Sjournals
Scientific Journals
Scientific Journal of Animal Science (2013) 2(6) 144-149
ISSN 2322-1704

Contents lists available at Sjournals
Scientific Journal of Animal Science
Journal homepage: www.Sjournals.com

Original article

The egg production performance of three layer strains kept under intensive system in the hot and humid tropics

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ARTICLE INFO

Article history:
Received 10 May 2013
Accepted 18 May 2013
Available online 29 June 2013

Keywords:
Lohmann
Black bovan
Strain
Egg quality
Egg performance

ABSTRACT

The egg production industry in Ghana is bereft with many challenges; prominent among them is the appropriate layer strain to use to achieve optimum production. It was against this background that a study was carried out to determine the egg production performance of the common layer strains kept in the country. A total of three hundred (300), eighteen week old layers, 100 each of Lohmann Brown (brown feathered), Lohmann Classic (white feathered) and Black Bovan (black feathered) strains were randomly allocated to a Completely Randomized Design (CRD) experiment with five replicate with 20 birds in each replicate group and kept up to 72 weeks. The birds were kept in an open-sided partitioned deep litter pens with a bird density of $0.39m^2$ per bird. Feeding and watering was provided *ad lib*. They were provided with layer mash of 17% crude protein and 3000kcal ME. Data on egg production, growth characteristics and egg quality were taken. Data obtained showed a significant (P<0.05) strain effects on egg production performance with Black Bovan strains laying their first egg significantly earlier (135 days) than their Lohmann counterparts (140 and 142 days). The Bovan layers also produced on hen-day basis, significantly at a higher rate (80.1%) than the Lohmann Brown (76.2%), which also produced significantly more eggs than its white feathered counterparts (72.4%). There were also significant differences (P<0.05) in terms of feed conversion ratio with the Bovan strains being significantly more efficient in converting feed to eggs than their Lohmann counterparts. Feed consumption was significantly affected by the strain of layers. It was also realized that the major determinants of egg quality were significantly (P<0.05) affected by the strain of the layer.

1. Introduction

The layer, unlike the broiler industry, has been one of the industries making considerable strides in the country over the years. The industry grew from 1.0% in the year 1990 to 10.5% in 2000, and continues to increase (MoFA 2010). Out of the total poultry population of about 52 million currently, about 60% of them are layers (MoFA, 2012). The national per capita egg consumption is one of the lowest in the sub-Sahara Africa, with an estimated average egg consumption of 20 eggs per annum as against the world average of 154 eggs per annum. Even though the contribution of the layer industry to the agricultural Gross National Product is low, its role in rural livelihoods and food security is enormous. The government of Ghana has therefore identified the poultry sector as the greatest potential for addressing the acute shortfall in the supply of meat and eggs and job creation. This probably might be due to their short generation interval, high rate of productivity, quick turnover rate, better feed conversion rate and low labour and land requirement.

The commercial egg production in the country is largely reliant on layer strains imported from Europe due to the absence of specialised breeding farms. Most of these layer strains were developed in temperate regions but due to the hot and humid conditions in the country, according to Fairfull (1990), these layer strains are not able to express their full egg laying potential. According to Ojedapo et al. (2008) adequate information on growth and egg production potential of different commercial layer strains is essential to poultry farmers so as to assist in the choice of layer strain to use. Again, because the egg production business is only profitable if the right and improved strains are used Agbamu (2005) there is therefore the need to have adequate information on growth and egg production potential of these imported layer strains under the hot and humid environments in the country so as to guide farmers in their choice of strain to use.

According to MoFA (2010) the following egg-laying strains are available in the country: Shaver, Starcross, Hisex Brown, ISA Brown, Bovan Black, Lohmann (Brown and White feathered strains), and Afabird (the only breed developed locally). Among these, the lohmann and the Bovan breeds are the commonly reared ones. The objective of the study was therefore to assess the egg production characteristics of the three most widely used layer strains in the country in order to recommend the most suitable to use for egg production under the hot and humid environments.

2. Methodology

2.1. Location of the study

The research was undertaken at the Teaching and Research Farm of School of Agriculture, University of Cape Coast. The experiment lasted 54 weeks. The location of the experiment lies in the coastal belt characterized by hot and humid conditions. The annual average temperatures range from 24.0^{0}C in the coolest part of the year and 34.5^{0}C in the hottest part of the year with an annual rainfall of 1500mm and a relative humidity of 65-80%. The location also lies within latitude 05^0 05`N and longitude 1$^0$ 15`W.

2.2. Management of the birds

The birds used were sampled from 3000 day-old chicks, 1000 each of Lohmann Brown, Lohmann White and Black Bovan which were imported from Holland. The birds were brooded at the Poultry Section of the University Farm. After eight weeks of brooding, they were transferred to a grower house and fed grower mash of 16% crude protein and 2700kcal ME. At sixteen weeks of age, 300 pullets, 100 from each strain were randomly selected and kept in an open-sided partitioned deep litter pens. The pens were divided into 9 compartments with a stocking density of 390cm^2 or 0.39m^2 per bird. Adequate ventilation was ensured in each compartment to make the birds comfortable. The floor was covered with wood shavings to act as absorbent for the faecal droppings. The birds were feed on layer mash of 17% crude protein and 2800kcal ME. Feeding and watering were done in such a way that the birds had enough to avoid over-feeding or under-feeding. The feeding and water troughs were cleaned daily to ensure there was no contamination. All the necessary prophylactic and vaccination schedules were followed.

2.3. Experimental design

Three hundred (300), sixteen week old commercial layers, 100 each of Lohman classic (white-feathered), Lohman Brown (brown-feathered) and Black Bovan (black-feathered) strains were assigned to a Completely Randomized Design experiment with three treatments (strains of layers) and five replications, with twenty birds in each replicate.

2.4. Data Collection

Each bird in the replicate group was weighed at the beginning of the experiment using an electronic top-loading balance of 5kg capacity. Thereafter, the birds were weighed every four weeks. The total weight of each replicate group was then divided by the number of birds to obtain the average weight per bird in grams for the replicate. The initial average weight was then subtracted from the final average weight to obtain the weekly weight gain in grams. This was then divided by the number of days to obtain the growth rate per bird per day in grams for each line. Feed provided was weighed using the same scale. Feed conversion ratio was calculated as the ratio of feed consumed in kilogram to weight of kilogram eggs. Hen-day egg production was therefore calculated as the percentage of the number of eggs laid to the number of hen days according to (National Animal Production Research Institute, 2002). The formula used was as shown below:

$$\text{Hen}-\text{dayeggproduction}(\%) = \frac{\text{Numberofeggslaid}}{\text{Numberofhen}-\text{days}}\text{X}\,100$$

$$Number\ of\ hen-days = no.of\ laying\ days\ X\ number\ of\ birds\ alive$$

Eggs were measured for internal and external quality traits. The following constituted external egg characteristics: egg weight (g), egg length and width (mm), shell weight (g) and thickness (mm). The determinants of internal egg quality traits are: albumen weight (g), albumen height (mm), yolk height (mm) and haugh unit (%). Egg dimensions (length and width) and shell thickness were measured using digital vernier calipers as explained by Al-shami et al. (2011). The other egg internal and external traits were measured or determined using the methods proposed by Haugh (1937), Ehtesham and Chowdhury (2002), Parmar et al. (2006), Kumari et al. (2008) and Nonga et al. (2010).

2.5. Statistical analysis

Data collected were subjected to one-way Analysis of Variance (ANOVA) with strain effect using the GenStat (Discovery Edition) Software. Where differences in means existed, the means were separated using the least significant difference (lsd) at 5% level of significance. The following linear model was used in the analysis of the results:

The linear model below was used for the data analysis.

$Y_{ij} = \mu + S_i + \varepsilon_{ij}$

Where Y_{ij} = performance of the jth layer of the ith strain

μ = overall general mean common to all observations

g_i = fixed effect due to ith strain (i = 1, 2, 3)

ε_{ij} = random error effects peculiar to each observation

3. Results and discussion

The age at sexual maturity of the three layer strains has been presented in Table 1. It could be seen that Black Bovan layer strains laid their first egg significantly earlier (135 days than the Lohmann brown (140) and the Lohmann white (141) layers. The former also laid significantly (P<0.05) more eggs (275 eggs) than the Lohmann strains. The egg production performance of the three strains at the University Farm is comparable to the annual egg production (230-270) of commercial layer strains in Ghana (Tweneboah, 2000 and Koney, 2004 and MoFA, 2010). According to Olawumi and Adeoti (2009) there are strain differences as far as egg production is concerned with brown feathered strains laying more eggs than their black feathered counterparts. This disagrees with the results from the present work. The existence of significant strain differences with regard to egg production has been reported by several authors (Charles and Tucker, 1993; Bateman et al., 2002; Yakubu et al., 2007 and Ojedapo et al., 2008). Duduyemi (2005) however reported of insignificant difference in egg numbers between the brown and black feathered strains of Bovan. This the author attributed to the intensive selection that has gone on in commercial layer strains over several generations. From Table 1 it could be seen that Black Bovan strains laid significantly (P<0.05) at a higher rate (80.1%) than the Lohmann Brown counterparts (76.2%) strains which also laid at a significantly (P<0.05) higher rate than their Lohmann white counterparts (72.4%). With the egg weight there was no significant difference (P>0.05) among the lines. Again with egg mass which is a product of egg weight and hen day average there was a significant difference (P<0.05) between the lines. From the table it would be clearly seen that black Bovan strains have significantly (P<0.05) higher eggs mass than the Lohmann strains. However within the two Lohmann strains the brown feathered bird had a higher mass than the white. Again from the table it would be clearly seen that black Bovan strains consume significantly (P<0.05) more feed than the Lohmann strains. However within the two Lohmann strains there was no significant difference (P<0.05) between them.

Table 1
The egg production and growth performance of the three strains of layers.

Parameters	Strains			
	Lohmann white	Lohmann brown	Black bovan	S.E.M
Egg production, no	263.5^{c}	270.4^{b}	275.6^{a}	3.1
Age at first lay, days	141^{b}	140^{b}	135^{a}	2.5
Rate of lay, %	72.4^{c}	76.2^{b}	80.1^{a}	1.2
Egg mass, g	45.8^{c}	47.3^{b}	50.2^{a}	1.1
Feed intake, g/bird/day	123.6^{b}	121.7^{b}	128.7^{a}	2.0
Feed conversion ratio	3.0^{b}	3.0^{a}	2.5^{a}	0.3
Initial body weight, kg	1.45^{b}	1.55^{a}	1.50^{a}	0.05
Final body weight, kg	1.50^{b}	1.65^{a}	1.65^{a}	0.05
Weight Gain, kg/bird	0.10^{b}	0.11^{b}	0.20^{a}	0.20
Mortality, %	5.1	5.0	4.7	0.2

Means in the same row for each parameter with common subscripts are not significantly (P<0.05) different
S.E.M refers to the standard error of means

Table 2
The external egg characteristics of the three layer strains.

Parameters	Strains			
	Lohmann white	Lohmann brown	Black bovan	SEM
Egg weight (g)	63.3	62.0	62.7	0.9
Egg shape index (%)	76.4^{a}	76.4^{b}	78.6^{a}	0.40
Egg shell wt (g)	5.7^{c}	6.8^{b}	7.9^{a}	0.03
Percent eggshell (%)	11.2	11.5	11.3	0.51
Egg shell thickness (cm)	0.39	0.37	0.38	0.01
Egg length (cm)	6.6	6.7	6.5	0.04
Egg width (cm)	5.2	5.2	5.1	0.03

Means within rows with different superscripts are significantly different (P<0.05)

From Table 2, it can be seen that Black Bovan layers laid significantly (P<0.05) heavier eggs as compared to the Lohnman breeds, an indication of genetic effects of egg weight. This confirms the observation by Pott *et al.* (1974), Arafa et al. (1982), Monira et al. (2003) and Alewi et al. (2012) that the weight of eggs was influenced by the type of breed. Egg shell weight and shape index were also significantly influenced by breed with Black Bovan layers laying eggs with significantly superior external qualities as compared to the Lohmann Breeds. This also confirms the observation by Singh et al. (2009) that different strains of laying hens vary significantly in egg shell quality. This could be that the Black Bovan strains have been selected for large egg size, making it a better choice if large egg size is desired. This could be that the Black Bovan strains have been selected for large egg size, making it a better choice if large egg size is desired. Again, the heavier weight of the Black Bovan strains compared to the Lohmann strains might be responsible for the bigger eggs laid by the former, as body weight is directly correlated with egg size.

The insignificant difference (P>0.05) in egg weight between the two Lohmann Strains could be as a result of possible close relationship between the two strains (Singh et al., 2009), that is, they two strains might be having similar genetic origins. Several researchers (Washburn, 1990; Bateman et al., 2002; Yakubu et al., 2007 and Ojedapo et al., 2008) have compared the eggs of brown and white laying strains and concluded that brown layers are heavier and lay bigger eggs than white layers. The data obtained in this present did not however agree with those reported results. There were also no significant differences (P>0.05) in egg shell thickness, percent egg shell and egg length, an indication of no genetic effects on these external egg parameters.

The effect of strain of layers on egg internal qualities have been presented in Table 3 with eggs from Black Bovan having significantly (P<0.05) heavier yolk weight, albumen weight, better percent albumen, better haugh unit and better albumen height than eggs from the Lohmann strains. According to Washburn (1990), there is a correlation between egg weight and albumen weight, meaning that as egg size increases, so does the percent of albumen. It was not surprising to observe that Black Bovan layers produced eggs with the best percent albumen as compared to the other strains. Egg freshness is classically measured by its haugh unit (HU). Haugh unit is the measure of albumen thickness upon breaking of the egg, following a standardized procedure. It is assumed that lower HU reflects lesser freshness and there have been several reports of breed effects on this egg quality trait. The Black Bovan strains were found to be superior in egg quality as far as haugh unit is concerned (Table 3) as compared with the Lohmann strains, a confirmation of breed effects on egg internal quality as observed by Hagan et al. (2011). There is therefore the need to consider the type of breed to keep with regards to egg production.

Table 3
The internal egg characteristics of the three layer strains.

Parameters	Strains			SEM
	Lohmann White	Lohmann Brown	Black Bovan	
Yolk weight (g)	14.9^{c}	15.7^{b}	16.9^{a}	0.77
Albumen weight (g)	29.9^{c}	32.5^{b}	37.7^{a}	0.55
Percent yolk (%)	29.7	28.8	29.6	0.15
Percent albumen (%)	58.0^{c}	61.3^{b}	63.3^{a}	1.10
Yolk colour	10.3	10.4	10.4	0.20
Haugh unit (%)	77.4^{b}	75.9^{b}	85.2^{a}	0.69
Albumen height (mm)	7.9^{c}	8.8^{b}	9.9^{a}	0.07
Yolk height (mm)	16.7	16.5	17.1	0.08

Means within rows with different superscripts are significantly different (P<0.05)

5. Conclusion

The results obtained showed that the Black Bovan strains of layers were superior in most of the egg production parameters taken, making them most suitable for the hot and humid environments experienced in the country. There is therefore the need to consider the rearing of the black feathered strains for the purposes of egg production. Any efforts at improving the egg production performance of exotic layer strains that are to be reared under hot and humid environments are to be targeted at the Black Bovan strains.

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