

REPEATABILITY OF EGG NUMBER AND EGG QUALITY TRAITS IN COMMERCIAL PULLETS

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ABSTRACT

Repeatability estimates of 0.09 for egg number to 30 weeks of age; 0.67, 0.53, 0.51, 0.20 and 0.26 for egg weight (EW), shell thickness (ST), Haugh unit (HU), yolk index (YI) and shape index (SI), respectively, at 22 weeks of age; and 0.85, 0.78, 0.82, 0.49 and 0.62 for the same traits, respectively at 30 weeks of age were obtained in a flock of exotic commercial pullets reared in cages. The expected relative genetic gain per generation of selection for repeated records was inversely related to the magnitude of repeatability. Thus, as laying progressed, repeatability estimates became higher and expected genetic gain from using additional records decreased and fewer records were required to characterize the pullets for inherent transmitting ability. While 4 eggs per hen are considered adequate for 22 - week EW, ST and HU, 8 eggs are required for YI and SI. The considered numbers of eggs for corresponding traits at 30 weeks are 3 and 4, respectively. Measurements on 10 eggs per hen are required for egg number to 30 weeks.

Key Words: repeatability, egg number, egg quality, transmitting ability, expected genetic gain

INTRODUCTION

Repeatability is a measure of an individual's ability to repeat its performance and maintain its ranking in a population in successive records. Traits such as birth weight and slaughter weight can only be measured once during the life span of an animal, whereas other traits like egg weight, egg number, body weight and egg quality traits can be measured at several periods. Variations commonly observed in these traits are due to both genetic and non-genetic factors. While all the components of genetic variance

affect repeatability, only the permanent portion of environmental variance affects it.

There is scanty information in available literature regarding repeatability of 22 - week egg quality traits. Ibe (1984) reported repeatability coefficients of 0.53, 0.69 and 0.76 for 32- week shell thickness, Haugh unit and egg weight, respectively in a randombred control population of White Leghorn chickens. Coefficients of 0.17, 0.68 and 0.66 for shell thickness. Coefficients of 0.17, 0.68 and 0.66 for shell thickness, shape index and Haugh unit, respectively were reported by King and Hall (1955) in one year-old commercial layers. Estimates ranging from 0.25 to 0.54 and 0.43 to 0.51 have been reported by Orgu (1983) and Ayorinde and Sado (1988) for egg number and egg weight, respectively. Goodman (1965) obtained values of 0.72, 0.52, 0.54 and 0.45 for egg weight, shape index, albumen height and shell thickness, respectively in the Japanese quail.

This study is an attempt to provide further information on repeatability estimates of egg number and different egg quality traits at 22 and 30 weeks of age in an exotic layer population in a tropical environment. The number of records required to adequately characterize the inherent transmitting ability of the pullets for the different traits and expected genetic gain per generation of selection using repeated records compared with selection based on a single record will also be determined.

MATERIAL AND METHODS

Material

A total of 56 commercial Harco pullets were used. The chicks were brooded and reared under standard management conditions on deep litter, with *ad libitum* feeding using commercial chick mash. The floor, feeder and waterer

spaces provided during the first four weeks were 0.23m², 11.5cm and 5.4cm per bird, respectively. From 4 to 6 weeks, the floor, feeder and waterer spaces were 0.45 m², 14.1 cm and 5.4 cm, respectively. At 6 weeks of age, the birds were randomly divided into two groups, with one group receiving ad libitum feeding and the other subjected to skip-one-day in a week feeding regime. During this period, which lasted until 18 weeks, the birds were given commercial grower mash analysed to contain 16% crude protein and 4.07 kcal M.E./g. The floor, feeder and waterer spaces provided at this time were 0.91m², 18.4cm and 13.73cm, respectively. At the 18th week, the birds were transferred and housed individually in battery cages and fed a commercial layer mash *ad libitum*. All birds were vaccinated against Newcastle disease on the second day following hatch.

Data Collection and Analytical Procedure

Egg production of each pullet was recorded daily from 22 weeks of age and the values summarised on weekly basis up to 30 weeks of age. The data were used to estimate repeatability of egg number. The first three eggs laid by each pullet at the age of 22 and 30 weeks were used to determine the repeatability of egg weight (EW) shell thickness (ST), Haugh Unit (HU), yolk index (YI) and shape index (SI) at those ages.

A Mettler P. 160 electronic weighing balance was used to measure egg weights while the USDA Interior Egg Quality Calculator was used to compute Haugh unit. Yolk index was measured as the ratio of yolk width to yolk height; shape index was measured as the ratio of egg width to egg length. A micrometer screw gauge was used to determine albumen and yolk heights; a paper thickness gauge was used to determine the shell-membrane thickness.

Harvey's (1987) Mixed Model Least-Squares and Maximum Likelihood Computer programme was used to estimate variance components, using the following mixed model:

$$Y_{ijk} = \mu + G_i + I_{ij} + \epsilon_{ijk}$$

where Y_{ijk} is the k th record of the j th pullet in the i th group, μ is the overall mean, G_i is the fixed effect of the i th group (full fed versus restricted), I_{ij} is the random effect of the j th pullet within the i th group, and ϵ_{ijk} is the random error. Above model yielded variance component due to differences among individual pullets (σ_1^2) and error variance component (σ_e^2)

which were used to obtain estimates of repeatability, using the expression:

$$R = \sigma_1^2 / (\sigma_1^2 + \sigma_e^2)$$

The standard error of the estimate was calculated using a formula described by Becker (1984).

The expected relative genetic gain per generation from selection based on repeated records compared with selection on a single record was computed with the following expression due to Lush (1945):

$$\{k/[1 + (k-1) R]\}^{1/2}$$

where k is the number of records per pullet and R is repeatability.

RESULTS AND DISCUSSION

Repeatability coefficients of the various traits measured at 22 and 30 weeks of age are presented in Table 1. Estimates for EW, ST and HU are relatively higher than those for YI and SI at both ages. Also, estimates for some traits are higher at 30 weeks than at 22 weeks. The magnitude of the repeatability coefficient gives an indication of the number of records required to characterize the inherent transmitting ability of an individual. Generally, fewer records per individual are required for traits with high repeatability than for those with lower values. Data in Table 1 show that fewer records will be required on each hen for EW, ST and HU than for YI and SI. Also, fewer records will be required for all traits at 30 weeks than at 22 weeks. A very low repeatability estimate was obtained for egg number to 30 weeks, indicating that the number of records per individual required to characterize its inherent transmitting ability will be greater than for egg

quality traits.

Repeatability coefficients obtained for EW, ST and HU (Table 1) are comparable to those reported by Ibe (1984) and Ayorinde and Sado (1988) for 32 - week and 50 to 57 - week old commercial layers, respectively. However, estimates of repeatability of egg number and 30 - week egg quality traits are comparable to some available literature values. Repeatability estimate for egg weight is similar to the values reported by Lerner and Cruden (1951) and Akinokun and Dettmers (1977) for Nigerian local chickens, although lower values were obtained by Scheinberg *et al.* (1953), Ibe (1984), and Goodman (1965) in exotic strains. While the estimate for ST obtained in this study is higher than those reported by Ibe (1984), repeatability estimate for HU is similar to that reported by Godfrey *et al.* (1954) and Dickerson and Lamoreux (1954). Repeatability coefficients for SI fall within the range of 0.58 to 0.68 reported by Kotaiah *et al.* (1974), Ayorinde and Sado (1988) and King and Hall (1955).

Discrepancies in these estimates probably reflect differences in the breed of chickens used, their ages and various environmental factors affecting the experimental animals. Scheinberg *et al.* (1953) obtained three different repeatability estimates for yolk weight in chickens of different genetic backgrounds, while King and Hall (1955) reported increase in repeatability as laying progressed.

The expected genetic gains per generation of selection for egg quality traits at 22 and 30 weeks of age are given in Tables 2 and 3, respectively. For all traits at both ages, the relative genetic gain increased with increasing number of records on each individual. However, the rate of increase was smaller for traits with high repeatability values. At 22 weeks, the relative efficiencies of measuring ten eggs instead of one to characterize hens are 19, 32 and 34% for EW, ST and HU, respectively, and 89 and 73% respectively for YI and SI. The former have relatively higher repeatabilities than the latter (Table 1). The corresponding values for EW, ST, HU, YI, SI and egg number at 30

weeks are 8, 12, 9, 36, and 235%, respectively.

Because of the additional cost of collecting more records and the greater expected genetic gain per generation due to shortened generation interval, number of eggs considered optimum per hen to adequately characterize for transmitting ability in the various traits at 22 weeks are 4 (EW, ST and HU) and 8 (YI and SI). With these numbers, greater genetic gains of the following magnitudes, relative to the gain using only one egg, will be realized: 15 to 26% for EW, ST and HU; and 68 to 83% for YI and SI. However, there will be 7 - 13% (for EW, ST and HU) and 27-39% (for YI and SI) less genetic gain using these numbers than using 280 eggs which is the expected optimum egg production of a well-managed Leghorn-type pullet in a year.

At 30 weeks, 3 eggs per pullet (for EW, ST and HU) and 6 eggs per pullet (for YI and SI) are considered adequate. These are expected to result in 5-8% and 21-32%, respectively greater genetic gain than measuring one egg per pullet, and 3-5% and 6- 11%, respectively less gain than measuring 280 eggs per pullet. For egg number to 30 weeks, at least 10 eggs per pullet may be required to adequately characterize them for transmitting ability. This will result in 137% greater genetic gain than measuring only one egg, and 98% less gain than measuring 280 eggs per pullet. It is therefore obvious that the larger the value of repeatability of a trait, the less the number of records required to adequately characterize individuals for their transmitting ability.

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Table 1 REPEATABILITY ESTIMATES FOR THE VARIOUS TRAITS

Trait ^a	22 - week	30 - week
EN		0.09 (0.036)
EW	0.67 (0.06)	0.85 (0.033)
ST	0.53(0.08)	0.78 (0.046)
HU	0.51 (0.085)	0.82 (0.038)
YI	0.20 (0.10)	0.49 (0.082)
SI	0.26 (0.09)	0.62 (0.069)

a EN = egg Number EW = egg weight ST = shell thickness HU = Haugh Unit YI = yolk index
SI = shape index
Standard errors are in parentheses

Table 2 RELATIVE GENETIC GAIN PER GENERATION OF SELECTION BASED ON REPEATED RECORDS FOR 22-WEEK EGG QUALITY TRAITS

No. of records	EW	ST	Trait ^a		
			HU	YI	SI
1	1.00	1.00	1.00	1.00	1.00
2	1.09	1.14	1.15	1.29	1.26
3	1.13	1.21	1.22	1.46	1.41
4	1.15	1.24	1.26	1.58	1.50
5	1.17	1.26	1.28	1.67	1.57
6	1.17	1.28	1.30	1.73	1.62
7	1.18	1.29	1.31	1.78	1.65
8	1.18	1.30	1.32	1.83	1.68
9	1.19	1.31	1.33	1.86	1.71
10	1.19	1.32	1.34	1.89	1.73
280	1.22	1.37	1.39	2.22	1.95

a See Table 1 for meanings of trait abbreviations

Table 3 RELATIVE GENETIC GAIN PER GENERATION OF SELECTION BASED ON REPEATED RECORDS FOR 30-WEEK EGG QUALITY TRAITS

No. of records	EW	ST	Trait ^a			
			HU	YI	SI	EN
1	1.00	1.00	1.00	1.00	1.00	1.00
2	1.04	1.06	1.05	1.16	1.11	1.36
3	1.05	1.08	1.07	1.23	1.16	1.60
4	1.06	1.09	1.08	1.27	1.18	1.78
5	1.07	1.10	1.08	1.30	1.19	1.93
6	1.07	1.11	1.09	1.32	1.21	2.05
7	1.07	1.11	1.09	1.33	1.22	2.15
8	1.07	1.11	1.09	1.34	1.22	2.24
9	1.07	1.12	1.09	1.35	1.23	2.31
10	1.08	1.12	1.09	1.36	1.23	2.37
280	1.08	1.13	1.10	1.43	1.27	3.35

a See Table 1 for meanings of trait abbreviations