IMPACT OF EGG WEIGHT, EGG SHAPE AND EGG STORAGE PERIOD ON EGG QUALITY TRAITS OF WHITE LEGHORN CHICKENS: A SHORT COMMUNICATION

TYASI, T. L.* – MUGWENA, N. R. – NGOBENI, N. T. – MAHLANGU, B. J. – RACHUENE, P. – MAKGOPA, L. F. – PHALADI, M. A. – HLOKOE, V. R. – MOKOENA, K. – MATHAPO, M. C.

School of Agricultural and Environmental Sciences, Department of Agricultural Economics and Animal Production, University of Limpopo, Private Bag X1106, Sovenga 0727, Limpopo, South Africa

**Corresponding author*
e-mail: louis.tyasi@ul.ac.za; phone: +27-15-268-2803

(Received 2nd Aug 2024; accepted 3rd Dec 2024)

Abstract. The White Leghorn chicken is an egg laying chicken breed with high egg quality performance. But the effect of egg weight, egg shape and egg storage period on egg quality traits of this breed remains poorly understood. The study was conducted to determine the impact of egg weight, egg shape and egg storage period on egg quality traits. A total of three hundred (300) eggs of White Leghorn layers aged 40 weeks were randomly collected at the poultry laying house of the University of Limpopo experimental farm. The egg weight was classified as small (<60 g), medium (60 to 69 g) and large (>69 g), egg shape was classified into shape index (SI) as sharp egg (SI < 72), normal (standard) egg (SI = 72–76) and round egg (SI > 76), and egg storage period was divided into five groups (0, 7, 14, 21 and 28 days) with 20 eggs per group. Egg weight (EW), shell weight (SW), albumen weight (AW), yolk weight (YW) and egg length (EL) were measured as egg quality traits. The results showed that egg weight and egg shape had an effect ($p < 0.05$) on EL, SW and AW but had no influence ($p > 0.05$) on YW, while the egg storage had no effect ($p > 0.05$) on either of the measured traits except EL ($p < 0.05$). This study suggests that egg weight, egg shape and egg storage period had an influence on EL with higher in large eggs, sharp eggs and eggs stored 7 days or longer.
Keywords: *egg quality traits, albumen weight, egg length, yolk weight, shell weight*

Introduction

Egg production is significant in poverty alleviation, creation of employment and income, particularly in developing countries (Stojčić and Perić, 2018). Chicken eggs are the most affordable source of protein (Şekeroğlu and Altuntaş, 2009) and consumed by humans daily (So et al., 2022). Egg quality traits such as egg weight, shell weight, albumen weight, yolk weight and egg length are parameters of egg that determines its quality (Murshed et al., 2024). Understanding the egg quality traits of each poultry species is critical for knowing the quality of the eggs for human consumption (Şekeroğlu and Altuntaş, 2009). There are several factors including egg weight, egg shape and storage period that have affected the quality traits poorly, resulting in poor quality, susceptibility to breakage and profit losses (Oleforuh-Okoleh and Eze, 2016; Lee et al., 2016; Duman et al., 2016). The egg shape caused several effects on egg quality characteristics, and it was shown that there is a correlation between egg shape and egg quality traits such as albumen length, egg yolk width, egg yolk height and egg yolk colour in laying hens (Duman et al., 2016). It is significant for farmers to be aware of the ideal egg weight, egg shape and egg storage period to improve egg quality traits (Melo et al., 2021). The White Leghorn chicken is an egg laying breed originating from Italy, that is commonly used in the egg-production industry due to its high performance

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

in egg production (Ceccobelli et al., 2013). Based on authors' knowledge there is limited literature on the influence of factors like egg weight, egg shape and egg storage period on egg quality traits of White Leghorn chicken breed. The objective of the study was thus to determine the effect of egg weight, shape, and egg storage period on egg quality traits of White Leghorn chicken breed.

Materials and methods

Ethical approval

University of Limpopo Animal Research Ethics Committee (ULAREC) issued ethical approval (AREC/42/2023:UG) for the commence of the study.

Study area, experimental design

The study was conducted at the University of Limpopo experimental farm, Limpopo province, South Africa. A complete randomized design was used as an experimental design. A total of 300 eggs were randomly collected from the poultry laying house.

Egg weight, egg shape and egg storage periods

All the eggs were grouped according to their weights. Egg weight was classified as small (<60 g), medium (60 to 69 g) and large (>69 g). Eggs were classified with respect to shape index (SI), namely as a sharp egg (SI < 72), a normal (standard) egg (SI = 72–76) and round egg (SI > 76). Classifying eggs for the shape index followed the procedure described by Alkan et al. (2015). The egg storage period was divided into five groups (0, 7, 14, 21 and 28 days). A total of 20 eggs were randomly allocated to each storage period and refrigerated at 4°C following the procedure explained by Melo et al. (2021).

Egg quality traits collection

Egg weight (EW), shell weight (SW), Albumen weight (AW) and yolk weight (YW) were measured using a digital weighing balance (Medidata®, USA) with accuracy of 0.001 g. A vernier caliper was used to measure the egg length (EL). All the egg quality traits were collected, and shape index was calculated following the procedure described by Hlokoe et al. (2023).

$$\text{Shape index (\%)} = \text{egg width} / \text{egg length} \times 100$$

Statistical analysis

A Statistical Package for Social Sciences (IBM SPSS, 2022) version 29.0 was used for data analysis. Pearson's correlation was used to determine the relationship between egg weight and egg quality traits. Analysis of Variance (ANOVA) was also used to determine the effect of egg weight, egg shape and egg storage period on egg quality traits and significance was observed at 5%. Duncan's multiple range test was used for mean separation. The following General Linear Model (GLM) was used:

$$\boldsymbol{Y_{ij}} = \mu + T_{\boldsymbol{i}} + \boldsymbol{e_{ij}}$$

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

where: Y_{ij} = j^{th} observation of the i^{th} treatment, μ = overall mean, T_i = fixed effect of the i^{th} treatment (egg weight, i = small, medium and large; egg shape, i = sharp, normal and round; storage period, i = 0, 7, 14, 21 and 28 days), and e_{ij} = residual error.

Results

Descriptive statistics

The results on the summary of the measured traits (*Table 1*) indicated that egg weight ranged from 48.88 g to 74.50 g.

Table 1. *Descriptive statistics of measured traits*

Traits	Minimum	Maximum	Mean	Standard deviation
Egg weight (g)	48.88	74.50	59.86	4.59
Egg length (mm)	51.50	66.02	57.27	2.45
Yolk weight (g)	7.20	23.12	17.66	2.02
Shell weight (g)	5.94	13.22	8.00	0.91
Albumen weight (g)	25.25	62.63	34.33	4.77

Correlation matrix

The results (*Table 2*) indicated that EW had a positively high remarkable correlation ($p < 0.01$) with EL and AW. The results further showed that EW had positive significant correlation ($p < 0.05$) with YW and SW.

Table 2. *Correlations matrix*

Traits	EW	EL	YW	SW	AW
Egg weight (EW)	1.00				
Egg length (EL)	0.62**	1.00			
Yolk weight (YW)	0.32*	0.01^{ns}	1.00		
Shell weight (SW)	0.33*	0.18^{ns}	0.03^{ns}	1.00	
Albumen weight (AW)	0.79**	0.58**	-0.14^{ns}	0.14^{ns}	1.00

ns = no significant ($p > 0.05$), * = significant ($p < 0.05$), and ** = significant ($p < 0.01$)

Effect of egg weight on egg quality traits

The results showed that EW had a significant effect ($p < 0.05$) on EL, SW and AW as presented in *Table 3*. The findings indicated that large egg weight had the highest EL, SW and AW as compared with other egg weights. The results further indicated that EW had no significant effect ($p > 0.05$) on YW.

Effect of egg shape on egg quality traits

The results showed that egg shape had an effect ($p < 0.05$) on EW, SW, AW and EL (*Table 4*). The results indicated that sharp egg shape had the highest EW, SW and AW while round egg shape had the lowest EW, SW, and AW. The results also showed that egg shape had no effect ($p > 0.05$) on YW.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

Table 3. *Effect of egg weight on egg quality traits*

Traits	Egg weight		
	Small, <60 g (Man ± SE)	**Medium, 60 to 69 g (Mean ± SE)**	**Large, >69 g (Mean ± SE)**
Egg length (mm)	56.27 ± 0.20^{c}	57.98 ± 0.27^{b}	62.94 ± 0.93^{a}
Yolk weight (g)	17.40 ± 0.17	18.08 ± 0.29	17.09 ± 1.40
Shell weight (g)	7.73 ± 0.09^{b}	8.30 ± 0.12^{a}	8.49 ± 0.38^{a}
Albumen weight (g)	31.62 ± 0.24^{c}	36.69 ± 0.54^{b}	45.87 ± 1.21^{a}

Means in row with different letters differ significantly at ($p < 0.05$). SE: standard error of means

Table 4. *The effect of egg shape on egg quality traits*

Traits	Egg shape		
	Sharp (Mean ± SE)	**Normal (Mean ± SE)**	**Round (Mean ± SE)**
EW	64.30 ± 1.48^{a}	59.16 ± 0.82^{b}	57.84 ± 0.62^{b}
EL	8.45 ± 0.35^{a}	8.00 ± 0.14^{ab}	7.75 ± 0.12^{b}
YW	17.55 ± 0.69^{a}	18.17 ± 0.27^{a}	17.14 ± 0.24^{a}
AW	38.29 ± 1.58^{a}	32.99 ± 0.77^{b}	32.95 ± 1.87^{b}
EL	41.74 ± 0.50^{a}	42.81 ± 0.21^{b}	44.03 ± 0.32^{c}

Means in rows with different letters differ significantly at $p < 0.05$. SE = standard error of means

Effect of egg storage period on egg quality traits

Table 5 showed that storage period had no significant effect ($p > 0.05$) on EW, YW, SW and AW. Furthermore, the storage period had a significant effect ($p < 0.05$) on EL. The findings showed that EL increased with an increase in the storage period.

Table 5. *Effect of egg storage period on egg quality traits*

Traits	Storage periods (days)				
	0 (Mean ± SE)	**7 (Mean ± SE)**	**14 (Mean ± SE)**	**21 (Mean ± SE)**	**28 (Mean ± SE)**
EW	$58.18^{a} \pm 1.07$	$58.32^{a} \pm 0.95$	$58.32^{a} \pm 0.84$	$57.06^{a} \pm 1.07$	$56.85^{a} \pm 1.02$
YW	$16.92^{b} \pm$ `0.38	$18.77^{a} \pm 0.42$	$18.67^{a} \pm 0.69$	$18.71^{a} \pm 0.55$	$19.4^{a} \pm 0.64$
AW	$32.82^{a} \pm 0.99$	$32.24^{a} \pm 0.72$	$32.19^{a} \pm 1.11$	$30.57^{a} \pm 1.41$	$29.20^{a} \pm 1.38$
SW	$8.36^{a} \pm 0.38$	$7.65^{a} \pm 0.33$	$7.45^{a} \pm 0.15$	$7.86^{a} \pm 0.44$	$8.25^{a} \pm 0.35$
EL	$44.69^{b} \pm 0.32$	$56.26^{a} \pm 0.55$	$57.53^{a} \pm 0.54$	$56.66^{a} \pm 0.82$	$56.51^{a} \pm 0.63$

Mean in rows with different letters differ significantly at ($p < 0.05$), SE = Standard error of means

Discussion

Egg quality is defined by its external and internal traits that make their measures important in egg production industry (Hlokoe et al., 2023). This study was conducted to investigate the effect of egg weight, egg shape and egg storage period of White Leghorn chicken eggs. White Leghorn eggs are commonly used in the egg industry since this breed is one of the genetically improved layers for egg production (Ceccobelli et al., 2013). The study first determined the relationship between egg quality traits and

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

revealed that egg weight was correlated with all the measured traits. The findings of the current study were consistent with those of Tyasi et al. (2022) who found that albumen height, egg length, shell weight had the highest correlation with egg weight in Potchefstroom Koekkoek chicken genotype raised in a traditional cage system in the Limpopo province. Subsequently, Alkan et al. (2015) reported a highly significant correlation among egg weight, egg length, egg width, yolk weight and albumen weight in Partridge (Alectoris chukar) hens reared in a cage system in Turkey. The correlation results of this study suggest that improving egg length, yolk weight, shell weight and albumin weight might improve the egg weight of White Leghorn chicken breed. According to Rashijane et al. (2023) correlated traits might be controlled by the same genetic materials, hence, it is critical to understand the correlation between traits. This study observed that egg shape and egg weight influenced egg length, shell weight and albumen weight with the sharp shape and large egg weight (>69 grams) with higher egg length, shell weight and albumin weight. Isnaini et al. (2023) found that egg shape did not significantly affect egg weight in white-nest swiftlet from Indonesia. However, this is contradictory to Alkan and Türker (2021) who reported that the albumen weight increased due to an increase in egg shape. Duman et al. (2016) reported that shell weight was not significantly affected by egg shape, although the sharp egg had the heaviest egg weight in laying hens raised in 2000 ATAK-S strain of laying hens raised under a traditional cage system in Turkey. A study conducted on Isa Brown layer chickens of Nigeria revealed an effect of egg weight on egg length (Ukwu et al., 2017), which is consistent with this study outcomes. Hagan et al. (2013) found that egg storage period caused a significant reduction in egg weight due to the loss of moisture from the egg content to the surrounding atmosphere through eggshell pores. Khatun et al. (2016) further reported that the length of storage did not affect shell weight of Isa Brown layers. Similarly, Çağlayan et al. (2009), and Tilki and Saatci (2004) found egg storage period in partridges (*Alectoris graeca*) did not affect yolk weight. However, the effect of storage period on albumen weight was statistically significant in partridges (*Alectoris graeca*) eggs, meaning the longer the storage period, the lower the albumen weight (Çağlayan et al., 2009). This study suggests that egg weight, egg shape and egg storage period might influence the egg quality traits. The results showed that the more time the egg is stored the longer the egg length and that might be due to reduction in egg weight. The findings of the current study might help the poultry farmers to know the egg quality traits that can be considered in selection during breeding for improvement of the egg weight in White Leghorn chickens.

Conclusion

The correlation findings displayed a link between egg weight and egg length, yolk weight, shell weight and albumen weight. The results further revealed that the egg length, shell weight and albumen weight were influenced by the egg shape and egg weight, while the storage period only influenced the egg length in White Leghorn chicken breed. More studies need to be done on the influence of egg weight, shape and egg storage period on more egg quality traits.

Conflict of interests. Authors state no conflict of interests.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

REFERENCES

[1] Alkan, S., Galiç, A., Karsli, T., Karabağ, K. (2015): Effects of egg weight on egg quality traits in partridge (Alectoris Chukar). – Journal of Applied Animal Research 43(4): 450-456. https://doi.org/10.1080/09712119.2014.980419.

[2] Alkan, S., Türker, I. (2021): Effects of egg shape index on egg quality in Partridges. – Ordu Üniversitesi Bilim ve Teknoloji Dergisi 11(2): 140-151. https://doi:10.54370/ordubtd.996530.

[3] Çağlayan, T., Alaşahan, S., Kırıkçı, K., Günlü, A. (2009): Effect of different egg storage periods on some egg quality characteristics and hatchability of partridges (Alectoris graeca). – Poultry Science 88(6): 1330-1333. https://doi:10.3382/ps.2009-00091.

[4] Ceccobelli, S., Di-Lorenzo, P., Lancioni, H., Castellini, C., Ibáñez, L. V. M., Alberto, S. A., Sarti, F. M., Weigend, S., Lasagna, E. (2013): Phylogeny, genetic relationships and population structure of five Italian local chicken breeds. – Italian Journal of Animal Science 12(3): 66. https://doi.org/10.4081/ijas.2013.e66.

[5] Duman, M., Şekeroğlu, A., Yıldırım, A., Eleroğlu, H., Camcı, O. (2016): Relation between egg shape index and egg quality characteristics. – European Journal of Poultry Science 80: 1-9. http://doi:10.1399/eps.2016.117.

[6] Hagan, J. K., Adjei, I. A., Baah, A. (2013): Effects of extended period of storage and strain of layer on quality of chicken eggs. – Journal of Science and Technology (Ghana) 33(2): 1-11. https://doi:10.4314/just.v33i2.1.

[7] Hlokoe, V. R., Tyasi, T. L., Mbazima, V., Gunya, B. (2023): Investigation of egg weight, ovarian follicles morphology and growth differentiation factor 9 mRNA expression in Potchefstroom Koekoek chicken breed. – Brazilian Journal of Poultry Science 25(3): 1-8. http://dx.doi.org/10.1590/1806-9061-2022-1723.

[8] IBM Corp. (2022) IBM SPSS Statistics for Windows, Version 29.0. – IBM Corp., Armonk, NY. https://www.scirp.org/reference/ReferencesPapers?ReferenceID=2010524.

[9] Isnaini, N., Wenas, K., Solihin, M. F., Sulistyo, H. E., Amertaningtyas, D., Andri, F. (2023): Effect of egg weight and egg shape index on hatching performance and eggshell quality of white-nest swiftlets. – Journal of Animal Health and Production 11(1): 20-24. https://doi:10.17582/journal.jahp/2023/11.1.20.24.

[10] Khatun, H., Rashid, M., Faruque, S., Islam, M., Ali, M. (2016): Study on egg quality characteristics of three commercial layer strains under different storage conditions. – International Journal of Animal Resources 1(2): 63-70. http://www.saulibrary.edu.bd/sauj/ijar/index.html.

[11] Lee, M. H., Cho, E. J., Choi, E. S., Sohn, S. H. (2016): The effect of storage period and temperature on egg quality in commercial eggs. – Korean Journal of Poultry Science 43(1): 31-38. http://dx.doi.org/10.5536/KJPS.2016.43.1.31.

[12] Melo, E. F., Araújo, I. C. S., Triginelli, M. V., Castro, F. L. S., Baião, N. C., Lara, L. J. C. (2021): Effect of egg storage duration and egg turning during storage on egg quality and hatching of broiler hatching eggs. – Animal 15(2): 100-111. https://doi.org/10.1016/j.animal.2020.100111.

[13] Murshed, M., Qaid, M. M., Gatasheh, M. K. (2024): The effect of storage periods on the internal and external quality characteristics of white and brown-shell table eggs in Saudi Arabia. – Indian Journal of Animal Research 58(5): 878-883. https://doi:10.18805/IJAR.BF-1611.

[14] Oleforuh-Okoleh, V. U., Eze, J. (2016): Effect of storage period and method on internal egg quality traits of the Nigerian native chicken. – Livestock Research for Rural Development 28(6). http://www.lrrd.org/lrrd28/6/olef28115.html.

[15] Rashijane, L. T., Mokoena, K., Tyasi, T. L. (2023): Using multivariate adaptive regression splines to estimate the body weight of Savanna goats. – Animals 13(7): 1146. https://doi.org/10.3390/ani13071146.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973

[16] Şekeroğlu, A., Altuntaş, E. (2009): Effects of egg weight on egg quality characteristics. – Journal of the Science of Food and Agriculture 89(3): 379-383. https://doi.org/10.1002/jsfa.3454.
[17] So, J. H., Joe, S. Y., Hwang, S. H., Hong, S. J., Lee, S. H. (2022): Current advances in detection of abnormal egg: a review. – Journal of Animal Science and Technology 64(5): 813-829. https://doi:10.5187/jast.2022.e56.
[18] Stojčić, M. D., Perić, L. (2018): Influence of the storage period on the quality characteristics of table eggs. – Contemporary Agriculture 67(3-4): 202-206. https://doi.org/10.1515/contagri-2018-0029.
[19] Tilki, M., Saatci, M. (2004): Effects of storage time on external and internal characteristics in patridge (Alectoris graeca) eggs. – Revista de Medicina Veterinaria 155: 561-564.
[20] Tyasi, T. L., Lebogang, L., Hlokoe, V. R. (2022): Comparative study of egg quality traits between Potchefstroom Koekoek and Hy-line Silver Brown layers. – Bulgarian Journal of Agricultural Science 28(1): 145-150. https://www.agrojournal.org/.
[21] Ukwu, H. O., Ezihe, C. O., Asaa, S. K., Anyogo, M. E. (2017): Effect of egg weight on external and internal egg quality traits of Isa Brown egg layer chickens in Nigeria. – Journal of Animal Science and Veterinary Medicine 2: 126-132. https://doi:10.31248/JASVM2017.051.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2303_49674973