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EFFECT OF LAYING AGE AND PLUMAGE COLOUR ON INTERNAL AND EXTERNAL QUALITY CHARACTERISTICS OF NOILER CHICKEN EGGS

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ABSTRACT

This study was conducted to evaluate the effect of laying age and plumage colour on the internal and external quality characteristics of eggs laid by Noiler chicken. Three hundred freshly laid eggs of three plumage colours (brown, barred and black) and age (young and old) were used for this experiment. External and internal quality parameters measured were: egg weight, egg length, egg width, shape index, albumen height, yolk height, yolk width, yolk index, yolk and albumen weight, Haugh unit, shell thickness, shell thickness and shell surface area. The data were subjected to General Linear Model procedure of SAS® (2002) with laying age, plumage colour and their two-way interaction as fixed effects. Significant differences ($P < 0.05$) were observed in albumen height, yolk height and Haugh unit as a result of differences in plumage colour. In addition, the study showed that age had a significant effect on all the parameters considered except egg shape index. The result showed that albumen height, yolk height and Haugh unit decreased with an increase in laying age. In conclusion, it was found that laying age and plumage colour had significant effect on the quality of eggs laid by Noiler chickens.

Key words: Noiler chicken; plumage colour; laying age; external egg quality; internal egg quality

INTRODUCTION

In Nigeria, where the production of animal protein falls far short of meeting the demands of a rapidly growing population (Adene and Oguntade, 2006) and the state of nutrition is characterized by gross inadequate protein intake, poultry is the most common livestock being kept (Amar-Klemesu and Maxwell, 2000). The Nigerian poultry industry in particular has been rapidly expanding in recent years and is, therefore, one of the most important and commercialized subsectors of the Nigerian agriculture (Adene and Oguntade, 2006). The poultry industry serves as a major source of animal protein in form of meat and eggs and has great potential of solving the national problem of inadequacy of animal products. Local chickens are among the many local resources of the poor people, living in the rural areas, which could be harnessed and utilized for poverty alleviation (Njue *et al.*, 2002). The indigenous poultry species, which includes Noiler chicken, makes significant contributions to animal protein availability in Nigeria through cheap poultry products, such as meat and eggs.

Poultry egg remains one of the cheapest, most affordable and acceptable animal product. Eggs possess two yardsticks that make them important as foodstuff; namely, they are rich in nutrient and serve important roles in many food products because of their functional properties (Silversides and Scott, 2001). Egg quality traits including external (egg weight, egg length, egg width, shell quality, shell

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thickness and shell surface area) and internal traits (albumen height, yolk height, yolk width, yolk index, Haugh unit, albumen and yolk parameters) are crucial not only for consumers but also essential for the egg product industry (Song *et al.*, 2000; Wolanski *et al.*, 2007). Egg weight is used to grade eggs into different categories and bigger eggs cause higher price. Also Haugh unit is a measure of overall internal egg quality.

Noiler chicken, a dual purpose breed of chicken with different plumage colours predominantly black, brown and barred, was recently developed by Amo Farm Sieberer Hatchery Limited, Nigeria for smallholder farmers to address the challenges of food and financial insecurities among rural population, especially women. Noiler chicken is bred to survive on low quality feedstuffs to provide good quality meat and eggs, but little or no research work has been done to evaluate the quality of the eggs. Noiler chicken comes in varieties of plumage colour, however, barred, black and brown are the predominant plumage colours. Buss and Guyer (1982) reported that there was some genetic dispersion in eggshell quality characteristics existing between species and between breeds, plumage colour and families within the lines. Many studies showed that hens with coloured feathers lay bigger eggs than hens with white feathers (Halaj and Grofík, 1994; Vits *et al.*, 2005; Halaj and Golian, 2011). The percentage of yolk tends to be larger in larger eggs and egg albumen tends to decrease with egg weight. Iposu *et al.* (1994) and Silversides (1994) reported negative correlations between the egg weight and albumen height as well as between the egg weight and Haugh unit. Padhi *et al.* (2013) reported that the egg weight showed significant difference in external egg characteristics for eggs laid by layers of different age, and the egg weight increases as the age of layers increases. Lee *et al.* (2016) classify age of hens as the major factor that has an effect on the quality of fresh eggs. Silversides *et al.* (2006) reported that the albumen weight is significantly different between different ages of chicken. Increase in the albumen weight with increase in age was reported, and increase in the egg weight at 40 weeks compared to 28 weeks was also reported by Rajkumar *et al.* (2009). As a result of long-term genetic selection, different plumage colours of laying hen vary significantly in the egg shell quality, egg size and production (Curtis *et al.*,1985). Hence, there is a need to assess the effect of laying age and plumage colour on external and internal egg quality. The objective of this study, therefore, was to determine the effect of laying age and plumage colour on external and internal egg quality characteristics of Noiler chickens.

MATERIAL AND METHODS

Experimental Location

The eggs used for this experiment were collected from Livestofarm, Modakeke Osun State, Nigeria and all the necessary measurements were taken at the Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife. The University is located at Log 7031' 18.2" N and Lat 4031' 33.9" E.

Data Collection and Analysis

A totally 300 freshly laid eggs were obtained across three plumage colours (black, brown and barred) at 26 weeks (young age) or 46 weeks (old age) of age from Noiler chicken. Fifty (50) eggs were collected for each plumage colour.

The external egg quality parameters measured were: egg weight, egg width, egg length, shell, shell surface area and percentage of shell thickness, shell weight. The internal egg quality parameters considered were: albumen height, haugh unit, yolk height, yolk index, yolk and albumen weight and yolk width.

Egg weight, yolk and albumen weight and shell weights were measured in grams using KERRO® electronic compact scale (model number BL50001) with a maximum capacity of 5000 g and sensitivity of 0.1 g.

Egg length (EL), egg width (EW), yolk height (YH), albumen height (AH) and yolk width (YW) were measured in centimetres using a Vernier calliper. Shell thickness (ST) in millimetres was measured using a micrometre screw gauge.

Haugh unit was calculated according to Haugh (1937) using the formula below:

$HU = 100 \log (H + 7.57 - 1.7\ W0.37)$

Shape Index = Egg width / Egg length

Yolk index = Yolk height / Yolk width x 100

Shell surface area = $W^{0.66} \times 4.67$

Data were subjected to General Linear Model (GLM) procedure of SAS (2002) with plumage colour, layer's age and their two-way interaction as fixed effects according to the following model:

$Y_{ijk} = \mu + S_i + A_j + (S*A)_{ij} + e_{ijk}$
Y_{ijk} = Trait measured,
μ = Overall means,
S_i = Plumage colour effect (i = 1, 2,3),
A_j = flock Age effect (j = young and old),
$(S*A)_{ij}$ = Interaction between Plumage colour and age,
e_{ijk} = Random error.

When significant differences among means were found, the means were separated using Duncan's Multiple Range and Least Squares Means tests of the same software.

RESULTS AND DISCUSSION

Table 1 shows the effect of plumage colour on internal and external quality characteristics of eggs laid by Noiler chickens. The parameters presented include egg weight, egg length, egg width, albumen height, yolk height, yolk index, yolk and albumen weight, shell weight, shell surface area, percentage shell thickness, shell thickness, egg shape index and Haugh unit.

There were significant differences in the yolk height, albumen height and Haugh unit ($P < 0.05$) as a result of difference in plumage colour, while there were no significant differences in the egg weight, egg length, egg width, yolk index, shell weight, shell thickness and shape index. This result is in agreement with the report of Dahloum *et al.* (2018), who evaluated the effect of plumage colour on egg quality characteristics of indigenous naked-neck chickens in Algeria. They reported that both yolk height and albumen height were influenced by plumage colour. They reported significant effect of plumage colour on all internal egg quality traits. The albumen height as well as yolk height in the present study was greater than those reported by Dahloum *et al.* (2018).

Further, this present result also agrees with the findings of Rayan *et al.* (2013), who reported some reproductive performance parameters and egg quality traits of two commercial layer plumage colour (brown and white variants). The authors reported significant differences in some internal egg qualities (particularly yolk and albumen). In this study, the yolk height of eggs laid by brown hens had significantly higher value compared to those of eggs laid by black and barred hens. Similarly, value of the albumen height of eggs laid by the brown bird was significantly higher compared to eggs

Table 1. Egg quality parameters of different plumage colours of Noiler chicken

Trait	Black ± SD	Barred ± SD	Brown ± SD	SEM	*P*-value
EW (g)	64.43 ± 5.85	63.14 ± 6.92	63.98 ± 6.08	0.500	0.186
EL (cm)	5.840 ± 0.31	5.832 ± 0.32	5.826 ± 0.25	0.024	0.920
EWD (cm)	4.377 ± 0.16	4.330 ± 0.17	4.313 ± 0.44	0.027	0.242
YH (cm)	1.929 ± 0.11^b	1.899 ± 0.16^b	1.967 ± 0.14^a	0.013	0.002
YW (cm)	4.041 ± 0.27	3.997 ± 0.31	4.080 ± 0.24	0.024	0.063
YI	47.700 ± 4.82	47.951 ± 4.34	48.343 ± 4.27	0.444	0.598
AH (cm)	0.821 ± 0.13^b	0.809 ± 0.14^b	0.870 ± 0.13^a	0.012	0.002
YAW (g)	56.164 ± 6.42	54.968 ± 5.31	55.690 ± 5.72	0.476	0.203
SI	75.111 ± 3.89	75.855 ± 5.02	75.700 ± 8.20	0.565	0.618
SW (g)	7.572 ± 0.57	7.522 ± 0.73	7.687 ± 0.79	0.676	0.210
ST (mm)	0.325 ± 0.04	0.323 ± 0.04	0.320 ± 0.04	0.003	0.556
% ST	32.010 ± 4.14	32.590 ± 4.30	32.310 ± 4.37	0.378	0.556
SSA	71.936 ± 4.38	72.928 ± 5.23	72.585 ± 4.55	0.375	0.167
HU	84.45 ± 0.79^b	84.44 ± 0.71^b	84.72 ± 0.63^a	0.067	0.004

EW = Egg weight, EL = Egg length, EWD = Egg width, YH = Yolk height, YW = Yolk width, YI = Yolk index, AH = Albumen height, YAW = Yolk + Albumen weight, SI = Shape index, SW = Shell weight, ST = Shell thickness, SSA = Shell surface area, HU = Haugh Unit, SD = Standard deviation, SEM = Standard error of mean.

laid by black and barred hens. However, there were no significant differences in the egg weight, egg length, egg width, yolk width, yolk and albumen weight, shell weight, shell thickness and shape index.

There were no significant differences in the egg weight, shell thickness and percentage shell thickness among the three plumage colours of Noiler birds. This disagrees with the report of Rayan *et al.* (2013), who reported that egg weight was significantly affected by plumage colour and that there was significant difference in shell thickness due to plumage colour. In their findings, brown plumage-coloured hens laid eggs that had significantly higher shell thickness compared to their white counterparts.

There were significant differences ($P < 0.05$) in the Haugh unit as a result of differences in plumage colour. The brown plumage had the highest value indicating the best in terms of internal quality among the other plumage colours. Consumer's egg preference could be for the brown plumage colour of Noiler chicken because of their superior internal quality.

Table 2 shows the internal and external characteristics of Noiler chicken eggs at different ages (old and young). Parameters evaluated include the mean egg weight, egg length, egg width, yolk height, yolk width, albumen height, yolk and albumen weight, egg shape index, shell weight, shell thickness, shell surface area, percentage shell thickness and Haugh unit.

There were significant differences ($P < 0.05$) in all the internal and external parameters with the exception of egg shape index. Egg weight showed significant ($P < 0.05$) difference between different ages, and the egg weight increased as the age of the birds increases.

In this finding, the albumen weight significantly ($P < 0.05$) increased with the advancement of layer ages. Rossi and Pompei (1995) obtained similar results. Suk and Park (2001) and Rayan *et al.* (2013) observed that the albumen weight increased with advancing age of layers. Shell thickness differed significantly ($P < 0.05$) among the different ages of birds. The shell thickness was higher in young Noiler birds compared to old Noiler birds. This disagrees with the report of Padhi *et al.* (2013), who determined the effect of age on egg quality in chicken and reported no significant differences ($P < 0.05$) among different ages of birds. A probable explanation for thin eggshell in older hens may be lessening of calcium deposition with the passage of time (Bare and Striem, 1998). It has been observed that

Table 2. Effect of laying age on egg quality parameters of Noiler chicken (Young and Old)

Trait	Old ± SD	Young ± SD	SEM	*P*-value
EW (g)	67.516 ± 4.90[a]	60.180 ± 5.34[b]	0.408	< 0.0001
EL (cm)	5.987 ± 0.25[a]	5.679 ± 0.26[b]	0.020	< 0.0001
EWD (cm)	4.429 ± 0.15[a]	4.251 ± 0.36[b]	0.022	< 0.0001
YH (cm)	1.949 ± 0.12[a]	1.914 ± 0.16[b]	0.010	0.0240
YW (cm)	4.148 ± 0.26[a]	3.932 ± 0.24[b]	0.020	< 0.0001
YI	47.184 ± 4.22[b]	48.812 ± 4.59[a]	0.361	0.0015
AH (cm)	0.810 ± 0.14[b]	0.857 ± 0.13[a]	0.010	0.0020
YAW (g)	58.864 ± 4.72[a]	52.350 ± 4.98[b]	0.388	< 0.0001
SI	74.973 ± 4.41	76.138 ± 7.18	0.461	0.6184
SW (g)	7.787 ± 0.67[a]	7.400 ± 0.69[b]	0.055	< 0.0001
ST (mm)	0.302 ± 0.04[b]	0.343 ± 0.04[a]	0.003	< 0.0001
% ST	34.320 ± 3.89[a]	30.286 ± 3.63[b]	0.308	< 0.0001
SSA	75.243 ± 3.63[a]	69.724 ± 4.06[b]	0.306	< 0.0001
HU	84.250 ± 0.72[b]	84.827 ± 0.65[a]	0.055	< 0.0001

EW = Egg weight, EL = Egg length, EWD = Egg width, YH = Yolk height, YW = Yolk width, YI = Yolk index, AH = Albumen height, YAW = Yolk + Albumen weight, SI = Shape index, SW = Shell weight, ST = Shell thickness, SSA = Shell surface area, HU = Haugh Unit, SD = Standard deviation, SEM = Standard error of mean.

Table 3. Interaction between age and plumage colour on egg parameters of Noiler chicken

Trait	Old Barred ± SD	Young Barred ± SD	Old Black ± SD	Young Black ± SD	Old Brown ± SD	Young Brown ± SD	SEM	*P*-value
EW (g)	68.088 ± 5.10^{a}	58.200 ± 4.23^{c}	68.318 ± 4.11^{a}	60.534 ± 5.34^{b}	66.144 ± 5.88^{a}	61.808 ± 6.08^{b}	0.708	0.0005
EL (cm)	6.067 ± 0.32^{a}	5.597 ± 0.22^{b}	5.982 ± 0.26^{a}	5.699 ± 0.28^{b}	5.913 ± 0.33^{a}	5.741 ± 0.25^{b}	0.035	0.0001
EWD (cm)	4.410 ± 0.19	4.217 ± 0.16	4.465 ± 0.28	4.290 ± 0.33	4.414 ± 0.45	4.247 ± 0.46	0.039	0.9440
YH (cm)	1.957 ± 0.11^{a}	1.839 ± 0.09^{b}	1.913 ± 0.13^{a}	1.945 ± 0.12^{a}	1.977 ± 0.15^{a}	1.957 ± 0.16^{a}	0.019	0.0005
YW (cm)	4.168 ± 0.23^{a}	3.824 ± 0.24^{b}	4.143 ± 0.22^{a}	3.941 ± 0.26^{b}	4.133 ± 0.18^{a}	4.029 ± 0.17^{b}	0.035	0.0033
YI	47.177 ± 4.25	48.224 ± 4.76	46.374 ± 4.56	49.528 ± 4.17	48.002 ± 4.28	48.683 ± 4.33	0.622	0.1047
AH (cm)	0.782 ± 0.12	0.836 ± 0.09	0.796 ± 0.10	0.846 ± 0.11	0.852 ± 0.13	0.889 ± 0.14	0.018	0.8927
YAW (g)	59.276 ± 5.78^{a}	50.660 ± 5.34^{e}	59.652 ± 5.38^{a}	52.676 ± 5.26^{d}	57.666 ± 4.88^{b}	53.714 ± 5.12^{c}	0.673	0.0024
SI	72.737 ± 4.21^{b}	78.972 ± 3.66^{a}	74.822 ± 5.30^{b}	75.399 ± 6.78^{b}	77.359 ± 7.41^{a}	74.041 ± 5.66^{b}	0.8001	<.0001
SW (g)	7.806 ± 0.69	7.238 ± 0.55	7.742 ± 0.61	7.402 ± 0.62	7.814 ± 0.57	7.560 ± 0.48	0.095	0.2388
ST (mm)	0.299 ± 0.02	0.340 ± 0.04	0.304 ± 0.03	0.347 ± 0.04	0.304 ± 0.03	0.341 ± 0.04	0.0053	0.8713
% ST	29.980 ± 3.89	34.040 ± 4.14	30.440 ± 4.10	34.740 ± 4.58	30.440 ± 3.94	34.180 ± 4.45	0.3783	0.8713
SSA	75.676 ± 4.40	68.196 ± 4.56	75.846 ± 5.33	70.010 ± 5.12	74.206 ± 6.16	70.964 ± 4.76	0.5315	0.0004
HU	84.073 ± 0.72	84.815 ± 0.68	84.148 ± 0.71	84.751 ± 0.69	84.526 ± 0.70	84.915 ± 0.73	0.0954	0.1758

EW = Egg weight, EL = Egg length, EWD = Egg width, YH = Yolk height, YW = Yolk width, YI = Yolk index, AH = Albumen height, YAW = Yolk + Albumen weight, SI = Shape index, SW = Shell weight, ST = Shell thickness, SSA = Shell surface area, HU = Haugh Unit, SD = Standard deviation, SEM = Standard error of mean.

the skeletal calcium available for shell calcification decreases with age. Regarding age, a significant ($P < 0.05$) depressing effect was obtained for the values of Haugh units, which decreased as layer age progressed. This agrees with the findings of Verheyen and Decuypere (1991), Yasmeen *et al.* (2008) and Rayan *et al.* (2013), who found that Haugh unit values decreased with increase in the layer age.

Table 3 shows the interaction effect between plumage colour and age on the internal and external egg quality characteristics of Noiler chicken. There were significant differences ($P < 0.05$) in egg weight, egg length, yolk width, yolk and albumen weight and shape index. However, no significant interaction effect on the egg width, albumen height, shell weight, shell thickness and Haugh unit was found.

The result obtained for egg weight indicated that the older black birds had the highest value, while the young barred birds had the least value for egg weight. For egg length, the older barred birds had the highest value, while the young barred birds had the least value. For yolk height and yolk width, there were significant differences as a result of the interaction between laying age and plumage colour. The older brown birds had the highest yolk height followed by older barred birds and older black birds with younger barred birds having the least value for yolk height and yolk width. From physiological point of view, egg weight is positively correlated with progressing age of hen, such phenomena held true also both for yolk or albumen weight as a major egg components. Yolk and albumen weight differs significantly with older black birds having the highest value followed by older barred birds and older brown birds with younger barred birds having the least value. Albumen height and Haugh units are the traits used to evaluate albumen quality, which reduces with age (Liljedahl *et al.*, 1984). There were no significant differences in the albumen height and Haugh unit as a result of the interaction between laying age and plumage colour.

CONCLUSION

External egg parameters including egg weight, egg length, egg width, shell weight, shape index, and shell thickness were not significantly influenced by plumage colour, while internal quality parameters,

such as Haugh units, albumen height and yolk height, were affected by plumage colour with brown plumage-coloured birds having the highest egg internal quality.

Furthermore, laying age had a significant effect on all the internal and external quality parameters considered. The interaction between laying age and plumage colour had significant influence only on the egg weight, egg width, yolk height, yolk width as well as yolk and albumen weight.

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