JAPSI (Journal of Agriprecision and Social Impact)
Volume 1 Issue 3 November 2024
e-ISSN: 3032-7849; p-ISSN: 3046-5397, Page 309-322
DOI: 10.62793/japsi.v1i3.32
Available online at: https://journal.kdp.co.id/index.php/japsi

The Quality of Quail Eggs Sold in Various Traditional Markets in Kediri City, East Java, Indonesia

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Abstract*. This study aims to evaluate the quality of quail eggs sold in various traditional markets in Kediri City, East Java, Indonesia. The research was conducted from July to September 2024 at several traditional market locations, namely Mrican Market, Campurejo Market, Semen Market, Bandar Market, and Pahing Market. The quality parameters tested include the presence of Salmonella, Total Plate Count (TPC), pH, air cell depth, and shell thickness. The quality testing of quail eggs was carried out at PSDKU UB Kediri. The results of the study show that the quail eggs sold in these markets are safe for consumption, with no Salmonella contamination (0 cfu/ml) and TPC values within safe limits (2.1 x 10³ to 4.4 x 10³ cfu/ml). The pH values of the eggs range from 6.3 to 6.9, indicating good freshness. The air cell depth ranges from 1.54 mm to 2.36 mm, and the shell thickness ranges from 0.19 mm to 0.20 mm, indicating good and consistent physical quality of the eggs. Overall, the quality of quail eggs in the traditional markets of Kediri City can be categorized as good based on the parameters tested.*

Keywords: *Kediri city, Traditional markets, Quail egg quality*

Received: September 16, 2024; Accepted: October 23, 2024; Published: November 9, 2024
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INTRODUCTION

Quail eggs are one of the leading food products that are quite popular among the Indonesian community, including in the East Java region. Among other animal-based food products, quail eggs have high nutritional content, such as protein, healthy fats, vitamins, and minerals (Ekpo et al. 2022). These eggs are widely sold in traditional markets, which serve as one of the main distribution centers for local food products. However, there are concerns regarding the quality of quail eggs sold in traditional markets, particularly in relation to freshness and microbiological safety (Moreira, Zotarelli, and Lima 2023) .

Traditional markets are known for handling and storage practices that are often less than optimal. The absence of adequate refrigeration facilities and insufficient sanitation oversight can accelerate the decline in egg quality (Škrbić et al. 2021). One of the common problems with egg products, including quail eggs, is the risk of bacterial contamination, such as *Salmonella* (Al-Ruaby and Issa 2023). This bacterium can cause serious health problems if contaminated eggs are consumed without proper handling (Thaha et al. 2024). Additionally, there is a potential decline in freshness, which can be observed through changes in pH values, enlargement of the air depth, and thinning of the eggshell (Kim 2022).

The physical quality of quail eggs sold in traditional markets is often unknown to consumers. However, quality parameters such as shell thickness and air depth depth can provide an early indication of the age and freshness of the eggs (Lew et al. 2019). Therefore, the main issue at hand is how to determine and ensure that the quail eggs sold in traditional markets remain safe for consumption and meet acceptable standards of safety and nutrition (Ahmed 2022).

Although many studies have been conducted on the quality of poultry eggs, such as chicken eggs, quail eggs have not received sufficient attention in terms of quality evaluation, particularly in traditional markets (Fera et al. 2023). Research on quail egg quality generally focuses more on the nutritional aspects, without giving enough attention to microbiological and physical factors that are crucial for consumer safety. Some studies may have analyzed the nutritional and microbial content on a small scale, but comprehensive studies involving several quality parameters, such as *Salmonella*, TPC, pH, air depth depth, and shell thickness, are still rarely found.

Furthermore, much of the research conducted on poultry eggs generally involves distribution in supermarkets or modern markets that already implement better storage standards, such as the use of refrigeration units. Research evaluating the quality of eggs in traditional markets, which often face challenges in terms of sanitation and product handling, is still very limited (Al-Asmar and Sabbah 2023). The absence of in-depth studies on the quality of quail eggs in traditional markets creates a knowledge gap, where information about the safety and quality of quail eggs sold in these markets is crucial to be known.

Another gap that needs attention is the limited use of testing technology in traditional markets. The process of testing egg quality using advanced methods such as *Salmonella* detection and TPC analysis is not easily accessible to traders and consumers in traditional markets. Therefore, this study aims to bridge this gap by providing a comprehensive evaluation of the quality of quail eggs sold in traditional markets using various relevant parameters.

The increasing consumption of quail eggs, whether as a daily side dish or as part of local culinary snacks, requires special attention regarding their quality and safety. Quail eggs have become a popular food alternative among various groups due to their small size, affordability, and high nutritional content (Czerwonka et al. 2024). However, if the quality of the eggs sold is not properly maintained, these products have the potential to become a source of illness for consumers.

The urgency of this research lies not only in the health aspect but also in the economic aspect. Traditional markets remain the main place for the community to purchase quail eggs, especially in urban and rural areas far from access to modern supermarkets. Therefore, ensuring that quail eggs sold in traditional markets meet good quality standards is essential for protecting public health and supporting the sustainability of quail egg farmers and traders.

Additionally, the risk of microbiological contamination, such as S*almonella*, has a significant impact on public health. Food poisoning cases caused by this bacterium can have serious health consequences, especially for vulnerable groups such as children, the elderly, and individuals with weakened immune systems (Kumar et al. 2014). Therefore, this research is necessary to provide a better understanding of the level of microbiological

contamination in quail eggs in traditional markets, as well as the steps that need to be taken to prevent it.

Furthermore, this study will also provide input for traders and traditional market managers on the importance of maintaining cleanliness and adhering to food handling standards. The results of this research can be used as guidelines to raise awareness of the importance of maintaining the quality of quail eggs through better storage practices and sanitation monitoring.

This research aims to evaluate the quality of quail eggs sold in traditional markets in Kediri City, East Java, based on several key parameters, including the presence of *Salmonella*, Total Plate Count (TPC), pH value, air depth depth, and shell thickness. This study also aims to provide a clear overview of the quality of quail eggs sold in traditional markets in Kediri City, as well as provide recommendations for traders and consumers about the importance of maintaining egg quality through proper storage and handling practices. Thus, the results of this research are expected to contribute to improving the safety and quality of quail eggs available to the public.

LITERATURE REVIEW

Quail eggs have high nutritional content, such as protein and healthy fats, making them popular among Indonesians, especially in East Java (Ekpo et al. 2022). However, the sale of quail eggs in traditional markets faces challenges in terms of quality, such as a decline in freshness and potential microbiological contamination (Moreira et al. 2023; Rusch et al. 2023). Traditional markets often lack adequate storage facilities and optimal sanitation oversight, which can accelerate the decline in egg quality (Škrbić et al. 2021). Therefore, this study aims to measure the quality of quail eggs in several traditional markets in Kediri using microbiological and physical parameters to ensure consumer safety.

Microbiological parameters, such as the presence of Salmonella and Total Plate Count (TPC), provide important insights into the quality and safety of quail eggs being sold. This study found that quail eggs in Kediri markets were free from Salmonella contamination and had TPC values within safe limits, between 2.1 x 10^3 and 4.4 x 10^3 cfu/ml (Sa'adah, Dwiyanti, and Lutpiatina 2024). Additionally, the physical quality of quail eggs, including pH, air cell depth, and shell thickness, are essential indicators for

assessing the freshness and durability of eggs during storage (Lew et al. 2019; Salah Eldein et al., 2024)

Storage conditions play an important role in maintaining the quality stability of quail eggs. In traditional markets, environmental factors such as temperature and storage cleanliness impact egg quality parameters, including pH and air cell depth, which indicate egg freshness (Zhang et al. 2023). Although this study's findings show good egg quality, continuous monitoring and education for traders are necessary to maintain this quality over the long term. Overall, this study emphasizes the importance of good storage practices and routine quality monitoring to support food safety in traditional markets (Dudusola 2009).

RESEARCH METHODS

This study was conducted at several different locations, including: Market 1: Mrican Market, Market 2: Campurejo Market, Market 3: Semen Market, Market 4: Bandar Market, and Market 5: Pahing Market. The quail egg quality testing was carried out at PSDKU UB Kediri. This research took place from July to September 2024. Several equipment and materials used to measure the research variables are:

1. Egg pH Measurement: A pH meter was used to measure the acidity or alkalinity (pH) of the egg whites and yolks. The materials used were quail eggs and standard buffer solutions (pH 4 and pH 7 for calibrating the pH meter). The testing procedure involved mixing the egg whites or yolks, placing them in a measuring container, and dipping the pH meter electrode into the sample. The pH measurement result is directly displayed on the device screen.
2. Microbiological Testing (*Salmonella* and TPC counts in cfu/ml): Equipment used includes an incubator, autoclave, laminar airflow cabinet, micropipette, and test tubes. The materials used for measuring *Salmonella* were SS agar, while for TPC, Plate Count Agar (PCA) was used.
3. Air Cell Depth Measurement:A candling device (egg candler) and calipers were used. Eggs were candled using the device to observe the position and size of the air cell within the egg. After the air cell was visible, a measuring tool such as a ruler or caliper was used to measure the depth of the air cell from the wider end

of the egg. Measurements were taken by estimating the distance between the eggshell and the inner membrane forming the air cell.

4. Shell Thickness Measurement: A micrometer screw gauge or calipers was used. Procedure: After the egg was cracked, the eggshell was cleaned and dried, then measured using the micrometer screw gauge or calipers. Measurements were taken at several different points on the shell to obtain an average shell thickness.

RESULTS AND DISCUSSION

Table 1. Quality of quail eggs sold in traditional markets in Kediri city

No	Salmonella (cfu/ml)	TPC (cfu/ml)	pH	Air Cell Depth (mm)	Shell Thickness (mm)
Market 1	0	$2.3x10^3±0,12x10^3$	6.5±0.06	2.14±0,08	0.20±0.006
Market 2	0	$4.4x10^3±0,08\ x10^3$	6.9±0.34	2.36±0,00	0.19±0.004
Market 3	0	$2.1x10^3±0,03\ x10^3$	6.3±0.26	1.54±0,06	0.19±0.003
Market 4	0	$2.3x10^3±0,02\ x10^3$	6.4±0.16	1.56±0,01	0.20±0.006
Market 5	0	$4.2x10^3±0,43\ x10^3$	6.7±0.14	2.22±0,02	0.19±0.002

Explanation:
- The data represents the results of three replicates ± standard deviation.
- The values shown are not significantly different

The Effect of Sales in Various Traditional Markets on *Salmonella*

In a study on the quality of quail eggs sold in various traditional markets in Kediri City, East Java, Indonesia, one of the measured parameters was the presence of Salmonella bacteria (cfu/ml) as an indicator of microbiological safety. Based on the results shown in Table 1, it was found that the *Salmonella* count in all quail egg samples tested was 0 cfu/ml, indicating that no *Salmonella* was detected in these samples. This result suggests that the quail eggs sold in traditional markets in Kediri City are microbiologically safe for consumption in terms of *Salmonella* contamination. The absence of Salmonella in the samples indicates that, in this case, the egg handling and storage practices applied by the traders were adequate to prevent contamination by this pathogenic bacteria (Sa'adah, Dwiyanti, and Lutpiatina 2024).

Salmonella is a pathogenic bacterium that can cause serious foodborne infections in humans, especially through the consumption of contaminated animal products such as eggs (Pouillot et al. 2020). The absence of *Salmonella* in the quail eggs tested indicates that these eggs were likely produced under hygienic conditions and sold and stored with adequate sanitation standards (Yousefi Amin et al. 2024).

However, despite the test results showing 0 cfu/ml, it is important to note that this only reflects the conditions at the time of sampling. Factors such as sanitation, storage, and environmental conditions in the market can change over time, and therefore, continuous monitoring and education for traders are essential to maintain good hygiene standards. Additionally, proper handling of the eggs, such as storing them at the correct temperature and avoiding cross-contamination, is important for ensuring long-term microbiological safety (Reski et al. 2024).

From a statistical standpoint, these results also show no significant differences between the samples, as all yielded similar results (0 cfu/ml). This reinforces the conclusion that the quail eggs sold in Kediri City's traditional markets were safe from Salmonella contamination at the time of sampling. This study highlights the importance of routine monitoring of animal products sold in traditional markets to ensure consumer safety and reduce the risk of foodborne disease outbreaks.

The Effect of Sales in Various Traditional Markets on Total Plate Count

The Total Plate Count (TPC) of quail eggs sold in various traditional markets in Kediri City reflects the total number of microorganisms present on the quail eggs. TPC serves as a key indicator for assessing the microbiological quality of the eggs, which directly impacts their safety and freshness. Based on the test results shown in the table, the TPC values of the quail egg samples range from 2.1×10^3 cfu/ml to 4.4×10^3 cfu/ml. These results indicate that all quail egg samples have a relatively low microbial count and remain within safe limits for consumption. Statistically, the test results show no significant differences between the quail egg samples in terms of TPC levels. This suggests that the handling and storage practices for eggs in various traditional markets in Kediri City are generally consistent, and environmental conditions do not cause significant variation in microbiological contamination levels.

The low and statistically insignificant TPC values across all samples indicate that the quail eggs sold in traditional markets in Kediri City were in good microbiological condition at the time of sampling. A low TPC typically reflects that the eggs were produced, handled, and stored under hygienic conditions, reducing the risk of bacterial contamination (Hubbard et al. 2023).

However, it is important to note that TPC does not specifically measure the presence of pathogenic microorganisms but rather indicates the total number of microbes.

Therefore, while the low TPC results suggest a low microbial load, further testing for pathogens such as Salmonella is necessary to ensure complete safety.

Overall, this study shows that the quality of quail eggs sold in traditional markets in Kediri City is generally good based on TPC parameters. The absence of significant differences between samples also suggests that storage and handling conditions in these markets are relatively uniform and adequate to maintain egg quality. Nevertheless, to ensure ongoing product quality and safety, regular monitoring of sanitation and handling practices is necessary, along with educating traders to maintain good hygiene practices (Saadat, Siddique, and Hashim 2024).

The Effect of Sales in Various Traditional Markets on pH

In a study evaluating the quality of quail eggs sold in various traditional markets in Kediri City, East Java, one of the analyzed parameters was the pH value. pH is an important indicator for assessing egg freshness, as the pH of eggs increases over time due to the evaporation of carbon dioxide through the pores of the eggshell (Salah Eldein, Abdel-Azeem, and El-Gamal 2024). The pH values shown in Table 1 for quail eggs range from 6.3 to 6.9.

The pH value of fresh quail eggs typically ranges between 6 and 7. The increase in pH of egg whites occurs due to the loss of carbon dioxide from the egg during storage, making the egg whites more alkaline. However, in this study, all egg samples showed pH values within the fresh range, indicating that the quail eggs sold in traditional markets in Kediri City still maintain good freshness.

The lack of significant differences in pH values between samples suggests that the storage and handling conditions for quail eggs in traditional markets are relatively consistent. This could indicate that the eggs are well stored, with no significant environmental changes affecting the pH value.

However, although the pH values are within the normal range and show no significant variation, it is important to remember that pH is just one of several indicators of egg freshness. Other factors, such as the presence of microorganisms and the physical quality of the eggs (such as shell thickness and air cell size), should also be considered to provide a more comprehensive assessment of quality.

Fresh eggs generally have a pH close to neutral (around pH 7.0) or slightly acidic. Over time, the pH of egg whites tends to increase to around 9.0 due to the loss of carbon

dioxide through the pores of the shell, so lower pH values (around 7.0 or slightly below) usually indicate that the eggs are still fresh.

For fresh quail eggs, pH values ranging from 6.3 to 6.9 are still considered normal, but other parameters such as smell, color, and texture should also be considered to ensure overall quality. If this pH measurement is considered alongside Total Plate Count (TPC) and microorganisms, pH values in this range generally indicate that the eggs have not undergone significant deterioration due to microbial activity. However, a slightly higher pH (such as 6.9) could be a sign that storage has been ongoing for some time. Further analysis referring to standard guidelines from relevant agencies (such as BPOM or SNI) could provide a more accurate assessment.

Overall, this study shows that the quail eggs sold in traditional markets in Kediri City have good and consistent pH values, indicating that the eggs are still fresh and suitable for consumption. To maintain this quality, it is important for traders to continue optimal storage practices, such as maintaining appropriate temperature and cleanliness in storage areas.

The Effect of Sales in Various Traditional Markets on Air Cell Depth

In this study, one of the parameters analyzed to assess the quality of quail eggs sold in various traditional markets in Kediri City, East Java, was the air cell depth. Air cell depth is an important indicator for determining egg freshness. The smaller the air cell, the fresher the egg, as eggs stored for longer periods will experience water evaporation through the pores of the eggshell, causing the air cell to enlarge. Based on the test results, the air cell depth of the quail egg samples ranged from 1.54 mm to 2.36 mm. ANOVA testing showed that the differences in air cell depth between samples were not statistically significant. This indicates that the variation in air cell depth across the samples is not large enough to be considered significantly different.

The relatively small air cell depth in quail eggs indicates that the eggs are still fresh (Zhang et al. 2023). The air cell depths found in this study are within the common range for fresh quail eggs, where the air cell in fresh eggs typically does not exceed 3 mm. The lack of significant differences between samples suggests that the storage and handling conditions of eggs in various traditional markets in Kediri City are generally uniform. This could be attributed to relatively good storage practices, preventing excessive water evaporation from the eggs, which typically causes the air cell to enlarge.

However, although the air cell depth results indicate that the quail eggs sold in traditional markets are still fresh, this is only one indicator of the overall quality of the eggs. Other parameters, such as pH, the presence of microorganisms, and shell thickness, also need to be considered to provide a complete picture of the egg quality. Overall, the results of this study indicate that the quality of quail eggs sold in various traditional markets in Kediri City, as seen from the air cell depth, is still good and consistent. These eggs remain fresh and suitable for consumption.

The Effect of Sales in Various Traditional Markets on Shell Thickness

In this study, the shell thickness of quail eggs sold in various traditional markets in Kediri City, East Java, was measured to evaluate the physical quality of the eggs. Shell thickness is an important factor in determining the quality and durability of eggs, as thicker shells provide better protection against microbial contamination and physical damage.

Shell thickness is an important indicator when evaluating egg quality, particularly in terms of protection and shelf life (El-Komy et al. 2024). In quail eggs, adequate shell thickness ensures that the eggs are more resistant to impact and microbial contamination (Behnamifar et al. 2020). The results of this study show that the shell thickness of quail eggs sold in traditional markets in Kediri City is relatively uniform.

The absence of significant differences in shell thickness between samples indicates that the quail eggs sold across these markets have nearly consistent physical quality. This could be attributed to similar production and handling conditions, both in terms of quail farming practices and post-harvest handling. Although there is no significant variation in shell thickness, the values observed generally fall within an acceptable range for quail eggs. Thicker shells provide better protection against contamination, making the eggs more durable and safe for consumption (Karabulut 2021).

However, it is important to remember that shell thickness is just one of many factors influencing overall egg quality. Other factors, such as freshness (e.g., pH, air cell depth) and microbiological conditions (e.g., TPC and Salmonella), are also essential when assessing the overall quality of the eggs (Drabik, Spasowska-Czarny, and Batkowska 2024). In conclusion, this study shows that the quail eggs sold in various traditional

markets in Kediri City have uniform shell thickness, providing adequate protection against contamination and physical damage.

CONCLUSION

Based on the research on the quality of quail eggs sold in traditional markets in Kediri City, East Java, it can be concluded that the quail eggs are safe for consumption, with no *Salmonella* contamination (0 cfu/ml) and TPC levels within safe limits (2.1×10^3 to 4.4×10^3 cfu/ml). The pH values range from 6.3 to 6.9, indicating good egg freshness, while the air cell depth (1.54 mm to 2.36 mm) and shell thickness (0.19 mm to 0.20 mm) also reflect good and consistent physical quality. Overall, the quality of quail eggs in the traditional markets of Kediri City can be categorized as good, with no significant differences found in any of the parameters tested.

LIMITATION

1. Location Coverage Limitations: The study was conducted only in traditional markets in Kediri City. The results may not be generalizable to other regions, either within the province or outside East Java. Market conditions, handling, and egg storage in other areas may differ, which could lead to different findings.
2. Time Frame Limitations: This study was likely conducted during a specific time period. The quality of quail eggs may change depending on seasonal factors or varying storage conditions during the summer or rainy seasons. Therefore, further research over a longer period or during different seasons may provide more comprehensive results.
3. Sample Limitations: If the sample size of quail eggs tested was limited to a few markets or a small number of samples, the results may not represent the overall market conditions in Kediri City. A larger sample size may be needed to improve the accuracy and validity of the findings.
4. Research Parameter Limitations: The study focused on several quality parameters, such as Salmonella, TPC, pH, air cell depth, and shell thickness. However, other factors may also affect egg quality, such as nutritional content (protein, fat, and vitamins), market sanitation conditions, or transportation methods, which were not analyzed.
5. Limitations of Testing Technology: The testing methods may have limitations in terms of sensitivity and accuracy. For example, the testing technique for

Salmonella might not detect contamination at very low levels, leading to results showing 0 cfu/ml even though there may be contamination at extremely low levels.

6. Generalization Limitations of Findings: This study focuses on traditional markets, and the findings may not be generalizable to quail eggs sold in supermarkets or modern markets, where handling and storage practices are typically different.

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