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REPEATABILITY ESTIMATES OF EXTERNAL AND INTERNAL EGG QUALITY TRAITS OF LOCAL MUSCOVY DUCKS

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Abstract

Repeatability is one of the genetic parameters that determines breeding values of traits. Studies on repeatability estimates of the internal and external quality traits of Nigerian Muscovy duck eggs were carried out at Poultry Unit, Teaching and Research Farm, Osun State University. Ejigbo. A total of 383 eggs collected from 50 ducks mated to 10 drakes were used for the studies. External egg quality studied includes: egg weight (EW), shell weight (SW), shell thickness (ST) egg length (EL), egg width (EWIEgg density (ED), egg shell index (ESI) and egg surface area (ESA), shell percentage (SP), shell density (SD), egg volume (EV) and shell surface area (SSA). The internal egg quality traits include: yolk colour (YC), yolk weight (YW), yolk height (YH), yolk diameter (YD), albumen height (AH), albumen diameter (AD), albumen weight (AW), yolk percentage (YP) yolk index (YI), albumen percentage (AP), and haugh unit (HU). The data collected were subjected to one way analysis of variance to determine variance components and repeatability estimates. Results showed that, repeatability estimates were ranged from low to moderately high and the repeatability values for external egg quality traits were: EW*(0.44±0.02), SW(0.11±0.01), ST (-0.01±0.01), EL (0.26±0.02), EWI (0.39±0.02), ED (-0.01±0.01), ESI (-0.02±0.01), ESA (0.44±0.02), SP (0.16±0.02), SD (-0.01±0.01), EV (0.14±0.02) and SSA (0.11±0.01) while that of the internal qualities were: YC (0.01±0.01), YW (0.41±0.02), YH (0.10±0.01), YD (0.04±0.01), AH (-0.11±0.00), AD (0.21±0.02), AW (0.42±0.02), YP (0.37±0.02), AP (0.34±0.02), while Haugh unit is (0.34±0.02) and albumen index (0.02±0.01). It was concluded that, traits with moderately high, to high estimates could be selected in the early part of the duck's lifetime while the low estimates of repeatability for some egg quality traits in this Muscovy duck indicates that improvement in these traits could be achieved through improvement of most of their non-genetic factors of Muscovy production.*

Key words**:** *Muscovy duck eggs, external egg quality traits, internal quality traits, repeatability estimates.*

INTRODUCTION

Repeatability estimate is one the important genetic parameters that could be used in estimating breeding values in animal genetic improvement programmes. This can assist breeders to decide if a particular trait can be improved through selection or by the improvement of the non-genetic factors.

[8] defined repeatability as a measure of the degree of association between records on the same animal for traits expressed more than once in an animal's life and that it's estimate indicates the gain in accuracy expected from multiple measurements. Several authors had estimated repeatability for different traits in livestock and in poultry species. [18]: for milk, fat, protein yields and lactose minerals and other milk traits in dairy cattle In Jersey cattle; [23] for body weight in pure and reciprocal crosses of Nigerian goats; [22] for egg weight in Japanese quail eggs; [21] for eggs at 40 weeks for laying birds; [1] for egg weight, egg length, egg width and shell weight in Isa Brown layers. There is paucity of information on repeatability estimates on egg quality traits in local Muscovy ducks.

Egg quality traits are characteristics of an egg that affects its acceptability to users and consumers. [15], indicated that both external

and internal egg quality traits in poultry hens had significant effects on the hatchability of incubated eggs, body weight and development of young chicks. [10] also noted that egg quality is indicative of the reproductive fitness of parents. [2] indicated that, weights of egg shell, albumen and yolk that form the major components of an egg as well as their ratios determine the amount and price of the product in the egg processing industry. The improvement of egg production parameters is desirable because of their economic importance and this can be achieved by improvement of both genetic and non-genetic factors influencing egg production. Repeatability estimates will guide animal breeders in designing appropriate breeding plans for genetic improvement of traits in livestock and poultry species. Therefore, the objective of this study was to estimate repeatability for both external and internal egg quality traits of the muscovy ducks which could serve as basis for the development of improvement programmes for this species in south-western Nigeria.

MATERIALS AND METHODS

Study location

This study was carried out at the Poultry Unit of the Teaching and Research Farm, Department of Animal Science, Osun State University, Ejigbo Campus. Ejigbo is prominent town in Yoruba land, and the headquarters of Ejigbo Local Government Area of Osun State on latitude 7^0, $54^{'}$ $0.00^{''}$ N and longitude 4^0 $18^{'}$ $54.00^{'}$[13]. E. The town is strategically located in the middle of the region as 35 kilometers (Km) north-east of Iwo, 30 Km from Ogbomoso in the north and 24 Km from Ede in the south-east. It is about 40 Km north-west of Osogbo the capital of Osun State.

Experimental units

A total of 60 Muscovy ducks was sourced from reliable farms across Osun state. Ten sire families consisting of five females (ducks) and one male (drake) per each family were used. The birds were winged banded for proper identification and randomly allocated to each family. Each family was placed in deep litter pens. The pens were cleaned, disinfected and littered with wood shavings which were changed once a week to prevent bad odour and wet litter which could lead to disease causing organisms build-up within the pens. Clean water was provided both in the morning and evening. Experimental birds were fed *ad-libitum* with layers' mash containing 18% crude protein and 2,500Kcal metabolisable energy at the rate of 170g per bird per day as recommended by [14].

Data collection and laboratory analysis

Eggs were collected daily in the morning and both the internal and external qualities of the eggs were analysed within 24 hours of lay. Eggs were weighed after collection before quality characteristics measurement. A minimum of three eggs were collected from each sire family continuously for ten days making a total of 383 eggs that were sampled. Using the procedures of [17], data were collected on the external and internal quality traits of the Muscovy duck eggs. External quality eggs were weighed using a 0.01g sensitive digital weighing scale, the length and width of egg were measured with digital vernier caliper. while the Internal egg quality data were taken by breaking the sharp end of the eggs. In order to carefully measure albumen and yolk parameters, the contents were emptied into a container and the yolks were carefully separated from the albumen and weighed using a sensitive balance. The egg yolk color score was determined using Roche yolk color fan having tabs from 1 to 15. The container was wiped dry after each weighing. The shell weight with membrane was determined by carefully placing the material on the sensitivity scale. However, to measure the shell weight only, the membrane of the shell was first removed and the shell thickness measured using micrometer screw guage. Other egg quality traits were obtained by mathematical calculations.

Albumen weight = egg weight- (yolk weight + shell weight)

Albumen percentage= (albumen weight/egg weight) x 100

Yolk percentage= (yolk weight/egg weight) x 100

Shell percentage= (shell weight/egg weight) x 100

Haugh unit (HU= 100log (h+7.57)-(1.7*W 0.37)
where:
h = albumen height and
W= weight of egg were weighed in cm and g respectively.
(Haugh unit determines the relationship of the height of the thick white to the weight of the egg and it is usually used to determine albumen quality).
The data obtained with respect to each trait were subjected to one-way analysis of variance using the following model described by [5].

$$Yij= \mu + T_i + e_{ij}$$

where:
Y_{ij}= individual observation on the i^{th} eggs belonging to the i^{th} sire family
μ= Overall mean
T_i= Fixed effect of ith sire family
e_{ij}= Residual random error

The variance components were determined from the mean square expectation of the ANOVA using the [19] and repeatability estimated using the following expression:

$$R = \frac{\delta_B^2}{\delta_B^2+\delta_E^2} \text{…….. …Equation 1}$$

δ_E^2=MSE

$$\delta_B^2 = \frac{MSB-MSE}{K} \text{……Equation 2}$$

where:
R = repeatability estimate [5]
MSB= mean square between individuals
MSE= mean square error
K= number of records
δ_B^2 =Variance between individuals in the population
δ_E^2 =Variance component (error) = the differences within individual bird measurement.
The standard error of the repeatability (SER) estimate was calculated using the procedure of [5].

$$SER = \frac{\sqrt{2(1-R)2(1+(-1)R)2}}{K(K-1)(N-1)} \text{……Equation 3}$$

where:
SER= Standard Error of Repeatability
R=repeatability estimate
K = number of eggs per bird; N = number of birds involved.

RESULTS AND DISCUSSIONS

Repeatability estimates of egg quality traits of Muscovy ducks

Repeatability (R) estimates in different egg quality traits in poultry species by several authors ranged between very low value of 0.03 and as high as 0.902±0.13 (Table 1).
Some of the repeatability estimates for some traits could not be estimated and they are indicated as inestimable. The values in this study fall within the range reported by different studies in poultry species.
The R estimates for the external and internal egg quality traits in the present study are shown in Tables 2 and 3 respectively.
The estimates for some of the external qualities are moderately high: egg weight (0.44±0.02), egg length (0.26±0.02), egg width (0.39±0.02) and egg surface area (0.44±0.02) while that of the internal qualities are: yolk weight (0.41±0.02), albumen weight (0.42±0.02), yolk percentage (0.37±0.02), albumen percentage (0.34±0.02), while Haugh unit is (0.34±0.02). This indicates that, these traits can be selected early in the life of Muscovy ducks. The repeatability estimate for egg weight in this study was lower than 0.76 what was reported by [22] in Japanese quail eggs. It is however similar with 0.44±0.24 reported by [21] for eggs at 40 weeks for layer chicken. R estimates for width and length of egg, shell and yolk weight, albumen diameter and weight were all higher than what [22] reported for quail eggs which might be as a result of differences the poultry species used.
[1] reported repeatability estimates for egg weight, length and width and shell weight to be 0.23±0.065, 0.42±0.18, 0.65±0.071 and 0.59±0.033, respectively while 0.86±0.108, 0.11±0.072, 0.54±0.034, 0.43±0.088, 0.12±0.072 and 0.81±0.117 for shell thickness, yolk weight, diameter and height, albumen height, and Haugh unit respectively, for chicken eggs.

The moderate estimates observed for egg weights were in agreement with the reports of [21] who reported a range of 0.12 to 0.85 and 0.05 to 0.62 in two strains of layer chicken studied. and [12] in local quail lines who reported a range of 0.081 to 0.088 indicating that repeatability estimates for egg numbers and egg weights in chicken were low.

It is pertinent to note that repeatability estimates for reproductive traits as reported by some authors [3]; [20]; [6] were generally low. This was attributed to the huge influence of differences in environment and age of the birds under study [8]. However, some authors had reported moderate values which include: [16] who reported a range of 0.22 and 0.36 for some egg quality traits in chicken.

These differences in values might be as a result of differences in species and location of studies.

In order to improve the accuracy of the breeding values of the Muscovy ducks, it would be important to collect more relevant records, improve rearing and management conditions and other non-genetic factors influencing egg production.

Traits with moderately high to high estimates could be selected for early in life, since few number of records will be needed to take decision on selection early in the ducks' lifetime.

The low estimates observed in this show that, non-genetic factors have major influence on the traits. R estimates for shell thickness, egg density, shape and index, shell density and albumen height could not be estimated because of negative variance components which could be because of small sample size or the negligible contributions of additive genetic variance component.

Low R estimates obtained for some external egg quality traits in this study indicate that there is need for an improvement in the non-genetic factors of production.

Table 1. Repeatability estimates of egg quality traits of poultry egg from the literature

S/N	Author	Species/Breed	Traits	R± SE
1	[1]	Chicken (Isa Brown Layers)	Egg weight Egg length Egg width Shell weight Shell thickness Yolk weight Yolk height Albumen height Haugh Unit	0.23± 0.065 0.42±0.18 0.65±0.07 0.59±0.033 0.86±0.108 0.11±0.07 0.54±0.034 0.43±0.088 0.81±0.12
2	[12]	Local quail lines Desert	Egg number Egg weight	0.088 0.087
		Brown	Egg number Egg weight	0.087 0.084
		White	Egg number Egg weight	0.088 0.081
3	[22]	Japanese quail	Egg weight Egg width, Egg length, Shell weight Shell thickness Yolk height Yolk diameter Yolk weight Albumen height Albumen diameter Albumen weight	0.76 0.04 0.09 0.002 0.15 Inestimable Inestimable 0.03 Inestimable 0.008 0.05
4	[16]	Chicken	Egg weight at 42 weeks Shell thickness Haugh unit	0.22 0.24 0.36
5	[21]	Quail	Egg number Weight of first egg Egg weight at 30 weeks Egg weight at 40 weeks	0.36 0.04 0.07 0.44
6	[11]	Chicken (Bovan Nera Black layers)	Egg weight Shell weight Egg weight at 25 weeks Egg weight at 51 weeks Egg weight at 72 weeks Yolk weight 25 weeks Yolk weight 51 weeks Yolk weight 72 weeks Albumen weight at 25 weeks Albumen weight at 51 weeks Albumen weight at 72 weeks	0.45±0.03 0.55±0.003 0.843±0.18 0.902±0.13 0.880±0.09 0.838±0.07 0.666±0.09 0.666±0.17 0.846±0.13 0.712±0.14 0.887±0.11
7	[9]	Chicken (Onagoidori) White Leghorn	Egg weight Shell weight Egg weight Shell weight	0.47 0.50 0.42 0.26

8	[7]	White Lohmann egg line	Egg weight Breaking strenght Dynamic stiffness Shell thickness Shape index Albumen height	0.75 0.33 0.71 0.36 0.65 0.23
		Brown egg line Lohmann	Egg weight reaking strenght Dynamic stiffness Shell thickness Shape index Albumen height	0.74 0.32 0.68 0.51 0.42 0.36
9	[9]	Onagoidori (Japanese chicken)	Egg weight Egg length Egg width Eggshell strength Shell weight Shell thickness Albumen weight Albumen height Yolk weight Yolk height Yolk colour	0.47 0.42 0.40 0.23 0.50 0.23 0.51 0.35 0.48 0.56 0.51
		White Leghorn	Egg weight Egg length Egg width Eggshell strength Shell weight Shell thickness Albumen weight Albumen height Yolk weight Yolk height Yolk colour	0.42 0.58 0.24 0.39 0.26 0.23 0.45 0.25 0.40 0.35 0.44
10	[4]	Chicken (Hubbard Layers)	Egg production Egg weight Egg index	0.40±0.14 0.58±0.05 0.60±0.05

Source: from the literature. R is the repeatability estimate and SE is standard error.

Table 2. Variance component and repeatability estimates of external egg quality traits of Muscovy ducks

Variables	**MS_B**	**MS_E**	**δ^2_E**	**δ^2_B**	**R**	**S.E (R)**
Egg weight (g)	297.99	33.71	33.71	26.43	0.44	0.02
Shell weight (g)	2.25	1.00	1.00	0.13	0.11	0.01
Shell thickness(cm)	20.75	22.71	22.71	-0.20	-0.01	0.01
Egg length(cm)	0.23	0.05	0.0	0.02	0.26	0.02
Egg width(cm)	0.15	0.02	0.02	0.01	0.39	0.02
Egg density (g/cm^3)	3.93	4.27	4.27	-0.03	-0.01	0.01
Egg shell index	215.93	262.45	262.45	-4.65	-0.02	0.01
Egg surface (cm^2)	172.93	19.42	19.42	15.35	0.44	0.02
Shell percentage (%)	3.16	1.11	1.11	0.21	0.16	0.02
Shell density (g/cm)	2.14	2.34	2.34	-0.02	-0.01	0.01
Egg volume (cm^3)	4,698.27	1,747.29	1,747.29	295.10	0.14	0.02
Shell surface (cm^2)	21.86	9.78	9.78	1.21	0.11	0.01

MS_B = Mean square within individuals, MSE = mean square between individuals, δ^2_B= variance component within individuals (estimating total genetic variance and portion of the environmental variance peculiar to individual birds); δ^2_E = variance component error (differences among measurements within the individual bird; R = repeatability estimate; S.E(R) = standard error of repeatability
Source: Own results.

Table 3. Variance component and repeatability estimates of internal egg quality traits of Muscovy duck

Variables	MS_B	MS_E	δ^2_E	δ^2_B	R	SE (R)
Yolk colour	2.43	2.17	2.17	0.03	0.01	0.01
Yolk weight (g)	68.49	8.69	8.69	5.98	0.41	0.02
Yolk height(cm)	0.17	0.08	0.08	0.01	0.10	0.01
Yolk diameter(cm)	6.23	4.32	4.32	0.19	0.04	0.01
Albumen height(cm)	0.03	13.97	13.97	-1.39	-0.11	Inestimable
Albumen diameter(cm)	1.25	0.35	0.35	0.09	0.21	0.02
Albumen weight(g)	159.12	19.22	19.22	13.99	0.42	0.02
Yolk percentage (%)	73.36	10.84	10.84	6.25	0.37	0.02
Yolk index	108.75	55.98	55.98	5.28	0.09	0.01
Albumen percentage%	89.10	12.75	12.75	7.64	0.37	0.02
Haugh unit	0.04	0.01	0.01	0.01	0.34	0.02
Albumen index	0.54	0.46	0.46	0.01	0.02	0.01

MS_B = Mean square within individuals, MSE = mean square between individuals, δ^2_B = variance component within individuals (estimating total genetic variance and portion of the environmental variance peculiar to individual birds); δ^2_E = variance component error (differences among measurements within the individual bird; R = repeatability estimate; S.E(R) = standard error of repeatability.
Source: Own results.

CONCLUSIONS

Repeatability estimates of both external and internal quality traits ranged from low to high. Traits with moderately high to high estimates could be selected for early in life, since few number of records will be needed to take decision on selection early in the ducks' lifetime. The low estimates of repeatability for other egg quality traits in the Muscovy duck indicate that improvement for these traits could be achieved through efficient rearing management and improvement of most of their non-genetic factors.

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