
The Effects of Genotype and Age of Layer Breeders on Egg Quality Traits

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Abstract:

The external and internal qualities of 120 eggs (60:60) from Isa Brown (IB) and Bovan Nera (BN) layer breeders were evaluated at 15th and 30th week of their production. The genotypes differed significantly ($P < 0.05$) in external egg quality traits except egg weight and egg length. IB recorded higher values in egg width, eggshell weight, eggshell thickness, shape index and shell ratio than BN, while the reverse trend was for egg length. This implies that IB genotype produced eggs with thicker shells than BN, which invariably will lead to a reduction in the rate of cracks and leakages both on the farm and in the hatchery thereby enhancing better hatchability. The age effect was significant ($P < 0.05$) for all the external egg quality traits. The analysis showed that eggs produced at 30th week were better in terms of external quality traits with the exception of egg shape index. There was positive and significant ($P < 0.05$) interaction effect between genotype and age on eggshell width and shell ratio but not for other traits. As regards internal egg quality traits, the genotypes differed significantly ($P < 0.05$) in all the traits except yolk width, yolk height and albumen weight. IB recorded higher ($P < 0.05$) values in yolk weight, albumen width and yolk ratio than BN, while the latter recorded higher values in albumen height, albumen ratio and haugh unit (HU) than the former. The effect of age on internal traits was positive and significant ($P < 0.05$) with the exception of yolk width, albumen width, yolk ratio and albumen ratio. The result showed that the 30th week analyses recorded higher ($P < 0.05$) values in these traits than 15th week. This implies that the quality of breeding eggs improves with the advancing age of the birds. Breed x age interactions were significant for yolk weight and albumen width but not found for other traits. IB genotype was considered the best for external egg quality traits and produced thicker eggshell. However, BN genotype produced superior egg quality than IB having recorded higher values ($P < 0.05$) in HU, which is a determinant of egg quality.

Key words: Genotype, age, egg, traits

Introduction

Chicken egg is a source of reproduction and animal proteins for human consumption.

According to Uluocak *et al.* (1995), the supply of animal proteins in sufficient and balanced proportion is considerable for the human health with respect to the physical and mental progress.

Egg quality is a determinant of the reproductive fitness of the parents and was defined by Stadelman (1977) as the characteristics of an egg that affects its acceptability to the consumers. The hatchability of fertile eggs from thin-shelled eggs according to Bennet (1992) was 3-9% lower than the thicker-shelled eggs. Peebles and Brake (1987) also reported depression of hatchability and weakening of the embryos due to reduction in eggshell quality. Egg quality is influenced by both genetic and non-genetic factors such as age, season, and environment and feed intake (Salahuddin and Howliger, 1991; Matsouka *et al.*, 1980). Egg weight as reported by Elahi (1983) varied with the size of the bird while Pandey *et al.* (1986) reported that weight and proportion of egg represented by albumen, yolk and shell varied significantly between strains of hens. As for the effect of the size of egg, Mengel *et al.* (1979) reported that medium-sized egg often hatched better than either large or smaller egg at any season. There is a correlation between egg weight and albumen and yolk weight (Chung and Stadelman, 1961) and between egg weight and chick weight (Narkhede *et al.*, 1981). Albumen quality has been reported as a quantitative genetic trait and Hill (1977) reported significant differences among strains of hens in albumen quality. The external and internal qualities of the egg are significant in the poultry breeding for their influence in the yield features of the future generations, breeding performance and quality and growth of chickens (Altinel *et al.*, 1996). The qualities of eggshell as reported by Altan *et al.* (1995) have a vital importance on the laying force,

embryo growth and the chick quality. The age of hens is also a factor in the evaluation of both external and internal egg qualities. Nagai and Gowe (1969) reported that age is more important than seasonal factors in determining egg quality. There is relatively little information on the effect of genotype and age of layer breeders on the quality of hatchable eggs produced under the same feeding, housing and management practices in Nigeria. Egg quality is very important in enhancing good hatchability of breeder eggs. Therefore, this study was undertaken to evaluate the differences in external and internal quality traits of eggs of Bovan Nera (BN) and Isa Brown (IB) layer breeders, and the effect of age on their egg qualities when measured at two different age periods during their production cycle.

Materials and Methods

Settable eggs were collected from Bovan Nera (BN) and Isa Brown (IB) breeders in their first year of lay from Ajanla Farms, Ibadan, Southwest, Nigeria. The birds were raised under similar housing, feeding and management practices. Thirty (30) fresh eggs from each breed were taken for analyses at 15th and 30th week in lay, respectively. The eggs were numbered on breed basis. Egg weight was determined using a sensitive digital top loading balance while egg length and egg width were measured using vernier caliper. The eggs were later broken on a flat plate at an equatorial region. Yolk height, yolk width, albumen height and albumen width were measured with vernier caliper, while yolk weight and shell weight were measured with a sensitive

digital electronic scale. The albumen weight was determined by the formular:

Albumen weight= Egg weight “ (Yolk weight + Shell weight).

Haugh unit (Haugh, 1937) was calculated using the following formular:

$$HU=100 \log (H+7.6^{1.7}w^{0.37})$$

Where HU=Haugh Unit. After Nesheim *et al.* (1979)

H=height of albumen in mm

W=weight of egg (gm)

Egg shape index was determined according to Reddy *et al.* (1979) as:

$$\text{width of egg/length of egg} \times 100$$

Albumen ratio= Albumen weight/egg weight x 100

Yolk ratio= Yolk weight/egg weight x 100

Shell ratio= Shell weight/egg weight x 100

Statistical analysis

The analysis of variance model used for the determination of significance was:

$$Y_{ijk} = \mu + G_i + A_j + (GA)_{ij} + e_{ijk}$$

Y_{ijk} = Observation of k^{th} measurement, of j^{th} age and i^{th} genotype.

μ - Common mean.

G_i - Fixed effect of the i^{th} genotype (1, 2)

A_j - Fixed effect of j^{th} age (1, 2)

$(GA)_{ij}$ - interaction effect of i^{th} genotype and j^{th} age

E_{ijk} = random error

Data analysis

The data obtained were analyzed using analysis of variance (ANOVA) and the differences determined by Duncan New Multiple Range Test (DMRT) of General Linear Model of SAS^R (2001) computer package.

Results and Discussion

Table 1 shows the plan of the experiment for the test of egg quality traits for the two strains. 30eggs each were collected for IB and BN genotypes at age 15th and 30th week.

External egg quality

The least squares means for the effects of genotype and age on external egg quality traits were presented in Table 2. The coefficient of determination (R^2) was highest for shell ratio (0.63) and lowest for egg width (0.09). The effects of genotype differed significantly ($P < 0.05$) for the traits such as egg width, egg shell weight, egg shell thickness, egg shape index and shell ratio but not significantly for egg weight and egg length. IB was superior to BN in all these traits where significant differences existed between genotypes. IB genotype produced better egg width and egg shape index ($P < 0.05$) and superior eggshell weight, eggshell thickness and shell ratio ($P < 0.001$) than BN genotype. Though, the genotypes recorded no significant

Egg quality traits of layers

Table 1: Plan for the test of egg quality traits

Genotype	Production age (week)	No. of eggs
IB	15	30
	30	30
BN	15	30
	30	30

IB- Isa Brown

BN- Bovan Nera

difference for egg weight and egg length, IB produced heavier egg than BN and the reverse trend was for egg length ($P>0.05$, Table 2). The difference between IB and BN in egg width, egg shell weight, egg shell thickness, egg shape index and shell ratio was 0.04cm, 1.16g, 0.04mm, 2.78 and 1.88%/egg, respectively (Table 2) all in favour of IB. The effect of age differed significantly ($P<0.05$) for egg width, and shell ratio and highly significant ($P<0.001$) for egg weight, egg length, eggshell weight and egg shape index. With the exception of egg shape index, the 30th week analyses were higher and superior to 15th week. Egg weight, egg length, egg width, egg shell weight and shell ratio were higher by 4.11g, 0.25cm, 0.05cm, 0.62g and 0.34%/egg, respectively in 30thweek than 15thweek analyses. There was no significant interaction ($P>0.05$) effects of genotype x age on egg weight, egg length, egg width and egg shape index except on egg weight and shell ratio (Table 2).

The genetic differences obtained in this result in eggshell thickness and shape index was in agreement with the findings of Monira *et al.* (2003) while the obtained result in egg width contradicted their findings. The researchers reported breed differences in egg shell thickness and shape index and no significant effect in egg width. Isa Brown genotype produced eggs with greater shell weight and thicker shells and this is a good quality enhancing the hatchability of fertile eggs. The result obtained on egg on egg weight and egg length was in agreement with the result of Prasad *et al.* (1981) who also reported no breed differences in these traits. In addition, the significant breed effect obtained in this result on shell ratio agrees with the findings of Fletcher *et al.* (1981) but contradicted the findings of Roberts (2000). Egg weight, egg length, shell weight and shell ratio increased in values as the hens advanced in age and this may be due to physiological changes in pullets such as increase in size of reproductive organs reported by Jeffery

Table 2: Least squares means showing external egg quality traits of Bovan Nera (BN) and Brown (IB) for two ages- 15th and 30th week

Traits	Genotype		Production age (week)	
	IB	BN	15	30
Egg weight (g)	56.38±0.56	55.43±0.56	53.84±0.56 ^b	57.95±0.56 ^a
Egg length (cm)	5.54±0.03	5.61±0.03	5.45±0.03 ^b	5.70±0.03 ^a
Egg width (cm)	4.26±0.02 ^a	4.22±0.02 ^b	4.21±0.02 ^b	4.26±0.02 ^a
Eggshell weight (g)	6.20±0.07 ^a	5.04±0.07 ^b	5.31±0.07 ^b	5.93±0.07 ^a
Eggshell thickness (mm)	0.29±0.01 ^a	0.25±0.01 ^b	-	-
Egg shape index (%)	77.07±0.44 ^a	75.29±0.44 ^b	77.33±0.44 ^a	75.0±0.44 ^b
Eggshell ratio (%)	11.0±0.10 ^a	9.12±0.10 ^b	9.88±0.10 ^b	10.22±0.10 ^a

a, b - means with the same superscripts are not significantly different (P>0.05).

(1941). It was considered that the difference between the obtained result and the result of other researchers might have resulted from the genetic structure, health condition, flock age, feed quality and the differences in the location, care and conditions of the flock.

Internal egg quality

The least squares means for the effects of genotype and age on internal egg quality traits were shown on Table 3. The coefficient of determination (R²) was highest for albumen ratio (0.34) and lowest for yolk width (0.03). The effect of genotype differed significantly (P<0.001) for the traits: yolk weight, albumen width, albumen

height, haugh unit (HU), albumen ratio and yolk ratio but not significant (P>0.05) for yolk width, yolk height and albumen weight. IB genotype was superior in yolk weight, albumen width and albumen yolk ratio to BN genotype while the latter was better in albumen height and albumen ratio and haugh unit than the former. Though the genotypes had no significant effect (P>0.05) on yolk width, yolk height and albumen weight, IB had wider yolk measure while BN recorded insignificant higher values in yolk height and albumen weight. The difference between the genotypes in yolk weight, albumen width and yolk ratio was 1.02g, 0.59cm and 1.38%/egg, respectively in favour of IB and the differences in albumen height, albumen ratio and haugh unit

Egg quality traits of layers

Table 3: Least squares means showing internal egg quality traits of Bovan Nera (BN) and Brown (IB) for two ages- 15th and 30th week

Isa

Traits	Genotype		Production age (week)	
	IB	BN	15	30
Yolk weight (g)	14.86+0.18 ^a	13.84+0.18 ^b	13.92+0.18 ^b	14.78+0.18 ^a
Yolk width (cm)	3.86+0.02	3.82+0.02	3.83+0.02	3.84+0.02
Yolk height (cm)	1.74+0.02	1.80+0.02	1.70+0.02 ^b	1.84+0.02 ^a
Albumen weight (g)	35.31+0.46	36.57+0.4	34.61+0.46 ^b	37.26+0.46 ^a
Albumen width (cm)	7.23+0.08 ^a	6.64+0.08 ^b	6.97+0.08	6.90+0.08
Albumen height (cm)	0.81+0.02 ^b	0.91+0.02 ^a	0.82+0.02 ^b	0.90+0.02 ^a
Haugh unit (HU)	90.56+0.81 ^b	95.86+0.81 ^a	91.69+0.80 ^b	94.74+0.81 ^a
Albumen ratio (%)	62.58+0.31 ^b	65.90+0.31 ^a	64.19+0.31	64.29+0.31
Yolk ratio (%)	26.43+0.30 ^a	25.05+0.30 ^b	25.93+0.30	25.54+0.30

a, b - means with the same superscripts are not significantly different ($P>0.05$).

(HU) was 0.10cm, 3.32% and 5.3/egg, respectively in favour of BN. The effect of age differed significantly ($P<0.05$) for haugh unit (HU) and highly significant ($P<0.01$) for yolk weight, yolk height, albumen weight and albumen height. However, no significant ($P>0.05$) effect of age was reported on yolk width, albumen width, yolk ratio and albumen ratio. With no exception, the 30th week analyses recorded higher values on yolk weight, yolk height, albumen weight, albumen height and haugh unit than 15th week analyses. The difference between the two age groups in yolk weight, yolk height, albumen weight, albumen height and haugh unit were 0.86g, 0.14cm, 2.65g, 0.08cm and 3.05/egg,

respectively in favour of 30th week (Table 3). There was no significant interaction effect ($P>0.05$) of breed x age on internal egg quality traits such as yolk width, yolk height, albumen weight, albumen height, haugh unit, yolk ratio and albumen ratio. However, there was significant interaction ($P<0.05$) between yolk weight and albumen width (Table 3).

The genetic differences obtained in this study in yolk weight, albumen width and albumen height was in agreement with the findings of Islam *et al.* (2001) while the obtained result in yolk width, yolk height and albumen weight contradicted their research findings. The obtained result on

albumen ratio and yolk ratio confirmed the findings of Pandey *et al.* (1986) who reported strain differences in the proportion of albumen and yolk of eggs. The breed differences on haugh unit obtained in this study confirmed the previous results (Hill, 1977; Zaman *et al.*, 2004). IB genotype produced eggs with higher proportion of yolk but BN was better and superior in albumen indices and had higher HU, which is a determinant of good egg quality. BN recorded higher value in HU (95.86 ± 0.81) as against 90.58 ± 0.81 recorded for IB and is therefore, considered the best in egg quality than IB.

In addition, the 30th week analyses of internal egg quality traits were superior to the 15th week with the exception of yolk ratio and albumen width. The obtained result contradicted the findings of Roberts (2000) who reported a decline in internal egg quality as the hens grew older. Haugh unit (HU) which is a determinant of internal egg quality increased with advancing age in this study and was in agreement with earlier findings (Zaman *et al.*, 2004) but in contrast to the findings of Roberts (2000). The eggs produced in 30th week contained a higher amount of yolk and albumen than those of the 15th week, an indication of better quality which will result to good hatching performance. The difference between this result and previous studies might be due to the difference in age when the experiment was carried out and the health status of the birds at the time of the experiment.

Conclusion

The findings of this study indicated that both genotype and environment affected the egg quality traits. The implication of this is that the egg quality traits are influenced by the environment external to the hens including weather conditions, feeds and age in addition to the genetic make-up of the hens. IB was superior to BN in most external egg quality traits while the reverse trends were for internal traits. Therefore, Bovan Nera may be considered as the best quality egg producer between the two genotypes having recorded highest value in HU which is a determinant of egg quality.

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