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ESTIMATION OF GENETIC PARAMETERS AND SELECTION FOR EGG PRODUCTION TRAITS IN A NIGERIAN LOCAL CHICKEN ECOTYPE

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ABSTRACT

Genetic evaluation and selection of a Nigerian local chicken ecotype was carried out over three generations. Heritabilities, genetic and phenotypic correlations in body weight at first egg, egg number and egg weight were estimated. The estimates were used to a construct selection index in each generation which was used to select the hens used as parents in the next generation. Pooled heritability estimates (over the three generations) of body weight at first egg, egg number and egg weight were 0.56, 0.44 and 0.28, respectively. Genetic and phenotypic correlations between body eight at first egg and egg weight were 0.41 and 0.70, respectively, with egg number: -0.18 and -0.28, respectively. They were estimated to be -.23 and -.39 for egg number and egg weight, respectively. Selected birds performed significantly ($p<0.05$) better than the base population in terms of egg production traits studied. The results of this study suggest that the egg production traits studied can be improved with selection in the Nigerian local chicken ecotype.

Keywords: egg production traits, genetic parameters, generations, local chicken, selection.

INTRODUCTION

In many countries the development of agriculture and breeding programs has resulted in serious changes in poultry breeding stocks during the last decades. The establishment of breeding institutions has led to a pronounced supra-regional propagation of certain chicken breeds due to improvements in performance. As a consequence the local breeds have decreased continuously to the same extent as the preferred high performance breeds have expanded. The results of recent research (in Nigeria) using local chicken (Ikeobi and Peters, 1996; Ayorinde *et al*., 2001; Udeh and Omeje, 2001; Tule, 2005) indicate that the local chicken is a repository of advantageous genes. These useful genetic attributes can be harnessed in crossbreeding programs for the development of egg-type and meat-type chickens (Nwosu, 1987). However, there exist limitations to the realization of total heterosis in such crosses with the exotic for unlike the exotics the local chicken cannot be considered a purebred - being unpedigreed, unselected and unsegregated (Omeje, 1985).

In order to incorporate the local chicken as a parent breed to produce strains of chicken that are adaptable to the local environment as well as achieving the much desired goal of making Nigeria self-sufficient in the sourcing of poultry breeding stock and boosting her poultry industry, there is need for the practice of selective breeding among local strains. An application of genetics towards improving these stocks should be undertaken through proper evaluation and documentation on a suitable selection procedure designed to provide an optimum genotype to the farmer. This implies that a breeding strategy, which recognizes the introduction and development of pure breeds and selection within local breeds, is beneficial. The purpose of this experiment was to obtain genetic parameter estimates on some egg production traits of the Nigerian local chicken and to study the effect of selection on these traits.

MATERIAL AND METHODS

The study was carried out at the Teaching and Research Farm of the Department of Animal Science, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. Abakaliki is located between Latitude 06^o 4'N and Longitude 08^o 65'E in the derived savanna ecological zone of Nigeria. Naturally, the day length of Abakaliki ranges between 12-14 hours all year round, it has an annual mean rainfall range of between 1500-2250mm with mean daily temperature ranges of 27^{o}C and relative humidity of 85% (Nwakpu, 2005). The experiment lasted for four years from 2003 to 2007 in which data on egg production traits were collected.

Experimental animals and management

The base population (G_0) for the selection experiment was hatched from eggs obtained from a random-bred local chicken population maintained at the poultry research unit of the Department of Animal Science, University of Nigeria, Nsukka farm. The birds, which for the purpose of this study have been classified as Light Ecotype (LE) were obtained from the swampy, rainforest and derived guinea savanna ecological zones of southeastern Nigeria. The LE, generally, has an average mature body weight ranging from 0.68 to 1.5kg, its other features has been described by Momoh and Nwosu (2008). A total number of 294 day-old chicks (G_0) were hatched at Nsukka. These were transferred to Abakaliki for the furtherance of the selection experiment. The day-old chicks were wing banded according to their sire and brooded in deep litter pens until 10 wk of age. At wk 10, sexing and separation of the males from the females were done using secondary sexual characteristics (comb size and tail feather shape). The pullets were reared in replicate pens until wk 18 wk when they were randomly assigned to individual cages. Feed and clean drinking water were given *ad libitum* throughout the experimental period. The birds were fed chicks ration (21%CP and 2750Kcal kg^{-1}) from day-old to week 8 of age. Grower's diet (15%CP and 2300Kcal kg^{-1}) was fed between week 8 and week 18, and after week18, a layers diet (17% CP and 2800Kcal kg^{-1}) was fed.

Data collection and statistical analysis

Individual data were collected from the hens for five egg production traits, namely, body weight at first egg (BWFE), egg number (EN), mean egg weight (EW) - during the first 90 days of the laying, age at first egg (AFE), and weight of first egg (WFE). Data were analyzed using SPSS 11.0 Packet Program according to General Linear Mode. Significant means were separated using Duncan's New Multiple Range Test. At the end of the first 90 days of laying genetic parameters - genetic and phenotypic correlations and heritability were estimated for body weight at first egg (BWFE), egg number (EN) and egg weight (EW) using paternal half-sib analysis analyzed according to least squares and maximum likelihood procedures (Harvey, 1990). This was applied in obtaining a selection index using individual hen egg production record for these three traits. In constructing the selection index to obtain the vector of partial regression coefficients ($\underline{b}$), estimates of the genetic and phenotypic parameters, and the net worth or relative economic value which were determined for each trait in each generation were solved using the matrix notation, $P\underline{b} = G\underline{a}$ according to Becker (1984) using the Mathcad7 Professional.

where

P = phenotypic variance-covariance matrix
$\underline{b}$ = vector of partial regression coefficients (weights)
G = genetic variance - covariance matrix
$\underline{a}$ = vector of relative economic values.
The selection index was defined as: $I = b_1X_1 + b_2X_2 + b_3X_3$

Where, b_1, b_2 and b_3 = standard partial regression coefficients or relative weights for the phenotypic value X of the trait in the index. X_1, X_2, and X_3 = phenotypic values of the traits (BWFE, EN and EW, respectively).

Whereas, the aggregate genotype (H) was:

$H = a_1G_1 + a_2G_2 + a_3G_3$

Where, G's = the genetic or breeding value of the i^{th} trait
a_i's = relative economic value of the same trait.

Hens which ranked above or equal to the total index score were selected as parents of the next generation. Males were selected based on their mature body weight - average selection intensity of 7% was used for the cocks. Three generations identified as G_0, G_1, and G_2 were studied. Data from the selected line, for each trait over the three generation were analyzed.

RESULTS AND DISCUSSIONS

Table-1 presents the effect of selection on the egg production traits studied. The results indicate disparities ($p<0.05$) between the base population (G_0) and the selected generations (G_1 and G_2) for all the traits measured.

Table-1. Egg production traits performance of LE over three generations[1].

	G_0	G_1	G_2
Trait[2]	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**
AFE(days)	159.47 ± 1.97^{a}	168.47 ± 1.90^{b}	164.78 ± 2.40^{ab}
BWFE(g)	962.50 ± 23.33^{a}	1024.65 ± 14.18^{b}	1062.90 ± 18.06^{b}
WFE(g)	30.62 ± 0.54^{a}	31.51 ± 0.42^{b}	31.92 ± 0.63^{b}
EW(g)	36.51 ± 0.55^{a}	38.06 ± 0.50^{b}	38.64 ± 0.49^{b}
EN(eggs)	33.40 ± 1.23^{a}	43.20 ± 2.24^{b}	47.18 ± 2.36^{b}

[ab]Means in the same row with different superscripts are statistically different ($p<0.05$).
[1]LE = Light Local Chicken Ecotype,
[2]AFE = Age at First Egg; BWFE = Body Weight at First Egg; WFE = Weight of First Egg; EW = Average Egg Weight; EN = Total Egg Number.

However, findings from all populations studied are still within the range of 153 - 206 days reported in literature for unimproved local chickens both in Nigeria and other countries (Choprakarn *et al*., 1998; Adedokun and Sonaiya, 2001; Demeke, 2003). Nwosu and Omeje (1985) noted that it takes about five and half to six months for the local chicken to mature. Tule (2005) worked with a random-bred population of the strain of birds used in this study and reported an average AFE of 156.5 ± 0.70 days and 155.85 ± 0.62 days for hens raised in the deep litter and battery cage systems of management, respectively. This is not so different from the result obtained from the base population in the present study. Furthermore, Tule (2005), working with the grandparents of the base population of this study, obtained a mean WFE of 25.70g. The findings of this study show that the mean WFE was increased over generations of selection. The BWFE for all generations of study is lower than 1447.1g averaged over both sexes for medium ecotypes of Tanzania under intensive management (Lwelamira *et al*., 2008) and a range of 1600 - 2200g obtained for South African local chickens by ARC (2005). However, the BWFE of the selected population by the G_2 was close to corresponding weights of the Tanzanian medium ecotype chicken under extensive management (Lwelamira, *et al*., 2008). WFE increased with increase in AFE and BWFE over the generations of selection. The present findings are in line with the works of Barbato (1999) who reported that body weight, generally, has been shown to be highly responsive to selection in chickens such that genetic improvement for growth has resulted in increase in egg weight and age at first egg/sexual maturity. Soller *et al*., (1984) investigated the minimum weight for onset of sexual maturity in chickens and suggested that the AFE is highly correlated with body weight.

Generally, BWFE, EN, EW, WFE and AFE increased with each succeeding generation. This is in affirmation with the work of Gowe (1970) which reported that long-term selection for high egg production in two strains of Leghorn was effective in increasing the performance of selected strains.

Heritability estimates and phenotypic and genetic correlations pooled over the three generations appear in Table-2. No previously published values for the genetic parameter estimates of BWFE, EN, and EW in the LE chickens could be found; these may be some of the first genetic parameter estimates for these traits in the Nigerian local chicken.

Table-2. Genetic parameter estimates of traits studied[1].

Traits[2]	BWFE	EW	EN
BWFE	.56	.41	-.18
EW	.70	.44	-.23
EN	-.28	-.39	.28

[1]Genetic correlations (below diagonal); phenotypic correlations (above diagonal); heritability (diagonal)
[2]BWFE = Body Weight at First Egg; EW = Average Egg Weight; EN = Total Egg Number

BWFE and EW were highly heritable, while EN was moderately heritable. These estimates clearly indicate the existence of substantial amount of additive genetic variance for these traits in this population. The heritability estimate for BWFE, EN and EW in the present study agrees closely with the findings of Lwelamira *et al*., (2009) who worked on two Tanzanian chicken ecotypes. Momoh and Nwosu (2008) reported heritability of 0.30 for body weight at 20th week of age in the Nigerian heavy chicken ecotype. The reported estimates of heritability for egg number for different strains/breeds of chicken varied from 0.11 to 0.53 (Francesh *et al*., 1997; Swaczkowski 2003; Luo *et al*., 2007). Estimate of heritability for egg number (0.28) in this study falls within this range. The heritability of EW in this study was 0.44. This estimate is quite close to the early egg weight heritability estimate of 0.45 reported by Nordskog (1981) for light breeds. Oni *et al*., (2000) reported an estimate of 0.24 for average egg weight in a strain of Rhode Island chicken under selection. The genetic and phenotypic correlations of EN with BWFE, and with EW were negative suggesting an increase in EN as BWFE and EW decreases. However, this did not correspond with the phenotypic observations/ performances of the LE chicken population studied. The discrepancies could be attributed to the selection method applied. Here, selection was based on an index score where the selection criteria traits were all selected for in a positive direction. Such selection invariably tends to increase the gene frequency of favored genes. Oni *et al*., (1991) reported a positive association between the body weight at first egg, egg number and egg weight in two strains of Rhode Island chickens; this supports the results of the present study.

CONCLUSIONS

Accurate estimates of genetic parameters are a pre-requisite for the establishment of a sustainable genetic improvement program. From the results of the present study, it was obvious that selection was effective in improving all the egg production traits studied by the last generation (G_2) of study, such that BWFE, EN, EW, and WFE were improved by 19.52%, 29.21%, 5.51%, and 5.39%, respectively. The heritability estimates in this study were moderate to high for the egg production traits studied. This is an encouraging factor for more intense selection within the Nigeria local chicken population, over several generations, before being crossbred with improved stocks in other to create new breed(s). the present finding suggests that using a selection index (which allows for simultaneous selection of many traits) for the egg production traits studied in LE Nigeria local chicken was able to improve these traits over three generations despite the negative correlation estimated between some traits.

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