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Estimates of Repeatability and Heritability of Egg Number in Sasso Hens in a Tropical Environment

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Abstract

The aim of this study was to derive variance components, and hence, estimate repeatability and heritability of weekly egg production in Sasso hens. The birds, each with an identification number, were randomly selected and kept in individual battery cages which permitted open ventilation. Egg production records of thirty eight (out of the initial fifty four stocked) Sasso birds with consistency in lay from week 31 to week 38 of age were utilized for subsequent analyses. The effect of age (week) on egg production was determined using one-way analysis of variance (ANOVA) procedure. Means were separated using Duncan's Multiple Range Test (DMRT) at 95% confidence interval. The components of variance were estimated using the PROC VARCOMP option of restricted maximum likelihood (REML) method of the General Linear Model (GLM) procedure to generate repeatability and heritability coefficients. The mean egg number per week was 3.51 with coefficient of variation of 19.0-23.4%. Egg production appeared to increase with age which was significant ($P<0.05$) from week 37-38. The variance component based on combined ages of the birds was 0.049 while that of the residual was 0.551. Repeatability estimate (R ± S.E.) was low (0.082 ± 0.011). However, the estimate of heritability (h^2S ± S.E.) for egg number in the current population was moderate (0.326 ± 0.011). Based on the heritability coefficient, elite birds with the best average performance for week 31-38 of age could be selected as parents to produce offspring with optimal egg production.

Keywords: Sasso; Layers; Variance; Genetic parameters; Improvement

Introduction

Total world egg production is said to be 78% (by weight) of that of poultry meat production and importance is being attached to its continuous production in a greater magnitude globally [1] to meet the demand of the ever growing population. To guarantee sustainable egg production therefore, there is a need for systematic genetic improvement through the selection of elite birds. The most important trait in layer selection programs remains egg production [2]. In Nigeria, genetic parameters such as repeatability and heritability are given prominence in determining appropriate animal evaluation [3,4]. Repeatability has been described as a term to estimate the extent of the consistency of the performance or behaviour of an individual over time [5]. On the other hand, the heritability of a trait, in the narrow sense, is the proportion of the total phenotypic variation that is due to additive genetic effect, which can be passed from the parents to the progeny.

There have been previous attempts at determining the repeatability and heritability estimates of egg production traits in layers in Nigeria [6-8]. However, there is dearth of reports on the genetic parameter estimates of the newly introduced Sasso chickens in the country. This study, therefore, aimed at estimating repeatability and heritability based on weekly egg production of Sasso birds in a tropical environment of Nigeria.

Materials and Methods

The guidelines on research ethics by International Council for Laboratory Animal Science and NC3Rs ARRIVE (Animals in Research: Reporting *in Vivo* Experiments) were strictly followed in the conduct of this experiment.

Experimental site

The research work was carried out at the Livestock Section of the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus, Lafia. It is located within the guinea savannah zone of North Central Nigeria and lies on latitude 08° 35N and longitude 08° 33E, respectively.

Experimental birds and their management

A total of Fifty four (54) Sasso hens were each kept in a battery cage. The birds, which were 30 weeks old, were arranged randomly with eighteen birds per replicate. Each bird was tagged with an identification number. The birds were fed commercial layer mash (Vital Feed) from week 30 to week 38 of rearing and supplied clean water *ad libitum*. There was strict adherence to routine vaccination and medication. Other management practices were in accordance with the description of Yakubu et al. [9].

Data collection

The egg production records of a total of thirty eight (38) birds with consistency in lay from week 31 to week 38 were used for further analysis. Eggs were collected twice (morning and evening) on a daily basis through the duration of the experiment.

Statistical analysis

One-way analysis of variance (ANOVA) procedure was used to determine the effect of week on egg production. Duncan's Multiple Range Test (DMRT) was used to separate the means at 95% confidence interval. Variance components for repeatability and heritability estimates were estimated using the PROC VARCOMP of restricted maximum likelihood (REML) method of the General Linear Model procedure of SPSS [10]. The linear additive model used was:

$Y_{ij}=\mu+\alpha_i+ei_j$

where,

Y_{ij}=Observation on the jth egg number of the i^{th} age of birds;

μ=Overall population;

α_i=effect of age variance of birds (31, 32, 33, 34, 35, 36, 37 and 38 weeks of age);

e_{ij}=error term.

Repeatability indicates the ratio between individual components to the total phenotypic variance which measures the correlation between repeated measurements of the same individual as indicated below [11]:

$R=V_G+VE_g/V_P$

where,

R=repeatability;

V_G=genotypic variance;

VE_g=general environmental variance;

V_P=phenotypic variance.

Computationally, R was derived using the method of Becker [12] as follows:

$R=\sigma^2 B / \sigma^2 B+\sigma^2 W$

where,

$\sigma^2 B$=variance component of the bird;

$\sigma^2 W$=variance component of error.

The standard error ($S.E.$) of repeatability (R) was calculated as:

$$S.E. = \sqrt{\frac{2(1-R)^2[1+(K-1)R]^2}{K(K-1)(N-1)}}$$

where:

K=number of records per age of bird;

R=repeatability coefficient;

N=total number of observations.

Heritability was defined as the ratio of additive genetic variance to phenotypic variance as follows:

$h^2=V_A/V_P$

where,

h^2=heritability;

V_A=additive genetic variance;

V_P=phenotypic variance.

The estimate of the narrow-sense heritability (h^2S) for egg production was calculated as indicated below following the method of Becker [12]:

$h^2S=4\sigma^2 S/(\sigma^2 S+\sigma^2 W)$

where,

h^2S=narrow sense heritability based on paternal half-sib correlation;

$\sigma^2 S$=sire (bird) variance component;

$\sigma^2 W$=error variance component.

The standard error ($S.E.$) of heritability (h^2S) was calculated as:

$$S.E. = \sqrt{\frac{2(1-t)^2[1+(K-1)t]^2}{K(K-1)(N-1)}}$$

Where,

t=intraclass correlation (t=1/4 h^2S);

K=number of records per age of bird;

N=total number of observations.

Results and Discussion

The mean egg number (3.51) with minimum and maximum values of 2 and 6 per week is shown in Table 1. The effect of age on egg number was found to be significant (P<0.05). Egg production tended to increase with age which was significant from week 37 to week 38. Although the coefficient of variation did not follow a definite pattern, its values (19.0-23.4%) are high enough; an indication that there is room for the improvement of egg production trait in the birds.

Week of production	Population size	Minimum value	Maximum value	Mean egg production	Standard deviation	Coefficient of variation (%)
31	38	3	6	3.29^{c}	0.69	21.1
32	38	2	6	3.32^{c}	0.77	23.4
33	38	2	5	3.24^{c}	0.63	19.6
34	38	3	6	3.47^{bc}	0.73	20.9
35	38	3	6	3.53^{bc}	0.76	21.6
36	38	3	6	3.53^{bc}	0.76	21.6

37	38	3	5	3.76^{ab}	0.71	19
38	38	3	6	3.97^{a}	0.85	21.5
Total	304	2	6	3.5^{1}	0.77	21.9

Table 1: Descriptive statistics of weekly egg production showing the effect of age. ^{abc}Means along column with different superscripts are significantly different (P<0.05).

The variance component of the pooled ages of the birds was 0.049 while that of error was 0.551. The percentage of the additive genetic variance (σ^2a) was 8.17% while that of the residual variance (σ^2e) was 91.83% (Table 2). The repeatability coefficient (pooled data for all ages) for egg number was low (0.082) including its standard error (0.011). However, the heritability estimate was moderate (0.326) with a very low standard error (0.011) (Figure 1). The repeatability value obtained in this study is comparable to the estimates of 0.07 and 0.17 reported for layers [13] and fall within range of 0.04–0.38 reported by Wolc et al. [2]. It was however lower than the values of 0.37 and 0.50 and 0.19 ± 0.05 and 0.32 ± 0.04 reported by Olowofeso and Adeleke [7] and Custodio [14]. This low R value may, however, be improved upon using more birds with a larger data set by incorporating more egg production records. The heritability estimate of the present study could be attributed to high additive genetic variances with the probability of the egg trait being transmitted from the parents to the progeny. This is congruous to the submission of Oleforuh-Okoleh [6]. The moderate heritability value might also not be unconnected with the availability of age variance as the model was fitted with age (week) of birds. This is consistent with the findings of John-Jaja [4] that the removal of age variance could lead to low estimates as age differential has been implicated in the growth and development of egg traits. However, their work centred on egg quality traits as against egg number in the current study. In a related study, Nurgiartiningsih et al. [15] reported that age variation at sexual maturity had a great influence on egg production. The accuracy or reliability of the heritability coefficient of the present study could be inferred from its very low standard error.

Parameters	K-value	Variance component	Percentage (%)
Age of birds	38	0.049	8.17
Residual		0.551	91.83

Table 2: Variance components of egg production trait. h^2S=Narrow Sense Heritability Estimate; R=Repeatability Estimate; S.E.=Standard Error.

The present heritability estimate is similar to the 0.30 ± 0.02-0.36 ± 0.04 reported by Biscarini et al. [16] but higher than the range of 0.17 ± 0.02-0.28 ± 0.11 reported by Oleforuh-Okoleh [6]. Nurgiartiningsih et al. [15] reported a range between 0.01 and 0.45 for egg production of hen-housed and survivor production while it varied from 0.15 to 0.51 in the submission of Ferreira et al. [17]. However, Unver et al. [18] gave estimates between 0.24 ± 0.12 and 0.54 ± 0.11 for the sire component of heritability (h^2S) with the highest recorded in birds that were 31-40 weeks of age. This phase of egg production is close to the 31-38 weeks of age of the current study, an indication that it could be prioritized when taking some breeding and management decisions.

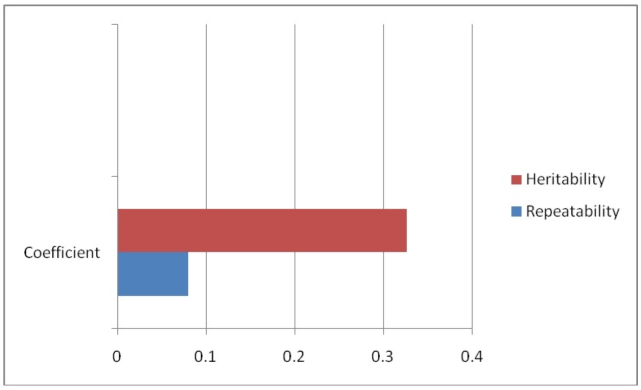

Figure 1: Repeatability and heritability coefficients for egg production.

The additive genetic variance is the contribution of the birds to the total variance component. Its present value is higher than the 2.3 and 4.5% recorded by El-Labban et al. [19]. Additive gene action seems to be important for egg number in the present study. Since egg production is a quantitative trait influenced by both genotypic and environmental variance and their interaction, the implication of the present finding is that there is room for early selection of Sasso birds in terms of egg production. Birds with the best average performance for week 31-38 of age stand a better chance of being selected; as selection on the parents will likely produce inherited changes in the offspring. This early selection, according to Ferreira et al. [17], may lead to a reduction in the range of subsequent generations, decrease in cost of production with concomitant increase in annual profit. This is in tandem with the report of a study carried out on a related species by Ribeiro et al. [20]. However, the variations in the repeatability and heritability estimates of our own study and those earlier carried out might be attributed to the genetic potential of the birds, age differential, sample size and other non-genetic components such as the environment including the methods of estimation.

Conclusion

The moderate heritability estimate obtained in the present study indicates that selection of birds could be done at this phase (31-38 week of age) of production to improve egg production. Low estimate was however observed in the case of repeatability. However, both genetic parameters could be improved upon by incorporating more egg production records and increasing the sample size in addition to better rearing environment.

Competing interests

The authors declare that there is no competing interest.

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References

1. Scanes CG (2007) The global importance of poultry. Poultry Science 86: 1057-1058.
2. Wolc A, Lisowski M, Szwaczkowski T (2007) Heritability of egg production in laying hens under cumulative, multitrait and repeated measurement animal models. Czech J Anim Sci 52: 254-259.
3. Toye AA, Sola-Ojo FE, Ayorinde KL (2012) Egg production, egg weight and egg mass repeatability, and genetic gain from use of multiple time-spaced records in Black Harco and Lohman Brown layers. Centrepoint Journal (Science Edition) 18: 147-156.
4. John-Jaja SA, Abdullah AR, Nwokolo SC (2016) Heritability estimates of external egg quality traits of exotic laying chickens under the influence of age variance in the tropics. Journal of the Saudi Society of Agricultural Sciences.
5. Dohm MR (2002) Repeatability estimates do not always set an upper limit to heritability. Functional Ecology 16: 273-280.
6. Oleforuh-Okoleh VU (2010) Improvement in egg production traits in the light local chicken ecotype using a selection index. A thesis submitted to the Department of Animal Science, Faculty of Agriculture, University of Nigeria, Nsukka, in fulfillment for the requirement of the award of the Doctor of Philosophy degree (Ph.D) in Animal Breeding and Genetics.
7. Olowofeso O, Adeleke MA (2012) Coefficient of repeatability for numbers of eggs laid by Bovan Nera and Harco Black layer strains in phases i and ii of production. Egypt Poult Sci 32: 259-262.
8. John-Jaja SA, Abdullah AR, Nwokolo SC (2016) Effects of age variance on repeatability estimates of egg dimensions of Bovan Nera Black laying chickens. J Genet Eng Biotech 14: 219-226.
9. Yakubu A, Ayoade JA, Dahiru YM (2010) Effects of genotype and population density on growth performance, carcass characteristics and cost-benefits of broiler chickens in north central Nigeria. Trop Anim Health Prod 42: 719-727.
10. SPSS (2015) Statistical Package for Social Sciences. Version 23. SPSS Inc., 444 Michigan Avenue, Chicago, IL60611, 2015.
11. Falconer DS, Mackay TF (1996) Introduction to Quantitative Genetics. 4th edn. Longman, Harlow.
12. Becker WA (1984) Manual of Quantitative Genetics. 4th ed. Academic Enterprises, Washington, USA.
13. Udeh I (2010) Repeatability of egg number and egg weight in two strains of layer type chicken. Int J Poult Sci 9: 675-677.
14. Custódio RWS (2000) Repeatability and heritability estimates for egg and chick production, with hierarchical matings, in meat-type chickens. Pesquisa Agropecuária Brasileira 35: 967-974.
15. Nurgiartiningsih VMA, Mielenz N, Preisinger R, Schmutz M, Schüler L (2005) Heritabilities and genetic correlations for monthly egg production and egg weight of White Leghorn hens estimated based on hen-housed and survivor production. Arch Geflügelk 69: 98-102.
16. Biscarini F, Bovenhuis H, Ellen ED, Addo I, van Arendonk JAM (2010) Estimation of heritability and breeding values for early egg production in laying hens from pooled data. Poultry Science 89: 1842-1849.
17. Ferreira PB, Rorato PRN, Breda FC, Michelotti VT, Rosa AP, et al. (2017) Genotypic parameters for egg production in pure breed hens by using random regression model. Ciência Rural 47: e20141631.
18. Unver Y, Oguz I, Akbas Y (2002) Genetic parameter estimation of partial egg production traits in layers. J Appl Anim Res 22: 243-248.
19. El-Labban AM, Iraqi MM, Hanafi MS, Heba AH (2011) Estimation of genetic and non-genetic parameters for egg production traits in local strains of chickens. Livestock Research for Rural Development 23, Article #10.
20. Ribeiro JC, da Silva LP, Soares ACC, da Costa CG, Leite CDS, et al. (2017) Genetic parameters for egg production in meat quails through partial periods. Ciência Rural Santa Maria 47: e20160374.