

EFFECT OF STORAGE PERIOD ON EGG QUALITY TRAITS OF QUAILS REARED UNDER CAGE AND FLOOR SYSTEMS

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Abstract: This study was conducted to determine the effect of storage period on internal and external quality traits of quail eggs produced under cage and floor management systems. A total of 200 fresh quail eggs were collected from birds reared in cage and floor systems (100 eggs per system) and stored for 0, 10, 20, and 30 days at room temperature. Egg quality parameters evaluated included egg weight, egg length, egg width, albumen height, albumen width, albumen weight, yolk height, yolk width, yolk weight, shell thickness, and shell weight. Results revealed that at day 0, albumen width, yolk height, yolk width, yolk weight, and shell thickness differed significantly ($P < 0.05$) between cage and floor systems. At day 10, egg length, egg width, and shell weight showed significant differences ($P < 0.05$). At days 20 and 30, only yolk height remained significantly different ($P < 0.05$) between the two management systems. Storage duration significantly affected most egg quality parameters, with progressive deterioration observed as storage period increased. This study demonstrated that both management system and storage duration significantly influenced quail egg quality traits, with floor-reared birds producing eggs with better yolk characteristics while cage-reared birds produced eggs with better albumen quality at day 0.

Keywords: Quail eggs, storage period, cage system, floor system, egg quality traits.

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Introduction

Quail (*Coturnix coturnix japonica*) production has gained significant attention in recent years as a viable alternative to conventional poultry production due to its low input requirements, short generation interval, high productivity, and excellent nutritional value of both meat and eggs (Oke *et al.*, 2025). Quail eggs are particularly valued for their rich nutrient content, including essential amino acids, vitamins, and minerals, making them an important component of human nutrition and food security strategies (Ingweye, Okafor, and Martins, 2024)

The quality of eggs at the point of consumption is influenced by numerous factors, including genetics, nutrition, management systems, and post-lay handling conditions (Hossain & Islam, 2023). Among these, management systems and storage conditions

play critical roles in determining the final quality of eggs available to consumers. Cage and floor management systems represent two predominant production methods in quail farming, each with distinct advantages and limitations affecting bird welfare, productivity, and product quality (Hossain *et al.*, 2024)

Storage period is particularly critical for egg quality, as eggs are biological products that undergo continuous physicochemical changes after lay. These changes include loss of carbon dioxide and moisture through the eggshell pores, leading to albumen liquefaction, yolk membrane weakening, and overall deterioration of internal quality (Samli *et al.*, 2005). The rate and extent of these quality changes depend on storage temperature, humidity, duration, and pre-storage handling conditions (Scott and Silversides, 2000).

Despite the growing importance of quail production in Nigeria and other developing countries, limited information exists on the

interactive effects of production systems and storage duration on quail egg quality traits. Insight into these relationships is essential for developing appropriate handling protocols, establishing quality standards, and guiding consumer preferences. This study therefore aimed to determine the effect of storage period on internal and external quality traits of quail eggs produced under cage and floor management systems.

Materials and Methods

Study Location

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Nigeria. The area lies within the tropical rainforest zone, characterized by mean annual rainfall of 1,500 mm, temperature range of 25-32°C, and relative humidity of 70-85% (Alao *et al.*, 2025).

Experimental Materials and Design

A total of 200 fresh quail eggs were collected from apparently healthy Japanese quails (*Coturnix coturnix japonica*) at 12 weeks of age. One hundred eggs were obtained from birds raised in a cage system (battery cages) and 100 eggs from birds raised on a deep litter floor system. All birds were fed identical commercial quail layers mash containing 20% crude protein and 2,800 kcal/kg metabolizable energy, with water provided *ad libitum*.

Eggs were collected within 24 hours of lay, cleaned of surface debris, and stored at room temperature (28±2°C) for 0, 10, 20, and 30 days. At each storage interval, 25 eggs from each management system were randomly selected for quality evaluation.

Egg Quality Measurements

External and internal egg quality traits were evaluated using standard procedures described by Jones (2012).

Egg weight (g) was measured using a sensitive electronic balance (Model: Scout Pro SPU2001, Ohaus, USA) with 0.01 g sensitivity.

Egg length (cm) and egg width (cm) were measured using a digital vernier caliper (Model: CD-6" ASX, Mitutoyo, Japan).

Eggs were carefully broken onto a flat glass plate for internal quality measurements. Albumen height (cm) and yolk height (cm) were measured using a tripod micrometer. Albumen width (cm) and yolk width (cm) were measured using a digital vernier caliper. Albumen height was also converted to millimeters (mm) by multiplying centimeter values by 10.

Yolk weight (g) was determined after carefully separating the yolk from albumen using an egg separator, followed by weighing on the electronic balance.

Albumen weight (g) was calculated as the difference between egg weight and combined yolk and shell weight.

Shell thickness (cm) was measured at three points (broad end, narrow end, and equator) using a digital micrometer screw gauge, and the average value was recorded. Shell weight (g) was determined after washing shells free of adhering albumen and air-drying for 24 hours.

Statistical Analysis

Data collected were subjected to statistical analysis using the General Linear Model procedure of SPSS (Version 25, IBM Corporation, Armonk, NY, USA). Means were compared using independent samples t-test to determine differences between cage and floor systems at each storage period. Significance was determined at $P < 0.05$.

Results

Storage period and rearing systems exerted variable effects on egg quality traits of quails as shown in Table 1. At day 0, egg weight, egg dimensions, albumen height, albumen height in millimeters, and albumen weight did not differ significantly ($P > 0.05$) between cage and floor systems, with egg weight ranging from 10.80 ± 0.20 to 11.40 ± 0.25 g. However, significant differences ($P < 0.05$) were observed for albumen width, yolk height, yolk width, yolk weight, and shell thickness. Albumen width was significantly higher in cage-reared birds (3.42 ± 0.07 cm) than in floor-reared birds (1.34 ± 0.04 cm), while floor-reared birds exhibited significantly higher yolk height (2.52 ± 0.05 cm) and yolk width (3.80 ± 0.20 cm). Yolk weight was significantly higher in cage-reared birds (3.40 ± 0.25 g) compared with floor-reared birds (0.10 ± 0.00 g).

At day 10, most egg quality traits were not significantly affected ($P > 0.05$) by rearing system. Egg weight remained comparable between systems, varying from 11.00 ± 0.32 to 11.20 ± 0.37 g. Significant differences ($P < 0.05$) were observed for egg length and egg width, with higher values recorded in cage-reared birds (4.00 ± 0.00 cm and 3.28 ± 0.14 cm, respectively). Shell weight was significantly higher in floor-reared birds (1.70 ± 0.20 g) compared with cage-reared birds (1.00 ± 0.00 g).

At day 20, no significant differences ($P > 0.05$) were observed between cage and floor systems for egg weight, egg dimensions, albumen height, yolk weight, shell thickness, shell weight, or albumen weight. Egg weight ranged from 10.80 ± 0.37 to 11.00 ± 0.32 g across systems. A significant difference ($P < 0.05$) was recorded for yolk height, with cage-reared birds producing eggs with higher yolk height (1.16 ± 0.07 cm) than floor-reared birds (0.66 ± 0.07 cm).

At day 30, most egg quality traits were not significantly influenced ($P > 0.05$) by rearing system. Egg weight ranged from 10.60 ± 0.40 to 10.80 ± 0.37 g, while albumen height varied between 0.50 ± 0.45 and 0.66 ± 0.05 cm. A significant difference ($P < 0.05$) was observed only for yolk height, which was higher in cage-reared birds (1.14 ± 0.14 cm) compared with floor-reared birds (0.60 ± 0.10 cm).

Table 1: : Effect of Storage Period and Rearing System on Egg Quality Traits of Quails

Parameter	Day 0 Cage	Day 0 Floor	Day 10 Cage	Day 10 Floor	Day 20 Cage	Day 20 Floor	Day 30 Cage	Day 30 Floor
EWt (g)	10.80±0.20	11.40±0.25	11.00±0.32	11.20±0.37	10.80±0.37	11.00±0.32	10.60±0.40	10.80±0.37
EL (cm)	3.68±0.11	3.76±0.12	4.00±0.00a	3.58±0.11b	3.90±0.12	3.60±0.14	3.84±0.09	3.74±0.10
EWd (cm)	2.82±0.11	2.72±0.08	3.28±0.14a	2.82±0.11b	3.02±0.14	2.82±0.07	2.82±0.49	2.82±0.16
AH (cm)	0.96±0.44	1.12±0.04	0.92±0.06	0.76±0.11	0.68±0.08	0.68±0.10	0.66±0.05	0.50±0.45
AH (mm)	9.60±0.40	11.20±0.37	9.20±0.58	7.60±0.08	6.80±0.80	6.80±0.97	6.60±0.51	5.00±0.45
AWd (cm)	3.42±0.07 ^a	1.34±0.04 ^b	3.62±0.27	3.76±0.22	—	—	—	—
YH(cm)	1.70±0.06 ^b	2.52±0.05 ^a	1.30±0.09	1.30±0.08	1.16±0.07 ^a	0.66±0.07 ^b	1.14±0.14 ^a	0.60±0.10 ^b
YWd (cm)	2.60±0.13 ^b	3.80±0.20 ^a	3.02±0.19	3.22±0.20	—	—	—	—
YWt (g)	3.40±0.25 ^a	0.10±0.00 ^b	3.80±0.20	3.80±0.20	4.20±0.37	4.60±0.25	3.80±0.58	1.80±0.02
ST (cm)	0.10±0.00 ^b	1.40±2.25 ^a	0.10±0.00	0.10±0.00	0.80±0.00	0.08±0.00	0.10±0.00	0.10±0.00
SWt (g)	—	—	1.00±0.00 ^b	1.70±0.20 ^a	1.80±0.20	1.60±0.25	1.60±0.25	1.00±0.00
AWt (g)	5.60±0.25	6.40±0.25	6.20±0.20	5.70±0.20	4.80±0.49	4.80±0.37	5.20±0.80	8.00±0.45

a,b: Means within the same storage day and row with different superscripts differ significantly (P < 0.05).

— = Data not recorded, EWt = egg weight, EL = egg length, EWd = Egg width, AH (cm) = Albumen height in centimeter, AH (mm) - Albumen height in millimeter, AWd - Albumen width, YH = Yolk height, YWd = Yolk width, YWt = Yolk weight, ST = Shell thickness, SWt = Shell weight, AWt = Albumen weight

Discussion

The findings of this study demonstrated that both management systems and storage durations significantly influenced the quality traits of quail eggs. The variations observed between cage and floor systems at different storage periods reflected the complex interactions between production environment and post-lay handling conditions.

At day 0, the absence of significant differences in egg weight, dimensions, and albumen height between systems suggested that both cage and floor systems could produce eggs of comparable basic quality when fresh. However, the significant differences observed in albumen width, yolk characteristics, and shell thickness indicated that management systems differentially affected specific egg components.

The higher albumen width in cage-reared birds might be attributed to reduced physical activity and stress in caged environments, potentially influencing albumen secretion during egg formation (Reis *et al.*, 2019). Conversely, floor-reared birds exhibited superior yolk dimensions and shell thickness, possibly due to increased access to insoluble grit and natural foraging behaviour that might enhance mineral utilization for shell formation (Stefanello *et al.*, 2014). The significantly higher yolk weight in cage-reared birds, despite lower dimensions, suggested differences in yolk density or composition between systems.

These findings partially aligned with those of Roll *et al.* (2009), who reported that laying hen management systems affected egg component yields, though they observed that cage housing enhanced egg production and quality parameters compared to floor systems. Similarly, Ereke *et al.* (2024) confirmed that housing systems significantly influence egg quality traits, with caged

systems generally producing higher albumen height and Haugh units. The contrasting yolk weight results between systems warrant further investigation into nutrient partitioning differences between cage and floor management in quails.

The progressive changes in egg quality parameters across storage periods reflected the well-documented deterioration processes in stored eggs. The decline in albumen height from 0.96-1.12 cm at day 0 to 0.66-0.50 cm at day 30 represented approximately 40-50% reduction, consistent with findings by Samli *et al.* (2005) who reported similar declines in albumen quality during storage.

Albumen deterioration resulted from carbon dioxide loss through eggshell pores, leading to increased pH and subsequent liquefaction of the thick albumen (Scott and Silversides, 2000). This process accelerated with storage time and temperature, explaining the progressive decline observed across storage intervals. The more rapid decline in albumen quality compared to other parameters suggested albumen characteristics are most sensitive to storage conditions.

Yolk quality also deteriorated with storage, evidenced by decreasing yolk height values. The weakening of the vitelline membrane during storage allowed gradual water migration from albumen to yolk, causing yolk flattening and reduced height (Shinn *et al.*, 2016). Hervé *et al.* (2024) confirmed that vitelline membrane deformation and rupture strength decrease by approximately 24-28% after 28 days of storage, regardless of hen age. The significant differences in yolk height between systems at later storage periods (days 20 and 30) suggested that floor-reared eggs might have stronger vitelline membranes or different yolk composition that influences deterioration rates.

The pattern of significant differences between systems varied with storage duration. At day 0, multiple parameters differed

significantly, suggesting inherent quality differences in fresh eggs. By day 10, differences were limited to dimensional traits and shell weight, indicating that some initial differences diminished with storage while others emerged.

The consistent significant differences in yolk height at days 20 and 30, with cage-reared eggs maintaining higher values, represented an interesting shift from the pattern at day 0 where floor-reared eggs had superior yolk height. This reversal suggested differential rates of yolk deterioration between systems. Eggs from floor-reared birds might undergo more rapid yolk membrane weakening during extended storage, possibly due to compositional differences in yolk lipids or membrane structure (Sokołowicz *et al.*, 2018).

The significant differences in shell thickness at day 0 and shell weight at day 10 indicated that shell characteristics differed between systems and influenced egg quality during early storage. Shell quality affected gaseous exchange and moisture loss rates, potentially explaining some of the differential quality changes observed (Stefanello *et al.*, 2014).

These findings have practical implications for quail egg producers, marketers, and consumers. The progressive deterioration in quality with storage time emphasized the importance of minimizing storage duration and maintaining appropriate storage conditions. The differential effects of management systems suggest that eggs from different production sources might require tailored handling protocols.

For immediate consumption, eggs from either systems are suitable given comparable fresh quality. However, if extended storage is anticipated, the better maintenance of yolk quality in cage-reared eggs at later storage periods might make them preferable, despite floor-reared eggs having superior shell characteristics initially. These trade-offs require consideration in developing quality assurance programs and consumer information.

The complete absence of albumen width and yolk width data for later storage periods limited comprehensive comparison of dimensional changes. Future studies should ensure complete data collection across all parameters to better understand the full spectrum of quality changes during storage.

Conclusion

This study demonstrated that both management system (cage vs floor) and storage durations significantly affected the quality traits of quail eggs. At day 0, significant differences were observed in albumen width, yolk dimensions, and shell thickness between systems, with cage-reared eggs showing superior albumen width and yolk weight, while floor-reared eggs exhibited better yolk dimensions and shell thickness. As storage progressed, the pattern of differences shifted, with yolk height becoming the primary differentiating parameter at days 20 and 30, where cage-reared eggs maintained higher values. Storage duration consistently led to deterioration in most quality parameters, particularly albumen height and yolk characteristics, regardless of management systems.

Recommendations

1. Quail egg producers should implement rapid collection and cooling protocols to minimize quality deterioration during storage, regardless of production system.

2. Eggs intended for extended storage (>10 days) should preferably be obtained from cage-reared birds due to better maintenance of yolk quality during prolonged storage.

3. For immediate consumption, eggs from both systems are acceptable, with selection based on specific quality preferences (e.g., shell strength from floor-reared eggs, albumen quality from cage-reared eggs).

4. Further research should investigate the biochemical basis for differential deterioration rates between cage and floor-reared eggs, including lipid composition, membrane structure, and mineral content.

5. Quality standards for quail eggs should consider both production system and storage history to provide accurate guidance to consumers and processors.

6. Producers should consider labeling eggs with production system information and recommended storage duration to assist consumer choice and ensure quality expectations are met.

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