



Storage period and temperature as determinants of egg quality: An analytical study

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ABSTRACT

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The study aimed to evaluate the impact of cold and room-temperature storage on the external and internal quality of eggs, as well as their microbial quality. A total of 108 fresh white eggs from the ICAR-CARI layer house were divided into two groups: the T1 group, stored at room temperature, and the T2 group, stored at 4°C. Egg quality was assessed on days 0, 3, 6, 12, 18, and 24. Results showed that egg quality decreased more significantly ($p \leq 0.05$) in the T1 group, with reductions in measurements like egg pH, and albumen quality. In contrast, eggs stored in cold conditions maintained a more stable quality across all parameters ($p \leq 0.05$). Microbial analysis indicated that eggs stored at room temperature had an increasing bacterial count, starting from 3.64 cfu/ml on day 0 and reaching 6.50 cfu/ml by day 24. However, eggs stored in cold conditions exhibited much lower bacterial growth, with a total plate count (TPC) of 3.64 cfu/ml on day 0, only rising slightly to 4.33 cfu/ml by day 24.

Keywords: Egg quality, Storage, Temperature

INTRODUCTION

Poultry production has witnessed substantial growth, both in terms of output and consumer demand. This expansion is largely driven by the widespread availability of eggs and meat, accessible even in the most local markets throughout the country. Such accessibility is a result of efficient integration across various sectors of the industry. Eggs, a natural gift from hens, offer a complete, wholesome and unadulterated source of nutrition suitable for individuals of all ages. As a highly versatile and widely accessible food, eggs are rich in high-quality proteins, healthy fats, and an array of essential macro and micronutrients. Encased within a protective shell, eggs are safeguarded against contamination, preserving their internal contents. However, this protective shell also poses a challenge, as it conceals the inner quality of the egg, especially when stored for extended periods and is a point of concern for consumers regarding freshness and quality. This concern primarily arises from the fact that as storage time and temperature increase, the internal quality of eggs begins to deteriorate and the changes are not visible externally. However, through breaking study analysis, inner quality can be assessed more accurately. Despite this, comprehensive knowledge regarding egg quality at specific storage intervals remains limited. In the Indian context, consumer awareness around factors like egg

quality, optimal storage temperatures, and recommended storage durations is also notably lacking.

Additionally, the majority of India's egg production is concentrated within three to four states, from which eggs are distributed nationwide to meet demand. Consequently, by the time eggs reach their destination, they may already have undergone quality degradation due to storage and transportation under varying climatic conditions, further intensifying concerns about their freshness. This issue has raised significant apprehension among consumers, stakeholders, wholesalers, and retailers regarding the preservation of egg quality, optimal storage practices, and ideal temperature conditions to maintain freshness. Extended storage, particularly under suboptimal conditions, can lead to quality deterioration, rendering eggs unfit for human consumption. Therefore, developing effective storage technologies is crucial for maintaining egg quality. Key factors influencing egg quality during storage include storage duration, temperature, humidity, air circulation, and handling practices (Samli, *et al.*, 2005). Egg quality deteriorates more rapidly at higher temperatures, as compared to colder storage environments. Understanding the impact of temperature and storage duration on the internal quality of eggs is serious for addressing precise quality-related questions. During storage, various changes occur within the egg, depending on temperature and time. The primary reason for quality deterioration is the gaseous exchange between the egg's internal contents and its surrounding

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environment. As the egg ages, exchange of gases occurs through pores, predominantly located at the broader end. This exchange causes a decline in internal quality, particularly in the albumen, where the thick albumen gradually transforms into a thin, watery consistency. Correct storage is essential to maintain the quality and culinary properties of eggs, as poor storage conditions can compromise egg quality within a matter of days. Reports suggest that on improper storage conditions changes such as thinning of the albumen, enlargement of the yolk and air cells, and absorption of odors if stored near strong-smelling foods.

The quality and market value of eggs are primarily determined by specific standards based on internal and external egg characteristics. High-quality eggs are defined by firm, thick albumen and plump yolks. Additional indicators of freshness include a small air cell (typically less than 4.7 mm in depth) and the absence of blood or flesh spots in the albumen. Eggs containing significant blood spots are classified as “lost” and deemed inedible. Internal egg quality, especially in stored eggs, varies notably in albumen pH and firmness (Rodrigo *et al.*, 2021). As water and CO₂ escape through the eggshell, pH of the albumen increases. The binding capacity of ovomucin and lysozyme decreases with storage time, resulting in reduced viscosity of albumen (Jiang *et al.*, 2022; Wlazlak *et al.*, 2024). The size of the air cell depends on the storage conditions and is thus not a reliable criterion for the age of the egg. Albumen height is more reliable in this regard but depends on egg size. Grade AA eggs, in particular, exhibit thick, firm albumen and small air cells, free of blood or meat spots. The albumen pH's increase is influenced by its buffering capacity and maintaining albumen pH between 8.3 and 8.5 is challenging without specific storage modifications. During extended storage, the pH of the yolk decreases as the vitelline membrane weakens. This deterioration facilitates lipid degradation, which in turn adversely impacts the yolk's emulsifying properties and flavour profile (Zhou *et al.*, 2021). Water moves from the albumen into the yolk due to osmotic pressure, altering the yolk structure and further weakening the membrane. A study conducted by Chen *et al.* (2023) highlighted the relationship between elevated water content in egg yolk and increased pH levels in the albumen, underscoring the critical role of albumen pH in maintaining the integrity of the vitelline membrane and yolk structure. As eggs age, carbon dioxide escapes through the shell, leading to a rise in albumen pH, which can reach levels around 9.5. This increase in pH is associated with structural changes in the albumen proteins, particularly affecting their gel strength and functionality (Quan and Benjakul, 2019). With this broad background this study has been considered as priority to know the effectiveness of temperature and storage duration on egg quality parameters under Indian scenario.

The results serve as valuable reference data for predicting the shelf life of eggs under various storage temperatures.

MATERIALS AND METHODS

Location and experimental design

The experiment was conducted at the Post-Harvest Technology Department of the Central Avian Research Institute to evaluate the effects of temperature and storage conditions on egg quality. A total of 108 freshly collected eggs of CARI-Priya from the ICAR-CARI layer house were allocated into two groups: Group T1 was stored at ambient temperature, while Group T2 was maintained in cold storage at 4°C. Study was systematically conducted on days 0, 6, 12, 18, and 24 days to monitor the impact of quality changes over time. On the day of examination, each egg of both the treatment groups were individually numbered, weighed on precision scales, and assessed for external and internal quality parameters, including shell integrity, albumen height, and yolk index. Measurements were taken at six-day intervals, allowing for a comprehensive analysis regarding quality deterioration and stability under the different storage conditions.

External egg quality

Egg weight and weight loss (%): Egg weight was recorded at first egg laid, and every six-day intervals from 0 day to 24th day. The egg weight was recorded to nearest of 0.05g accuracy by using weighing balance.

The weight loss was calculated weekly in relation to the respective egg weight on day zero, according to the equation given by Paula *et al.*, 2021.

Weight loss (%) =

$$\frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Initial weight (g)}} \times 100$$

Shape index: The egg's maximum length and breadth were precisely measured using a Vernier caliper, and the shape index was subsequently calculated following the formula described by Schultz, 1953.

$$\text{Shape Index} = \frac{\text{Max. breadth of egg (cm)}}{\text{Max. length of egg (cm)}} \times 100$$

Shell thickness: Eggshell thickness is measured by using specialized equipment, such as an eggshell thickness gauge. For calculation of eggshell thickness, the average of three different edges viz (broad, middle and narrow) measured.

Air cell diameter: The air cell diameter of an egg can be accurately measured by positioning the egg under a candling lamp and using a Vernier caliper to measure the diameter of the air cell. According to Narushin *et al.*, 2024, the following formula is commonly applied.

Air Cell Diameter = Width/Diameter of the air cell visible under candling

This method allows for consistent and precise measurement of the air cell size, which is an essential indicator of egg freshness and quality.

Internal egg quality

Haugh unit score: Haugh unit is the most widely used parameter for albumen quality. The height of the albumen (mm) and egg weight (g) were used for calculation of Haugh unit using following formula described by Haugh, 1937.

$$\text{Haugh unit: } 100 * \log (\text{height of albumen (H)} + 7.75 - 17 * \text{egg weight (W)} - 37)$$

Where: H = The height of the egg and W = Egg weight

pH of eggs: The yolk was separated from the albumen, and both were distributed into glass beakers. pH determination of the pH of the albumen then and the yolk were measured with a pH meter (Electronic Instrument Ltd). About 2.0 g of the sample was homogenised in 20.0 ml of de-ionised water in a beaker. The pH meter was first standardised using buffer solution of pH 4.01 and 9.20. The electrode was then rinsed with de-ionised water and dipped into the homogenate allowing sufficient time for stabilisation before taking the reading (Eke *et al.*, 2013)

Microbial load estimation: Microbial load in eggs typically refers to the presence and concentration of microorganisms, such as bacteria, fungi, and molds, on the eggshell and within the egg contents (albumen and yolk). Monitoring microbial load is crucial for assessing egg safety, as eggs can harbor pathogenic bacteria, which pose significant health risks.

Total plate count (TPC): The Total Plate Count (TPC) method for estimating microbial load, as described by FSSAI (2018) guidelines, is a widely used technique to assess the total number of viable bacteria present in eggs. This method involves the following steps: Eggs were broken under sterile conditions to obtain yolk and albumen samples. The albumen and yolk samples were mixed together followed by dilution and plating of the samples. The collected sample is diluted in sterile PBS and plated onto a plate count agar medium that supports bacterial growth. The agar plates are incubated at a specified temperature (typically 35-37°C) for 24-48 hours, allowing viable bacterial colonies to develop. After incubation, colonies are counted manually or with an automated colony counter. The results, expressed as colony-forming units per milliliter (cfu/ml) or per gram (cfu/g) of egg content, provide an estimate of the microbial load. The TPC method, as standardized by Singh *et al.*, 2022 provides an overall indication of bacterial presence and helps to assess egg hygiene and quality, serving as a benchmark for safe handling and storage practices.

Statistical analysis

Data analysis was conducted using SPSS software (version 26). A one-way ANOVA was performed to identify significant differences between treatment group means, with Duncan's multiple range test used for post hoc comparisons. Data variability was expressed as standard

error (SE), and a significance level of $P \leq 0.05$ was applied to determine statistical significance.

RESULTS AND DISCUSSION

This study examined how key quality parameters of eggs are influenced by varying storage conditions, particularly storage time and temperature. By analysing changes in egg quality over different temperatures and durations, we aimed to identify optimal storage conditions to preserve eggs under Indian conditions. Findings from this study contributed valuable insights into maintaining egg freshness and integrity, which is essential for ensuring the quality and safety of eggs during storage.

External egg quality

Egg weight loss (%): The impact of storage temperature and duration on the weight of chicken table eggs is illustrated in Table 1. Statistical analysis showed highly significant differences ($P \leq 0.001$) in egg weight between the treatment groups over time. On 0th day, the egg weight measured was 51.26 and 53.43 for T1 and T2 respectively. As storage progressed, the weights gradually decreased, the eggs weight measured were 49.86 vs 52.62; 49.3 vs 52.39; 47.49 vs 52.01 and 47.41 vs 51.92 for T1 and T2 respectively on 6th, 12th, 18th and 24th day of storage. Similarly, the egg weight loss percentage observed were on day 6, the weight loss percentage was recorded as 2.42% for T1 and 1.53% for T2. By day 24 of storage, the weight loss had increased to 9.74% for T1 and 3.94% for T2. Specifically, a marked decline in egg weight was observed in the T1 group stored at room temperature, with the decrease becoming more pronounced as storage time progressed. In contrast, eggs stored at 4°C in the T2 group maintained a relatively stable weight over the same period. These findings indicate that room-temperature storage causes substantial weight loss in eggs, while refrigeration at 4°C preserves weight stability. Weight loss in eggs during storage is largely attributed to ongoing chemical reactions, particularly the escape of carbon dioxide (CO₂) from the egg white (albumen). As storage time and temperature rise, gas exchange intensifies between the egg's internal environment and the surrounding air. Through the pores in the eggshell, oxygen enters while CO₂ diffuses out, progressively lowering the egg's weight (Usturoi *et al.* 2014). This phenomenon was clearly demonstrated in our study, where both temperature and storage duration significantly influenced weight loss. Higher temperatures expedite gas diffusion and water vapor loss, thereby amplifying weight reduction. For instance, eggs stored at around 23.9°C for 14 days exhibit more weight loss compared to those stored under refrigeration, as warmer conditions accelerate evaporation and CO₂ release. The escape of CO₂ not only diminishes weight but also affects the egg's internal pH, altering the quality of the yolk and albumen over time. Therefore, effective storage practices

Table 1: Effects of storage period and temperature on external egg quality

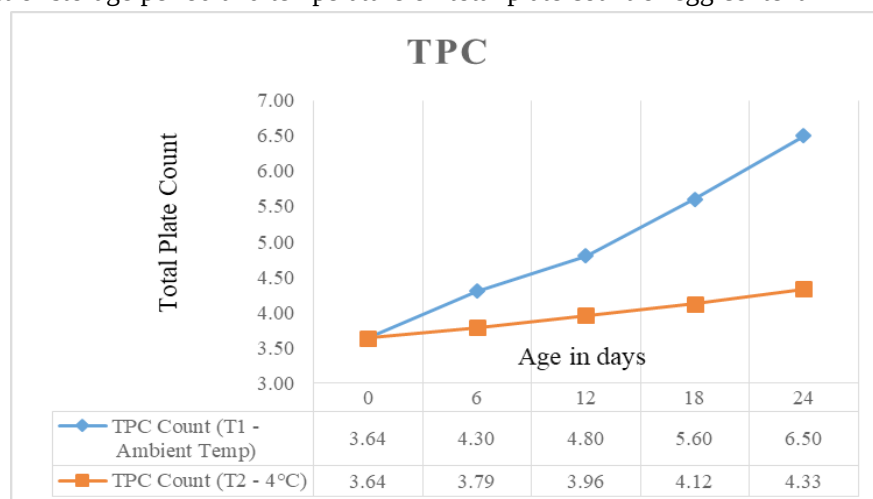
Parameter	Temperature/ Duration (days)	0 th	6 th	12 th	18 th	24 th	p value
Egg weight	T1 (Room Temperature)	51.26±0.53 ^A	49.86±0.52 ^A	49.3±0.52 ^A	47.49±1.17 ^{AB}	47.41±0.53 ^B	0.034
	T2 (4°C)	53.43±0.76	52.62±0.75	52.39±0.76	52.01±0.76	51.92±0.76	0.086
Egg weight loss (%)	T1 (Room Temperature)	-	2.42±0.00 ^A	3.93±0.08 ^B	7.78±2.18 ^C	9.74±1.74 ^D	0.000
	T2 (4°C)	-	1.53±0.0 ^A	2.00±0.18 ^B	2.74±0.27 ^B	3.94±0.21 ^{BC}	0.045
Air cell diameter (in mm)	T1 (Room Temperature)	13.36±0.73 ^A	14.73±0.8 ^{AB}	17.82±0.97 ^B	23.36±1.27 ^C	27.50±1.50 ^D	0.000
	T2 (4°C)	13.23±0.72 ^A	14.09±0.77 ^A	16.43±0.89 ^{AB}	19.70±1.07 ^{AB}	23.19±1.26 ^B	0.035
Egg shell thickness (in mm)	T1 (Room Temperature)	0.34±0.005	0.35±0.002	0.34±0.003	0.34±0.003	0.34±0.003	0.601
	T2 (4°C)	0.34±0.006	0.34±0.005	0.33±0.002	0.34±0.005	0.33±0.001	0.322
Shape Index	T1 (Room Temperature)	76.59±0.53	76.59±0.53	76.34±0.31	75.95±0.76	75.93±0.43	0.561
	T2 (4°C)	76.51±0.33	76.48±0.31	76.24±0.34	75.88±0.95	75.71±0.45	0.452

N=10 mean± SE the mean values between rows with different superscript A,B,C,D,E, were significantly different ($p \leq 0.001$)

Table 2: Effects of storage period and temperature on internal egg quality

Parameter	Temperature/ Duration (days)	0 th	6 th	12 th	18 th	24 th	p value
pH of Egg	T1 (Room Temperature)	7.16±0.06 ^A	7.37±0.06 ^B	7.6±0.06 ^C	7.83±0.07 ^C	8.06±0.07 ^D	0.000
	T2 (4°C)	7.09±0.09 ^A	7.2±0.09 ^{AB}	7.32±0.09 ^{AB}	7.43±0.09 ^{AB}	7.55±0.09 ^B	0.032
pH of Egg Albumen	T1 (Room Temperature)	7.87±0.07 ^A	8.11±0.07 ^B	8.36±0.07 ^C	8.61±0.07 ^{CD}	8.87±0.08 ^D	0.000
	T2 (4°C)	7.79±0.09 ^A	7.92±0.1 ^{AB}	8.05±0.1 ^{AB}	8.18±0.1 ^{AB}	8.31±0.1 ^B	0.024
pH of Egg Yolk	T1 (Room Temperature)	6.21±0.02 ^A	6.40±0.02 ^B	6.60±0.02 ^{BC}	6.80±0.02 ^B	7.00±0.02 ^C	0.000
	T2 (4°C)	6.17±0.05 ^A	6.27±0.05 ^{AB}	6.37±0.05 ^{AB}	6.48±0.05 ^{AB}	6.58±0.05 ^B	0.038
Haugh Unit	T1 (Room Temperature)	85.84±1.43 ^A	60.09±1.00 ^B	49.27±0.82 ^C	41.88±0.69 ^D	33.5±0.56 ^E	0.000
	T2 (4°C)	86.08±1.32 ^A	70.58±1.08 ^{AB}	62.11±0.95 ^B	52.80±0.81 ^C	48.24±0.65 ^C	0.022

N=10 mean± mean values between rows with different superscript A,B,C,D,E,.. were significantly different ($p \leq 0.001$)

Graph 1: Effect of storage period and temperature on total plate count of egg content

are critical in mitigating weight loss and preserving the quality of eggs.

Shape index: The effect of storage duration and temperature on egg size indicators is presented in Table 1. No significant differences ($p \geq 0.05$) in size indicators of egg clusters were observed as a result of varying storage duration and temperature. These findings align with the results reported by Song *et al.* (2000), who also noted that egg size indicators remained unaffected by storage duration and temperature. Similar reports stated by Raji *et al.* (2009) that the egg width and length being unaffected by varying storage temperature and period. Collectively, our results reinforce existing knowledge in the field of poultry farming, highlighting the stability of egg size indicators under different storage conditions.

Air cell diameter: The air cell diameter is a reliable indicator of egg freshness, with its size at the broad end of the egg directly influencing its external quality. Table 1 illustrates the impact of both storage duration and temperature on the air sac diameter in eggs. Over the course of storage, a statistically significant ($p \leq 0.001$) expansion in air sac diameter was observed, peaking after 24 days. Initially, on day 0, the eggs across both treatment groups displayed similar air sac diameters, with no meaningful differences. However, eggs stored at room temperature exhibited a significantly larger ($p \leq 0.001$) air sac diameter compared to those kept in refrigerated conditions. These observations align with findings by Akyurek and Okur (2009), who recorded an increase in air cell size of up to 5 mm within seven days, irrespective of storage temperature. Similarly, our results corroborate those of Grashorn *et al.* (2016), who documented a marked air cell expansion exceeding 6 mm after 25 days at 22°C. A key factor in assessing egg freshness is the air cell's size, which enlarges due to the diffusion of gases and water vapor through the eggshell over time. Several elements, including eggshell thickness, pore density, and cuticle integrity, influence this permeability. These structural characteristics are frequently cited as contributing to weight loss and enlarged air cells, particularly as shell thickness diminishes with the hen's age and as egg weight increases.

Egg shell thickness: The results regarding the effect of storage duration and temperature on eggshell thickness are presented in Table 1. Eggshell thickness typically averages around 0.3 mm, exhibiting a remarkable uniformity across the shell. In the current study, we found no significant effects of either temperature or storage duration on eggshell thickness ($P \geq 0.05$). These findings align with previous research conducted by Monira *et al.* (2003) and Jin *et al.* (2011), who also reported no notable impact of storage duration on eggshell weight or thickness, despite some indications of minor reductions

associated with prolonged storage periods. Although extended storage durations can lead to minor decreases in shell weight and thickness, these reductions are attributed to the shrinkage of shell membranes and the cuticle layer rather than temperature or time (Grashorn *et al.*, 2016). Grashorn *et al.* (2016) elaborated that the permeability of the eggshell is influenced by several factors, including shell thickness, the number of pores, and the quality of the cuticle. Notably, eggshell thickness tends to diminish with the advancing age of hens and increasing egg weight, with these factors often cited as contributing to weight loss and the enlargement of the air cell. Furthermore, it has been observed that eggshell thickness significantly decreases as hen age increases. Similarly, storage duration has also been shown to negatively affect eggshell thickness; however, this effect has not been consistently reported in other egg storage studies (Ramos *et al.*, 2010; Maciel *et al.*, 2011).

Internal egg quality

Internal egg quality parameters, such as the Haugh unit, albumen thickness, yolk index, pH levels, and yolk colour are vital indicators of an egg's freshness, nutritional value, and culinary suitability. These factors impact consumer satisfaction, as fresher eggs have a firmer albumen and a rounder yolk, both signs of high quality. Higher Haugh units and balanced pH levels maintain the egg's functional properties, essential for cooking and food processing, such as emulsifying and binding. Additionally, these quality indicators help in grading eggs, determining shelf life, and ensuring eggs meet industry standards for safety, making them indispensable in both retail and food production.

pH of the egg: The pH of the egg is a critical indicator used to assess freshness. Table 2 illustrates the whole pH levels of eggs stored at different temperature over a 24-day period. Both temperature and storage duration significantly ($p \leq 0.05$) affected the pH of the eggs. Initially, the pH values were similar for both treatment groups, averaging around 7. However, as the eggs aged, there was a notable increase in pH, particularly at ambient temperatures, where treatment groups exhibited higher pH values compared to those stored at 4°C. This change can be attributed to various internal phenomena occurring during storage, including evaporation and the diffusion of carbon dioxide from the eggs, which likely shifts the equilibrium of the carbonate-bicarbonate buffer system toward increased CO₂ production (Figueiredo *et al.*, 2013). The most significant pH increase was observed within the first 7 days of storage, followed by a slower rate of increase throughout the remainder of the storage period. These findings align with those reported by Scott and Silversides (2000), as well as Samli *et al.* (2005), who noted that egg aging and temperature contribute to increased pH levels in whole eggs.

pH of egg albumen and yolk: Albumen plays a crucial role in eggs, serving as an antimicrobial and antibacterial agent due to the presence of various proteins. In addition to proteins, the pH and viscosity of albumen are significant factors contributing to its inhibitory activity against microorganisms. The results regarding the pH of albumen and yolk from the present study are presented in Table 2. The findings indicate a significant decline in the pH of albumen and its viscosity ($p \leq 0.05$) over the storage duration. It is evident that both storage time and temperature can influence the pH of egg albumen. Throughout the entire storage period, the pH of albumen was significantly ($p \leq 0.05$) higher at room temperature compared to refrigerated conditions. This difference may be attributed to the increased evaporation occurring in eggs stored at ambient temperatures. Our findings were consistent with reports suggesting that albumen pH shifted to alkalinity quicker at room temperature (9.52) than at refrigeration (8.64) where it remained stable after a certain period (Feddern *et al.*, 2017). Jin *et al.* (2011) reported for albumen pH, there was a significant relationship between temperature and storage period ($p \leq 0.001$), which was consistent with our findings.

Haugh Unit: The results of the Haugh unit (HU) measurements are presented in Table 2. Significant ($p \leq 0.001$) declines in HU were observed due to storage time and temperature. These findings align with those reported by Scott and Silversides (2000), who noted a decrease in HU from 91.4 to 76.3 at 5°C over a 10-day period. The effects of storage time and temperature were further exacerbated, leading to decreases of 53.7 and 40.6 HU at different storage conditions, with room temperature exhibiting a more pronounced decline in Haugh units during the storage period. Adamski *et al.* (2017) stated that only the group of eggs kept at 23°C (72.27 to 32.66 HU) instead of refrigeration (72.27 to 71.6 HU) showed a substantial drop in the value, indicating that a loss in albumen HU was related to air temperature. Sati *et al.* (2020) also suggests a drastic fall in HU for eggs stored at room temperature (91.24 to 60.23) than under refrigeration (96.91 to 86.34). These findings were supported by other authors (Samli *et al.*, 2005 and Jin *et al.*, 2011) which were consistent with our study's results.

Microbial Load/Total Plate Count: It is generally considered that the microbial load of eggs increases with age. To investigate this relationship, we analyzed the total plate count in relation to storage temperature and duration. The results were illustrated in Graph 1. The graph clearly shows that the eggs stored at room temperature experienced a significant increase in bacterial count, starting at 3.64 cfu/ml on day 0 and reaching 6.50 cfu/ml by day 24. In contrast, eggs stored under cold conditions exhibited significantly lower bacterial growth, with the total plate count (TPC) beginning at 3.64 cfu/ml on day 0 and rising only marginally to 4.33 cfu/ml by

day 24. These findings were supported by reports of Saleh *et al.* (2020) who stated low levels of microbial contamination of eggs stored under refrigeration as compared to room temperature. The proteins in egg albumen, such as lysozyme and ovotransferrin, may have antibacterial action against the microbes associated with eggs, and the shell matrix contains proteins with antimicrobial qualities that regulate microbial invasion (Saleh *et al.*, 2020). Together with a low refrigeration temperature, these elements influence the total microbial count, extending the egg's shelf life.

CONCLUSION

The study has established that storing eggs in refrigerators does not negatively impact their quality characteristics. In contrast, exposure to room temperature has been shown to adversely affect several aspects of egg quality. Specifically, room temperature storage leads to increased weight loss, elevated yolk weight and pH levels and greater yolk lipid oxidation. Additionally, it also results in a reduction of both the Haugh unit (HU) and albumen weight over various storage periods. Based on these findings, it is recommended that eggs be stored in refrigeration for more than 28 days but less than 60 days, while they can be safely kept at room temperature for up to 12 days.

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