

ARTICLE

Comparison of Local and Imported Egg Quality and the External Conditions Affecting It from a Microbiological and Chemical Perspective

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ABSTRACT

This research investigated the microbiological and chemical quality of local and imported eggs, the effect of temperature and duration of storage on eggs, and the effect of shell integrity on the quality of eggs. One hundred local and one hundred imported eggs were purchased from five different shops. Eggs were left either at room temperature (25 °C) or at refrigeration temperature (4 °C) for a maximum of 35 days. Intact eggs were compared to cracked eggs. For the microbiological analysis, total plate count and identification of *Salmonella*, *Escherichia coli*, and *Staphylococcus aureus* were done. For the chemical analysis, albumin and yolk pH, malondialdehyde (MDA) content, and protein were determined. Compared to local eggs, imported eggs also had higher albumin and yolk pH and malondialdehyde (MDA) content. Eggs stored at room temperature in the presence of shell integrity showed significant deterioration of quality after 14 days. Eggs refrigerated in the presence of shell integrity were of acceptable quality for 28 days for local eggs and 21 days for imported eggs. Quality of local eggs is better compared to imported eggs. Shell integrity and refrigeration are critical for quality and safety of eggs.

Keywords: Egg Quality; Local Eggs; Imported Eggs; Microbiological Contamination; Chemical Quality; Storage Temperature

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INTRODUCTION

Eggs are a fantastic source of nutrients including complete proteins, vitamins, minerals, and lipid components (Vlaicu *et al.*, 2021; Madkour *et al.*, 2025). However, like all animal products, they are highly perishable and subject to deterioration. There are both microbiological and chemical pathways that result in the degradation of egg quality. One of the most significant of these pathways is oxidative stress, particularly in relation to the commercial stressors of poultry production, and it has a severe impact on egg quality during storage (Surai *et al.*, 2019; Oke *et al.*, 2024). The quality of the eggs the consumer gets is impacted by constrained production and processing practices, as well as storage, transport, and retail practices (Abo Ghanima *et al.*, 2020a; Abo Ghanima *et al.*, 2020b). In many instances, imported eggs have longer transport times, undergo variable temperature transport, and have longer storage times. It has been shown that the addition of antioxidants to the diets of laying hens improves egg quality and oxidative stability (Darmawan *et al.*, 2022; Al-Rasheed *et al.*, 2026; Zhao *et al.*, 2021). It is reasonable that along with other factors, the differing diets of hens could explain quality changes.

Microbial contamination may arise from trans-shell penetration or transovarian transmission. Transovarian transmission may be more prevalent in eggs contaminated with *Salmonella enteritidis*, *Escherichia coli*, and

Staphylococcus aureus (Liu *et al.*, 2019; Abbas *et al.*, 2022). Dietary layering of probiotics and antioxidants has been shown to greatly enhance the immune system and decrease the absorption of pathogens (Xu *et al.*, 2023; Obianwuna *et al.*, 2022). Chemical deterioration of eggs tends to affect lipid peroxidation of the yolk, denaturation of proteins, and loss of egg pH. Malondialdehyde is a proven and reliable indicator of oxidative lipid damage (Nawab *et al.*, 2019; Zhao *et al.*, 2021). Eventually, eggs will lose carbonate, and the albumen pH will increase from approximately 7.6 to 9.2.

Physical deterioration is worsened by changing external conditions, particularly high ambient temperature (Al-Otaibi *et al.*, 2022). Higher temperatures and long-term storage cause cumulative damage to eggs (El-Ratel *et al.*, 2024). Cracked eggs will show increased deterioration due to damage allowing microbial entry (Cheng *et al.*, 2021). There is not much research on quality differences between local and imported eggs. Hence, this study compared the local and imported eggs' microbiological and chemical quality, and assessed the effect of external conditions on the quality parameters of eggs.

MATERIALS AND METHODS

Sample Collection

100 local eggs and one hundred imported eggs were obtained from retail outlets. Local eggs were gathered from within 50 km of the sampling site within 3–5 days of oviposition, whereas imported eggs required an estimated 14–21 days for transit. All eggs were collected in insulated containers and transported to the laboratory within 2 hours of being sampled.

Experimental Design

There were three experiments designed for this study. The first experiment was the evaluation of baseline quality parameters (Day 0) for 20 local and 20 imported eggs. In the second experiment, the effects of storage duration and temperature were evaluated. Local and imported eggs ($n = 80$ per group) were stored at room temperature ($25 \pm 2^\circ\text{C}$) and in a refrigerator ($4 \pm 1^\circ\text{C}$). Samples were removed for analysis on days 1, 7, 14, 21, 28, and 35. In the last experiment, the effects of shell integrity were assessed on 40 other eggs. Hairline cracks were artificially induced in the eggs and the eggs were compared to intact eggs after 7 days of room temperature storage.

Microbiological Analysis

The pooled homogenate of eggs were homogenized and then plated following a serial dilution. A total plate count was made after incubation at 37°C for 48 hours. Detection of *Salmonella* was made after a 24 hour enrichment in buffered peptone water and then selective enrichment in Rappaport-Vassiliadis broth and plating on (Xylose Lysine Deoxycholate). MacConkey and EMB agar were used for *Escherichia coli*, while Baird-Parker agar was used for *Staphylococcus aureus*.

Chemical Analysis

A digital pH meter was used to measure the pH of albumin and yolk. The determination of malondialdehyde content was carried out using the thiobarbituric acid reactive substances test. One gram of yolk was mixed with trichloroacetic acid and thiobarbituric acid, heated, centrifuged, and the absorbance was measured at a wavelength of 532 nm. Protein content was determined using the Kjeldahl method. The determination of protein concentration was done using the Kjeldahl method.

Statistical Analysis

The data were analyzed using SPSS version 26.0. The comparison of local and imported eggs was done using

independent t-tests. The analysis of the effects of temperature and duration was done using two-way ANOVA with Tukey's post-hoc test. The comparison of the prevalence of pathogen was done using Chi-square tests. The level of significance was $P < 0.05$.

RESULTS

Baseline Quality Comparison

In the Table (1) Upon arrival on day zero, we found many striking differences when comparing local and imported eggs. Local eggs had lower bacterial contamination and had total plate counts of 3.2 log CFU/g. The imported eggs drew a greater concern with total plate counts of 4.8 log CFU/g ($P < 0.01$). Salmonella was in 8% of the imported eggs and in 2% of local eggs. E. coli was found in 5% of the imported eggs but was found in 0% of the local eggs. Also, *S. aureus* was found in 0% of the local eggs and in 3% of the imported eggs. Additionally, chemical quality parameters were evaluated. Imported eggs showed deterioration. The albumin in the imported eggs had a pH of 8.42 and local eggs had a pH of 7.85 ($P < 0.01$). Yolk pH was also higher in in the imported eggs at 6.45 compared with local eggs at 6.28 ($P < 0.05$). Malondialdehyde content was also higher in imported eggs at 0.87 nmol/g compared with 0.48 nmol/g in local eggs ($P < 0.001$) and albumin protein was also lower in imported eggs at 9.8% compared with 10.6% in local eggs ($P < 0.01$). There was also no significant difference in the yolk protein. There were a significant number of baseline differences and thus imported eggs were in a worse quality state when compared with local eggs in the Figure (1)

Table (1) Baseline quality parameters of local and imported eggs upon arrival

Parameter	Local Eggs (n=20)	Imported Eggs (n=20)	P-value
Total Plate Count (log CFU/g)	3.2 ± 0.4	4.8 ± 0.6	<0.01
Salmonella positive (%)	5% (1/20)	8% (4/20)	<0.05
E. coli positive (%)	0% (0/20)	5% (1/20)	N.S
S. aureus positive (%)	0% (0/20)	5% (1/20)	NS
Albumin pH	7.85 ± 0.12	8.42 ± 0.18	<0.01
Yolk pH	6.28 ± 0.09	6.45 ± 0.11	<0.05
MDA (nmol/g yolk)	0.48 ± 0.06	0.87 ± 0.10	<0.001
Albumin protein (%)	10.6 ± 0.4	9.8 ± 0.5	<0.01
Yolk protein (%)	15.8 ± 0.5	15.2 ± 0.6	NS

NS: Not significant ($P < 0.05$); CFU: Colony forming units; MDA: Malondialdehyde

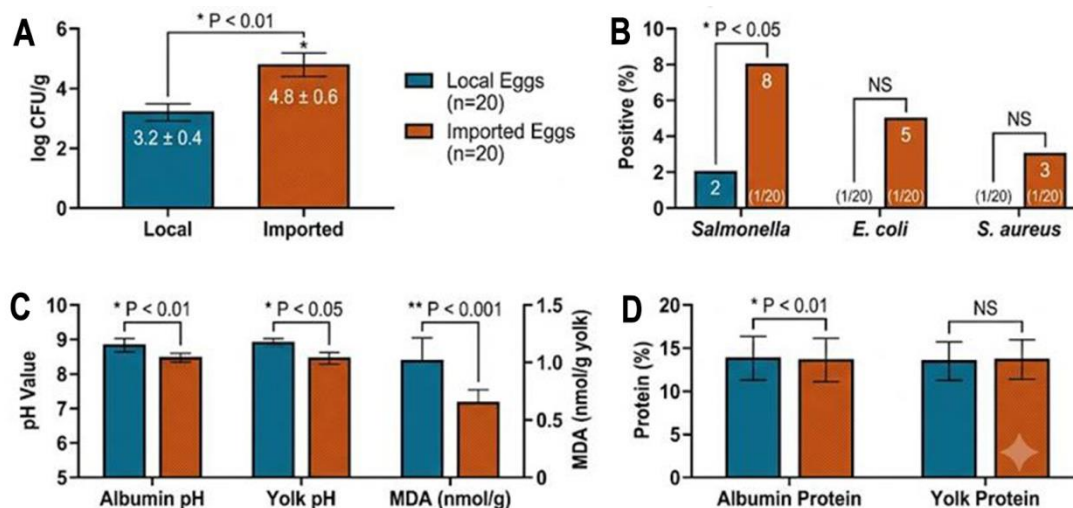


Figure (1) Baseline quality parameters of local and imported eggs upon arrival. (A) Microbial Load (Total Plate Count). (B) Pathogen Prevalence (%). (C) Physicochemical and Lipid Oxidation Parameters. (D) Pathogen Prevalence (%).

Effects of Storage Temperature and Duration

Table (2) Storage temperature was a critical factor in quality deterioration. Storage of local eggs in ambient temperature resulted in increases of total plate counts from 3.2 log CFU/g at day 1 to 5.2 log CFU/g at day 14, to 7.4 log CFU/g at day 21, and to 9.3 log CFU/g at day 35. For imported eggs stored at ambient temperature, total plate counts rose from 4.8 log CFU/g at day 1 to 7.2 log CFU/g at day 14, to 8.5 log CFU/g at day 21, and to 9.8 log CFU/g at day 35. Local eggs exceeded the 6 log CFU/g acceptability limit between days 14 and 21, while the limit was exceeded by imported eggs between days 7 and 14.

For eggs stored at the refrigeration temperature, the growth of microorganisms was dramatically slowed. For local eggs stored at refrigeration temperature, increases in total plate counts were 3.2 at day 1 to 3.5 at day 14, to 3.8 at day 21, and to 4.8 at day 35. For imported eggs, total plate counts increased from 4.7 at day 1 to 5.3 at day 14, to 5.8 at day 21, and to 7.2 at day 35. Storage of local eggs at refrigeration temperature maintained counts below 6 log CFU/g for 28 days, while for imported eggs, the limit was maintained for 21 days.

Albumin pH similarly exhibited temperature-dependent changes. Local eggs, initially at room temperature with pH at 7.85 on day 1, rose to 8.92 on day 14 and to 9.45 on day 35, surpassing the pH threshold of 9.0 between days 7 and 14. In contrast, imported eggs, also at room temperature, went from 8.42 on day 1 to 9.15 on day 14 and to 9.58 on day 35, already showing unacceptable quality when first assessed. Under refrigeration, local eggs remained below pH 9.0 for the 35-day period, with an average of 8.42 on day 35. Imported eggs, also under refrigeration, remained below pH 9.0 for 28 days, reaching 8.92 on day 35.

Malondialdehyde accumulation at room temperature also showed an increase. Local eggs, at room temperature, showed an increase from the 0.48 nmol/g to 1.18 on day 14, to 1.62 on day 21, and to 2.18 on day 35, representing a 354% increase. Imported eggs, at room temperature, showed an increase from 0.87 on day 1 to 1.86 at day 14, to 2.34 on day 21, and to 2.92 on day 35. Under refrigeration, local eggs showed an increase to 0.82 nmol/g by day 35 (71% increase), while imported eggs showed a 72% increase, reaching 1.48 nmol/g.

Table (2) Microbiological and chemical quality over storage duration at different temperatures

Parameter	Storage	Day 1	Day 7	Day 14	Day 21	Day 28	Day 35
Local TPC (log CFU/g)	RT	3.2	3.8	5.2	7.4	8.6	9.3
	RF	3.2	3.3	3.5	3.8	4.2	4.8
Imported TPC (log CFU/g)	RT	4.8	5.6	7.2	8.5	9.2	9.8
	RF	4.7	4.9	5.3	5.8	6.5	7.2
Local Albumin pH	RT	7.85	8.34	8.92	9.24	9.38	9.45
	RF	7.85	8.02	8.15	8.28	8.35	8.42
Imported Albumin pH	RT	8.42	8.78	9.15	9.41	9.52	9.58
	RF	8.41	8.55	8.68	8.79	8.85	8.92
Local MDA (nmol/g)	RT	0.48	0.72	1.18	1.62	1.94	2.18
	RF	0.48	0.52	0.61	0.68	0.75	0.82
Imported MDA (nmol/g)	RT	0.87	1.24	1.86	2.34	2.68	2.92
	RF	0.86	0.94	1.08	1.22	1.35	1.48

RT: 25°C Room temperature; RF: 4°C Refrigerated; TPC: Total plate count; MDA: Malondialdehyde.

Effect of Shell Integrity

After 7 days at room temperature, the findings showed marked deterioration of local and imported eggs, in both of microbiological and chemical parameters (Figure 2). Cracked local eggs had a total plate count of 5.4 log CFU/g, a ten-fold increase compared to the 3.8 log CFU/g of intact eggs. Salmonella was present in 15% of the cracked local eggs, compared to 5% of the intact local eggs. For imported eggs, total plate count of intact imported eggs was 5.6 log CFU/g, and in the

cracked imported eggs it was 7.2. Intact imported eggs had 10% *Salmonella*, which increased to 25% in the cracked imported eggs. With respect to chemical integrity, local eggs had albumin pH of 8.92 compared to intact eggs whose albumin pH was 8.34, a difference of 0.58. Imported eggs, whose intact albumin was at 8.78, had cracked imported eggs with albumin pH at 9.24, also over the allowable limit. Local cracked eggs had an increase of 86% Malondialdehyde over intact eggs, and 68% in imported cracked eggs. Results indicate that minor cracks in the egg shell compromised the overall integrity of the egg in a short time.

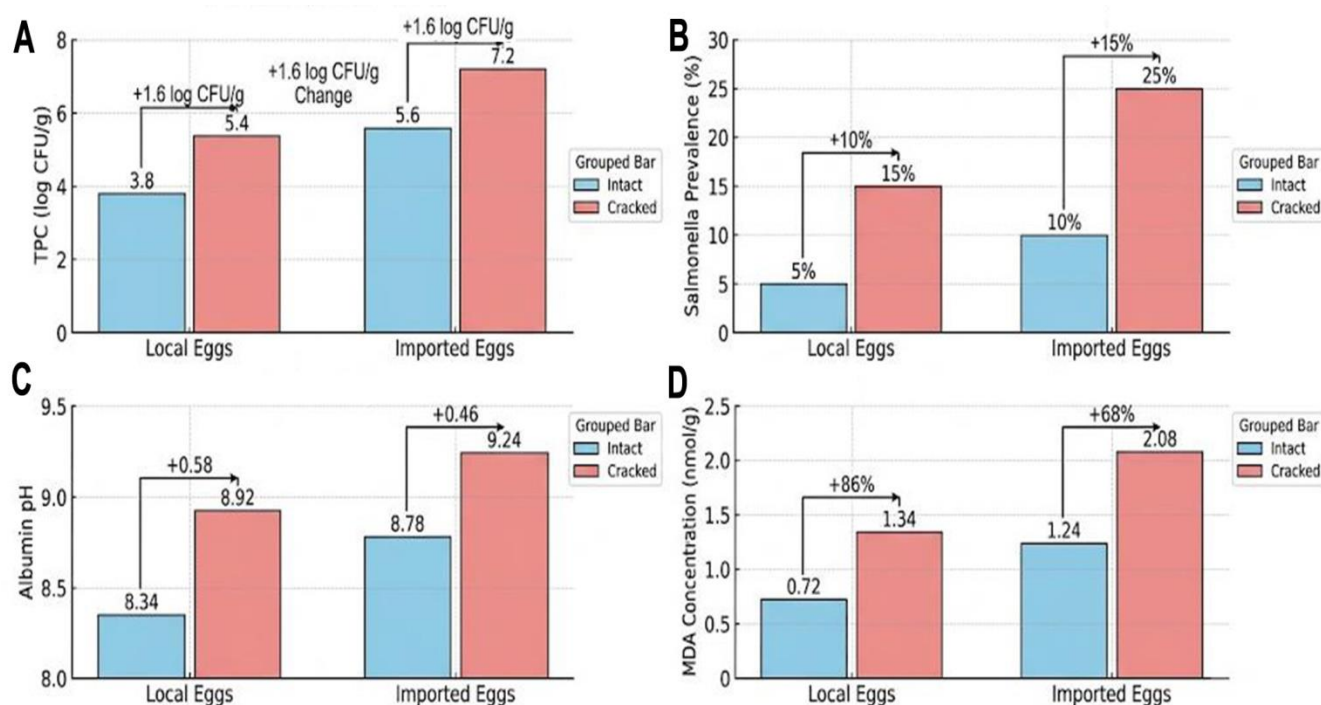


Figure (2) Visualizing Egg Quality Degradation: Intact vs. Hairline Cracked Eggs after 7 days at Room Temperature. (A) TPC (log CFU/g), (B) *Salmonella* prevalence (%), (C) Albumin pH, (D) MDA concentration (nmol/g).

Summary of Acceptable Storage Durations

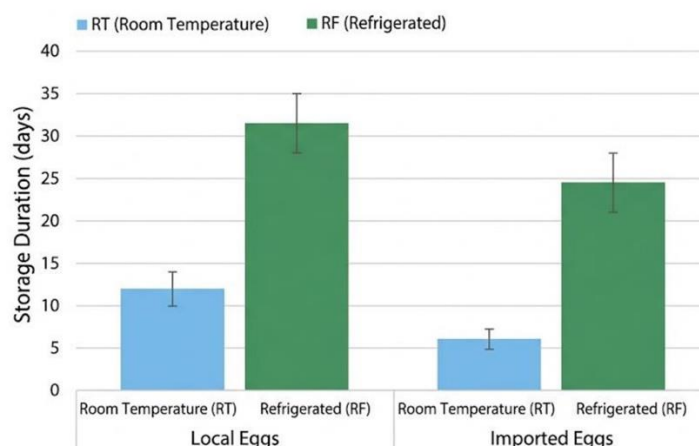
The maximum recommended storage durations for maintaining egg quality are presented in Table 4. Local eggs, kept at room temperature, are still considered good for 10 to 14 days. If kept refrigerated, it is 28 to 35 days. Local eggs, on the other hand, are good for 5 to 7 days at room temperature and 21 to 28 days, if kept refrigerated. Local vs. Imported eggs results have implications for both retailers and consumers.

Figure (3) illustrates the recommended maximum storage duration (in days) for both local and imported eggs under room temperature (RT) and refrigeration (RF) conditions. Under room temperature conditions (represented by the blue bars), locally produced eggs maintained an acceptable shelf life averaging approximately 12 days (with a recommended range of 10 to 14 days), whereas imported eggs exhibited a significantly shorter duration, averaging around 6 days (with a recommended range of 5 to 7 days).

Conversely, refrigerated storage (represented by the green bars) substantially prolonged the storage capacity of both categories; local eggs demonstrated the highest stability with an average duration of 32 days (range of 28 to 35 days), while imported eggs reached an average of 25 days (range of 21 to 28 days). The error bars at the top of each column denote the standard deviation (or standard error) of the storage period measurements.

Table (4) Recommended storage duration for acceptable quality of eggs

Quality Criterion	Local - RT	Local - RF	Imported - RT	Imported - RF
TPC < 6 log CFU/g	14 days	>35 days	7 days	28 days
Albumin pH < 9.0	14 days	>35 days	7 days	28 days
MDA increase < 100%	14 days	>35 days	7 days	21 days
No Salmonella detected	14 days	>35 days	7 days	21 days
Recommended maximum	10-14 days	28-35 days	5-7 days	21-28 days

**Figure (3)** Comparison of recommended maximum egg storage duration (days) under RT and RF conditions

DISCUSSION

Evidence suggests that, when compared to imported eggs, locally produced eggs are found to be better in terms of microbiological and chemical quality when they reach the retail market. This evidence is consistent with previous studies showing that as the number of links in the supply chain decreases, and as the time between the supply and sale of eggs to consumers decreases, the quality of the eggs is better (Darmawan *et al.*, 2022; Al-Rasheed *et al.*, 2026). The higher total plate counts and pathogens in imported eggs are the result of microbial proliferation during transport, which is worsened by a lack of adequate storage temperature (Liu *et al.*, 2019).

This implies that there is deterioration in the chemical quality of imported eggs, which occurs even prior to the eggs being sold to consumers. This is evidenced by the increased albumin pH and malondialdehyde of the imported eggs. It has been shown, by Zhao *et al.* (2021) and Heng *et al.* (2021) that the dissipation of CO₂ and lipid peroxidation occur and progress with the poor storage of eggs. The nearly doubled malondialdehyde in imported eggs is a concern from a nutritional stand point, as lipid peroxidation leads to loss of lipid integrity and essential fatty acids and results in the formation of toxic by-products (Surai *et al.*, 2019; Oke *et al.*, 2024).

This study agrees with past studies, which showed that refrigeration has a major protective effect. Storage of eggs in refrigerated conditions was found to slow down the deterioration of eggs, both physically and microbiologically, in the studies conducted by Gu *et al.* (2022) and Wang *et al.* (2022). The results in this study show that eggs which are imported, even when stored in the best conditions, have a shorter shelf life because of their baseline quality.

Egg quality and preservation are affected by shell integrity. Cheng *et al.* (2021) and Wang *et al.* (2024a) similarly found that cracked egg shells allow bacteria entry and facilitate the exchange of gases and the loss of moisture. The supply chain handling of eggs is very important as microbial counts in the shells of eggs that have been cracked is significantly higher as

are deterioration rates.

Local eggs that are stored in the refrigerator are better for quality. Because of the deterioration of imported eggs, they should be eaten faster than local eggs. Eggs that are cracked should be removed from sale and imported eggs should be kept in the refrigerator. In order to improve the quality of eggs, control of the temperature during transportation is required.

CONCLUSIONS

This study demonstrates that locally produced eggs exhibit superior quality compared to imported eggs across all evaluated microbiological and chemical parameters. Commercially available imported eggs showed higher total bacterial counts, an increased prevalence of *Salmonella*, elevated albumen pH, and higher malondialdehyde (MDA) levels—indicating greater lipid peroxidation and overall structural and microbial deterioration. Refrigeration at 4 °C inhibits chemical and microbiological quality deterioration for up to 28-35 days for local eggs and 21-28 days for imported eggs. When stored at room temperature, locally sourced and imported eggs had an acceptable quality for only 10-14 days and 5-7 days, respectively. Regardless of source, eggs with cracked shells had a ten-fold increase in total plate counts and a greater degree of quality deterioration. Shorter supply chains and the integrity of the shell contributed to superior local eggs. To protect safety and quality, refrigeration and shell integrity must be maintained. For imported eggs, consumers should buy local, refrigerate, and eat sooner.

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