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Age-Related Changes in Egg Quality of Hy-Line Brown Hens

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Abstract: The present study was conducted to monitor age-related changes in egg quality during the entire production cycle of laying hens. Thirty eggs were sampled from the commercial farm on a weekly basis for egg analysis. In order to increase in confidence in sampling, farm personnel were educated to collect the eggs from the pre-determined cages during the whole period and all layers were subjected to an identical farm management and fed a commercial layer diet. In total, 1,470 eggs were sampled and transported to the laboratory of Korea Institute for Animal Products Quality Evaluation. The parameters for egg quality included egg weight, eggshell color, eggshell breaking strength, eggshell thickness, Haugh unit and yolk color. It was shown that egg weight increased as the hen aged. Eggshell breaking strength gradually decreased, but eggshell thickness was randomly scattered without showing any age-related trends during the laying period. The intensity of eggshell color kept relatively constant while yolk color increased with age. Finally, Haugh unit as an indicator of freshness of eggs was consistently decreased as the hens aged. In this study, we noticed that eggshell breaking strength and egg weight were negatively correlated ($r = -0.500$, $p<0.001$). Eggshell color did not significantly correlate with eggshell thickness ($r = -0.074$, $p>0.50$), but marginally and positively correlated with egg weight ($r = 0.248$, $p = 0.082$). It is concluded that among the various egg quality parameters analyzed, egg weight, eggshell breaking strength or Haugh unit reduced as the hens aged. Further study is needed to include various parameters of egg quality such as chemical or nutritional composition which will provide more insight into the age-mediated changes in egg quality.

Key words: Egg quality, eggshell color, age, laying hens

INTRODUCTION

It is well-known that the age of hens affects the eggshell quality (Odabasi *et al*., 2007; Zita *et al*., 2009) including egg weight, eggshell quality (i.e., eggshell weight, eggshell breaking strength) and albumen and yolk characteristics. Eggshell color is an important aspect of egg quality in many countries albeit that it did not reflect the internal quality of eggs (Lang and Wells, 1989). For example, consumer preference for brown-colored eggs over white-colored eggs in some countries including Korea has been well reported (Lee *et al*., 2003). The quality of eggshell has also gained much attention as it is considered the natural packing material for the egg contents. Thus, higher eggshell strength will be beneficial in securing salable eggs during the production chain. In addition, as this egg parameter is known to be affected by hens' age, it is reported that the incidence of cracked eggs could even exceed 20%, especially at the late-phase production cycle (Nys, 1999), which led to substantial economic losses to the industry. Thus, nutrition-mediated interventions (Waldroup and Hellwig, 1995; Grobas *et al*., 1999a,b; Keshavarz, 2003; Novak *et al*., 2004; Safaa *et al*., 2008; Shim *et al*., 2013) have been implemented to improve the quality of eggs, especially laid at the late-phase production. In many studies monitoring the age-related changes in egg quality, it is common practice to sample representative eggs at different ages of hens for the entire laying period. However, there were hardly any reports to monitor those egg parameters on a weekly basis during the production cycle, which prompted us to conduct to monitor age-related changes in egg quality on a weekly basis. The parameters for egg quality were chosen based on the guidelines set by the Korea Institute for Animal Products Quality Evaluation.

MATERIALS AND METHODS

Animals and experimental design: To monitor the age-related changes in egg quality, we selected a commercial laying hen farm with 12 flocks, located in Gyeong-buk province, South Korea. All layers (Hy-Line Brown hen) were subjected to identical environmental conditions and management. And all layers were housed at environmentally controlled facility with room temperature of 22°C, exposed to 14 h of light/day and fed three times a day to provide a daily allowance of 110 g of diet/hen. The commercially available diet (Kyeong-Chuk Co., Young-Chon, Korea) for layers were used. For egg sampling, thirty eggs were weekly collected during a laying period of 21 to 70 weeks.

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Egg analysis: All measurements were conducted at the laboratory of Korea Institute for Animal Products Quality Evaluation (Gunpo, Korea). In total, 1,470 eggs were used for analysis. Initially, eggs were weighed after collection. Egg shell color was measured on the blunt end of the eggs with a QCR color reflectometer (TSS England). Yolk color was determined by the colorimetric method and a QCC device (TSS England). Egg shell thickness was evaluated by a TSS QCT shell thickness micrometer (TSS England) in equatorial region. Egg shell strength was measured by shell-breaking device (QCR SPA, TSS England). Haugh units were calculated based on the formula using the egg weight and albumen weight as described (Haugh, 1937).

Statistical analysis: All data obtained in this study were presented as means (±SD) on a weekly basis. Pearson's correlation coefficients were calculated to reveal, if any, relationships between two variables. A value of $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

In this study, we monitored the age-related changes in egg quality such as egg weight, eggshell strength, eggshell thickness, Haugh unit and the color intensity of eggshell and yolk color during the entire laying cycle. As shown in Fig. 1, egg weight increased as the hens aged. Eggshell strength gradually decreased, but eggshell thickness did not show any trends during the laying period (Fig. 2). Haugh unit as an indicator of freshness of eggs was consistently decreased as the hens aged (Fig. 3). Finally, eggshell color slightly increased while yolk color gradually increased with age (Fig. 4). In this study, all eggs analyzed were obtained from hens subjected to identical environmental conditions during the entire laying period in the commercial farm. Thus, it is likely that the changes in egg qualities could be closely associated with the ages of laying hens.

In general, it is well-known that egg weight gradually increases as the hens aged (Hy-Line management, 2014). Simultaneously, the incidence of shell quality problems and the proportion of broken eggs increase. Roland (1979) reported that the egg loss due to egg handling from farm to consumer was estimated to be approximately $480 million annually in the U.S. and these losses are often related to the poor shell quality of eggs produced at the late phase of production cycle. Thus, various nutritional interventions via reduction in the levels of crude protein (Keshavarz, 2003; Shim *et al*., 2013), essential amino acids (Waldroup and Hellwig, 1995; Novak *et al*., 2004), linoleic acid (Grobas *et al*., 1999a; Safaa *et al*., 2008) or energy contents (Grobas *et al*., 1999b) have been implemented to lower egg weights especially at the late phase of the laying production.

It was found that eggshell breaking strength and eggshell thickness was not correlated ($r = +0.234$, $p = 0.101$). However, it was noted that eggshell breaking strength and egg weight were negatively correlated ($r = -0.500$, $p<0.001$). The latter observation corroborates with the previous study by Roland (1979) who concluded that the decline in eggshell quality with age of the hen is a result of an increase in egg size without a proportionate increase in calcium carbonate deposition in the eggshell.

Although eggshell color is not an indicator of internal quality of eggs, consumers in various countries prefer brown eggs over white eggs. In those countries, eggshell color intensity is often dictated by consumer preference. In this study, eggshell color did not change as the hens aged. In addition, it was not significantly correlated with eggshell thickness ($r = -0.074$, $p>0.50$), but marginally and positively correlated with egg weight ($r = +0.248$, $p = 0.082$). This is in contrast to the previous study of Odabasi *et al*. (2007) who reported that the color intensity of eggshells from Hy-Line brown hens decreased as the hens aged. The latter postulated that the change in eggshell color as the laying hen aged is attributed to an increase in egg size without a concomitant increase in pigmentation. The clear explanation for the difference in the eggshell color between Odabasi *et al*. (2007) and ours is not readily

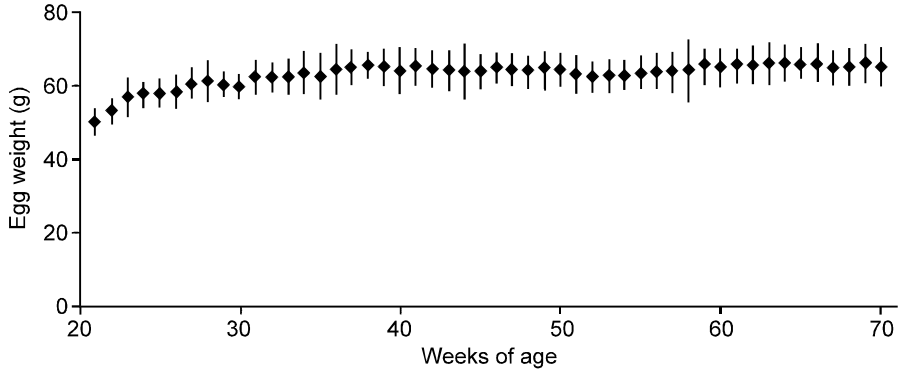

Fig. 1: Age-related change in egg weight of Hy-Line brown laying hens during the production cycle. Values are expressed as means (±SD, n = 30). Egg weight was positively associated with age of hens ($r = +0.740$)

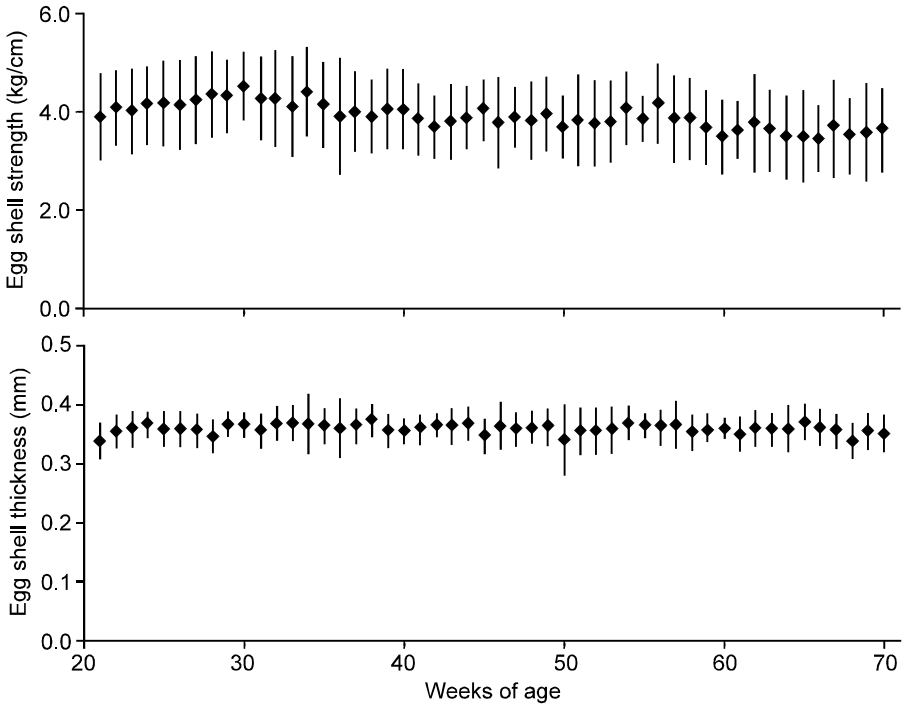

Fig. 2: Age-related change in eggshell quality of Hy-Line brown laying hens during the production cycle. Values are expressed as means (±SD, n = 30). Age of laying hens was negatively associated with eggshell strength (r = -0.780), but weakly with eggshell thickness (r = -0.133)

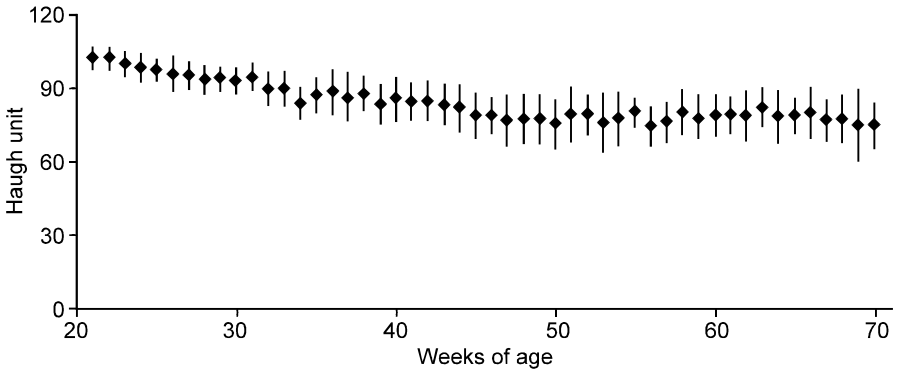

Fig. 3: Age-related change in Haugh unit of Hy-Line brown laying hens during the production cycle. Values are expressed as means (±SD, n = 30). Age and Haugh unit were inversely correlated (r = -0.890)

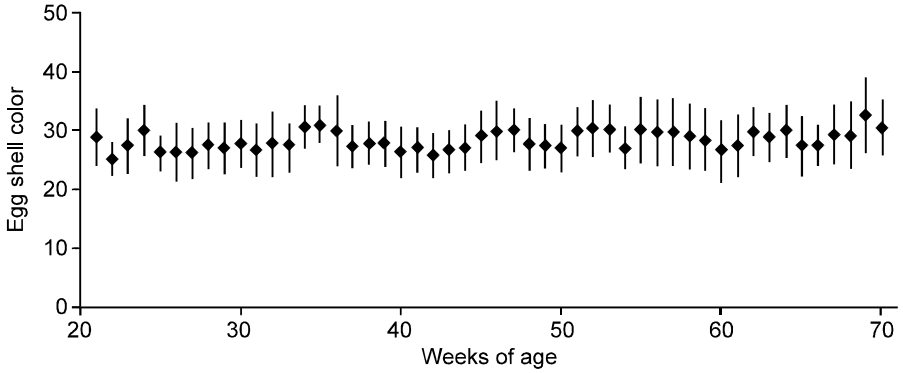

Fig. 4: Continued

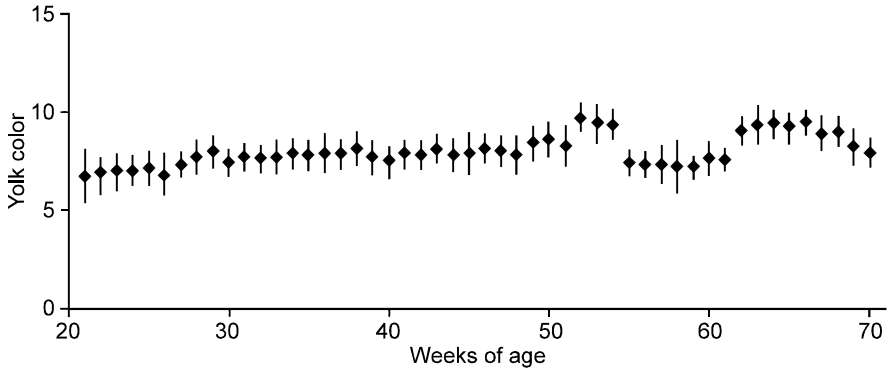

Fig. 4: Age-related change in the color intensity of eggshell and yolk of Hy-Line brown laying hens during the production cycle. Values are expressed as means (±SD, n = 30). Age of laying hens was moderately associated with eggshell color (r = +0.416) and yolk color (r = +0.619)

available. In this study, we sampled eggs from commercial farm weekly from 21 to 70 weeks of age while Odabasi *et al*. (2007) sampled at three time points, i.e., 33, 50 and 67 weeks of age. Other factors responsible for the difference in eggshell color could be diet, environment, stress which are known to affect the pigmentation of eggshell. In addition, eggs laid in the afternoon vs. those in the morning were paler, indicating the time-dependent variation in shell color (Campo *et al*., 2007). In any events, further study is needed to clarify this discrepancy.

Conclusion: In conclusion, the present report confirmed that among the various egg quality parameters analyzed, egg weight, eggshell breaking strength or Haugh unit reduced as the hens aged. Of interest, it was found that the intensity of egg color, which could be a consumer perception of egg quality, was not altered during the production cycle, which needs to be clarified.

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