Fertility, Body Weight and Survivability of Two Lines of Broiler Stock under Selection

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Abstract

This study was conducted to evaluate the performance of two lines of broiler breeders under selection. The traits of interest were fertility, body weight and survival rate. A total of 120 day-old broiler chicks were hatched from two lines of broiler breeder chickens under selection (Sire and Dam lines). The chicks were hatched from a population of breeder hens and cocks with a mating ratio of 1 broiler cock to 6 broiler hens (1:6). Eggs were collected and pedigreed according to the lines and sire information. The eggs were weighed on a Camry model digital sensitive scale in grams. Eggs were set and hatched in a Buckeye incubator. Each hatched chick was tagged and weighed at hatching and then weekly up to 8 weeks. Data were analyzed using general linear model (GLM). Correlation and regression analysis were based on pooled data from both lines. Results showed that the lines differed with respect to fertility (67.67% and 83.00%), hatchability (77.79 and 49.00) and survival rate (77.78 and 94.14).Also changes in body weight increased as their ages increased with the dam line being superior. There was a low R^2 value of between 0.05 – 0.33 when egg weight and hatch weight were pooled and considered as independent variables. In conclusion the lines were superior to each other differently as the sire line had better egg weight and hatchability while the dam line was better in fertility, survival rate and body weight performance. This variation in traits can be used in selection for hybrid strain in the broiler.

Key words: Performance, sire and dam lines, fertility, hatchability

Introduction

The constantly growing worldwide demand for low-cost protein of animal origin has led to major investments in genetics by the poultry industry. This growing demand has led to an increase for broiler meat due to its fast growth rate, tenderness and taste when compared with other meat types (Olawumi, 2013). Also, the efficient production of poultry meat from broiler chickens has evolved through the development of specific lines by intense selection for higher growth rate of birds up to market weight.

Currently, there is an improvement in potentials of new broiler strains (Kemp and Kenny, 2003) to provide high quality and low-cost protein for the world population. With the genetic improvements made by breeders, broiler hybrids still differ in their efficiency due to the specific selection objectives (Emmerson, 1997). Hence evaluation of promising crosses selected for high fertility, high live weight, high weight gain, feed conversion, survival rate, carcass traits and adaptation potential would contribute to high efficiency of broiler chicken production.

The knowledge of heritability estimates and genetic correlations are fundamental. This will makes it possible to have information about the nature and action of genes involved in the inheritance of traits and to monitor the genetic variation of traits that are to be selected by geneticists (**Venturini, *et al.,* 2014**). Traits of interest depend on numerous factors which researchers have reported substantial effect of strain on live weight (Ojedapo *et al.*, 2008; Razuki *et al.*, 2011), feed conversion and carcass composition (Havenstein *et al.*, 2003; Santos *et al.*, 2004; Marcato *et al.*, 2006; Nikolova and Pavlovski, 2009), carcass weight (Rondelli *et al.*, 2003), and abdominal fat (Barbato, 1992; Fontana *et al.*, 1993).

Fertility in poultry is regarded as an independent trait of either the male or the female. However, genetic and non-genetic factors originating from both the male and female affect fertilization of the egg and subsequent embryo development. According to Brillard (2003), fertility of an individual egg is a function of the genotype of the embryo to which both parents (sire and dam) contribute. Hatchability however, is the rate of hatching incubated or fertile eggs into viable chicks after 21 days incubation. It is determined on the basis of all eggs set and after candling on the eighteenth day of incubation (Orunmuyi *et al.,* 2011). The production of first-quality chicks depends on the breeding and hatching performance of the parent stock. Failure to hatch is caused by infertility or by death of embryo after fertilization. The observation of Kabir and Suleiman (2012) was that fertility and hatchability are interrelated heritable traits that have variations among breeds. Consequently, the survival of newly hatch chicks stems from factors that affects hatchability like time of egg storage (Lapao *et al.,* 1999), genetic factors, nutrition, environmental and disease. Therefore, the objective of this study was to evaluate the performance of the lines under selection on fertility rate, body weight and survival rate of the chicks.

Materials and Methods

Experimental site

The experiment was conducted at the Research Unit of the Poultry Research Programme of National Animal Production Research Institute, Shika-Zaria. Shika lies between latitude 11° 12' 42" N and longitude 7 ° 33' 14" E and its on altitude 640m above sea level (Ovimaps, 2014). The temperature of Shika ranges between 14.5 – 39.5 °C with a humidity range of 21 - 72% occurring during the early dry and wet season respectively. Detailed description of Shika climate has been given elsewhere by Kabir *et al.* (2006).

Experimental birds and their managements

A total of 120 day-old broiler chicks were hatched from two lines (Sire and Dam) of broiler breeder populations under selection. The mating ratio for the breeding flock from which the chicks were hatched was 1 cock to 6 hens. Eggs were collected and labeled according to sire identification and line. This was to enable the identification of the pedigree of each chick hatched. Each egg was then weighed prior to setting using a Camry digital sensitive weighing scale. The stock from which eggs were collected was put on a broiler restriction diet of 170g per bird per day. Pens were supplied with hanging bell feeder's and water troughs to provide feed and water. Eggs that were collected for the study were then taken to the hatchery where the eggs were examined for mechanical damage. Potassium permanganate (K_2Mno_4) was used to fumigate the eggs. Settable eggs were put into setting trays according to line and then put into the setter. Three days to hatching, the eggs were candled and hatchable eggs were then transferred into individual cubicle in the partitioned hatching tray. At hatch each tagged chick was weighed to obtain the hatch weight while un-hatched eggs were also recorded accordingly. Subsequent weight records were taken weekly for eight weeks. The chick's survival percentage was obtained as the total number of birds that survived from day-old till the birds were eight weeks of age.

Data Analysis

Data obtained were subjected to statistical analysis using general linear model of SAS (2002). Correlation and regression analysis was done using information from pooled data of both lines. The Coefficient of Variation (CV) was obtained by expressing the standard deviation as a percentage of the average weight, that is: CV% = (SD/Mean) x 100. The following simple linear equation was used to predict body weight from egg weight and hatch weight:

$$Y = a + bx$$

Where; Y = body weight, a = regression intercept, b = regression coefficient and x = independent variable.

The mathematical model is as expressed below:

$$Y_{ijk} = \mu + L_i + S_j + e_{ijk}$$

Where;

Y_{ijk}=measurement of trait on the i^{th} line of the j^{th} egg size of the k^{th} random error; μ=overall mean; L_i=effect of the i^{th} line (sire and dam), S_j= effect of the j^{th} egg size (small, medium and large) and e_{ijk} = random error assumed to be normally and independently distributed.

Percent fertile, hatchability, infertile eggs and percent survival were estimated as follows:

$$\% \text{ infertile} = \frac{\text{Total number of infertile eggs}}{\text{Total number of eggs set}} \times 100$$

$$\% \text{ fertile} = 100 - \% \text{ infertile}$$

$$\% \text{ hatchability} = \frac{\text{Total number of hatched egg}}{\text{Total number of fertile eggs}} \times 100$$

$$\% \text{ survival} = \frac{\text{Total number of birds alive}}{\text{Total number hatched}} \times 100$$

Results and Discussions

Table 1 presents the Least Square Means (±SE) for various traits in two lines of broiler breeders under selection. All traits differed significantly (P<0.001) between the lines. Egg weight was highest in the sire line while higher number of egg set was obtained in the dam line. Percentage fertility and survival were better in the dam line while percentage hatch was higher in the sire line. Degree of spread as shown by the coefficient of variation ranged from 0.03 to 0.12 across all measured traits. The observed significant differences in the lines for performances in egg traits, fertility, hatchability and survival were consistent with the report of Hristakieva *et al.* (2014) who studied the effect of genotype on production traits in ROSS and COBBS broiler chickens. In a review of factors that influence egg fertility and hatchability in poultry, genetic differences have been reported by King'ori (2011) as a major factor influencing these traits. Differences in mean weight of egg set per line have also been reported by Hristakieva *et al.* (2014). Mean fertility reported in the dam line were in agreement with the observation of 84.16-86.36% reported by Hristakieva *et al.* (2014) while that of the sire line were lower. Hatchability % as a proportion of fertile egg though high was lower than the range of 90.66-91.58 reported (Hristakieva *et al.*, 2014). Survival percentage observed in the dam line was comparable to the industry standard for Cobb 500 breeder (Ramaphala 2013) while that of the sire line were considerably lower.

Table 1: Least squares means (±SE) for various traits in two lines of broiler under selection

Parameters	Sire line	Dam line	CV (%)	P-Value
Eggs weight (g)	59.12±0.03[a]	55.02±0.03[b]	0.12	0.001
Eggs set	67.05±0.014[b]	82.02±0.014[a]	0.09	0.001
Eggs fertility (%)	67.67±0.0001[b]	83.00±0.0001[a]	0.04	0.001
Eggs hatchability (%)	77.79±0.0001[a]	49.00±0.0001[b]	0.03	0.001
Eggs unhatched (%)	23.23±0.0001[a]	51.47±0.0001[b]	0.03	0.001
Survival rate (%)	77.78±0.0001[b]	94.17±0.0001[a]	0.04	0.001

[ab]Means in the same row with different superscripts are statistically different (P<0.05), CV= Coefficient of variation

Table 2: Effect of line (±SE) on the body weight performance of two lines of broiler under selection

Parameters (g)	Sire line	Dam line	CV (%)	P-Value
Hatch weight	37.73±0.61[ns]	37.52±0.80[ns]	11.99	0.72
BW (week 1)	74.84±1.39[ns]	76.74±1.84[ns]	15.82	0.86
BW (week 2)	186.99±4.04[ab]	195.13±5.33[a]	24.36	0.05
BW (week 3)	355.27±6.48[b]	386.36±8.56[a]	27.21	0.001
BW (week 4)	469.68±11.21[b]	478.36±14.80[a]	33.12	0.05
BW (week 5)	516.61±22.10[b]	526.68±29.18[a]	39.91	0.05
BW (week 6)	986.25±31.33[b]	1133.89±41.37[a]	38.01	0.01
BW (week 7)	1283.44±36.00[b]	1350.90±47.54[a]	35.81	0.01
BW (week 8)	1991.82±54.73[b]	2119.32±72.00[a]	35.88	0.01

[ab]Means in th e same row with different superscripts are statistically different (P<0.05), ns= not significant, CV= Coefficient of variation
BW=body weight

Table 2 shows the effect of lines on body weight performance. Hatch weight and body weight at week 1 had no significant (P>0.05) difference however, body weights from weeks 2 to 8 had significant (P<0.05) differences with dam line performing better. The values obtained for hatch weight in this study were lower (42.86-44.96g) than those reported by Hristakieva *et al.* (2014). Also, the weekly body weights obtained in this study were lower than those reported by the same authors. The differences could be attributed to differences in the potentials of the breeder stocks, level of selection, environment and nutrition. However the values obtained for the study were similar to those reported by (Adejoh-Ubani *et al.*, 2015) who worked using the same lines on selection response. The non significant differences in hatch and weight at week 1 are not in agreement with the findings of Adejoh-Ubani et al. (2015); Hristakieva et al. (2014). Subsequent differences in weight were consistent with the observations made by several authors (Ojedapo et al., 2008; Razuki et al., 2011). The importance of the dam line having significantly better weight than the sire line may be in the supposition that the hybrid resulting from the cross of the two lines will receive better growing ability from the dam through the egg which will influence hatch weight and subsequent weight gain.Effects due to sex within lines are shown in tables 3 and 4. In both lines, hatch weight and weight at week 1 did not differ significantly (P>0.05). Male birds were consistently heavier than their female counterpart from the fourth week to the eighth week in the sire line but from the third week to the eight week in the dam line. The highest body weight recorded for males was 2273.31±70.76g in the dam line while for females it was 1987±104.96g in the sire line. The observed heavy weights in males than females in both lines are consistent with the sexual dimorphism in chicken where males are heavier than females. This result obtained agreed with the findings of Scheuermann et al., 2003 who studied the muscle development broiler chickens and how sex plays a vital role in muscle development. The findings of sexual dimorphism also agrees with those of Mendes et al. (2004); Tahir et al. (2011) and Hristakieva et al. (2014) in broiler breeds and strains in most ages.

Table 3: Effect of sex within sire line (±*SE*) *on the body weight performance*

Parameters (g)	Sire line			
	Male	Female	CV (%)	P-Value
Hatch weight	37.58 ± 0.92^{ns}	38.40 ± 1.17^{ns}	11.99	0.72
BW (week 1)	73.54 ± 2.12^{ns}	77.05 ± 2.68^{ns}	15.82	0.86
BW (week 2)	180.61 ± 6.15^{ab}	197.36 ± 7.74^{a}	24.36	0.05
BW (week 3)	331.66 ± 9.87^{b}	352.91 ± 12.47^{a}	27.21	0.001
BW (week 4)	473.91 ± 17.06^{a}	458.79 ± 21.58^{b}	33.12	0.05
BW (week 5)	538.06 ± 33.63^{a}	507.04 ± 42.53^{b}	39.91	0.05
BW (week 6)	997.91 ± 47.68^{a}	961.66 ± 60.32^{b}	38.01	0.01
BW (week 7)	1362.34 ± 54.79^{a}	1248.00 ± 69.30^{b}	35.81	0.01
BW (week 8)	2120 ± 82.98^{a}	1987 ± 104.96^{b}	35.88	0.01

^{ab}Means in the same row with different superscripts are statistically different ($P<0.05$), ns= not significant,
CV= Coefficient of variation

Table 4: Effect of sex within *dam line (±SE) on the body weight performance*

Parameters	Dam line			
	Male	Female	CV (%)	P-Value
Hatch weight	37.88 ± 0.79^{ns}	36.65 ± 1.10^{ns}	11.99	0.72
BW (week 1)	65.13 ± 1.81^{ns}	66.43 ± 2.52^{ns}	15.82	0.86
BW (week 2)	191.37 ± 5.24^{ns}	201.90 ± 7.30^{ns}	24.36	0.05
BW (week 3)	390.88 ± 8.41^{b}	377.80 ± 11.72^{a}	27.21	0.001
BW (week 4)	484.46 ± 14.55^{a}	462.94 ± 20.27^{b}	33.12	0.05
BW (week 5)	558.17 ± 28.68^{a}	469.31 ± 39.95^{b}	39.91	0.05
BW (week 6)	1205.59 ± 40.67^{a}	987.11 ± 56.66^{b}	38.01	0.01
BW (week 7)	1450.54 ± 46.72^{a}	1284.80 ± 65.09^{b}	35.81	0.01
BW (week 8)	2273.31 ± 70.76^{a}	1969.50 ± 98.59^{b}	35.88	0.01

^{ab}Means in the same row with different superscripts are statistically different ($P<0.05$), ns= not significant

Table 5 shows the pooled pearson correlation coefficients between egg weight, hatch weight and weekly body weight. All correlations were positive except those between egg weight and body weights from week 3 to week 8. Positive but not significant ($P>0.05$) correlations were found between hatch weigh and body weights from week 3 to 8. The positive and significant correlations ranges between low (0.23) to very high (0.98). The observed decrease in the correlation of egg weight and weekly body weight and hatch weight with weekly body weights are in agreement with the findings of Shadparvar and Enayati (2012) in Mazandaran native breeder hens. The authors reported that egg weight only influences hatch weight, while hatch weight correlates with the first two weeks body weight after which their association diminishes. The observed high and positive correlations among weekly body weights from the second week to the eight week are consistent with the report of Ramaphala (2013) in Cobb broiler chickens.

Table 5: Pooled correlation coefficient for egg weight, hatch weight and body weight at various ages

Parameters	EWT	HWT	BWwk1	BW wk2	BW wk3	BW wk4	BW wk5	BW wk6	BW wk7	BW wk8
EWT										
HWT	0.39**									
BWT wk 1	0.17^{ns}	0.57***								
BWT wk 2	0.01^{ns}	0.23*	0.69***							
BWT wk 3	-0.05^{ns}	0.12^{ns}	0.55***	0.88***						
BWT wk 4	-0.05^{ns}	0.14^{ns}	0.39**	0.68***	0.72***					
BWT wk 5	-0.05^{ns}	0.14^{ns}	0.31**	0.59***	0.65***	0.94***				
BWT wk 6	-0.03^{ns}	0.11^{ns}	0.26**	0.54***	0.61***	0.89***	0.96***			
BWT wk 7	-0.04^{ns}	0.13^{ns}	0.34**	0.57***	0.64***	0.86***	0.91***	0.94***		
BWT wk 8	-0.04^{ns}	0.12^{ns}	0.30**	0.54***	0.62***	0.83***	0.88***	0.91***	0.98***	

Tables 6 and 7 showed the pooled regression equations for predicting body weights from egg weight (table 6) and hatch weight (table 7) respectively. When egg weight was employed as the independent variable for the regression, only hatch weight had significant regression with an R^2 value of 0.15. However, when hatch weight was used as the independent variable, body weights at week 1 (R^2= 0.33) and week 2 (R^2=0.05) had significant predictions. All other regressions were insignificant with very low R^2 values. The regression of body weights and hatch weight from egg weight with interest on hatch weight observed in this study agrees with the findings of Tahir *et al.* (2011) who reported significant impact of egg weight in predicting chick weight. Although the authors reported a high R^2 value of 0.when compared to the R^2 value of 0.15 obtained in this study. This discrepancy may be likened to level of selection on the trait. Also, the influence of hatch weight in predicting weight at the first week agreed with the findings of Tahir *et al.* (2011) but disagrees with their findings in subsequent weeks.

Table 6: Pooled *regression equation for predicting body weight from on egg weight*

Traits (Y)	Equation Model	Co-efficient of determination R^2	P-value	LOS
Hatch weight	Y=20.90+0.29X	0.15	0.0002	S
BWT wk 1	Y=58.94+0.29X	0.03	0.12	NS
BWT wk 1	Y=129.58+0.07X	0.0002	0.901	NS
BWT wk 1	Y=324.26-0.47X	0.002	0.65	NS
BWT wk 1	Y=490.24-0.66X	0.002	0.66	NS
BWT wk 1	Y=516.71-1.46X	0.003	0.62	NS
BWT wk 1	Y=882.23-1.18X	0.0009	0.78	NS
BWT wk 1	Y=1145.39-1.67X	0.0014	0.73	NS
BWT wk 1	Y=1600.97-2.93X	0.002	0.7	NS

X = Egg weight, Y = Dependant variables or body weight, LOS = Level of Significant, S = Significant, NS= Not Significant, BW=body weight

Table 7: Pooled *regression equation for predicting body weight from hatch weight*

Traits (Y)	Equation Model	Co-efficient of determination R^2	P-value	LOS
BWT wk 1	Y=16.18+1.31X	0.33	0.0001	S
BWT wk 1	Y=63.04+1.61X	0.05	0.03	S
BWT wk 1	Y=218.99+1.56X	0.02	0.25	NS
BWT wk 1	Y=454.42+2.6X	0.02	0.19	NS
BWT wk 1	Y=487.45+4.92X	0.02	0.21	NS
BWT wk 1	Y=500.18+5.69X	0.01	0.31	NS
BWT wk 1	Y=860.05+7.69X	0.02	0.23	NS
BWT wk 1	Y=1103.51+11.4X	0.02	0.25	NS

X = Hatch weight, Y = Dependant variables or body weight, LOS = Level of Significant, S = Significant, NS= Not Significant, BW=body weight

Conclusion and Recommendation

The lines were superior to each other differently as the sire line was better in egg weight and hatchability while the dam line was better in fertility, survival rate and body weight performance. These variations in these traits can be used in the development and production of a hybrid strain of broiler.

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