

EGG WEIGHT, SHELL THICKNESS AND CHOLESTEROL CONCENTRATION IN SPECIALIZED BREEDS OF EGG-TYPE CHICKENS AS INFLUENCED BY LAYER AGE

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ABSTRACT

The effect of breeds on egg quality of egg-type chickens from Plymouth Rock and White Leghorn commercial laying hens was investigated. The aim was to determine the egg weight, cholesterol levels and shell thickness on a commercial poultry farm over twelve weeks. A total of 408 laying hens were evaluated for the two breeds, which commenced from the fifth week into lay for twelve weeks. The birds were aged 24 weeks at the commencement of the study. The biological material consisted of 50 randomly collected eggs per week, and all eggs laid during the study period were weighed. Conventional AOAC methods were used to analyze the eggs. All data were analyzed using the R-core statistical package, and results were presented graphically. The results showed that the White leghorn breed (red, breed 1) had a heavy and significant average egg weight (50-60g) over Plymouth rock (blue, breed 2), which recorded a mean average of 20-37g. Shell thickness was the same for the two breeds at week 1 (47mm). White leghorn had consistent shell thickness between 49 and 53mm, while the Plymouth rock breed increased from 41 to 50mm. Eggs from the Plymouth rock breed had a cholesterol concentration of 0.57 – 0.65 mmol/L, while the White leghorn breed ranged from 0.51 – 0.55 mmol/L. It can be concluded that since the two breeds performed differently under similar dietary and management conditions, the White leghorn breed influenced better and had higher egg weight and shell thickness, while the nutritive value component from cholesterol was higher in the Plymouth rock.

Keywords: Laying hen, egg weight, cholesterol, shell thickness

INTRODUCTION

The intensive selection and increasing use of highly productive layers of egg type in recent years have led to the displacement of native or local breeds by more productive and specialized ones, causing the populations to lose genetic diversity (Krawczyk *et al.*, 2011). Studies have shown that a number of factors, including housing system, management, and breeds, affect egg quality in a commercial flock (Zemkova *et al.*, 2007; Lichovnikova and Zeman 2008; Singh *et al.*, 2009; Djukic-Stojcic *et al.*, 2009), the economic efficiency of production (Miao *et al.*, 2005; Usturoi and Radu-Rusu, 2006) and consumers' marketing preferences. This is with the view to complying with the fowl welfare requirement.

Radu-Rusu *et al.* (2014) explain that in human nutrition, the total lipid proportions in foods and their components like cholesterol and fatty acids are of concern and are a very often discussed theme. However, Nau *et al.* (2010) specified that the supposition that high cholesterol content negatively influences cardiovascular disease dynamics is a misjudgment since it is not supported by most human nutrition and cardiology epidemiological studies. Cholesterol and its esters are found only in egg yolk, where they form an emulsion of low-density lipoproteins (LDL), very low-density lipoproteins

(VLDL) and high-density lipoproteins (HDL). The HDL is called 'good cholesterol,' accounting for 8% of dehydrated yolk (Vorlova *et al.*, 2001).

Bessei (2010) discussed that laying hens generally preferred nesting in furnished cages. Freedom of movement, dust bathing, scratching and roosting behaviours are signs that the fowl adapt well to improved cages. These conditions imitate those from the natural environment or the deep litter system. Van den Brand *et al.* (2004) discussed that the weight of eggs from outdoor layers was lower at an early age but increased more with age than in the eggs from hens in cages. Hence demonstrated, the age of hens is an essential factor affecting the weight of eggs. Other authors, including Silversides and Scott, 2001 Oloyo, 2003 Van den Brand *et al.*, 2004 confirmed that the egg weight increased with the hen's age.

Research comparing egg weights between different egg-type chicken breeds is enormous. However, considering the cholesterol level and egg weight from these different breeds and the nutritional effect that the cholesterol could have on the consumer's health either when consumed in whole egg or other combined product mixtures has not been evaluated, and there is little or non-available information with regards these two breeds housed in a similar environment. Also, the

shell thickness comparison will demonstrate which of these breeds has a better eggshell, as egg transportation in developing countries is left to the mercy of poor transport systems. Hence, a better eggshell will help mitigate cracks and other mechanical egg damage.

Therefore, this study aimed to test the hypothesis that different breeds produce different concentrations of cholesterol on commercial layers fed the same feed under the deep litter rearing system.

MATERIALS AND METHODS

Experiment location

The poultry farm was located at 23/25 Kano Street, Kawo New Extension, Kaduna State. It has coordinates latitude 10°35'04.2N and longitude 7°27'27.1E (Omonijo, 2014) with a mean annual rainfall ranging from 880mm to 1380mm and a temperature of 26°C and 34°C (DURD, 2014)

Experimental birds

The Plymouth rock and White leghorn commercial laying birds were used for this study. A total of 408

were evaluated from the fifth week of lay for twelve (12) weeks. The birds were 24 weeks old and were being managed on a deep litter management system. The birds were adequately medicated and vaccinated when due and were fed a standard commercial layer diet (Table 1) throughout the experimental period. The birds were housed according to breeds in different pens of fifty.

Laboratory Analysis and Data Collection

Fifty (50) freshly laid eggs were collected at random for each breed weekly for the cholesterol, shell thickness and egg weight analysis (g). Conventional AOAC methods were used to analyze the eggs (AOAC, 1990). The procedures include:

All sampled eggs were washed adequately with distilled water and then dried. The egg weight (gram) was taken using a sensitive digital weighing scale (0.1g). Each egg was then cracked open, and the content was poured into a saucer while the egg yolk was then taken and transferred into a test tube. The empty eggshell was rinsed, and the thickness was taken using a micrometre screw gauge (mm). The cholesterol concentration was assessed on the egg yolk using the titrimetric method of the 941.09 protocol as specified by AOAC, 1990. According to this method, Cholesterol (mg) = 0.55 + 0.688 x mL 0.2N Na₂S₂O₃.

Table 1. Nutritional value of the commercial layer diet fed

Ingredients	ME (kcal/kg)	CP (%)	DM (%)	CF (%)	Oil (%)	Ash (%)	NFE (%)
Content per kg feed	3,193.53	23.19	92.14	10.67	5.88	8.02	52.24

ME = Metabolizable energy, CP = Crude Protein, DM = Dry Matter, NFE = Nitrogen Free Extract

The metabolizable energy of the feed was calculated using the Ponzenga equation as shown below:

$$ME = 37\% * CP\% + 81.8 * EE\% + 35 * NFE\% \text{ (Ponzenga, 1985).}$$

Data Analysis

All data were analyzed using the R-core statistical package, and results were presented graphically.

RESULTS AND DISCUSSIONS

The result of Figure 1 showed that White leghorn (red) had a significantly heavier ($P \leq 0.05$) egg weight in the period of the experiment over Plymouth rock (blue) when compared. White leghorn had small egg weight slightly lower than 50g at the 4th week and about 60g for the heavier size at the 3rd week. Most of the egg weights for breed 1 were weighing an average of 50g. Plymouth rock had small egg size throughout the collection period, with an average egg weight of less than 20g in the 4th week for the small size, while the

big egg size weighed 37g in the 5th week. The egg weight for White leghorn were slightly lower than those reported by Barbara et al. (2020) on Messa-43 hens (63.8g) and Hy-line Brown hens (62.4g), while Plymouth rock had much lower egg weight. Several researches have confirmed the influence of breed and genotype on egg size (Biesiada-Drzazga, 2009; Biesiada-Drzazga and Janocha, 2009; Silversides and Scott, 2001). Egg size is also determined by the age of the hen (Sokolowicz et al., 2012); however, for the Plymouth rock breed, this did not follow the report of Sokolowicz et al. (2012) that change in age leads to an increase in egg weight. Hence, the egg weight did not improve above the 37g average. Economically, the size of eggs is commonly considered by consumers because it determines the cost at which eggs are sold, amongst other factors.

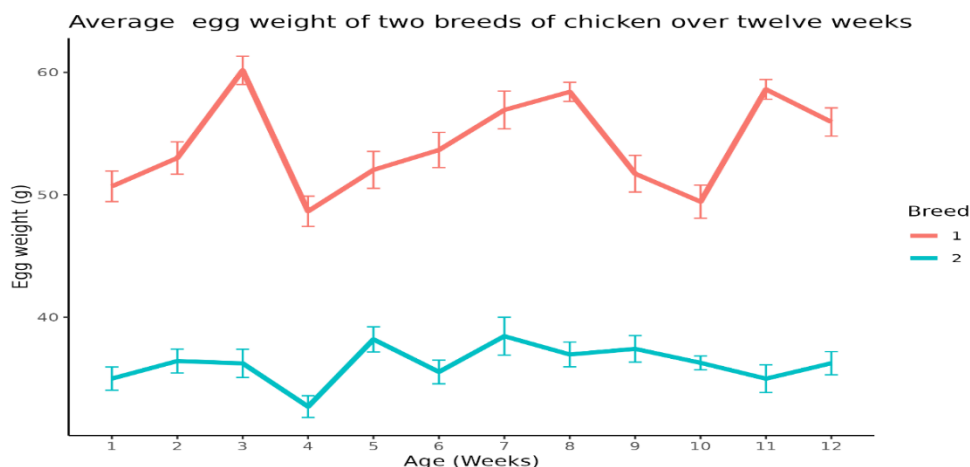


Figure 1: Egg weight averages for breeds of commercial chickens over twelve weeks of lay

Figure 2 represents the shell thickness of two commercial breeds of chicken over a twelve-week collection period. The breeds had an intercept of shell thickness at the first week of about 47mm. The standard errors for the means, irrespective of the breeds, were high. Breed 1 (red) had a consistent shell thickness of between 49 – 53mm, while breed 2 had a lower thickness at an early age and then maintained an increment from the 9th week (41mm) to the 11th week (50mm). Zita et al. (2018) discussed that the housing system influences the eggshell thickness and that

laying hens on deep litter have significantly higher shell thickness than those in the cage, which agrees with the values obtained in this study as the birds were raised on the deep litter system. The findings from this study base on breed effect are in discrepancy with those of Zita et al. (2018), that the strength of the eggshell or eggshell thickness is not influenced by breed. This eggshell thickness difference is likely because while egg weight was selected, better shell thickness as a complimentary trait was selected.

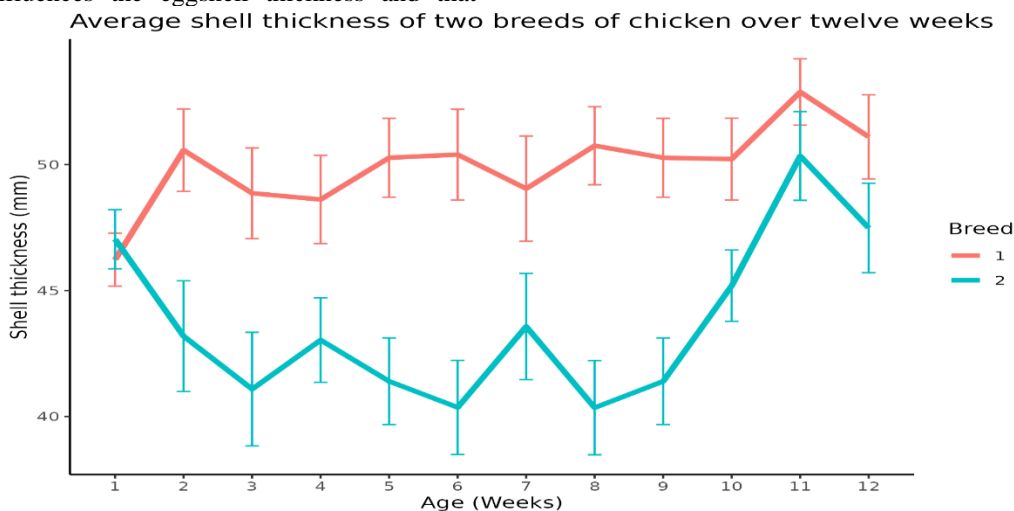


Figure 2: Shell thickness averages for breeds of commercial chickens over twelve weeks of lay

Figure 3 shows the cholesterol level of two commercial breeds of chicken over a twelve-week collection period. Breed 2 (blue) had a significant higher cholesterol level than breed 1 (red), while their cholesterol curve pattern was similar. Breed 2 had cholesterol levels of 0.57 – 0.65 mmol/L, while eggs

from breed 1 ranged from 0.51 – 0.55 mmol/L. The values obtained in our study from the two breeds were higher at all the ages sampled over those of Vorlova et al. (2001), who reported cholesterol content from week 1-60 with a ten-week interval and obtained a range of 368.20mg to 437.63mg in Hisex brown layers breed

housed in a cage. Our results also varied with those of Ingr et al. (1987), who detected an average cholesterol content of 400mg per 100g of fresh egg. The differences obtained from all these results is likened to the different breeds or strain, feed and management

system; hence, cholesterol content in the eggs of chickens agrees with the fact that it is influenced by genetic factors, diet composition, lay intensity, layer age and medical treatment (Vorlova et al., 2001; Elkin and Yan, 1999).

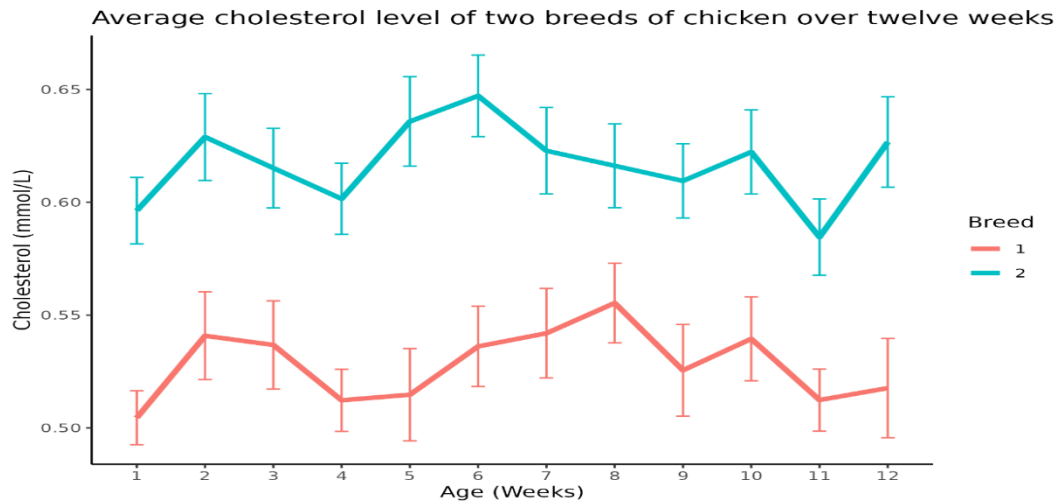


Figure 3: Cholesterol levels for breeds of commercial chickens over twelve weeks of lay

CONCLUSION

It can be concluded that the traits measured in the study are influenced by strain and age. Therefore, the two breeds performed differently under similar dietary and management conditions despite that they have different genetic compositions. The White leghorn breed influenced better and higher egg weight and shell thickness, while the nutritive value component from cholesterol was higher in the Plymouth rock.

REFERENCES

- AOAC (1990). Official methods of analysis, 13th ed. Food composition, Additives, Natural contaminants Eggs and eggs products (chapter 24). Association of Official Analytical Chemists, Inc. Arlington, Virginia, USA. 1018 pp.
- Biesiada-Drzazga, B. (2009). Estimation of morphological composition and physical traits of hatching eggs in the selected meat hen stocks. *Rocz. Nauk. PTZ*, 5(1): 35–42.
- Biesiada-Drzazga, B. and Janocha, A. (2009). Impact of hen breed and rearing system on the quality of eggs for consumption]. *Żywn. Nauka Technol. Jakość*, 3(64): 67–74 [in Polish].
- Djukic-Stojcic, M., Peric, L., Bjedov, S. and Milosevic, N. (2009). The quality of table eggs produced in different housing systems. *Biotechnology in Animal Husbandry*, 25(5-6): 1103-1108.
- DURD, (2014). Department of Urban and Regional Development. Federal Ministry of Lands, Housing and Urban Development. Case study of Kaduna, Kaduna State.
- Elkin, R.G. and Yan, Z. (1999). Relation between inhibition of mevalonate biosynthesis and reduced fertility in layering hens. *Journal of Reproduction and Fertility*, 116: 269-275s.
- Ingr, I., Simeonova, J. and Stavkova, J. (1987). Cholesterol content in market hen eggs. *Nahrung*, 31: 933-940.
- Krawczyk, J., Sokolowicz, Z. and Scymczyk, B. (2011). Effect of housing system on cholesterol, vitamin and fatty acid content of yolk and physical characteristics of eggs from Polish native hens. *Arch. of Poultry*, 75(3): 151-157. ISSN 0003-9098.
- Lichovnikova, M. and Zeman, L. (2008). Effect of housing system on the calcium requirement of

- laying hens and on eggshell quality. *Czech Journal of Animal Science*, 4: 162-168.
- Miao, Z.H., Glatz, P.C. and Ru, Y.J. (2005). Free-range poultry production - A review. *Asian-Australian Journal of Animal Science*, 18: 113-132.
- Oloyo R. A. (2003). Effect of age on total lipid and cholesterol of hen eggs. *Indian Journal of Animal Science*, 73: 94–96.
- Omomijo, A. G. (2014). Rainfall amount and number of rain days in Kaduna, Northern Nigeria-Implication on crop production. International Conference on Agricultural , Ecological and Medical Science (AEMS-2014) July 3-4.
- Paузenga, U. (1985). Feeding parent stock. *Zootecnia International*, 22-25.
- R-Core Team (2013). A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. <http://www.R-project.org/>
- Radu-Rusu, R.M., Usturoi, M.G., Leahu, A., Amariei, S., Radu-Rusu, C.G. and Vacaru-Opriş, I. (2014). Chemical features, cholesterol and energy content of table hen eggs from conventional and alternative farming systems. *South African Journal of Animal Science*, 44 (1): 33-42. URL: <http://www.sasas.co.za> ISSN 0375-1589 (print), <http://dx.doi.org/10.4314/sajas.v44i1.5>
- Silversides, F.G. and Scott, T.A. (2001). Effect of storage and layer age on quality of eggs from two lines of hens. *Poultry Science*, 80: 1240–1245.
- Singh, R., Cheng, K.M. and Silversides, F.G. (2009). Production performance and egg quality of four strains of laying hens kept in conventional cages and floor pens. *Poultry Science*, 88: 256-264.
- Sokołowicz, Z., Krawczyk, J., Herbut, E. (2012). Quality of eggs from organically reared laying hens during their first and second year of production. *Żywn. Nauka Technol. Jakość*, 4(83):185–194 [in Polish].
- Usturoi, M. and Radu-Rusu, R.M. (2006). Alternative solutions to be used in laying hens' husbandry, *Bullet. Cluj-Napoca University of Agricultural Science and Veterinary Medicine*, 62: 32-36.
- Van den Brand, H., Parmentier, H.K. and Kemp, B. (2004). Effects of housing system (outdoor vs. cages) and age of laying hens on egg characteristics. *British Poultry Science*, 45: 745–752.
- Vorlova, L., Sieglova, E., Karpiskova, R. and Kopriva, V. (2001). Cholesterol content in eggs during the laying period. *ACTA VET BRNO*, 70: 387-390.
- Zemkova, L., Simenova, J., Lichovnikoa, M. and Somerlikova, K. (2007). The effect of housing systems and age of hen on egg weight and cholesterol concentration of egg. *Czech Journal of Animal Science*, 52(4): 110-115.
- Zita, L., Jenikova, M. and Hartlova, H. (2018). Effect of housing system on egg quality and the concentration of cholesterol in egg yolk and blood of hens of native resources of the Czech Republic and Slovakia. *Journal of Apply Poultry Research*, 27:380–388. <http://dx.doi.org/10.3382/japr/pfy009>