Strain effects on egg fertility and hatchability traits of Nigerian locally adapted and exotic chickens

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Abstract

The research was conducted to evaluate the strain effects on egg fertility and hatchability traits of egg produced by two Nigerian locally adapted and exotic chickens. Data were collected from Naked neck, Frizzled feather, Isa brown and Marshall eggs produced from artificially inseminated of these birds. Significant (P < 0.05) effects were observed between the egg fertility, hatchability and the genotypes. Egg set (89.00), fertile eggs (83.50), hatchable eggs (64.50) and infertile eggs (5.50) were better for Isa brown hen than other considered genotypes. Correlation coefficients exist between hatchability and fertility (0.945) for Frizzle feather birds. Meanwhile, the Isa brown and Marshall birds also showed a very highly positively significant (P < 0.001) relationship between egg set and fertility (0.966), hatchability and fertility (0.922) for both strains respectively. It can be concluded that Isa brown with its potential for good fertility and hatchability traits can be adopted by poultry farmers in this area compared with other genotypes considered.

Key words: Naked neck, frizzled feather, Isa brown, Marshall, fertility, hatchability traits

Introduction

Fertility and hatchability are the most important determinants for producing more chicks from a given number of breeding flocks within a given period. Fertility in poultry is traditionally regarded as an independent trait either of the male or the female, but genetic and non-genetic factors originating from both the male and female affect egg fertilization and embryonic development (Brillard, 2003). Fertility of an individual egg is also a function of the genotype of the embryo, to which both parent contribute. Therefore, both paternal and maternal component should be accounted for simultaneously when analyzing fertility. Peters (2000), discovered that the effect of strain and breed difference do affect fertility of egg where he revealed that smooth/normal feathered local chicken laid more fertile eggs than the exotic strain followed by frizzled feathered strain and naked neck strain respectively. Hatchability to a large extent is a derivative of fertility and the presence of major genes and strain/breed difference that affects embryonic livability (Peters et al., 2005).

Fertility and hatchability are major parameters of reproductive performance which are most sensitive to environmental and genetic influences (King'Ori, 2011). Fertility refers to the percentage of incubated eggs that are fertile while hatchability is the percentage of fertile eggs that hatch. The aim of this study was to evaluate the strain effects on fertility and hatchability traits of naked neck, frizzled feather, Isa brown and Marshall chickens in derived savanna environment of Nigeria.

Materials and methods

Experimental Site

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso is situated in the derived savanna zone of Nigeria on longitude 4° 15' East of the Greenwich meridian and latitude 8° 15' North Eastwards from Ibadan, the capital of Oyo state. The altitude is between 300 and 600 m above sea level. The mean annual temperature is above 27 °C while that of rainfall is 1247 mm (BATC, 2006).

Experimental Animal and Management

A total number of 120 birds comprise of 30 each of frizzled feather, naked neck, Isa brown and Marshal birds. The local birds were sourced around the Ogbomoso metropolis while the exotic birds were obtained from a reputable breeder farm in Ibadan, Nigeria. The distributions of the birds were 10 cocks: 20 hens of frizzled feather, naked neck, Isa brown and Marshal birds. The birds are reared under intensive system management with the use of a battery cage. Prior to the arrival of the birds, the poultry pen together with the battery cage was properly disinfected using formalin. Upon arrivals the birds, the birds were allowed to adapt for seven days and they were subjected to proper health care such as deworming and delousing. Afterwards, they were transferred to the cage with each bird occupying a cell with each cell properly identified. Routine management was followed.

Experimental Feed and Feeding

The birds were fed *ad-libitum* with a commercial breeders mash containing 17.5% Crude Protein and 2700 kcal/kg Metabolizable Energy. Clean and cool water was supplied *ad-libitum*. Medication and vaccination was done as at when due.

Mating procedure

Artificial insemination through hand massage technique was employed. Semen was collected from the cocks using semen collection apparatus and each hen was inseminated in turn. The collection of the semen was done in the evening:

The mating design is as follows:

Marshal (male) x Marshal (female) = ML_m x ML_f;
Isa brown (male) x Isa brown (female) = IB_m x IB_f;
Frizzled feather (male) × Frizzle feather (female) = FF_m x FF_f;
Naked neck (male) × Naked neck (female) = NN_m x NN_f.

Egg collection and incubation

Eggs laid by the hens were labelled along the genotype's lines that is, 309 naked neck eggs, 635 frizzle feather eggs, 890.00 Isa brown eggs and 250 marshal eggs. They were allowed accumulating in a cool room for five days before being transferred to the hatchery for incubation. The eggs were set in a cabinet type incubator at a commercial hatchery in Ibadan, Oyo state. The eggs were set along the sire's line at a temperature ranging between 37 °C and 39 °C and a relative humidity between 55% and 56% for the first 18 days while the temperature was then increased to a range between 39 °C and 40 °C, a relative humidity between 70% and 75% from the 19th day to hatchery time, candling of the eggs were done at the 18th day of the incubation period and unfertilized eggs and dead germs were sorted out.

Data Collection

When the birds were laying, the following parameters were obtained based on different genotypes of the birds, egg set per genotype, number and percentage of fertile eggs, number and percentage of infertile eggs, number of eggs hatched and hatchability percentage, number of dead in shell and percentage were obtained by procedure described by Adedeji et al. (2015) as calculated as follow:

Egg set = Total number of eggs (fertile and infertile) by genotypes;

Fertile eggs = Total number of eggs that are fertile;

Infertile eggs = Total number of eggs that are infertile;

Dead in shell: dead chicks in shell due to poor hatching;

$$\text{fertility} = \frac{\text{Total number of fertile eggs}}{\text{Total number of egg set}} \times 100;$$

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

$$\text{Mortality} = \frac{\text{Total number of dead chicks}}{\text{Total number of fertile}}.$$

Data Analysis

Data were subjected to One-Way Analysis of Variance in a Completely Randomized Design using the procedure of SAS (2003) and significant means separate with Duncan Multiple Range Test. The below model was adopted:

$Y_{ij} = \mu + \alpha_i + e_{ij}$,

Where:

Y_{ij} = individual observation;

μ = overall mean;

α_i = fixed effect of i^{th} genotypes (i = 1, 2, 3, 4);

e_{ij} = experimental errors which is evenly distributed.

Correlation coefficient of egg fertility and hatchability traits were done using the formula below:

$$r = \frac{\Sigma XY}{(\Sigma X^2 \Sigma Y^2)^{1/2}},$$

Where:

r = correlation coefficient;

ΣXY, ΣX^2 and ΣY^2 = sum of the variables.

Results

Table 1 revealed the absolute values of egg set, fertility and hatchability estimated in different genotype of chickens. Isa brown birds had the highest egg set (890.00), fertile eggs (835.00), and dead on shell (190) than other considered genotypes while Marshall birds had the highest infertile egg (40%).

Table 2 revealed the mean values of egg fertility and hatchability of four genotypes of chickens. The result revealed that fertility and hatchability was highest in the Isa brown strain with mean percentage of 83.50 and 64.50 followed by frizzle feathered strain with mean percentage fertility and hatchability of 43.00 and 35.00 while marshal strain recorded the least mean percentage fertility and hatchability of 14.00 and 11.50.

Table 3 shows the phenotypic correlation coefficient of naked neck chicken. Very highly positive significant ($P < 0.001$) correlation was obtained between egg set and fertility (0.932); while the highly positive significant ($P < 0.01$) correlation was obtained between egg set against infertility (0.932 of egg fertility and hatchability 0.707), egg set against dead shell (0.637). The values noted for correlation coefficient for naked neck birds ranged from 0.110 to 0.932.

The phenotypic correlation coefficient of egg fertility and hatchability of frizzled feather birds

Table 1. Absolute values of egg set, fertility and hatchability estimated in different genotypes

		Genotypes			
Parameters	N	Naked neck	Frizzled feather	Isa brown	Marshal
Egg set	2084	309.00	635.00	890.00	250.00
Fertile eggs	1655	240.00 (77.67%)	430.00 (67.72%)	835.00 (93.82%)	150.00 (60%)
Hatchable eggs	1325	180.00 (75%)	350.00 (81.40%)	645.00 (77.24%)	150.00 (100%)
Infertile eggs	429	69.00 (22.33%)	205.00 (32.28%)	55.00 (6.18%)	100.00 (40%)
Dead in shell	330	60.00 (25%)	80.00 (18.60%)	190.00 (22.75%)	0

N = Number of observation, Figures in parenthesis are in %

is presented in table 4. Very highly positive significant (P < 0.001) relationship was observed between fertility and hatchability (0.945) while the positive significant (P < 0.05) correlation exist between egg set against fertility (0.882), infertility (0.675), hatchability (0.735) and dead shell (0.712). Fertility and dead shell also revealed a positive correlation.

Table 5 indicates the phenotypic correlation coefficient of egg fertility and hatchability of Isa

Table 2. Mean value of Egg fertility and hatchability traits as affected by genotype of chickens

		Genotypes			
Parameters	N	Naked neck	Frizzled feather	Isa brown	Marshal
Egg set	2084	30.40 ± 6.29^{c}	63.00 ± 12.20^{b}	89.00 ± 10.13^{a}	25.00 ± 7.85^{d}
Fertile eggs	1655	24.00 ± 6.86^{c}	43.00 ± 10.47^{b}	83.50 ± 11.88^{a}	14.00 ± 4.99^{d}
Hatchable eggs	1325	18.00 ± 5.01^{c}	35.00 ± 8.60^{b}	64.50 ± 8.61^{a}	11.50 ± 4.02^{d}
Infertile eggs	429	6.90 ± 3.52^{b}	2.05 ± 6.50^{c}	5.50 ± 3.37^{b}	11.00 ± 4.09^{a}
Dead in shell	330	6.00 ± 2.87^{b}	7.50 ± 3.67^{b}	19.00 ± 5.67^{a}	2.50 ± 1.12^{c}

^{a,b,c,d,}Means occupying same row having different superscripts are significant different (P < 0.05) N = Numbers of observation

Table 3. Phenotypic correlation coefficient of egg set, egg fertility and hatchability traits of Naked-neck chickens

	Egg set	Fertility	Infertility	Hatchability	Dead in shell
Egg set					
Fertility	0.932^{***}				
Infertility	0.707^{*}	0.402			
Hatchability	0.912^{**}	0.930^{***}	0.489		
Dead in shell	0.637^{*}	0.768^{**}	0.110	0.479	

* – (P < 0.05): significant, ** – (P < 0.01): highly significant, *** – (P < 0.001): very highly significant

Table 4. Phenotypic correlation coefficient of egg set, egg fertility and hatchability traits of Frizzled feather chickens

	Egg set	Fertility	Infertility	Hatchability	Dead in shell
Egg set					
Fertility	0.882^{*}				
Infertility	0.675^{*}	0.249			
Hatchability	0.735^{*}	0.945^{***}	0.035		
Dead in shell	0.712^{*}	0.679^{*}	0.390	0.423	

* – (P < 0.05): significant, ** – (P < 0.01): highly significant, *** – (P < 0.001): very highly significant

Table 5. Phenotypic correlation coefficient of egg set, fertility and hatchability of egg laid by Isa brown

	Egg set	Fertility	Infertility	Hatchability	Dead in shell
Egg set					
Fertility	0.966^{***}				
Infertility	0.397	0.622^{*}			
Hatchability	0.872^{*}	0.895^{**}	0.53		
Dead in shell	0.699^{*}	0.736^{*}	0.492	0.358	

* – (P < 0.05): significant, ** – (P < 0.01): highly significant, *** – (P < 0.001): very highly significant

Table 6. Phenotypic correlation coefficient of egg set, fertility and hatchability of egg laid by Marshall birds

	Egg set	Fertility	Infertility	Hatchability	Dead in shell
Egg set					
Fertility	0.893*				
Infertility	0.834*	0.498			
Hatchability	0.889**	0.992***	0.499		
Dead in shell	0.791*	0.896**	0.427	0.835*	

** – (P < 0.05): significant, ** – (P < 0.01): highly significant, *** – (P < 0.001): very highly significant*

brown. Egg set and fertility (0.966) were very highly positive significant (P < 0.001) correlated. Fertility and hatchability (0.895) was highly positive correlated. The positive significant (P < 0.05) correlation existed between egg set and hatchability (0.872) and dead shell (0.699), fertility against infertility (0.622) and dead shell (0.736).

Table 6 revealed the phenotypic correlation coefficient of egg fertility and hatchability traits of Marshall birds. Fertility and hatchability (0.992) was very highly positive significant (P < 0.001) correlated, while a highly positive correlation exist between egg set against infertility (0.834) and hatchability (0.889). Fertility against dead shell (0.896). However, egg set and fertility (0.893), dead shell and egg set (0.791) and dead shell and hatchability (0.835) were positively significant (P < 0.05). The range of values observed was between 0.427 and 0.893.

Discussion

The current study on egg fertility and hatchability traits of locally adapted chickens and exotic birds show that these variables were strains dependent. The differences that existed may be attributed to genotype, ratio of male to females as Campbel et al. (2003) and Akanno et al. (2007) revealed that poor semen quality can cause infertility in chickens. The present results on absolute values of egg fertility and hatchability was in line with finding documented by Ajayi et al. (2008) for different genotypes of indigenous chicken also similar with discovery of Orumuyi et al. (2010) for the strains of Rhode Island chicken. This result of this study is in disagreement with Asuquo et al. (1993), who stated that lower percentage hatchability by exotic strain could be attributed to large egg size, that eggs with the intermediate to large size ranges hatch better than those within larger size and above range that is, Isa brown layers. The values reported presently on fertile egg and hatchability was in line with works of Szwackowki et al. (2003) who reported similar ranges of values for fertility and hatchability. But this result was discovered with the observation of Orunmuyi et al. (2010). These authors reported lower values than the present results. Malago and Batilwake (2009) reported the same ranges of values that agreed with this present result for fertility and hatchability in Rhode Island Red chickens. However, the values obtained for egg production, egg set, fertility, hatchability, infertile and dead in shell were all favored the Isa brown strain, the current results on all these variables were in agreement with the documentation of Mishra et al. (1990); Singh and Belsave (1991) who reported strain differences in fertility and hatchability traits. Swan (2004) revealed that eggs within very small size range do not hatch. The mean values of hatchability as affected by genotype in this study suggests that hatchability may not entirely be a function of fertility because of some intrinsic factors associated with the eggs (Branwell et al., 1996; Anyehie et al., 2008). These intrinsic factors may include the external traits and internal traits of the egg. The external traits are egg weight, shape index, shell thickness, colour and cleanliness. The internal traits are haugh unit and yolk index (Ibe, 1998; Marion, 2002). Other factors that can affect hatchability of fertile eggs could be incubator management factors like mal-positioning of eggs, improper turning and irregular temperature (Benneth, 1992). The present result indicated significant positive correlation for all variables between fertility and dead in shell, hatchability on egg set and hatchability of fertile eggs, hatchability on set eggs and frizzle feathered, the above mentioned findings compare favorably with works of Islam et al. (2002). The significant correlation found between the Naked neck and all the hatchability parameters agreed with Islam and Nishibori (2009) who reported significantly positive correlation between Naked neck and some hatchability parameters on Bangladesh chickens. The present finding for exotic chickens was not in agreement with the report documented by Islam et al. (2002). The authors reported lower values on white leghorn and Rhode Island Red chickens. The present results was similar to the results obtained by Islam et al. (2002) on barred Plymouth rock, White Leghorn, Rhode Island Red and White Rock chickens. The moderate to high estimates obtained for fertility and hatchability were earlier documented by Tai et al. (1994); Poivey et al. (2001) in Brown Isaiah ducks. The high correlation is a reflection of additive variability in the birds.

Conclusion

The study showed that there were notable differences among the genotypes with respect to egg set, dead in shell, fertility, and hatchability. Isa brown chickens performed better in relation to fertility and hatchability followed by frizzle feathered chickens. Also, the present results indicates that the exotic birds that is, Isa brown were favored in terms of egg set, fertility, and hatchability.

Fertility and hatchability traits should be among the growth and production parameters to be considered in any breeding programme aimed at the genetic improvement of the indigenous fowl in Nigeria. The local chickens should be improved by cross breeding the exotic strain (Isa brown). The exotic strain should be used by farmers also because of its large egg size and body weight. It could be concluded that Frizzle feathered chickens can be improved for fertility and hatchability when crossed with Isa brown chickens due to nearness to productivity.

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