_1 3,000.00 mg, Vit. B_2 5,500.00 mg, Niacin 55,000.00 mg , Calcium Pentotenate 11,500.00 mg, Vit.B_6 500,000.00 mg, Folic Acid 1,000.00 mg, Vit. B_{12} 25.00 mg, Cholin Chloride 500,000.00 mg Folic Acid 1,000.00 mg, Biotin 80.00mg, Iodine !,500.00 mg, Cobalt 300.00 mg, Selenium 120.00 mg, Anti-oxidant 120,000.00 mg.

Data collection

Data were collected on the following performance indicators:

Feed intake

Feed consumption for each day was obtained from the difference between the feed given per day and the left over.

$$\text{Total feed intake (kg)} = \text{Total feed given (kg)} - \text{Total feed left over (kg)}$$

$$\text{Feed intake per bird} = \frac{\text{Total feed intake (kg)}}{\text{Number of birds per treatment}}$$

Body weight gain

The initial body weights of birds were determined while subsequent body weights were recorded on weekly basis. Body weight gain (g) was calculated as

$$\text{Body weight gain per bird} = \text{Final weight (g)} - \text{Initial weight (g)}$$

Percentage mortality

Mortality was recorded daily and percentage mortality was calculated as

$$\text{Mortality \%} = \frac{\text{Total number of dead birds}}{\text{Total number of birds}} \text{ x100}$$

Carcass characteristics evaluation

At the end of 8th week of age, 9 birds per treatment, 3 birds per replicate whose weight were close to the average of the treatment groups, were selected for carcass analysis. The live weights of the chickens selected were recorded and thereafter slaughtered by neck decapitation. Upon slaughter and primary carcass processing, the processed carcasses were cooled in a cooling chamber for 24 h at 0 to 4°C. Following the chilling procedure, the carcasses were weighed to obtain the dressing percentage. Thereafter, the dressed cold carcasses were dissected into primal cuts (breast, drumstick, thigh, wing, pelvis and back) following the method prescribed by the Regulation on Poultry Meat Quality (Raseta and Dakic, 1984). The thighs and drumsticks were removed from the carcass by cutting above the thigh, towards the acetabulum and behind the pubic bone (the pelvic/thigh incision). Then, the drumsticks were separated from the thighs by cutting perpendicular to the joint between the drumstick and thigh bone. The wings were removed from the so-called "shoulder" incision through the joint (articulation) surfaces of the scapula and the coracoid. The breast was separated by a cut perpendicular to the ventral joints of the "rib" incision. The back-pelvis separation was performed by cutting perpendicularly to the vertebral column at the final vertebral level, the "lumbar" incision. Following the carcass dissection, the cuts were weighed and measured for percentage of dressed cold carcass weight.

Physical observation and gait scoring (Leg problem)

All birds from each of the management systems were observed twice a week for gait scoring using a digital camera as described by Kestin *et al.* (1992) with scores ranging from 0 to 5 (score 0 has normal and agile walking style and inclination, scores 1 and 2 have slight defects of varying degrees that result in abnormal gait, but the defects do not seriously compromise the ability of the birds to move, score 3 has gait defect that impairs walking ability to the extent that the bird has a limp, with a jerky or unsteady strut and loss of maneuverability, acceleration and speed and the birds often prefer to squat when not forced to move, score 4 is a severe gait defect

and score 5 is incapable of sustained walking on its feet. These scores were used to categorize the leg problem into 3 classes: none for scores 0-1, slight for gait scores 2-3 and severe for gait scores 4-5.

Statistical analysis

Paired sample t-test was performed on data collected on growth performance and carcass characteristics and Chi-square test was performed on data obtained for leg problem using SPSS version 20. A level of significance as minimal acceptable level was assessed at $P \leq 0.05$.

Results and Discussion

Management system had significant effect on final live weight (kg/bird), total weight gain (kg/bird), feed conversion ratio, and total feed intake (kg/bird) of Marshal broiler chickens (Table 2). Birds under intensive system had higher final weight ($P \leq 0.05$; 2.21±0.05), total weight gain ($P \leq 0.05$; 1.83±0.03) and total feed intake ($P \leq 0.05$; 3.92±0.00). The significant decrease in weight gain obtained in birds on the semi intensive production system may be due to increased physical activity in the run which consequently led to increased energy requirement and a reduction in energy utilization for meat synthesis. This is in agreement with the findings of Palvolvski *et al.* (2009) who reported that chickens reared under intensive system achieved considerable higher body weight compared to chickens raised free range. Also the result is in agreement with the findings of Castellini *et al.* (2002) who reported that outdoor organic treatment reduced growth rate compared to intensive deep-litter system. Birds under intensive system recorded a significantly lower feed conversion ($P \leq 0.05$; 2.15±0.03). This low feed conversion ratio obtained in birds on the intensive management system may be due to restricted activity and movement among the birds which increased conversion of feed to meat. This may also be because birds under the semi intensive management system were exposed to fluctuating environmental conditions and increased exercise on paddocks thereby increasing their energy demand with consequent decrease in the use of feed for body weight gain. Management system had no significant effect on mortality rate. Thus, it appeared that although the birds under semi intensive system were exposed to poor growth performance, yet they were able to survive the harsh environmental condition.

Table 2: Growth performance of Marshal broiler chickens under intensive and semi-intensive management systems (3 – 8 wk)

	Management system		
Parameters	Intensive	Semi intensive	*P*- value
Initial weight (kg/bird)	0.38±0.00	0.38±0.00	-
Final weight (kg/bird)	2.21^{a}±0.05	1.75^{b}±0.05	0.004
Total weight gain (kg/bird)	1.83^{a}±0.03	1.37^{b}±0.02	0.005
Total feed intake (kg/bird)	3.92^{a}±0.00	3.18^{b}±0.02	0.00
Feed conversion ratio	2.15^{a}±0.03	2.32^{b}±0.03	0.04
Mortality (%)	0.00±0.00	1.00±1.73	0.43

^{ab}Means in the same row with different superscripts differ significantly ($P \leq 0.05$)

No significant difference was observed in dressing percentage of chickens raised in the intensive and semi intensive management systems ($P \leq 0.05$; Table 3). The finding of non-significant difference between the management systems for dressing percentage is similar to the result of Bogosavljević-Bošković *et al.* (2011), who reported that management system did not have a significant effect on dressing percentage in Cobb 500 broilers. In addition, Dou *et al.* (2009) while comparing dressing percentage in broilers under both systems also reported no significant difference.

All major cut parts considered were not significantly different between the management systems except for thigh %. Broiler chickens reared under intensive system gave higher thigh % ($P < 0.05$; 11.44%) compared to those under semi intensive (10.92%). The significantly higher value obtained for thigh % in birds under intensive management system is in support of the work of Poltowicz and Doktor (2011), who reported a higher value for thigh % in Ross 308 broiler birds managed under intensive system.

Birds under semi intensive system had higher ($P > 0.05$; 6.10%) small intestine compared to those under intensive system (4.50%). The non-significant difference obtained in abdominal fat in birds between management systems is in contrast with the report of Wang *et al.* (2009) who reported that birds on semi intensive management system recorded lower abdominal fat. The non-significant difference obtained in the present study might be attributed to the strain of broiler birds used in this study which favoured abdominal fat accumulation. According to Nikolova *et al.* (2007) abdominal fat content was significantly influenced by the strains of broiler chickens where Hubbard broiler chickens were found to record significantly higher abdominal fat content than Cobb 500 broiler chickens. In addition, Acar *et al.* (1991) also recorded significant differences in accumulation of abdominal fat in chickens of different genotypes which indicated the great influence of genetic factor.

Table 3: Effect of intensive and semi-intensive management systems on carcass yield of Marshal broiler chickens

	Management systems		
Parameters	Intensive	Semi intensive	*P*- value
Live weight (g)	1761.11±96.22	1633.33±19.25	0.22
Dressing (%)	66.94±5.38	54.55±11.67	0.19
Abdominal fat (%)	1.32^{a}±0.20	0.88^{b}±1.88	0.00
Major cut parts[1]			
Thigh	11.44^{a}±0.15	10.92^{b}±0.05	0.05
Drumstick	9.65±0.30	9.78±0.12	0.56
Wing	9.36±0.83	9.13±0.43	0.65
Back	13.90±0.16	13.27±0.62	0.30
Breast	18.47±1.17	13.27±0.61	0.11

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Parameters	Management systems		
	Intensive	Semi intensive	*P*- value
Visceral organs[2]			
Gizzard	2.28±0.24	2.73±0.06	0.10
Heart	0.48±0.06	0.50±0.09	0.88
Offals[3]			
Small intestine	4.49±0.43	6.09±0.36	0.06

[123]Percentages of the live weight.

[ab]Means on the same row with different superscript differ significantly (P≤0.05)

Management system had significant influence on the gait score of Marshal broiler birds (Table 4). Birds under intensive system had higher slight ($P < 0.05$; 41.50%) and severe ($P < 0.05$; 7.80%) leg problems than the birds under semi intensive system which recorded 0.00% for slight and 25.76% for severe leg problem. The significantly reduced percentages of slight and severe leg problems under the semi intensive management system might be attributed to the fact that free-range system offers the freedom for chickens to exercise in the paddock, which might improve the development of the bones, reduce leg weakness problems and could be beneficial for health maintenance (Miao *et al.*, 2005). Number of birds with no leg problem under the semi intensive management system (79.10%) significantly increased when compared with those under intensive system (54.50%). According to Rieter and Besse, (1998) high incidence of leg problems in birds under intensive management system was attributed to lack of adequate exercise under the intensive system, which is one of the factors responsible for failure of long bones thus resulting in the high incidence of leg problems in commercial meat type chickens. The result of the findings in this study is in agreement with the report of Sonatra *et al.* (2001) who reported that poor management condition (e.g., high stocking density) increased leg problems and was generally detrimental to health, and this had a direct effect on the behavior of the bird.

Table 4: Gait score of Marshal broiler chickens reared on intensive and semi intensive management systems

Leg problem/ Gait scoring	Management system		
	Intensive	Semi intensive	*P*-value
None (%)	54.50^{b}±0.50	79.10^{a}±1.81	0.00
Slight (%)	41.50^{a}±1.32	25.76^{b}±2.04	0.02
Severe (%)	7.80^{a}±2.71	0.00^{b}0.00	0.04

[ab]Means on the same row with different superscript differ significantly ($P \leq 0.05$)

Conclusion

It can be concluded that broiler birds should be reared in intensive management system for better growth performance and carcass cuts. However, birds reared on semi intensive management system had fewer leg problems compared to birds reared on intensive management system which is a sign of improved welfare. The fewer severe leg problems observed in birds raised in semi intensive management system will help improve their market value thereby making birds more profitable to rear on semi intensive management system.

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