

Comparative Egg Production and Mortality of Two Commercial Egg Strains, Indigenous Chicken and Their Inbred Progenies

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Abstract

The aim of this study was to compare the monthly hen day egg production (HDEP %), egg weights, total egg mass and mortality of two commercial egg strains and the indigenous chicken with their inbred progenies. The results indicate significant ($P < 0.05, 0.01$) inbreeding depression in the HDEP %, egg weight and total egg mass of the two commercial strains but not in the indigenous chicken. Brooding mortality was higher in the parents compared to their inbred progenies. The inbred progenies recorded higher mortality than the parents during the rearing and laying periods especially in the two commercial strains. It was concluded that the exotic commercial hybrid should not be used as breeders for the production of day old chicks for commercial egg production.

Keywords: commercial hybrids, dominance, egg weights, hen day egg production, inbreeding depression, total egg mass

1. Introduction

Commercial poultry production in Nigeria is predominantly dependent on the exotic chickens imported into the country. The indigenous chicken constitutes about 80% of the estimated 185 million chicken populations in Nigeria (FAOSTAT, 2011). Most of the poultry meat and eggs consumed in Nigeria are produced by commercial farms. The indigenous chicken contributes about 20% of eggs and 50% of meat in Africa (Pym et al., 2006). The demand of poultry meat and eggs is usually higher during the festive seasons than other periods. During the festive seasons, many birds are culled or sold and there is usually need for restocking. Consequently the demand for day old chicks and replacement pullets become too high that desperate and shrewd poultry dealers and hatcheries resort to the use of commercial hybrids to generate day old chicks through inbreeding (Ogbu et al., 2012). The consequence of this is that low grade and poor quality chicks are sold to farmers. The performance of these birds is usually characterized by poor growth rate, poor feed conversion and high mortality. Studies comparing commercial hybrids, the indigenous chicken with their random bred progenies were conducted by Udeh and Omeje (2011) and Ogbu et al. (2012). The authors generally reported significant reduction in body weight, weight gain, feed conversion ratio and increase in age at sexual maturity in the progenies. The present study tends to differ from the ones reported earlier by comparing the monthly hen day egg production, egg weight at different periods and mortality of two commercial egg strains, the indigenous chicken with their inbred progenies.

2. Materials and Methods

Experimental Site: The experiment was conducted at the poultry breeding and research unit, Department of Animal Science, Enugu State University of Science and Technology, Enugu, Nigeria.

Experimental Animal: This comprise 250 one day old pullets and 50 one day old cockerels each of two commercial egg strains: H and N Brown Nick (strain 1) and Black Olympia (strain 2) procured from a reputable hatchery in Ibadan, Oyo State, Nigeria. The indigenous chicken (strain 3) comprise of 250 chicks of mixed sex hatched from a population of random breeding local chickens. Their hatching was arranged to correspond with the arrival of the exotic chicks. The chicks from each strain were brooded and reared separately according to sex from day old to sexual maturity by adhering to standard management procedures described by Oluyemi and Robert (1979). The indigenous chicks were separated into sex at 4 weeks of age. Each strain of chickens was reared in two replicates

on deep litter pens. Within strain mating was done at 28 weeks of age when the birds have laid for two months using the surviving layers (195 for strain 1, 230 for strain 2 and 125 for strain 3). Mating was random in deep litter pens using a mating ratio of 1 cock for 10 hens. Eggs were collected for two weeks, incubated and hatched. An average of 240 chicks was produced from each strain in a single batch. The chicks were divided into two replicates per strain and brooded in separate pens for 4 weeks. The sexes were separated at 4 weeks of age and the chicks reared according to strain and sex to sexual maturity. Similar management conditions were provided for the parents and progenies as much as possible.

Data Collection and Analysis

Data were collected on the following parameters:

- 1) Mortality which was recorded on daily basis during the brooding, rearing and laying periods.
- 2) Daily egg numbers recorded from the onset of lay (18-20 weeks) to 40 weeks of age. The egg number was summarized into HDEP (%).
- 3) Weight of first eggs (WFE), g: average weight of first 10 eggs laid consecutively for each strain.
- 4) Egg weight at 30 weeks (EW30), g: determined as the average weight of eggs laid on two consecutive days by each strain at 30 weeks of age.
- 5) Egg weight at 40 weeks (EW40), g: the weights of sample of eggs laid per strain on two consecutive days at 40 weeks of age
- 6) Total egg mass (TEM), kg: the direct product of egg number (hen day) and average egg weight in each strain.

Data on HDEP %, egg weight and TEM for parents and progenies in the three strains were subjected to analysis of variance using the following statistical model, $X_{ijk} = \mu + G_i + S_{ij} + E_{ijk}$

Where

X_{ijk} = the k^{th} observation e.g. egg weight in the j^{th} strain within the i^{th} generation.

μ = Overall mean

G_i = effect of i^{th} generation on the trait.

S_{ij} = effect of the j^{th} strain in the i^{th} generation.

E_{ijk} = residual effects assumed to be independent and normally distributed with zero mean and variance. The analysis of variance was done using SPSS (2007). Within strain comparison between parents (P_0) and progenies (P_1) was done for each trait using the independent t-test option of SPSS (2007). Percentage inbreeding depression (ID %) of the progeny generation was calculated using the following expression given by Talebi et al. (2010).

$$ID (\%) = \frac{P_0 - P_1}{P_0} \times 100$$

Where

P_0 = mean of parents for a trait

P_1 = mean of progeny for the same trait

It was assumed that the coefficient of inbreeding in the parental population was zero. The significance of inbreeding depression was tested by calculating the t-statistic using the formula:

t_{cal} for ID% = estimated value of ID/ standard error of the mean (SEM).

Standard error of the mean (SEM) = $\sqrt{6^2P_0 + 6^2P_1}$

Where

6^2P_0 = variance of parental mean

6^2P_1 = variance of progeny mean.

The calculated $-t$ statistic was compared to the tabulated value at error degree of freedom (Ogbu et al., 2012).

3. Results and Discussion

3.1 Hen Day Egg Production

Table 1 presents the monthly HDEP % of the three parent strains and their inbred progenies. There was no significant difference between the two exotic parents (strains 1 and 2) in HDEP % throughout the 4 months period. Both strains were however superior to strain 3 for the same trait. This was expected because the exotic had under

gone continuous improvement for egg production contrary to the indigenous which remain unselected, unimproved and usually raised under extensive and scavenging conditions. Previous reports showed that the indigenous chickens were inferior to the exotic strains and their crosses in egg production (Hill & Modebe, 1961; Akinokun & Dettmers, 1977; Nwosu, 1979; Omeje & Nwosu, 1983). Omeje and Nwosu (1983) attributed the lower egg production performance of the indigenous chicken compared to the exotic on their long pause length of 3 days. The non significant difference between strain 1 and strain 2 in HDEP % could imply either that the two strains were not genetically different or they responded similarly to environmental conditions influencing rate of egg production in chickens. Highly significant ($P < 0.01$) difference between the three inbred progeny strains were obtained at the 3rd and 4th month of lay with the exotics (strains 1 and 2) performing better than the indigenous chicken (strain 3). The average of the 4 month periods of lay indicate that strain 2 was the most superior in this trait, followed by strains 1 and 3 in that order. It is also important to note that HDEP % of the three strains increased from month 1 to 2, decreased slightly in month 3 (strains 1 and 2) and finally peaked at month 4 in the parent generation. In the inbred progeny generation, the HDEP % of the three strains showed a steady increase from month 1 to 4. Table 2 compares the monthly HDEP % of the parents (P_0) and progeny (P_1) generations of the three strains. In both strains 1 and 2, the parents were significantly ($P < 0.01$) superior to their progenies in HDEP % whereas in strain 3, such difference between the two generations were not significant ($P > 0.05$) in most of the periods. The average of the 4 months period indicates the superiority of the parents over the progenies in strains 1 and 2 only. The apparent superiority of the two exotic parent strains (P_0) over their inbred progenies (P_1) in HDEP % indicates decrease in performance of the progenies in the trait. Such decrease in performance was reported by Ogbu et al. (2012) for body weight, weight gain, and feed conversion ratio in the same flock of chickens. The decrease in performance referred to as inbreeding depression was further tested for significance and shown in table 3. The estimates were mostly significant ($P < 0.05, 0.01$) in strains 1 and 2 and mostly negative and non significant ($P > 0.05$) in strain 3. It was highest in month 1 in both strains 1 (74.46%) and 2 (67.00%) but decreased from month 1 to 3. The average estimates for the 4 months were as follows: strain 1 (51.40%), strain 2 (42.39%) and strain 3 (-6.68%). The phenomenon of inbreeding depression arises from dominance gene action which is known to affect fitness traits (Falconer & Mackey, 1996). It is usually characterized by loss of heterozygosity and break up of epistatic gene combinations in the parents (Kerje et al., 2003; Subramanya & Bishop, 2011). Studies by Foster and Kilpatrick (1987), Abplanalp (1990) and Flock et al. (1991) showed that inbreeding depression was higher in egg number compared with other egg production traits. The non-significant inbreeding depression for HDEP % in strain 3 may be due to the fact that the factors responsible for the trait have stabilized by long term panmixia among the indigenous chicken population in the wild state so that one generation of inbreeding might not have been strong enough to dislodge most of the loci.

Table 1. Monthly Hen day egg Production of the three Parent Strains and their inbred Progenies

| Month | Parent | | | Inbred progeny | | |
|------------|--------------------|--------------------|--------------------|---------------------|--------------------|--------------------|
| | Strain 1 | Strain 2 | Strain 3 | Strain 1 | Strain 2 | Strain 3 |
| 1 | 59.05 ^b | 52.20 ^b | 15.96 ^a | 15.08 ^a | 17.56 ^a | 17.34 ^a |
| | ±5.65 | 2.83 | 1.30 | 1.53 | 1.70 | 1.96 |
| 2 | 64.94 ^b | 63.59 ^b | 20.56 ^a | 29.30 ^a | 32.99 ^a | 26.56 ^a |
| | ±4.65 | 3.03 | 1.15 | 2.18 | 2.24 | 1.21 |
| 3 | 60.66 ^b | 51.99 ^b | 34.64 ^a | 40.42 ^b | 45.58 ^b | 32.62 ^a |
| | ±3.73 | 2.73 | 4.46 | 3.10 | 4.68 | 0.99 |
| 4 | 81.28 ^b | 82.50 ^b | 34.72 ^a | 45.10 ^b | 48.62 ^b | 36.14 ^a |
| | ±4.75 | 2.06 | 2.89 | 3.12 | 3.71 | 1.06 |
| 0-4 months | 66.83 ^b | 62.82 ^b | 26.47 ^a | 32.48 ^{ab} | 36.19 ^b | 28.16 ^a |
| | ± 2.57 | 2.03 | 2.01 | 1.92 | 2.40 | 1.43 |

For each generation, monthly row means with different superscript letters are significantly different ($P < 0.01$).

Table 2. Comparative monthly hen day egg Production of three parent strains (P₀) and their inbred Progeny (P₁) Generations

| Month | Strain | | | | | |
|------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | 1 | | 2 | | 3 | |
| | P ₀ | P ₁ | P ₀ | P ₁ | P ₀ | P ₁ |
| 1 | 59.05 ^b | 15.08 ^a | 53.20 ^b | 17.56 ^a | 15.96 ^a | 17.34 ^a |
| | ±5.65 | 1.53 | 2.83 | 1.70 | 1.30 | 1.96 |
| 2 | 64.94 ^b | 29.30 ^b | 63.59 ^b | 32.99 ^a | 20.56 ^a | 26.56 ^a |
| | ±4.65 | 2.18 | 3.03 | 2.24 | 1.15 | 1.21 |
| 3 | 60.66 ^b | 40.42 ^b | 51.99 ^b | 45.58 ^a | 34.64 ^a | 32.62 ^a |
| | ±3.73 | 3.10 | 2.73 | 4.46 | 4.26 | 0.99 |
| 4 | 81.28 ^b | 45.10 ^a | 82.50 ^b | 48.62 ^a | 34.72 ^a | 36.14 ^a |
| | ±4.75 | 3.12 | 2.06 | 3.71 | 2.89 | 1.06 |
| 0-4 months | 66.83 ^b | 32.48 ^a | 62.82 ^b | 36.19 ^a | 26.47 ^a | 28.16 ^a |
| | ± 2.57 | 1.92 | 2.03 | 2.40 | 2.01 | 1.43 |

For all row values within each strain, a<b (P<0.01).

Table 3. Percentage inbreeding depression (ID) and T-statistic (t cal) of monthly hen day egg production of two commercial egg strains and the indigenous chickens

| Strain | Month Gen | 1 | | 2 | | 3 | |
|------------|----------------|-------|----------------------------|-------|----------------------------|-------|----------------------------|
| | | Mean | ID (t cal) | Mean | ID (t cal) | Mean | ID (t cal) |
| 1 | P ₀ | 59.05 | 74.46 ^{**} (2.95) | 53.20 | 67.00 ^{**} (5.38) | 15.96 | -8.65 ^{NS} (0.30) |
| | P ₁ | 15.08 | | 17.56 | | 17.34 | |
| 2 | P ₀ | 64.94 | 54.88 ^{**} (2.67) | 63.59 | 48.12 [*] (3.19) | 20.56 | -29.18 [*] (6.18) |
| | P ₁ | 29.30 | | 32.99 | | 26.56 | |
| 3 | P ₀ | 60.66 | 32.64 ^{NS} (1.68) | 51.99 | 12.33 ^{NS} (0.59) | 34.64 | 5.83 ^{NS} (0.45) |
| | P ₁ | 40.42 | | 45.58 | | 32.62 | |
| 4 | P ₀ | 81.28 | 44.51 [*] (1.96) | 82.50 | 41.07 [*] (2.42) | 34.72 | -4.09 ^{NS} (0.47) |
| | P ₁ | 45.10 | | 48.62 | | 36.14 | |
| 0-4 months | P ₀ | 66.83 | 51.40 ^{**} (4.01) | 62.82 | 42.39 ^{**} (3.37) | 26.47 | -6.38 ^{NS} (0.91) |
| | P ₁ | 32.48 | | 36.19 | | 28.16 | |

* Significant (P<0.05), ** significant (P<0.01).

NS: Not significant (P>0.05). Tabulated t-statistic at 0.95 = 1.7530, 0.99 = 2.602 for df = 15.

3.2 Egg Weight and Total Egg Mass

The results of egg weight and total egg mass of the three parents and the inbred progenies are presented in Table 4. As observed in HDEP %, the indigenous chicken (strain 3) was very inferior to the exotic (strains 1 and 2) in egg weight and total egg mass in both parents and progeny generations for the same reason that they were unselected and undeveloped. On the other hand, the exotic chickens have been selected and developed over a long time for high egg production. Between the exotic types, strain 1 was significantly (P<0.01) superior to strain 2 in WFE and EW30 in the parent generation. This may be attributed to the late maturing of strain 1 which came to lay about 12 days after strain 2 and 3. It has been established that age at first egg influences egg weight in poultry especially during the early part of lay (Adenowo et al., 1995; Udeh, 2010). The trend was reversed in the progeny generation where strain 2 was superior to strain 1 on WFE and TEM. This may be due to the late coming to lay of strain 2 compared to strain 1. The comparison between parents and inbred progeny generations of the three strains in egg weight and total egg mass are presented in Table 5. The parents (P₀) were significantly (P<0.01) superior to the progeny (P₁) generation in WFE, EW30, EW40 and TEM in strain 1 and only in EW40 and TEM in strain 2. The two generations of strain 3 were similar in WFE, EW30, EW40 and TEM. Table 6 shows that percentage inbreeding depression (ID) for WFE, EW30, EW40 and TEM were significant (P<0.05, 0.01) in strains 1 and 2 but

not in strain 3. The implication was that strains 1 and 2 carried different complementary gene pairs for egg weight while the genes governing the trait in the indigenous had become more homozygous. Inbreeding depression occurs as a result of loss of fitness associated with dominant genes at heterozygous loci. According to Woodard et al (1983) inbreeding in chicken has been found to have deleterious effect on most reproductive traits such as egg production, fertility, hatchability and post hatch mortality.

Table 4. Egg weight at different periods and total egg mass of the three parent strains and their inbred progenies

| Traits | Parent | | | Progeny | | |
|-----------------|-----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | Strain 1 | Strain 2 | Strain 3 | Strain 1 | Strain 2 | Strain 3 |
| WFE;g | 49.41 ^c ±0.70 | 41.76 ^b 0.81 | 33.98 ^a 0.24 | 45.70 ^b 1.00 | 48.96 ^c 0.80 | 34.19 ^a 0.36 |
| EW30, g | 56.06 ^c ±0.37 | 53.85 ^b 0.49 | 41.49 ^a 0.49 | 52.21 ^b 0.69 | 53.52 ^b 0.63 | 40.61 ^a 0.62 |
| EW40, g | 59.81 ^b 0.46 | 58.26 ^b 0.52 | 41.34 ^a 0.67 | 54.93 ^b 1.07 | 54.22 ^b 0.68 | 40.51 ^a 0.63 |
| TEM (weekly),kg | 0.27 ^b 0.01 | 0.24 ^b 0.01 | 0.08 ^a 0.01 | 0.12 ^b 0.01 | 0.13 ^b 0.01 | 0.08 ^a 0.01 |

Within each generation, row means superscripted with different letters are significantly different ($P < 0.01$).

Note: WFE: Weight of first egg, EW 30: Egg weight at 30 weeks of age, EW40: Egg weight at 40 weeks of age, TEM: Total egg mass.

Table 5. Comparative mean values for egg weight and total egg mass of three parent strains (P_0) and their inbred progeny (P_1)

| Strain | 1 | | 2 | | 3 | |
|-----------------|-----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | P_0 | P_1 | P_0 | P_1 | P_0 | P_1 |
| WFE, g | 49.14 ^b ±0.70 | 45.70 ^a 1.00 | 41.76 ^a 0.81 | 48.96 ^b 0.80 | 33.98 ^a 0.24 | 34.19 ^a 0.36 |
| EW30, g | 56.06 ^b ±0.37 | 52.21 ^a 0.69 | 53.85 ^a 0.49 | 53.52 ^a 0.63 | 41.49 ^a 0.49 | 40.61 ^a 0.62 |
| EW40, g | 59.81 ^b ±0.46 | 54.93 ^a 1.07 | 58.26 ^b 0.52 | 54.22 ^a 1.07 | 41.34 ^a 0.67 | 40.51 ^a 0.63 |
| TEM (weekly),kg | 0.27 ^b ±0.01 | 0.12 ^a 0.01 | 0.24 ^b 0.02 | 0.13 ^a 0.01 | 0.08 ^a 0.02 | 0.08 ^a 0.01 |

For each strain results and trait, mean values with different superscript letters are significantly different ($P < 0.01$).

Table 6. Percentage inbreeding depression (ID) and T-statistics (t cal) of egg weight and total egg mass of two commercial egg strains and the indigenous chickens

| Strain | Trait | Gen. | 1 | | 2 | | 3 | |
|--------|-------|------|-------|---------------|-------|---------------------------|-------|----------------------------|
| | | | Mean | ID(t cal) | Mean | ID(t cal) | Mean | ID(t cal) |
| WFE | P_0 | | 49.41 | 7.51*(1.95) | 41.76 | -17.24*(4.79) | 33.98 | -0.62 ^{NS} (0.45) |
| | P_1 | | 45.70 | | 48.96 | | 34.19 | |
| EW30 | P_0 | | 56.06 | 6.87*(2.47) | 53.85 | 0.61 ^{NS} (0.24) | 41.49 | 2.12 ^{NS} (0.85) |
| | P_1 | | 52.21 | | 53.52 | | 40.61 | |
| EW40 | P_0 | | 59.81 | 8.16*(2.22) | 58.26 | 6.93*(2.56) | 41.34 | 2.01 ^{NS} (0.69) |
| | P_1 | | 54.93 | | 54.22 | | 40.51 | |
| TEM | P_0 | | 0.27 | 62.96*(19.73) | 0.24 | 45.83**(35.57) | 0.08 | 0.00(0.00) |
| | P_1 | | 0.12 | | 0.13 | | 0.08 | |

* Significant ($P < 0.05$), ** significant ($P < 0.01$), NS: Not significant ($P > 0.05$).

3.3 Percentage Mortality

Table 7 presents the percentage mortality of the three parent strains and their inbred progenies. There was higher incident of mortality during the brooding period than the rearing or laying periods in the parents (P_0) and progeny (P_1) generations. This was quite in order because at the brooding stage the chicks were highly sensitive to environmental conditions than adult birds. The thermo-regulatory system in chicks had not developed which make them vulnerable to extreme temperature conditions. Other factors that can cause brooding house mortality are exhaustion caused by high temperature, poor ventilation, high intensity of light, stress of transportation, pasty vents or yolk sac infection (Raghavan, 1999). Among the parent strains, brooding house mortality was highest in strain 3 (50.61%), followed by strain 1 (21.33%) and strain 2 (7.37%). The reason was that apart from the aforementioned factors which cause mortality in chicks, the indigenous chicken (strain 3) had the initial problem of adapting to intensive system of management. Similar observation was reported by Demeke (2004) in the indigenous chicken of Ethiopia. The relatively higher brooding mortality suffered by strain 1 compared to strain 2 was due to higher susceptibility of strain 1 chicks to coccidiosis which affected the exotic chicken during the first 6 weeks of age. Table 8 compares the mortality rate of parents (P_0) with the progeny (P_1) strains. The parents suffered higher brooding house mortality than their progeny. This could be attributed to greater susceptibility of the parents to environmental conditions such as diseases during the brooding period than the progenies. In the case of the indigenous chicken, there was the initial problem of the parent chicks adapting to the intensive system of management. The trend was reversed during the rearing and laying periods when the inbred progenies recorded higher mortality compared with the parents especially in strains 1 and 2. This was probably as a result of inbreeding which accumulated lethal and deleterious genes in these strains thereby minimizing their chances of survival. Ibe et al. (1983) reported that inbreeding resulted to increased mortality in chicken. There was no incident of laying mortality in both the parent and progeny generations of strain 3. The mean values of the three periods combined indicated that the progeny had lower mortality than the parent strains. This might have been caused by the higher brooding mortality observed in the parents compared with the progeny strains.

Table 7. Percentage mortality of the three parent strains and their inbred progenies at different periods

| Periods | Parent | | | Inbred Progeny | | |
|------------|----------|----------|----------|----------------|----------|----------|
| | Strain 1 | Strain 2 | Strain 3 | Strain 1 | Strain 2 | Strain 3 |
| Brooding | 21.33 | 7.37 | 50.61 | 9.42 | 2.28 | 7.90 |
| Rearing | 1.67 | 0.00 | 2.09 | 6.85 | 3.33 | 6.92 |
| Laying | 0.00 | 1.32 | 0.00 | 3.59 | 1.59 | 0.00 |
| 0-40 weeks | 7.67 | 2.90 | 17.57 | 6.62 | 2.40 | 4.94 |
| | ±6.85 | 2.27 | 16.53 | 1.69 | 0.51 | 2.49 |

Note: Results not tested statistically because the mortality data were few.

Table 8. Comparative mortality (%) of parents (P_0) and progeny (P_1) generations of three strains of chicken

| Strain | 1 | | 2 | | 3 | |
|------------|-------|-------|-------|-------|-------|-------|
| | P_0 | P_1 | P_0 | P_1 | P_0 | P_1 |
| Brooding | 21.33 | 9.42 | 7.37 | 2.28 | 50.61 | 7.90 |
| Rearing | 1.67 | 6.85 | 0.00 | 3.33 | 2.09 | 6.92 |
| Laying | 0.00 | 3.59 | 1.32 | 1.59 | 0.00 | 0.00 |
| 0-40 weeks | 7.67 | 6.62 | 2.90 | 2.40 | 17.57 | 4.94 |

4. Conclusion and Recommendation

The most important conclusions drawn from this study are:

- 1) There was significant decrease in the HDEP %, egg weight and total egg mass in the progenies of the two commercial hybrid strains but not in the indigenous chicken. The significant decrease was referred to as inbreeding depression (ID).

- 2) Higher brooding mortality was recorded in the parent strains compared to their progenies. The reverse was the case for rearing and laying mortality in the two commercial hybrid strains.
- 3) Therefore, generating replacement stocks from commercial hybrid strains should be avoided because of its obvious poor performance in growth and egg production traits.

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