ISSN: 2591-7986

Strain by environmental interaction effects on broiler chickens performance in the derived southern guinea Savannah region of Nigeria.

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Abstract

The study was conducted at a poultry farm along kilometer three, Gboko road, Makurdi, Nigeria. A total of 1004 day-old chicks of three commercial broiler strains, 360 marshal, 322 Arbor Acre and 322 Hubbard) were procured from three different reputable farms. The birds were brooded according to standard brooding technique. The birds were fed *ad-lib* with a commercial pelletized broiler starter feed containing 20% crude protein and 2800 kcal/kg metabolisable energy (from day one to 5th week. This was followed by a commercial broiler pelletized finisher diet containing 19% crude protein and 2900 kcal/kg ME to eight weeks of age. The study was conducted to provide information on the performance of some broiler brands to identify those that are suited for use under the humid tropical conditions of Nigeria. There were significant ($P<0.05$) differences in the effect of strain on daily body weight gain, feed consumption and feed conversion efficiency. Marshal consumed significantly more feed (129.00 g) than Hubbard and Arbor Acre (126.93 g and 123.19 g), respectively. Daily body weight gain was also highest in the marshal (320.00 g). This was followed by Arbore Acre (318.20 g) and least in the Hubbard strain (301.40 g). Arbore Acre had significantly highest feed conversion efficiency (2.5154 ± 0.09), followed by marshal (2.3913 ± 0.08) and least with Hubbard (2.3064+0.08). The energy requirement for body maintenance was least in Arbore acre strain, followed by Hubbard while Marshal Strains had highest energy requirement for maintenance. In the event of conditions limiting feed intake, the performance of Marshal and Hubbard strains will be grossly affected. These strains will be easily heat stressed compared to Arbore acre strain which require small amount of energy for maintenance. Feed intake limiting factors may not affect Arbore acre significantly as little feed energy will be diverted for maintenance. Arbore acre has superior performance. Marshal strain can be adopted and manage to attain market weight at six weeks exploiting the fast body weight gain while avoiding the large feed energy that will be required for maintenance at weeks 7 and 8.

Keywords: Broiler-brands, Body-weight, Energy-requirement, Feed-conversion, Tropical condition.

Accepted on December 14, 2017

Introduction

There is persistent advocacy for the improvement of the world nutritional status, through increase in the intake of protein foods of Animal origin. Ibe and Nwakalor [1] reported that, Nigerians consumes about 10 g of animal protein per day lower than the 35 g recommended by Food and Agricultural Organization (FAO). Consequently, the expansion of the Nigeria commercial poultry industries had been recommended as the quickest way to help bridge the animal protein deficiency gap [2]. The renewed pressure for the expansion of the Nigerian poultry industries had resulted to rapid increase in parent stocks which hatch and sell broiler strain chicks using different brand names [3]. Genetic difference or divergence is expected to exist between these broiler brands due to the quality of parent stock, breeding efficiency and variation in the pedigree from which the brands may have originated [4]. The expected genetic differences or divergence is also expected to be translated into difference in the performance of the broiler brands (feed intake, feed conversion efficiency, body weight gain, target market weight the entire management needs as well as production cost) under humid conditions.

While the brands may differ in their genetic superiority enhancing variation in their phenotypic values, the covariance between the genotypes and the environment and the interaction between the genotypes and the environment are more critical than the genotypes superiority [5,6]. The covariance between the genotypes and the environment as well as the genotypes environmental interaction effects determines the degrees of susceptibility or tolerance to environmental stress, ease of management as well as the economy of production. The degree of susceptibility and tolerance to environmental stress interns determine the cost of inputs, total production cost as well as the economic weight of the broiler brand. Broiler birds are selected and managed to improve feed efficiency and body weight at market age. These traits are affected by environmental stress especially thermal stress, under which the birds reduce feed intake, body weight gain and feed conversion efficiency as means of adaptive response to ambient stress [7]. The biological mechanisms for cooling, (panting), that birds use during hot weather also utilizes energy generated from feed intake [8]. No two or more brands of broiler birds would have same expressions in broiler traits. In addition, the covariance and interaction reactions to the environment effect, of these various brands, are not similar for feed energy diverted to physiological processes of body cooling and maintenance is also expected to vary according to the broiler brand. The net income or economic weight of a broiler brand is associated with energy input and it conversion to body tissue. Any effect that would limit feed intake, feed conversion, body weight gain or divert significant feed energy to other physiological needs than body building would reduce the net income of the enterprise involving the brand.

Feed conversion efficiency had been reported to decline with increase in target market weight as reported by the authors [9,10] that for an 8-week bird, 80 percent of feed energy is diverted to body maintenance. The authors also observed that as maintenance energy increased with age and target market weight, feed conversion efficiency declines; noting that at target market weight feed consumption adds less to expected incremental benefits in broiler production. Broiler brands are expected to differ in their reaction to these effects. The inputs needs, management challenges, cost of production and the expected revenues of the enterprise would also vary in relation to the effects of these conditions on the broiler brand. The magnitude of these effects would determine the cost of production, the profit margin and sustainability of the enterprise. These in turn will determine the choice of a broiler brand and efficiency of the enterprise since broiler brands differed in their genotypes. In addition, the magnitude of their genotype environmental covariance and interaction effects determining their efficiency would also vary in any production environment as reported by Razuki et al. [11].

This scenario becomes more critical and important when broiler production is carried out under highly challenging climatic conditions of the humid tropics (high relative humidity and temperature), poor production environment and management. This is because most broiler production has been targeted as an avenue of job creation, poverty alleviation and economic empowerment by the Nigerian government and non-governmental organizations or as a backyard enterprise to support statutory income sources. This policy had drawn participants into the broiler production industry that do not have the capacity nor the expertise to provide basic needed production environment and management services that would enhance productivity.

The interaction between the broiler brands and the stressful climate conditions, poor production environment and poor management service provided would further limit the expression of the phenotypic value of even the most superior genotypes, thereby undermining the potential of the enterprise and success of the policy. It may even be worse with participant(s) who may have used broiler brands that were highly susceptible to these effects, that the revenue could not offsets the production cost. To these categories, the enterprise and policy were unable to achieve their objectives and hence had failed.

It is however evidenced that, most of these producers are unaware of the important of genotype by environmental interaction enhancing broiler tolerance or susceptibility as a factor determining total production efficiency than initial day old chick weight and specific performance at certain stages of production. Thus there is need to provide information on the performance of some broiler brands to identify those that are suited for use under the humid tropical conditions of Nigeria. The objectives of the study was to provide comparative information on the fitness of broiler brands under humid tropic conditions of Nigeria.

Materials and Methods

The study was conducted at a poultry farm along kilometer three, Gboko road, Makurdi, Nigeria. Makurdi is located between latitude 7° 50-89" N and longitude 7' E. It lies in the middle belt of Nigeria and is characterized by two seasons; dry and rainy seasons. The dry seasons occurs between October-March while the rainy seasons takes place from April and September. In the hot dry season, between February through March, temperatures may reach 35° to 40°C. the relative humidity is between 47 to 87 percent.

A total of 1004 day-old chicks of three commercial broiler strains, 360 marshal, 322 Arbor Acre and 322 Hubbard) were procured from three different reputable farms. The birds were brooded according to standard brooding technique [12]. The birds were fed ad-lib with a commercial pelletized broiler starter feed containing 20% crude protein and 2800 kcal/kg metabolisable energy (from day one to 5th week). This was followed by a commercial broiler pelletized finisher diet containing 19% crude protein and 2900 kcal/kg ME to eight weeks of age.

The birds were vaccinated against Newcastle disease and Mare using spray cabinet at the source. Lakota was given at day 3 and repeated at 28 day. Vitamin–mineral supplement and coccidiostat were provided in drinking water. 'Agracox,' an anti-biotic, was administered in water as a prophylactic measure against bacteria infections. The birds were selected randomly into 6 treatments, in a 3 × 2 (strain by sex) factorial arrangement. Each trait was replicated twice with a minimum of 40 birds. Data were generated on daily feed intake which was measured as

$$\text{F.I / week} = \frac{\text{total feed served} - \text{leftover}}{\text{No of birds}}$$

Where F.I=feed intake.

Individual/average live body weight was measured using a non-digital weighing scale measuring to the nearest 1 g. Body weight gain (BWG) calculated on weekly bases as

$$\text{BWG} = \frac{\text{Current weight} - \text{Previous weight}}{\text{No of weeks}}$$

Where BWG=Body weight gain.

Feed conversion efficiency (FCE) was calculated on weekly bases as

$$\text{FCE} = \frac{\text{Weight gain}}{\text{Feed intake}}$$

Where FCE=Feed conversion efficiency.

Statistical analysis

The data generated were subjected to general linear model procedures of SAS (1990), using the Model.

$Y_{ijk}=\mu+S_i+A_j+B_k+E_{ijkl}$

Where Y_{ijk}	=	Individual measurement
μ	=	Population mean
S_i	=	Effect of strain (J=1, 2, 3)
A_j	=	Effect of age (J=1, 2, 3 ----- 8 weeks)
B_k	=	Effect of sex (K=1, 2)
E_{ijkl}	=	Residual or random error.

Results

Effect of strain on BWG, FC and FCE

There were significant (P<0.05) differences in the effect of strain on daily body weight gain, feed consumption and feed conversion efficiency. Marshal consumed significantly more feed (129.00 g) (P<0.05) than Hubbard and Arbor Acre (126.93 g and 123.19 g) respectively. Daily body weight gain was also highest in the marshal (320.00 g). This was followed by Arbore Acre (318.20 g) and least in the Hubbard strain (301.40 g). Arbore Acre had significantly (P<0.05) highest feed conversion efficiency (2.5154+0.09), this was followed by marshal (2.3913+0.08) and least with Hubbard (2.3064+0.08) (Table 1).

Effect of age on BWG, FC and FCE

There was significant differences (P<0.05) in body weight gain across to the ages. There was significant (P<0.05) higher daily body weight gain (BWG) at week 6 (421.20 g) followed by that at weeks 4 and 7 (333.30 g and 333.02 g). This was low at week 5 and least at week 8 (260.60 and 217.70). Feed conversion and feed intake was highest at week 6 followed by that of week 7 and 8 (136.47+2.59, 132.33+3.03) respectively. Week 5 had the feed intake of 125.08+1.55 while week 4 had the least feed intake (106.78+1.35) (Table 2). The coefficient of variation for BWG, FC and FCE were high.

Feed conversion efficiency

There was significant (P<0.05) difference in feed conversion efficiency (FCE) at all the ages. FCE was significantly (P<0.05) highest at 4 weeks, followed by weeks 6 and 7, weeks 5 FCE was low while week 8 recorded the least significant (P<0.05) value (Table 2).

Effect of strain and age on BWG, FI and FCE

Analysis of variance result indicated significant (P<0.05) effect of strain and age on BWG, FI and FCE (Table 3).

Table 1. *Effect of Strain on body weight gain, feed consumption and feed consumption efficiency.*

Variables	Strain	Mean ± SE
Body weight gain (g)	Marshal Arbore Acre Hubbard	32.00^a ± 10.50 318.20^b ± 11.20 301.40^c ± 10.0
Feed consumption (g)	Marshal Arbore Acre Hubbard	129.00^a ± 2.33 123.19^b ± 2.45 126.93^c ± 2.17
Feed conversion efficiency	Marshal Arbore Acre Hubbard	2.391^a ± 0.08 2.515^b ± 0.09 2.306^c ± 0.08

[a,b,c]Figures with different superscripts down the group are significant (P<0.05) different.

Discussion

Effect of strain on body weight gain

The significant (P<0.05) difference in body weight gain of the strains is an indication of their genetic variability in this trait. Deeb and Lamont [4] had reported that genetic differences existed among broiler strains. Marshal strain was superior in this trait followed by Arbore Acre and Hubbard been the least.

Effect of strain on feed consumption

The higher feed consumption of Marshal strain followed by Hubbard is an indication of the genetic variation between them [11] and their different energy requirement, since birds eat to satisfy their energy requirement. The lowest feed intake of Arbore Acre strain on the other hand implied that it energy requirement was very low compared to the other strains [13]. It is reasonable to inferred from the above that, any factor limiting feed intake will affect grossly, the performance of Marshal followed by that of Hubbard while AR hoe Acre strain will be least affected due to their genetic differences.

Effect of strain on feed conversion efficiency

Feed conversion efficiency of Arbore Acre was superior to that of both Marshal and Hubbard strains. Again this is an indication that more feed energy was converted to body building and only a little left for body maintenance. Limiting feed intake by increase in environmental temperature will affect Arbore acre strain marginally. On the other hand, the lower feed conversion

Table 2. *Effect of age on body weight gain, feed consumption and feed conversion efficiency of the strains.*

Variables	Age in (weeks)	Means ± SE	Coefficient of Variation (CV) (%)
Body weight gain (g) (BWG)	4 5 6 7 8	333.02^a ± 7.41 260.60^b ± 11.60 421.20^c ± 16.10 333.30^d ± 14.00 217.70^e ± 13.20	26.71 53.51 45.96 50.42 72.60
Feed consumption (g) (FC)	4 5 6 7 8	106.73^a ± 1.35 125.08^b ± 1.85 136.47^c ± 2.59 132.33^d ± 3.03 131.27^e ± 4.50	15.16 17.79 22.77 27.44 41.16
Feed conversion efficiency (FCE)	4 5 6 7 8	43.09^a ± 0.07 52.04^b ± 0.10 62.10^c ± 0.1 2.43^d ± 0.11 1.46^e ± 0.09	27.01 56.29 43.23 53.36 72.68

[a,b,c,d,e]Figures with different letters within a variable are significant (P<0.05) different.

Table 3. *Analysis of variance result on effect of strain and age on body weight gain, feed consumption and feed conversion efficiency.*

Variables	Sources of variation	Degree of freedom	SS	MS	Fcal
Body weight gain (g)	Strain Age (week) Error	2 4 704	50481 3505192 15650206	25240 876298	1.14* 39.42**
Feed consumption (g)	Strain Age (week) Error	2 4 704	4167.0 79034.0	2084 19758	1.79* 17.02**
Feed conversion efficiency	Strain Age (week) Error	2 4 704	5.306 265.492 863.146	2.653 66.373 1.226	2.16* 54.14**

*Significant at (P<0.05)
**Significant at (P<0.05)

efficiency of Marshal and Hubbard strains indicated that, their energy requirement for maintenance was high. Limiting their feed intake by environmental factors therefore would drastically affect their performance. The low feed consumption and the high feed conversion efficiency made Arbore acre strain superior to Marshal and Hubbard strains. It will be easy to manage during heat stress period compared to the other strains.

Effect of age of bird on body weight gain, feed consumption and feed conversion efficiency

Body weight was highest at week 6 followed by that at weeks 4 and 7. At week 4, feed energy consumed was used for body building as the energy required for maintenance was low; hence the feed conversion efficiency was very high at these age. At weeks 6 and 7 part of energy intake was diverted to body maintenance leaving a balance for tissue building hence the decline in feed conversion efficiency from 3.092+0.07 at week 4 to 2.99+0.1 and 2.43+0.11 at weeks 6 and 7, respectively [8,9].

Feed consumption increases steadily from weeks 4 to 8, the maintenance energy also increase as the birds advanced in age while feed conversion efficiency also declines with age [7]. It is important to give the birds special attention in quality of feed and feeding at weeks 4, 6 and 7. The high coefficient of variation in body weight feed consumption and feed conversion efficiency at weeks 7 and 8 were indicators of severe effect of environmental factors on these parameters at these ages. The significant ($P<0.05$) effect of strain and age of birds on the analysis of variance result indicated that there was variation in the genotype as well as the energy requirement of the strains. This resulted to varied expression of their potentials on body weight gain, feed consumption and feed conversion efficiency. Age also played a significant role in eliciting the responses of the stains. The body weight gain, feed consumed and feed consumption efficiency were all affected by specific physiological demands at specific age. This determined maintenance energy requirement, feed intake, feed conversion efficiency and the ultimate body weight gain [14,15].

Conclusion and Recommendation

Conclusion

Body weight differed among the strains. Marshal had the highest body weight followed by Hubbard while Arbore acre was the least; feed consumption was also highest in Marshal, followed by Hubbard and Arbore acre. Feed conversion efficiency was highest in Arbore acre, followed by Marshal and least in Hubbard. The energy requirement for body maintenance was least in Arbore acre strain, followed by Hubbard while Marshal Strains had highest energy requirement for maintenance. In the event of conditions limiting feed intake, the performance of Marshal and Hubbard strains will be grossly affected. These strains will be easily heat stressed compared to Arbore acre strain which require small amount of energy for maintenance. Feed intake limiting factors may not affect Arbore acre significantly as little feed energy will be diverted for maintenance.

Recommendation

These three strains can be reared in the derived Savannah region of Nigeria but Arbore acre however is superior. Marshal strain however, can be adopted and manage to attain market weight at six weeks exploiting the fast body weight gain while avoiding the large feed energy that will be required for maintenance at weeks 7 and 8.

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