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Evaluation of the Effectiveness of Turmeric Extract with Various Concentrations as a preservative on the Internal Quality of Eggs from Purebred Chicken

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ABSTRACT. *This study aims to evaluate the effectiveness of white turmeric (Curcuma zedoaria) extract solution at various concentrations for 10 hours as a preservative for the internal quality of laying hen eggs. This research was conducted at the Animal Husbandry Laboratory, Islamic University of Malang, from April 20th to May 20th, 2025. The research material consisted of 64 eggs from laying hens aged 0–1 day with an average weight of 57–60 g, 600 g of dried and ground white turmeric powder, and 6 liters of clean water as a solvent. The method used is a Completely Randomized Design (CRD), with 4 treatments and 4 replications: (P0 control, P1 10%, P2 20%, P3 30%), and 4 replications. The parameters observed include: egg weight before and after treatment, egg white index, egg yolk index, and Haugh unit. The data was analyzed using ANOVA, and if there were differences between treatments, the Least Significant Difference (LSD) test was performed. The research results show that soaking eggs in white turmeric extract has a highly significant effect (P<0.01) on egg weight, albumen index, yolk index, and Haugh units. The average egg weight is 53.52 g for P0, 56.16 g for P1, 56.66 g for P2, and 58.83 g for P3. The albumen index is 0.028 for P0, 0.045 for P1, 0.050 for P2, and 0.090 for P3. The yolk index is 0.26 for P0, 0.29 for P1, 0.32 for P2, and 0.33 for P3. The Haugh unit is 76.78 ± 6.95. The best treatment was obtained at a white turmeric solution concentration of 30% (P3). Based on the research findings, it was concluded that soaking eggs in white turmeric extract for 10 hours showed a highly significant effect (P<0.01) after storage for 20 days at room temperature.*

Keywords: Turmeric, egg, quality, soaking, SNI

INTRODUCTION

Chicken eggs are a food item that deteriorates easily, especially when stored at room temperature without special treatment, with an optimal shelf life of only about 10–14 days. After passing this range, egg quality tends to decline due to the release of CO_2 gas and water vapor thru the shell pores, leading to an increase in pH, a decrease in albumen viscosity, and changes in the white index and yolk index (Triawan et al., 2021; Chen et., 2023). This quality decline accelerates the spoilage process and potentially poses health risks to consumers. These challenges become increasingly significant in areas with inadequate cooling facilities, making it necessary to develop effective, safe preservation strategies that can maintain egg quality during storage. One promising approach is the utilization of natural materials containing bioactive compounds, such as curcuminoids, tannins, phenolics, flavonoids, and essential oils, which possess antimicrobial and antioxidant activity. These bioactive compounds can slow down the rate of quality deterioration, inhibit the growth of pathogenic and spoilage bacteria, and prevent lipid oxidation, thus potentially extending shelf life and maintaining egg quality more optimally (Bae, 2015: Feddern et al., 2017).

One natural ingredient with great potential as an egg preservative is white turmeric. White

turmeric rhizome is known to contain various bioactive compounds that play an important role in its pharmacological activity, with the main components being 8–9% curcuminoids, 2.7% tannins, 20.275% phenolics, 4.8% flavonoids, and 3–5% essential oils (Bae, 2015; Syaifuddin, 2019). The presence of these compounds provides strong antimicrobial and antioxidant activity, thus being able to prevent egg quality deterioration and inhibit the growth of pathogenic and spoilage bacteria, as well as prevent lipid oxidation in food (Hanif et al., 2023; Krisnaningsih et al., 2024). With these characteristics, white turmeric rhizome extract is considered to have great potential as a natural preservative for laying hen eggs because it can maintain organoleptic quality, preserve nutritional content, and extend shelf life during storage (Abdeldaiem, 2014).

The availability of raw materials is one of the important aspects in supporting the use of white turmeric as a natural preservative. National horticultural data shows that Indonesia's biopharmaceutical crop production in 2023 reached 535,695.47 tons, including commodities such as turmeric, ginger, and cardamom (Ariani et al., 2023). Although this data does not separate production by species, Abdeldaiem (2014); Bae (2015); and Listyana (2018) reported that white turmeric production in Indonesia reached 32,450-42,089 tons per year, while the demand for white turmeric raw materials for the phytopharmaceutical industry was estimated at around 3,000 tons per year. This indicates that white turmeric has relevant supply potential and sustainable demand within the natural ingredient processing industry.

Traditionally, white turmeric has long been used as an ingredient in herbal medicine and traditional remedies, so its safety and effectiveness profile is widely known. In the context of egg preservation, white turmeric extract can be formulated into various dosage forms such as soaking solutions, powders, or capsules. This formulation allows the bioactive compounds to work optimally on the eggshell surface, suppress microbial contamination, and maintain egg quality during storage without requiring refrigeration facilities. With its adequate rhizome production potential and scientifically proven bioactive characteristics, white turmeric is a promising candidate for development as a natural preservative in the food sector, particularly for edible egg products.

In line with the growing interest in using natural preservatives, consumers are increasingly demanding the availability of safe, nutritious, and environmentally friendly food. Nugraha et al. (2017) and Krisnaningsih et al. (2024) reported that white turmeric extract can improve the nutritional quality of salted egg products thru its antimicrobial and antioxidant activity, which stems from its content of bioactive compounds such as phenolics, curcuminoids, flavonoids, tannins, and essential oils. Although this research was applied to salted eggs, the biological protective mechanisms produced by the active compounds in white turmeric remain relevant for application to laying hen eggs, particularly in maintaining internal quality and preventing spoilage during storage. These findings strengthen the prospect of utilizing white turmeric as an effective natural preservative, while also supporting food security and providing healthier and more sustainable preservation alternatives.

Because they possess antimicrobial and antioxidant properties comparable to white turmeric, various herbal plants such as betel leaves, melinjo leaves, and avocado seeds also show great potential as natural preservatives. (Bae, 2015) reported that betel leaf extract, rich in tannins, kavikol, and kavibetol, can close shell pores and inhibit the growth of egg-damaging microbes. In line with this, Novitanti (2021), showed that flavonoids and tannins in melinjo leaves are able to form a protective layer that maintains the quality stability of eggs during storage. Sigar et al. (2020) also reported that soaking eggs in avocado seed extract containing

tannins, phenolics, and flavonoids was effective in extending the shelf life of eggs. Overall, this evidence suggests that herbal plants containing antimicrobial and antioxidant bioactive compounds offer promising prospects as natural preservatives in efforts to sustainably improve food quality and safety.

Based on existing research gaps, this study aims to evaluate the effectiveness of white turmeric (*Curcuma zedoaria*) extract at various concentrations as a natural preservative in maintaining the internal quality of purebred layer chicken eggs and extending their shelf life at room temperature. The treatment was carried out by brief soaking for 10 hours, after which the eggs were stored at room temperature for up to 20 days without additional treatment, thus simulating the distribution and storage conditions commonly found at the household and traditional market levels. The research evaluation focused on egg weight parameters, egg white index (EWI), yolk index (YI), and Haugh units as the main indicators for determining internal quality. To date, there have been no more specific studies to evaluate the effectiveness of direct application of white turmeric extract through brief immersion on laying hen eggs. Therefore, this research is expected to make a significant contribution to the development of practical and sustainable nature conservation strategies.

MATERIALS AND METHODS

Location and Time of Research

This research was conducted at the Laboratory of the Faculty of Animal Husbandry, Universitas Islam Malang. The implementation time of this research began on April 20, 2025 to May 20, 2025.

Research Materials and Equipment

The research material consisted of 64 Lohmann Brown laying hen eggs aged 0–1 day, obtained from Mr. Sahroni's farm in Wagir District, Malang City. Eggs have an average weight of 57–60 g per piece, which falls into the large egg category according to SNI standards (2008). The chickens were raised in open-air ventilated battery cages and fed a specially formulated commercial production phase pellet feed with a crude protein content of 17–18%, enriched with vitamins and minerals to produce high-quality eggs. The second material used was 600 g of white turmeric powder purchased from the online store Apk Lazada, with bioactive compound content including 8–9% curcuminoids, 2.7% tannins, 20.275% phenolics, 4.8% flavonoids, and 3–5% essential oils. The third material was 6 liters of clean water used as a solvent for the egg soaking process. The water used must be free from microbial contamination, so in this study, bottled water that has undergone sterilization and is guaranteed safe was chosen. Water quality is very important because it can affect the stability and quality of eggs during soaking.

Meanwhile, the research equipment or laboratory instruments used to support the accuracy of the treatment process and sample measurement include:

1. Measurement and Analysis Tools
   a. Digital scales, used to weigh eggs before and after treatment, as well as to weigh white turmeric powder for making the soaking solution.
   b. Vernier Caliper, used to measure egg white index and egg yolk index with high precision.
   c. Thermometer, used to monitor and record room temperature during storage.
2. Collection and Soaking Tools
   a. Basins (3 pieces), used as containers for soaking eggs in each concentration of white turmeric solution.
   b. Measuring Cylinder, used to measure the volume of water in making the turmeric solution as the soaking medium.
   c. Egg trays (4 pieces), used to collect and store eggs after the soaking process.

3. Observation Tools
   a. Petri dishes (4 pieces), used as containers for cracked eggs for visual observation and measurement of internal quality parameters.

Research Design

The research method used is experimental research applying a Completely Randomized Design (CRD). The selection of this design refers to (Sigar et al., 2020; Krisnaningsih et al., 2024). Who asserts that the use of CRD must consider data homogeneity so that variability between treatments can be optimally controlled. Based on these considerations, this study established four treatments and four replications, ensuring that the experimental structure still met the principle of data uniformity. Each replication consists of four eggs that serve as the experimental units. The treatments applied were as follows: P0 (eggs without soaking as a control), P1 (soaking in 10% white turmeric solution), P2 (soaking in 20% white turmeric solution), and P3 (soaking in 30% white turmeric solution).

Research Procedure

This research was conducted in several stages, including the preparation of white turmeric solution, the egg preparation stage, the egg soaking stage, the egg storage stage, and the egg quality testing stage.

1. Egg preparation stage: Before weighing, the eggs will be cleaned of dirt using warm water to remove microorganisms attached to the eggshells, then dried with tissue. After cleaning, they will be labeled according to the research treatments: (P0-control) 16 eggs with uniform weight, (P1) 16 eggs with uniform weight, (P2) 16 eggs, and (P3) 16 eggs with uniform weight. After everything is prepared, the eggs will be weighed sequentially to obtain the initial weight as a baseline for the study.
2. White Turmeric Extra Preparation Stage: The preparation stage for the white turmeric solution involves weighing the white turmeric powder according to the treatment requirements, which are (P1) 100 grams for a 10% concentration + 1000 ml of clean water as a solvent, (P2) 200 grams for a 20% concentration + 2000 ml, and (P3) 300 grams of turmeric powder for a 30% concentration + 3000 ml of clean water as a solvent. Turmeric powder will be mixed with water according to the treatment, then stirred until homogeneous. After everything is mixed evenly, the turmeric solution will be filtered using an Eagle Stainless Steel Sieve into a separate container to obtain the white turmeric solution extract ready for use as the soaking medium for laying hen eggs in the study.
3. Egg soaking stage: Eggs were placed in each treatment container containing 16 eggs. Each egg group was then soaked for 10 hours in white turmeric extract according to the treatment concentration. The soaking container is covered with a clean cloth to prevent contamination from the outside air and maintain the purity of the solution during the soaking process.
4. Egg Storage Stage: After soaking for 10 hours, the eggs will be dried using kitchen paper towels. Once dried, the eggs will be placed in egg trays with the blunt end facing up. Each egg will be labeled and stored at room temperature (20-25°C) for 20 days.
5. Quality Testing Phase: After being stored for 20 days at room temperature, the eggs will undergo quality testing. The initial process involved weighing the final weight and measuring egg parameters for each treatment. After being weighed, the eggs will be broken, and their contents will be placed in Petri dishes to measure the egg white index and egg yolk index parameters. The measurement results will then be recorded and analyzed to determine the internal quality of the eggs. Each measurement result will be carefully recorded according to the research treatment.

Research Variables

The research variables observed are as follows:

1. Egg weight

Before being soaked in white turmeric solution, the eggs will be weighed first using a digital scale to obtain the initial weight, which will serve as a reference for the decrease in egg weight during the research process. After obtaining the initial weight, the eggs will be soaked in white turmeric solution for 10 hours and then stored at room temperature for 20 days.

2. Egg white index

The egg white index is obtained from the ratio between the height of the egg white and the average diameter of the thick egg white. Egg white height and average diameter of thick egg white. Eggs are measured using a caliper. Determination of the egg white index can be calculated using the following formula:

$$\text{Egg white index} = \frac{Egg\ white\ height\ (mm)}{Average\ diameter\ of\ egg\ white\ (mm)}$$

3. Yolk index

It is obtained from the ratio between the yolk height and the average yolk diameter. The yolk index can be calculated using the following formula:

$$\text{Yolk index} = \frac{Yolk\ height\ (mm)}{Average\ yolk\ diameter\ (mm)}$$

4. Haugh unit egg

The Haugh Unit (HU) is a variable used to assess the internal quality of eggs, specifically the viscosity of the egg white (albumen). The Haugh Unit value is obtained thru calculation based on albumen height and egg weight using the formula:

$$HU = 100 \text{ X } \log (h + 7.57 - 1.7 \times W00.37)$$

Explanation:
HU = Haugh Unit; h = albumen height (mm); W = egg weight (grams).

The higher the Haugh Unit value, the better the quality of the egg.

Data Analysis

The research data was first tested for normality and homogeneity of variance to ensure that the data met the basic assumptions for statistical analysis. After both of these assumption tests are met, analysis of variance (ANOVA) is used to determine if there are significant differences in the effects between treatments (P1–P3). If ANOVA shows a significant difference, then the Least Significant Difference (LSD) test is used to identify which treatments are significantly different. The entire analysis process was conducted with the assistance of Microsoft Excel software, which was used to test assumptions, perform ANOVA, and conduct post-hoc tests, resulting in more systematic, accurate, and efficient results.

RESULT AND DISCUSSION

The Effect of White Turmeric Extract on The Egg Weight of Laying Hens

Egg weight is the total mass of the egg (shell, white, and yolk) expressed in grams, according to (Chen et al., 2023). This value reflects the quality and freshness of the eggs, as weight loss indicates the loss of water and CO_2 during storage. Based on (SNI 3926:2008), layer chicken eggs are categorized into 4 categories: (<50 g) small category, (50–56 g) medium category, (57–60 g) large category, and (>60 g) very large category. The average egg weight from the research results for each treatment is presented in Table 1.

Table 1. Effect of White Turmeric Extract on Average Egg Weight

Treatment	Initial mean weight (g)	Difference in decrease (g)	Final mean weight (g)	P-value
P0	57	3.48	53.52 ± 0.80^{a}	0.08
P1	58	2.60	56.16 ± 0.02^{b}	
P2	59	2.34	56.66 ± 0.12^{c}	0.00
P3	60	1.17	58.83 ± 0.03^{d}	

Note: Treatment with the notation (b,c,d) shows a highly significant difference (P<0.01) compared to the egg weight of laying hens, while notation a does not show a significant difference based on the LSD test at the 1% level.

Based on the data in Table 1, soaking broiler chicken eggs in white turmeric extract for 10 hours has a highly significant effect on the average final weight of the eggs after storage for 20 days at room temperature. The results of the Least Significant Difference (LSD) test at the 1% level showed that treatments with different notations (b, c, d) had highly significant differences (P<0.01) compared to the control P0, which was given notation (a) and did not show significant differences. Analysis of egg weight loss showed clear variation between treatments: control eggs P0 experienced the greatest weight loss of 3.48 g, from 57 g to 53.52 g. Meanwhile, eggs soaked in white turmeric extract showed lower weight loss; P1 decreased by 2.6 g from 58 g to 56.16 g, P2 decreased by 2.34 g from 59 g to 56.66 g, and P3 decreased by only 1.17 g from 60 g to 58.83 g. These differences confirm that without white turmeric treatment, water evaporation and CO_2 gas diffusion through the shell pores occur more rapidly, leading to more significant internal egg quality decline, which will impact egg weight loss.

It can be confirmed that treatment with white turmeric extract has been proven effective in slowing egg weight loss due to its bioactive compound content, namely 8–9% curcuminoids, 2.7% tannins, 20.275% phenolics, 4.8% flavonoids, and 3–5% essential oils. These compounds directly contribute to forming a protective layer on the shell surface. Tannins and flavonoids are astringent and can interact with proteins on the shell, resulting in a semi-permeable layer that inhibits water evaporation and gas diffusion. Meanwhile, Curcumin and phenolic compounds act as antioxidants and antimicrobials, preventing the oxidation of egg white proteins and inhibiting the growth of spoilage microorganisms. This combination of mechanisms not only reduces egg weight loss but also helps maintain the stability of the albumen and yolk index. The higher the concentration of white turmeric extract used, the more effective the protective layer formed in maintaining the internal quality of the eggs during storage.

These findings are consistent with reports (Hanif et al., 2023), which state that bioactive compounds in white turmeric form a protective layer on the shell surface and slow down egg mass loss. Hagan et al. (2017) and Riawan et al. (2017) also reported that tannins, phenolics, flavonoids, and essential oils play a role in inhibiting CO_2 evaporation and maintaining the pH stability of egg whites, thus suppressing egg weight loss during storage. The final egg weight of treatment P3 (58.83 g), which falls within the range of SNI 3926:2008 (57–60 g per egg for large egg category), confirms that white turmeric extract at a concentration of 30% is effective in maintaining the physical and internal quality of eggs, while also strengthening its role as a natural preservative that preserves the quality of egg whites and yolks during 20 days of storage at room temperature.

The Effect of Extra White Turmeric Soaking on The Egg White Index of Purebred Layer Chickens

The albumen index is the ratio of the height of the thick albumen to the average diameter of the albumen, used to assess the freshness and internal quality of eggs. The higher the albumen index value, the thicker and fresher the albumen Krisnaningsih et al. (2024). Based on SNI 3926:2008, good quality eggs have an albumen index value between 0.050–0.174. The research results can be presented in Table 2.

Table 2. Effect of White Turmeric Extract on Average Egg White Index

Treatment	Average egg white index	P-value
P0	0.028 ± 0,001[a]	0.02
P1	0.045 ± 0,0012[b]	
P2	0.050 ± 0,001[c]	0.00
P3	0.090 ± 0,001[d]	

Note: Treatment with the notation (b,c,d) shows a highly significant difference (P<0.01) compared to egg white index of laying hens, while treatment does not differ significantly based on the SLD test at the 1% level.

Based on Table 2, soaking eggs in white turmeric extract for 10 hours has a highly significant effect on the egg white index value after storage for 20 days at room temperature. Treatments P1, P2, and P3 resulted in egg white index values ranging from 0.045, 0.050, and 0.090, while the control eggs (P0) had the lowest index value of 0.028 on day 20. The results of the BNT test at the 1% level showed that treatments with different notations (b, c, d) provided highly significant differences ($P<0.01$) compared to P0, which was given the notation (a) and did not show significant differences at the 1% level. This value indicates that soaking using white turmeric extract is effective in slowing down the decline in egg white quality until the third week of storage. Compared to the provisions of SNI 3926:2008, which states that the white index of good quality eggs is in the range of 0.050-0.174, the values in treatments P2 and especially P3 still meet this quality standard.

The difference in egg white index values is also supported by the trend of decreasing egg weight. Eggs in the control treatment (P0) showed a greater weight loss compared to the soaking treatments P1–P3, indicating that water and gas loss occurred more rapidly in the unsoaked eggs. This difference confirms that white turmeric extract acts as an inhibitory layer on the shell surface, thereby reducing the rate of evaporation and respiration through the shell pores. The effectiveness of this inhibition also contributes to maintaining the internal quality of the eggs, including keeping the egg white index value within the standard quality range according to SNI. Bioactive compounds in white turmeric, such as tannin content, curcuminoids, essential oils, and phenolic compounds, have been proven to play a role in maintaining the egg white index value. Tannin, which is astringent, can bind to proteins on the shell's surface, creating a semi-permeable layer. Meanwhile, curcumin and other curcuminoids are antimicrobial and antioxidants, inhibiting the enzymatic activity of microorganisms and reducing the oxidation of egg white components that can accelerate the decrease in albumen viscosity. Therefore, eggs treated in this way maintain their quality due to the addition of extra white turmeric.

These findings are consistent with those of Sigar et al. (2020) and Krisnaningsih et al. (2024), who reported that tannin, phenolic, and volatile solutions from avocado seeds can maintain egg white index by forming a protective layer that reduces water loss. Nuro et al. (2012); Sedya & Rinawidiastuti (2022) research also showed that plant extracts rich in tannins, such as lemongrass and mangosteen peel, improve albumen stability and maintain internal egg moisture through a similar mechanism. Therefore, the increased egg white index value in treatment P3 is a strong indication that white turmeric extract functions as an effective natural coating agent. Its bioactive compounds not only slow down the dehydration process and changes in the structure of albumen protein, but also play a role in maintaining the overall internal quality of the egg. This includes the potential for increased yolk index value due to vitelline membrane stabilization and slowed diffusion of egg white fluid into the air cell. The consistency of the egg white index value at P3 with the SNI standard further supports the conclusion that a 30% concentration of white turmeric extract is able to maintain the physical quality of eggs in the good category even when stored for up to 20 days at room temperature.

The Effect of Extra White Turmeric Soaking on The Average Yolk Index of Laying Hens

The yolk index is the ratio of the height of the yolk to the average diameter of the yolk, used to assess the freshness and internal quality of the egg. The higher the yolk index value, the rounder and fresher the yolk. According to SNI 3926:2008, good quality eggs have a yolk index value between 0.33–0.52. The analysis results can be presented in Table 3.

Table 3 shows that immersing layer chicken eggs in white turmeric extract for 10 hours had a highly significant effect on the average yolk index after storage for 20 days at

room temperature. Based on the BNT test at a 1% level, treatments with different notations (b, c, d) showed highly significant differences (P<0.01) compared to the control P0 with notation (a), which did not show significant differences. The yolk index value increased from 0.29 at P1 (10%), 0.32 at P2 (20%), and 0.33 at P3 (30%), while the control P0 obtained the lowest value (0.26). The decrease in value in the control group is related to the degradation of the egg's internal quality due to water evaporation, the diffusion of CO_2 gas thru the shell pores, and the reduction in the content and stability of albumen proteins, which play a role in maintaining the structure and viscosity of the egg white. Data regarding the trend of egg weight loss and egg white index values support these findings, as eggs not soaked in white turmeric extract experienced greater weight loss and lower egg white index compared to treated eggs. These differences confirm the role of white turmeric extract as an inhibitor of dehydration and gas diffusion through the shell pores, thus helping to maintain egg quality during storage.

Table 3. Effect of White Turmeric Extract on Average Yolk Index

Treatment	Average yolk index	P-value
P0	0.26 ± 0.01[a]	0.30
P1	0.29 ± 0.001[b]	
P2	0.32 ± 0.01[b]	0.00
P3	0.33 ± 0.01[c]	

Note: Treatments with notations b, c, and d show a highly significant difference between treatments (P<0.01) for the yolk index of laying hens, while treatments with notation a did not show a significant difference based on the LSD test at the 1% level.

This study confirms that bioactive compounds in white turmeric extract, including curcuminoids (curcumin, demethoxycurcumin, bis-demethoxycurcumin), tannins, essential oils, and phenolic compounds, directly contribute to protecting the internal quality of eggs. Tannins form bonds with proteins on the shell surface, creating a semi-permeable layer that reduces water loss and gas diffusion. Curcumin and phenolic compounds, flavonoids, are antioxidants and antimicrobials, thus suppressing lipid oxidation in egg yolks and inhibiting the growth of spoilage microorganisms (Akter et al., 2014; Hanif et al., 2023). With this mechanism, the viscosity and structural stability of the egg yolk are maintained, thus slowing down the decline in internal quality during storage in this study.

These findings are consistent with the research by Sigar et al. (2020), who reported that eggs soaked in tannin, phenolic, and avocado seed extracts had a yolk index of 0.33–0.36 after 14 days of storage, which was higher than untreated eggs (0.24). The consistency of these results supports the hypothesis that bioactive compounds in white turmeric extract form a semi-permeable protective layer on the shell, maintaining internal moisture and slowing the degradation of egg yolk proteins and lipids. The increase in yolk index value in treatment P3 indicates that white turmeric extract at a concentration of 30% is most effective in maintaining yolk quality, and this value remains within the SNI 3926:2008 standard for good quality fresh eggs (0.33–0.52), confirming its role as an efficient natural preservative agent.

The Effect of Extra White Turmeric Soaking on The Haugh Unit of Laying Hen Eggs

The Haugh Unit (HU) is a standard parameter for assessing the internal quality of eggs, particularly concerning the quality of the egg white (albumen). The Haugh Unit value describes the relationship between the height of the thick egg white and the weight of the egg, where a higher HU value indicates better freshness quality of the egg. The analysis results can be seen in Table 4.

Table 4 shows that immersing layer chicken eggs in white turmeric extract for 10 hours had a very significant effect on the Haugh Unit (HU) value after 20 days of storage at room temperature. Based on the BNT test at a 1% level, treatments with different notations (b, c, d) showed highly significant differences (P<0.01) compared to the control P0, which was given

notation (a) and did not show significant differences (P>0.01). HU values increased consistently from P1 (74.80), P2 (78.65), to P3 (85.40), with an overall average of 76.78 ± 6.95, while the P0 control group obtained the lowest HU value of 68.25, which falls into the moderate quality category. This data shows that without extra treatment with white turmeric, the HU value of eggs significantly decreased during storage due to albumen protein degradation, internal moisture loss, and the diffusion of CO_2 gas thru the shell pores. The difference in HU values between the control and white turmeric extract concentration treatments strengthens the evidence that white turmeric extract acts as a natural preservative, maintaining the internal quality of the eggs.

Table 4. Effect of Turmeric Extract on Haugh Unit (HU) Value of Laying Hen Eggs

Treatment	Mean HU (± SD)	Description	P-value
P0	68.25 ± 0.04[a]	Quality is medium.	0.03
P1	74.80 ± 0.001[b]	Good quality	
P2	78.65 ± 0.001[c]	Very good quality	0.00
P3	85.40 ± 0.00[d]	Very good quality	
Average	76.78 ± 6.95	-	

Note: The notation treatments (b, c, d) show a highly significant effect (P<0.01) of the treatments on egg Haugh Unit values, while notation (a) has no significant effect based on the LSD test at the 1% level.

The increase in HU value for treatments P1–P3 correlated with the concentration of white turmeric extract, which contains bioactive compounds such as tannins, curcumin, essential oils, and phenolic compounds. Tannins are astringent, allowing them to bind to proteins on the shell surface, forming a semi-permeable layer that reduces water evaporation and CO_2 gas diffusion. Curcumin and phenolic compounds act as antioxidants and antimicrobials, preventing the oxidation of albumen proteins and inhibiting the growth of spoilage microorganisms, thus maintaining the stability of egg white viscosity and preserving the Haugh unit value during storage (Syaifuddin, 2019; Ali et al., 2019). With this mechanism, soaking white turmeric extract not only maintains the physical structure of the albumen but also improves the overall shelf life of the eggs.

The highest value for P3 (85.40) falls into the Grade AA category according to SNI 3926:2008, indicating that a 30% concentration of white turmeric extract is capable of maintaining the internal quality of eggs at the best level for 20 days of storage. The greater decrease in HU in the control compared to the treatment confirms the natural preservative function of white turmeric extract. In other words, the bioactive compounds in the extract not only form a protective layer on the shell but also provide chemical stability to the albumen protein, keeping the HU value high and the internal quality of the egg optimal, thus strengthening the role of white turmeric as an effective natural preservative agent.

CONCLUSION

Based on the research results, soaking eggs in white turmeric extract for 10 hours significantly affected (P<0.01) the internal quality of layer chicken eggs after 20 days of storage at room temperature, including egg weight, albumen index, yolk index, and Haugh Unit value. The highest concentration treatment, P3 (30%), yielded the best results in maintaining egg internal quality, while the lowest value was obtained in P0 (control) without white turmeric extract. Therefore, white turmeric extract has been proven effective in maintaining the quality and freshness of eggs during storage.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organizations related to the material discussed in the

manuscript. Conflicts of Interest should be stated in the manuscript.

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