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Research

The Effect of Temperature and Storage Duration on The Quality of Arabian Chicken Table Eggs

Herwin Pisestyani[1*], Erlangga Putra Wijaya[2], Denny Widaya Lukman[1], Ekowati Handharyani[3]

[1]Division of Veterinary Public Health and Epidemiology, School of Veterinary Medicine and Biomedical Sciences, IPB University, Jln. Agatis Kampus IPB Darmaga, Bogor 16680, Indonesia
[2]Undergraduate Program of Veterinary Medicine, School of Veterinary Medicine and Biomedical Sciences, IPB University, Jln. Agatis Kampus IPB Darmaga, Bogor 16680, Indonesia
[3]Division of Pathology, School of Veterinary Medicine and Biomedical Sciences, IPB University, Jln. Agatis Kampus IPB Darmaga, Bogor 16680, Indonesia
***** Corresponding author: herwinpi@apps.ipb.ac.id
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ABSTRACT

The limited supply of local chicken eggs creates a market opportunity for Arab chicken eggs, as they closely resemble native eggs in shape, size, and shell color, making them difficult to distinguish. This study aimed to evaluate the quality changes of Arab chicken eggs stored under refrigeration (4–7 ℃) and room temperature (20–25 ℃). An experimental randomized block design was applied with four treatments: refrigerated eggs placed on trays (K1) and stacked in baskets (K2), and eggs stored at room temperature on trays (K3) and in baskets (K4). Quality parameters measured included egg weight, air cell height, yolk index (YI), albumen index (AI), and Haugh unit (HU). Five eggs from each treatment group were examined every 5 days over a 45-day storage period, totaling 200 eggs. Results revealed significant differences ($P < 0.05$) in all quality parameters over time. Eggs stored under refrigeration maintained quality significantly longer ($P<0.05$) compared with those stored at room temperature. However, placement on trays versus stacking in baskets showed no significant effect ($P>0.05$). These findings suggest that temperature and storage duration are crucial factors affecting egg quality, with refrigeration effectively preserving the quality of Arab chicken eggs.

Keywords: quality of Arabian chicken eggs, storage duration, storage method, storage temperature

ABSTRAK

Minimnya pasokan telur ayam lokal (kampung) menjadi peluang pasar bagi telur ayam arab, dikarenakan kemiripan bentuk, ukuran dan warna cangkangnya sehingga sulit untuk dibedakan. Tujuan dari penelitian ini adalah mengetahui perubahan kualitas telur ayam arab selama penyimpanan di refrigerator (4-7 ^{O}C) dan suhu ruang (20-25 ^{O}C). Desain penelitian eksperimental menggunakan sistem rancangan acak kelompok, dengan perlakuan telur disimpan di *refrigerator* disusun pada rak telur (K1) dan ditumpuk dalam keranjang (K2), disimpan di suhu ruang menggunakan rak telur (K3), dan ditumpuk dalam keranjang (K4). Parameter yang diamati, yaitu bobot telur, tinggi kantung udara, Indeks Kuning Telur (IKT), Indeks Putih Telur (IPT), dan *Haugh unit* (HU). Lima butir telur pada masing-masing kelompok diamati kualitasnya selama 45 hari penyimpanan dengan interval 5 hari sehingga total sampel berjumlah 200 butir. Hasil menunjukkan adanya perbedaan nyata ($P<0,05$) pada semua parameter kualitas telur terhadap waktu penyimpanan telur ayam Arab. Telur ayam Arab yang disimpan di suhu ruang dan *refrigerator* menunjukkan perbedaan yang signifikan ($P<0,05$). Kualitas telur yang disimpan di rak telur dan ditumpuk di keranjang tidak menunjukkan perbedaan yang nyata ($P>0,05$). Faktor yang memengaruhi kualitas telur secara signifikan yaitu suhu dan waktu penyimpanan. Penempatan telur di *refrigerator* mampu mempertahankan kualitas telur ayam Arab lebih lama dibandingkan dengan telur yang disimpan di suhu ruang.

Kata kunci: cara penyimpanan, kualitas telur ayam Arab, lama penyimpanan, suhu penyimpanan

INTRODUCTION

Eggs are a valuable source of nutrients, including proteins, fats, vitamins, and minerals essential for human health (Indrawan *et al*., 2012). In Indonesia, local chicken eggs are often consumed not only as food but also as traditional medicine, believed to improve stamina (Marlya *et al*., 2021). However, the limited production of local chickens is primary due to genetic constraints and traditional rearing systems (Sodak, 2011). To meet consumer demand, Arabian chicken eggs are increasingly used as an alternative, as they closely resemble local eggs in taste, quality, and appearance. Arabian chickens are highly productive layers, capable of producing up to 300 eggs per year with an average weight of 30–35 g (Argo *et al*., 2013).

Egg quality, however, is strongly affected by storage conditions. Prolonged storage reduces freshness and nutrient content, while appropriate storage helps preserve quality and extend shelf life. According to SNI 3926:2023, eggs should be stored at room temperature (80–90% humidity) for up to 14 days, or under refrigeration at 4–7 °C (60–70% humidity) for up to 30 days (BSN, 2023). Given the increasing use of Arabian chicken eggs, proper storage and handling are critical to ensure consumer safety and maintain nutritional quality. Therefore, this study aimed to evaluate the external and internal quality of Arabian chicken eggs stored under different conditions and temperatures to determine the most effective storage method for preserving their quality.

MATERIALS AND METHODS

Research Design

The samples were freshly laid eggs from 32-week-old Arabian hens from the same farm and coop. The research design was a randomized block design. The eggs were divided into four groups, namely eggs stored on egg racks in a refrigerator (K1), stacked in baskets in a refrigerator (K2), stored on egg racks at room temperature (K3), and stacked in baskets at room temperature (K4). The refrigerator temperature ranged from 4–7 °C with relative humidity of 20–30%, and the room temperature from 25–27 °C with relative humidity of 50–70%. Observations started from day 0 when the hens laid the eggs, followed by observations for 45 days with observation intervals of 5 days. Five eggs were used at each observation time. The parameters observed were exterior and interior quality parameters.

External Quality Measurement

External egg quality includes egg weight and air cell height. Egg weight was measured by weighing unbroken eggs using a digital scale (Figure 1).

Air cell height measurement began with candling the eggs first, marking the air cell using a pencil, and measuring it using an official egg air cell gauge.

Figure 1. External egg measurement

Internal Quality Measurement

Internal egg quality includes yolk index, albumen index, and Haugh Unit. The yolk index is determined by measuring the height and diameter of the yolk (Figure 2), and is calculated using the following formula:

$$\text{Yolk Index} = \frac{a}{b}$$

Description:
a = height of egg yolk (mm)
b = diameter of the egg yolk (mm)

Figure 2. Yolk index

The measurement of the egg albumen index begins with measuring the height and the average diameter. The egg albumen index (Figure 3) is then calculated using the following formula:

$$\text{Egg White Index} = \frac{a}{b}$$

Description:
a = depth of thick albumin (mm)
b = average diameter (b1+b2) of the thick albumen (mm)

Figure 3. Egg white index

The HU value is obtained by weighing the egg before breaking it and then measuring the thickness of the egg white using calipers. The HU value is calculated using the following formula:

$$HU = 100 \log (H+7{,}57 - 1{,}7 W^{0{,}37})$$

Description:
H = thickness of the thick albumen (mm)
W = egg weight (grams)

Data Analysis

External and internal egg quality data were first tested for normality (Shapiro–Wilk test) and homogeneity of variance (Levene's test) to ensure compliance with the assumptions of ANOVA. Subsequently, the data were analyzed using one-way ANOVA, followed by Tukey's HSD test to determine significant differences among treatments. All results are presented in tables and graphs.

RESULTS

External Quality of Arab Chicken Eggs Stored at Cold Temperature and Room Temperature

The average initial weight of freshly laid Arabian chicken eggs was 50.760 ± 2.379 g and 49.990 ± 2.211 g (Table 1). Although no significant differences (P>0.05) were observed between eggs stored under refrigeration and at room temperature during the storage period (Table 2), egg weight decreased progressively with time. The lowest weight was recorded on day 40 at room temperature (45.020 ± 3.223 g), whereas refrigerated eggs maintained relatively higher weights on day 45 (46.140 ± 4.053 g for K1 and 45.490 ± 2.920 g for K2). Based on SNI 3926:2023, egg size shifted from medium (day 0–15) to small (day 20–45).

The initial air sac height was 0.280 ± 0.123 cm and 0.340 ± 0.097 cm (Table 1). Eggs stored under refrigeration showed a significant increase (P<0.05) on day 30, whereas those stored at room temperature exhibited earlier changes starting on day 15. Quality deterioration was observed from grade I to grade II by day 30 in refrigerated eggs, while room-temperature eggs declined as early as day 10.

The average yolk index (YI) at day 0 was 0.441 ± 0.037 and 0.438 ± 0.019 (Table 1). YI remained stable under refrigeration with no significant changes (P>0.05) during 45 days but declined significantly (P<0.05) in room-temperature eggs from day 10 onwards.

The albumen index (AI) at day 0 was 0.085 ± 0.027 and 0.079 ± 0.018 (Table 1). No significant differences (P>0.05) were observed in AI values for either storage condition throughout the 45 days.

The initial Haugh unit (HU) values were 82.458 ± 10.831 and 77.496 ± 7.393 (Table 1), classifying both groups as AA quality. Eggs stored under refrigeration maintained more stable HU values until day 45, whereas those at room temperature showed a faster decline.

External Quality of Arab Chicken Eggs During Storage Using Egg Trays and Stacking

At the beginning of storage (day 0), the average weight of Arabian chicken eggs ranged from 49.14 ± 2.555 g (K3) to 51.82 ± 1.920 g (K1). Throughout the 45-day storage period, egg weight decreased progressively, but no significant differences (P>0.05) were observed between eggs placed on shelves or stacked in baskets, either under refrigeration or at room temperature (Table 2; Figure 4). This indicates that the storage method did not influence egg weight, although storage time contributed to weight loss.

Air cell height increased linearly in all treatment groups during storage (Figure 5). No significant effect (P>0.05) of the storage method was detected, but temperature and duration strongly influenced air cell development. Initially, all eggs were classified as grade I (<0.5 cm). Quality deterioration occurred earlier at room temperature, with K3 eggs downgraded to grade II on day 15 and K4 on day 20. In contrast, refrigerated eggs showed slower deterioration, with K2 downgraded on day 30 and K1 on day 40.

The yolk index (YI) at day 0 ranged between 0.435 ± 0.020 and 0.442 ± 0.056 (Figure 6). YI values decreased with storage time, particularly under room temperature, but differences between shelf and basket storage were not significant (P>0.05). All groups were classified as grade II according to BSN (2023).

Similarly, the albumen index (AI) values on day 0 ranged from 0.071 ± 0.012 (K3) to 0.098 ± 0.031 (K1) (Figure 7). AI declined steadily across storage days, yet no significant differences (P>0.05) were observed between eggs stored on shelves and in baskets. Eggs stored at room temperature (K3 and K4) fell below grade III criteria between days 10 and 35. By days 40–45, thick albumen could no longer be distinguished, making AI measurement impossible.

The initial Haugh unit (HU) values varied across treatments, from 73.14 ± 5.98 (K3) to 88.62 ± 9.08 (K1) (Figure 8). Based on USDA (2000) standards, groups K1, K2, and K4 were classified as AA, while K3 was classified as A. HU values declined with storage time, particularly under room temperature, but again, no significant differences were observed

between storage methods. For instance, the K4 group declined from AA to A quality by day 20.

Overall, the results demonstrate that temperature and storage duration significantly affected egg quality (P<0.05), whereas the storage method (shelf vs. basket) had no significant effect (P>0.05) (Table 2). Refrigeration was more effective in maintaining egg weight, air cell stability, yolk and albumen indices, and HU values compared to room temperature storage.

Table 1. External and internal quality of Arabian chicken eggs stored at refrigerator temperature and room temperature for 45 days of storage

Day	Weight (g)		Air sacc (cm)		Yolk Index		Albumen Index		Haugh Unit	
	Refrige-rator	Room temperature	*Refrige-rator*	Room temperature	*Refrige-rator*	Room temperature	*Refrige-rator*	Room temperature	*Refrige-rator*	Room temperature
0	50,760 ± 2,379^{aA}	49,990 ± 2,211^{aA}	0,280 ± 0,123^{aA}	0,340 ± 0,097^{aA}	0,441 ± 0,037^{aA}	0,438 ± 0,19 ^{aA}	0,085 ± 0,027 ^{aA}	0,079 ± 0,018 ^{aA}	82,458 ± 10,831 ^{aA}	77,496 ± 7,393 ^{aA}
5	51,000 ± 3,197^{aA}	48,500 ± 3,951^{aA}	0,411 ± 0,078^{aA}	0,390 ± 0,074^{aA}	0,463 ± 0,020^{aA}	0,362 ± 0,22 ^{bA}	0,079 ± 0,023 ^{aA}	0,058 ± 0,009 ^{aA}	80,414 ± 8,368 ^{aA}	72,807 ± 5,617 ^{aA}
10	50,260 ± 3,845^{aA}	48,570 ± 3,736^{aA}	0,360 ± 0,070^{aA}	0,440 ± 0,070^{aA}	0,450 ± 0,025 ^{aA}	0,321 ± 0,018 ^{bB}	0,076 ± 0,016 ^{aA}	0,043 ± 0,013 ^{aA}	81,219 ± 5,155 ^{aA}	67,778 ± 5,858 ^{aA}
15	50,340 ± 5,424^{aA}	48,400 ± 2,553^{aA}	0,333 ± 0,141^{aA}	0,511 ± 0,060^{bB}	0,453 ± 0,028 ^{aA}	0,295 ± 0,330 ^{bB}	0,076 ± 0,027 ^{aA}	0,033 ± 0,007 ^{aA}	81,687 ± 6,267 ^{aA}	59,447 ± 6,236 ^{bA}
20	47,245 ± 3,292^{aA}	47,790 ± 2,159^{aA}	0,380 ± 0,079^{aA}	0,544 ± 0,053^{bB}	0,427 ± 0,023 ^{aA}	0,233 ± 0,024 ^{bB}	0,078 ± 0,020 ^{aA}	0,028 ± 0,005 ^{aA}	81,050 ± 6,909 ^{aA}	59,447 ± 4,833 ^{bB}
25	47,443 ± 2,910^{aA}	46,260 ± 4,512^{aA}	0,410 ± 0,057^{aA}	0,600 ± 0,125^{bB}	0,433 ± 0,021 ^{aA}	0,211 ± 0,030 ^{bC}	0,076 ± 0,016 ^{aA}	0,025 ± 0,006 ^{aA}	77,667 ± 6,830 ^{aA}	57,167 ± 6,836 ^{bB}
30	48,990 ± 3,272^{aA}	45,450 ± 3,594^{aA}	0,460 ± 0,084^{aB}	0,620 ± 0,063^{bB}	0,439 ± 0,038 ^{aA}	0,180 ± 0,019 ^{bC}	0,070 ± 0,015 ^{aA}	0,025 ± 0,003 ^{aA}	76,513 ± 8,165 ^{aA}	55,556 ± 6,839 ^{aB}
35	47,110 ± 4,498^{aA}	46,070 ± 3,295^{aA}	0,500 ± 0,067^{aB}	0,740 ± 0,117^{bC}	0,422 ± 0,067 ^{aA}	0,147 ± 0,023 ^{bC}	0,069 ± 0,019 ^{aA}	0,028 ± 0,019 ^{aA}	78,643 ± 6,568 ^{aA}	59,501 ± 7,976 ^{aB}
40	45,930 ± 2,767^{aA}	45,020 ± 3,223^{aA}	0,520 ± 0,063^{aB}	0,725 ± 0,089^{bC}	0,456 ± 0,028 ^{aA}	0,164 ± 0,025 ^{bC}	0,080 ± 0,008 ^{aA}		81,098 ± 3,842 ^{aA}	
45	46,140 ± 4,053^{aA}	45,490 ± 2,920^{aA}	0,550 ± 0,053^{aB}	0,767 ± 0,050^{bD}	0,416 ± 0,046 ^{aA}	0,150 ± 0,018 ^{bC}	0,071 ± 0,024 ^{aA}		70,340 ± 12,430 ^{aA}	

Table 2. Factors affecting the quality of Arabian chicken eggs during storage

Parameters	P value (Significant)		
	Temperature	Storage Method	Duration of Storage
Eggs weight	0,070	0,133	0,007*
Air sacc	0,000*	0,510	0,000*
Yolk Index	0,000*	0,880	0,005*
Albumen Index	0,000*	0,601	0,024*
Haugh unit	0,000*	0,792	0,032*

* Significantly different results (P<0.05)

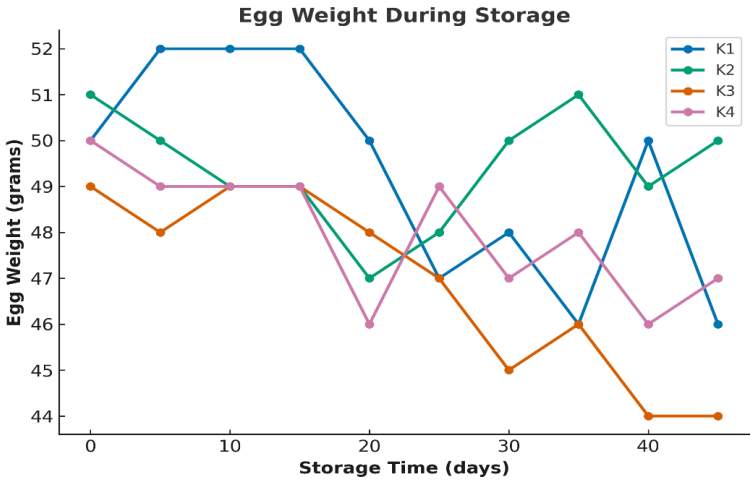

Figure 4. Changes in the weight of Arabian chicken eggs during storage arranged on egg racks and stacked in baskets at refrigerator temperature and room temperature

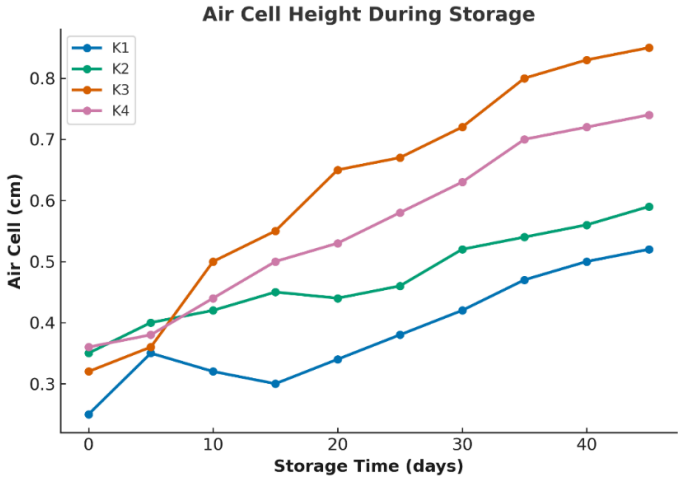

Figure 5. Changes in the air cell height of Arabian chicken eggs during storage arranged on egg racks and stacked in baskets at refrigerator temperature and room temperature

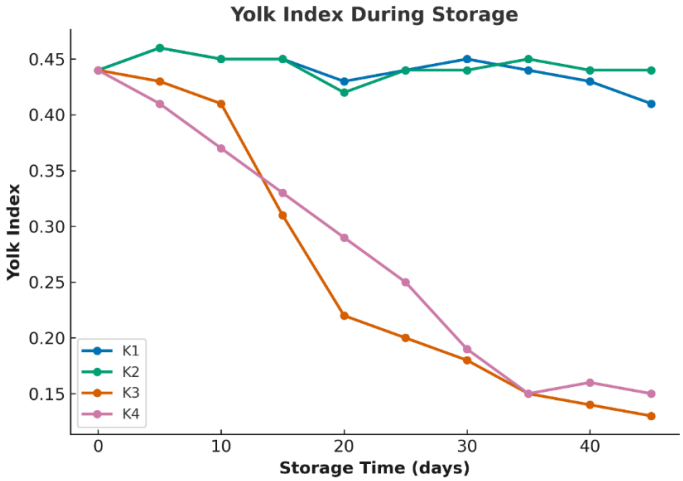

Figure 6. Changes in the yolk index (YI) of Arabian chicken eggs during storage, arranged on egg racks and stacked in baskets at refrigerator temperature and room temperature

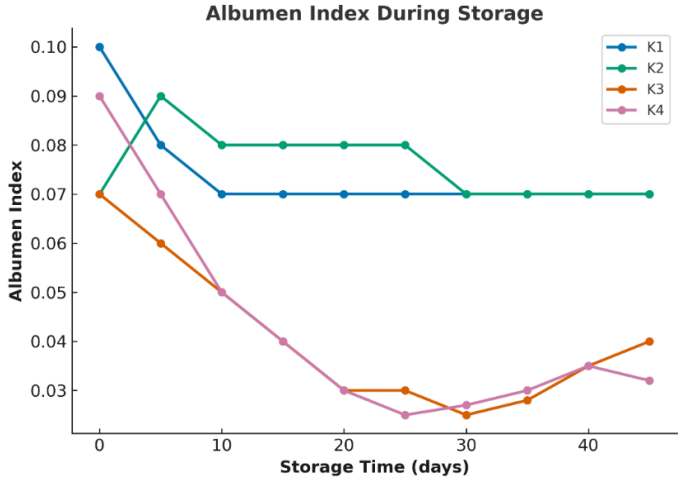

Figure 7. Changes in the egg albumen index (EWI) of Arabian chicken eggs during storage arranged on egg racks and stacked in baskets at refrigerator temperature and room temperature

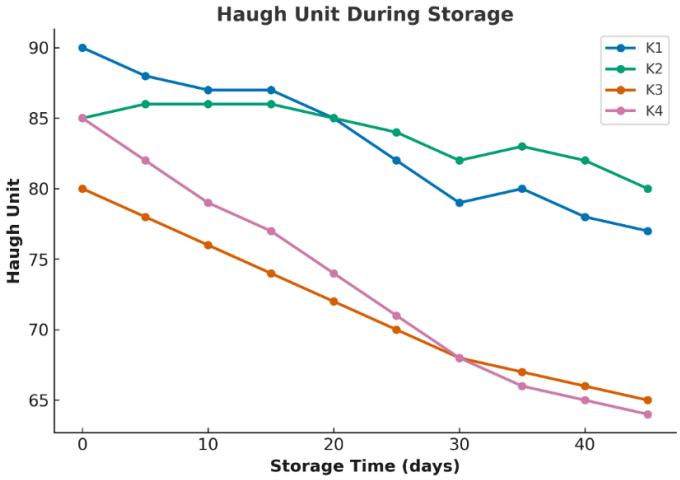

Figure 8. Changes in Haugh Units of Arabian chicken eggs during storage arranged on egg racks and stacked in baskets at refrigerator temperature and room temperature

DISCUSSION

Egg white is composed of several proteins, among which ovomucin plays a central role in maintaining viscosity by forming a gel matrix within the albumen (Nasution *et al*., 2018; Febria *et al*., 2022). The high Albumen Index (AI) values observed in freshly laid Arabian chicken eggs confirm the intact structure of ovomucin. Over time, however, the protective cuticle layer on the eggshell deteriorates, facilitating gas (CO_2, NH_3, H_2S) and water loss. The depletion of CO_2 disrupts the buffering system, accelerates the breakdown of ovomucin, and reduces albumen viscosity. This process occurred more rapidly at room temperature, while refrigeration substantially delayed the decline by limiting evaporation.

The reduction in albumen viscosity creates osmotic imbalances, promoting water migration into the yolk (Purdiyanto & Riyadi, 2018). Consequently, the vitelline membrane weakens, leading to a decrease in yolk index (YI) (Fresli *et al*., 2019). In this study, YI declined significantly earlier in eggs stored at room temperature compared to refrigeration, supporting the role of temperature as the dominant factor in preserving yolk integrity. Although storage time inevitably reduces quality, the data indicate that temperature exerts a stronger influence than duration. Cold storage consistently slowed deterioration across all quality parameters, even beyond 30 days, compared with room temperature, where rapid declines were observed within 10–20 days.

The Haugh Unit (HU), which integrates egg weight and albumen height, is a robust indicator of internal quality. The observed variations in HU during prolonged refrigeration may also reflect genetic or physiological variation among hens, despite standardized age and rearing conditions. This aligns with reports that intrinsic biological variability contributes to quality differences (Syaifulloh *et al*., 2021).

The increase in air cell height and weight loss in eggs stored at room temperature further confirms the role of evaporation as the primary driver of quality decline (Rebecca, 2016). Importantly, the storage method (shelf vs. basket) did not affect any parameter ($P>0.05$), suggesting that surface-wide evaporation dominates over positional effects. This finding corroborates earlier work (Cardetti *et al*., 1978) but contrasts with more recent reports highlighting the influence of storage orientation (Çam *et al*., 2022; Djaelani, 2016).

From a regulatory perspective, the Indonesian National Standard (SNI 3926:2023) recommends room-temperature storage (20–25 °C) for a maximum of 14 days and refrigerated storage (4–7 °C) for up to 30 days. Our findings extend this evidence by showing that refrigeration can preserve Arabian chicken egg quality beyond 30 days, whereas room temperature storage results in rapid deterioration after 10–15 days. Similar conclusions are reported by international standards such as USDA (2000), which emphasizes refrigeration for maintaining Grade AA or A quality.

These results underline that temperature is a more critical determinant of egg quality than storage duration. For practical application, households are strongly advised to use refrigeration to maintain egg freshness, particularly when longer storage is required. For smallholder farmers and traditional markets where refrigeration access is limited, the study highlights the importance of selling eggs within 7–10 days to maintain consumer-acceptable quality. At the household level, refrigeration at 4–7 °C

remains the most effective strategy for preserving the nutritional and sensory quality of Arabian chicken eggs.

This study demonstrates that storage temperature is the dominant factor influencing the quality of Arabian chicken eggs, while storage duration plays a secondary but cumulative role. Refrigeration (4–7 °C) effectively slowed the deterioration of egg weight, air cell height, yolk index, albumen index, and Haugh Unit, maintaining acceptable quality for more than 30 days. In contrast, eggs stored at room temperature (20–25 °C) experienced rapid declines in quality within 10–15 days.

"*The authors declare no conflict of interest with any parties involved in this research*."

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