Jurnal Sain Peternakan Indonesia
Available at https://ejournal.unib.ac.id/index.php/jspi
DOI: https://doi.org/10.31186/jspi.id.20.1.47-60

P-ISSN 1978-3000
E-ISSN 2528-7109
Volume 20 Issue 1 January-March 2025

Effectiveness of Ethanol Extract of Teak Leaf and Abdominal Chicken Oil in Extending the Shelf Life of Table Eggs

H. N. Siswara[1*], M. F. H. Firdaus[1], T. H. Saputro[1], and K. Huda[1]

[1]Animal Science Department, Polytechnic of Agriculture and Animal Science Mapena
Jl. Imam Bonjol, Singgahan, Tuban Regency 62361, East Java, Indonesia
Corresponding author: hamzahnata@gmail.com
Revised: 2025-03-05, Accepted: 20254-03-20, Publish: 2025-03-30

ABSTRACT

Eggs are nutritious livestock products that can quickly decrease in quality, even physically, chemically, and biologically. This research was conducted to determine the effect of using teak leaf extract and chicken abdominal fat on weight loss, air cells, yolk, and albumen quality during storage. The treatments were divided into 4, namely P0 (control), P1 (teak leaf extract), P2 (chicken abdominal oil), and P3 (teak leaf extract and chicken abdominal oil 1:1). This research was conducted for 20 days. The data was analyzed using a completely randomized design (CRD) factorial pattern with two factors, four treatments, and three replications. This research used Duncan's Multiple Range Test to test the different treatments. The results show significant differences ($P<0.05$) in egg weight loss, air cell, yolk index, albumen pH, yolk pH, albumen water content, and haugh unit. The best treatment after the 20th day of storage is P3 treatment. These results indicate that the combination treatment of teak leaf extract and chicken abdominal oil can be used as an egg storage technology.

Keywords: Abdominal chicken fat, Eggs, Shelflife, Teak leaves

INTRODUCTION

An egg is a livestock product with complete nutrition and is easily digested by the human body. (Yuceer & Caner, 2014). The nutrients include minerals, vitamins, proteins, carbohydrates, and fats. (Rêgo et al., 2014; Triawan et al., 2021). Eggs are generally damaged after being stored at room temperature for over 14 days. The damage level of eggs includes physical (including breaking the eggshell) and chemical aspects. Chemical damage to eggs can be caused by the evaporation of water (H_2O), carbon dioxide (CO_2), ammonia (NH_3), nitrogen (N_2), and hydrogen sulfide (H_2S) from the egg. It is caused by microbial contamination from outside, which enters through the pores of the eggshell and then damages the egg's contents. (Datukramat et al., 2021). Microbes degrade some of the compounds in eggs, especially albumen so that albumen becomes thinner and speeds up the evaporation of water, CO_2, NH_3, N_2, and H_2S gases. (Riawan et al., 2017).

Eggs can experience a decrease in quality, which can be caused physically, chemically, or biologically. So, it is necessary to preserve them from damage and meet the criteria for egg consumption based on the Indonesian National Standard (SNI) or the United States Department of Agriculture (USDA). One method of preserving eggs that is often used is wet. The wet method, spraying teak leaf extract and chicken abdominal fat, is rarely used.

Teak leaf (*Tectona grandis*) extract can be used as a source of natural antioxidants that are easy to obtain. The antioxidant and cytotoxic activities of teak leaf extract may be due to the presence of different phytocomponents such as tannins, phenolic acids, and flavonoids. (Ghareeb et al., 2014). Thus, these materials can be used to preserve eggs because they can inhibit bacteria from entering the egg's pores. Tannin has biological activity as an antioxidant, so the tannin content will influence oxidation activity. (Malangngi et al., 2012). In addition, it also prevents the oxidation reaction of chicken fat, which is used to cover the eggshells. Chicken abdominal fat is a layer found around the gizzard and between the abdominal muscles and intestines. (Salam et al., 2013). Chicken oil was obtained from rendering chicken abdominal fat to produce liquid oil. Chicken abdominal oil was expected to cover pores in the eggshells. Combining teak leaf extract and chicken abdominal oil for coating table eggs was predicted to prevent eggs from decreasing quality physically, chemically, and biologically. The choice of these two materials is also due to the abundant stock of materials around. Teak leaves grow a lot in the Tuban Regency area, while chicken abdominal fat is a by-product of slaughtering chickens. Chicken slaughtering places in Tuban Regency are also easy to find in the market or nearby. This research aims to find natural preservatives that inhibit bacterial growth and prevent evaporation of water content and gases in laying chicken eggs. Furthermore, the shelf life of chicken eggs can be increased when stored at room temperature.

MATERIALS AND METHODS

Tools and Materials. The materials used for this research were 480 chicken eggs from *Isa brown* strain 42 weeks old, teak leaf (*Tectona grandis*), chicken abdominal fat, 96% ethanol, and distilled water. The tools used were an egg tray, 100 ml sprayer, oven, rotary evaporator, magnetic stirrer, porcelain cup, petri dish, desiccator, digital scale, pH meter, digital thermohygrometer, gloves, and calipers.

Extracting teak leaves and rendering abdominal chicken fat. Teak leaf extract was obtained from selected teak leaves and then made into simplicia by ovening it for 10 hours at a temperature of 50 ℃ (Warnis et al., 2020), then grinding it into a powder measuring 80 mesh. According to Nuri et al. (2020), 200 grams of Simplicia were macerated using 2 liters of 96% ethanol for 24 hours, stirring occasionally, and then filtering. The residue was macerated again twice in the same way. The filtrate was combined and concentrated with a rotary evaporator (Heidolph Laborota 4000) at a temperature of 70°C and low pressure. A concentration of 12.5% (w/v) was used for spraying diluted with distilled water. Chicken abdominal oil was taken from chicken abdominal fat which had gone through a modified dry rendering extraction process for 2 hours in an oven at a temperature of 80°C (Kamini et al., 2016). Next, testing the phytochemical and antibacterial activity of teak leaf extract. Antibacterial activity test using agar disk diffusion. The inhibition zone is shown by a clear zone in the agar disk, and the diameters are measured with a caliper.

Alkaloid identification. A total of 1 mL of each extract was placed into separate reaction tubes, then 2 mL of 2N HCl was added. Subsequently, 1 mL of each filtrate was placed into each reaction tube. Then, in tube 1, 2 drops of Mayer's reagent were added, Wagner's reagent to tube 2, and Dragendorff's reagent to tube 3. Positive results were indicated by the formation of a white sediment in tube 1, a brown sediment in tube 2, and an orange sediment in tube 3 (Oktavia et al., 2020) With modification.

Flavonoid identification. 1 ml of ecoenzyme is reacted with 2 mg of powder magnesium (Mg) and 3 drops of 37% HCl. A positive result is indicated by a color change to red, yellow, and orange. (Ramadani et al., 2022).

Steroid identification. A total of 1 mL of extract was placed into a reaction tube. Add three drops of anhydrous CH_3COOH (acetic acid). Concentrated H_2SO_4 was added three drops slowly to the tube's wall. Subsequently, the formation of a bluish-green ring indicates the presence of steroids. (Oktavia et al., 2020) With modification.

Saponin identification. 1 ml of ecoenzyme is put into a tube reaction added 20 ml of hot water, then shake vigorously for 10 seconds. Positive contains saponin; if it forms a high foam of 1-10 cm for not less than 10 minutes and adds one drop of 2N HCl, the foam does not disappear. (Maharani et al., 2021).

Tanin identification. A total of 1 mL of extract was placed into a reaction tube. Add 3 drops of 5% FeCl solution. A dark blue or bluish-black color indicates the presence of tannin. Second, 1 mL of the test solution was added to a reaction tube, followed by the addition of 3 drops of 10% gelatin. The formation of a white sediment indicates the presence of tannin.

Selecting the Eggs. Collecting fresh eggs aged 0 days with criteria that comply with normal egg standards, namely: eggs have a normal eggshell shape, smooth, whole, uniform in shape, and clean based on the National Standardization Agency. (BSN, 2008).

Spraying the Eggs. In this research, 12.5% (w/v) of teak leaf extract was used to spray the eggs. A total of 12,5 g teak leaf extract was diluted in 100 mL aquadest. Another material is abdominal chicken oil, which is rendered from fat. Spraying the eggs according to the predetermined code, namely P0 (control), P1 (teak leaf extract only), P2 (abdominal chicken oil only), and P3 (combination 1:1 of teak leaf extract and abdominal chicken oil) which were stored at room temperature for 20 days with storage stages of 0, 10, and 20 days. Then, spray each egg with a dose ± 2 mL/egg individually, it is based on (Oliveira et al., 2022). The number of eggs used consisted of 10 eggs in each replication. The replication used was four times and consisted of 2 factors. The first factor consisted of giving teak leaf extract and abdominal chicken oil, namely P0, P1, P2, and P3, while the second factor consisted of storage time, namely 0, 10, and 20 days.

Data Analysis. The research data were analyzed using analysis of variance (ANOVA) from a factorial Completely Randomized Design (CRD). If the treatment showed a significant effect (P<0.05), it was continued with Duncan's Multiple Range Test (DMRT).

Research Variables. *Temperature and humidity:* A digital thermohygrometer was used for measurements. Observations were made in the morning, afternoon, and evening for 20 days. *Egg weight loss:* Egg weight loss was carried out to determine how much egg weight decreases during storage. The measurement used the following formula:

$$\text{Egg weight loss} = \frac{\text{initial weight-final weight}}{\text{initial weight}} \times 100\%$$

Eggshell thickness: Eggshell thickness measurements were carried out by measuring eggshell fragments using a micrometer with an accuracy of 0.01 mm.

Eggshell weight: A digital scale was used to find the weight of the eggshells. Before weighing the eggshell, the white membrane layer was removed to obtain the complete weight of the eggshell. *Egg index (EI):* The index of the Egg was measured using a caliper to determine the transverse width, longitudinal width, and length of the egg. The egg index result used was the formula for the comparison between the width and length of the egg multiplied by 100% (Aulia et al., 2016). *Egg air cell:* The air cell was counted by breaking the egg on the blunt side and then measuring the depth of the air cell using a caliper. Air cavities are measured using a cm unit. *Egg yolk index (YI):* The height and diameter of the yolk were measured on a glass table. Digital calipers with an accuracy of 0.001 mm are used. The recorded data was used to calculate it by dividing the height by the diameter of the egg yolk. *Albumen index (AI):* The ratio of the thick albumen's height to the albumen's average diameter. The tool used was a caliper. The albumen index formula is:

$$AI = \text{albumen height} \div 0.5 \times (\textit{width} + \textit{length of albumen})$$

Water content of egg yolk and albumen: Measuring the water content of eggs using the method (AOAC, 2005). The yolk and white were separated after the eggs were cracked. Then, 2 grams of egg yolk or white were put in the porcelain cup, the weight of which was known. Then, it was heated at 105˚C until the weight stabilized. The formula for calculating water content is as follows:

$$\text{Water content} = \frac{\text{Difference in total weight before- after oven}}{\text{total weight before oven}} \times 10$$

Value of egg yolk and albumen pH: After previous analysis, egg yolks or albumen were placed separately in a beaker glass. Value of pH analysis used a calibrated digital pH meter. The pH measurement results are the results of the egg yolk or white.

Haugh unit (HU): Apart from egg weight, albumen height was also measured on a glass table using a digital caliper. HU was calculated using the following formula:

$$HU = 100 \log (\text{albumen height} + 7.57 - 1.7 \text{ egg weight}^{0.37})$$

RESULTS AND DISCUSSION

Antibacterial activity and phytochemical composition

Egg quality can be seen from several conditions, such as egg yolk, albumen, air cell, HU, physicochemical properties, and eggshell characteristics. The following are the data obtained from the research. Phytochemical and antibacterial activity tests were carried out before applying teak leaf extract and rendered chicken abdominal fat to egg storage. Table 1 shows the test results. Based on a report from (Ouchari et al., 2019), inhibition zone diameters of 10-20 mm were categorized as vigorous antibacterial activity. All concentrations of teak leaf extract in Table 1 were categorized as vigorous antibacterial activities. This research used a 12.5% concentration of teak leaf extract to spray the eggs. They were phytochemically tested to ensure phytochemical compounds were available in teak leaf extract, as shown in Table 2.

Table 1. Diameter of the inhibition zone of antibacterial activity of teak leaf extract

Percentage of teak leaf extract (w/v)	*Escherichia coli* ATCC 25922	*Salmonella typhimurium* ATCC 14028
Control – (40% DMSO)	0.00 ± 0.00^{f}	0.00 ± 0.00^{f}
6.25	11.20 ± 0.30^{e}	10.20 ± 0.35^{e}
12.5	12.50 ± 0.25^{d}	12.75 ± 0.28^{d}
25	13.05 ± 0.30^{c}	13.65 ± 0.33^{c}
50	15.40 ± 0.20^{b}	16.55 ± 0.20^{b}
Control + (Ciprofloxacin)	28.56 ± 0.25^{a}	30.46 ± 0.25^{a}

Calculation of the inhibition zone of the antibacterial activity of the Integrated Laboratory, Politeknik Pertanian dan Peternakan Mapena, Tuban (2024)

A phytochemical test shows that teak leaf extract contains some biochemical compounds. It is an alkaloid, flavonoid, saponin, tannin, and steroid. These biochemical compounds could be antibacterial and antifungal for eggs stored. That is why, from this screening, we continued to apply egg coating while stored at room temperature.

Table 2. Phytochemical test results of teak leaf extract

Phytochemical test	Reagent	Result	Remarks
Alkaloid	Mayer	+	White sediment shown
	Wagner	+	Brown sediment shown
	Dragendroff	+	Orange sediment shown
Flavonoid	HCL, Mg	+	Color change to yellowish
Saponin	Aquadest, HCl	+	Foam on the surface of the tube
Tanin	$FeCl_3$	+	Color change to bluish-black
	Gelatin	+	White sediment shown
Steroid	CH_3COOH, H_2SO_4	+	Color change to bluish-green

Remarks: + (indicates positive result); - (indicates negative result).

Air Cell

The results show a significant effect ($P<0.05$). The highest mean on the 20th day is P0, 5.47 ± 0.31 mm. The lowest average is in P2 and P3. In treatments P2 and P3, the air cell values do not experience a significant change on the 10th and 20th days of storage. Likewise, on the 0th to 10th day of storage, the air cell value only increases smaller than treatments P0 and P1. Teak leaf extract and abdominal fat can close the eggs' pores, thus preventing evaporation so that the process of increasing the air cell can be suppressed.

An air cell forms in the blunt part of the egg after egg laying, which is caused by shrinkage of the egg contents (Loffredi et al., 2021). Low air cell depth indicates fresh egg quality. (Pan et al., 2022). The results in Table 3 show an increase in the air cell's depth according to the storage length. It is the opinion of (Djaelani, 2016) The air cell will increase in size according to storage time. The size of the air cell is caused by the evaporation of water and the release of gas that occurs during storage. (Hagan & Eichie, 2019; (Jazil et al., 2013). The result of the air cell obtained on day 0 is 0.70 mm, falling into quality category II. On the 10th and 20th days, the air cell values are 2.65 mm and 2.88 mm, both of which are in quality III. This aligns with BSN guidelines (2008) that quality I have an air cell height of < 0.50 cm, quality II has 0.50 to 0.90 cm, and quality III has > 0.90 cm air cell height. The longer the eggs are stored, the greater the air cell depth.

Table 3. Exterior and eggshell characteristics

Day Storage	Treatment				Average
	P0	P1	P2	P3	
Air Cell (mm)					
0	1.51±0.87 [a]	1.30±0.86 [a]	0.77±0.15 [a]	0.80±0.43 [a]	
10	4.87±0.58 [de]	4.03±0.39 [cd]	2.65± 0.46 [b]	3.02± 0.80 [b]	
20	5.47± 0.31 [e]	5.47± 0.28 [e]	2.88± 0.54 [b]	3.10± 2.72 [b]	
Eggshell Weight					
0	6.07 ± 0.12	5.93 ± 0.42	6.20 ± 0.20	6.13 ± 0.46	6.08 ± 0.30[b]
10	5.28 ± 0.02	5.33 ± 0.05	5.11 ± 0.01	4.89 ± 0.04	5.15 ± 0.03[a]
20	6.67 ± 0.31	6.67 ± 0.31	6.93 ± 0.64	6.20 ± 0.35	6.62 ± 0.40[c]
Average	6.01 ± 0.15[a]	5.98 ± 0.26[a]	6.08 ± 0.28[a]	5.74 ± 0.28[a]	
Eggshell Thickness					
0	0.50 ± 0.04	0.48 ± 0.02	0.51 ± 0.02	0.48 ± 0.04	0.49 ± 0.03[b]
10	0.41 ± 0.05	0.42 ± 0.02	0.41 ± 0.01	0.40 ± 0.01	0.41 ± 0.02[a]
20	0.51 ± 0.01	0.54 ± 0.04	0.50 ± 0.01	0.51 ± 0.02	0.52 ± 0.02[b]
Average	0.47 ± 0.03[a]	0.48 ± 0.03[a]	0.47 ± 0.01[a]	0.46 ± 0.02[a]	
Egg Weight Loss					
0	0.00 ± 0.00[a]	0.00 ± 0.00[a]	0.00 ± 0.00[a]	0,00 ± 0.00[a]	
10	1.53 ± 0.31[b]	1.00 ± 0.20[ab]	0.27 ± 0.23[a]	0,33 ± 0.31[a]	
20	4.33 ± 1.80[d]	2.67 ± 0.76[c]	0.93 ± 0.76[ab]	0,93 ± 0.12[ab]	
Egg Index					
0	0.81 ± 0.02	0.80 ± 0.02	0.80 ± 0.01	0.82 ± 0.03	0.81 ± 0.02[a]
10	0.80 ± 0.02	0.80 ± 0.01	0.81 ± 0.01	0.80 ± 0.00	0.80 ± 0.01[a]
20	0.80 ± 0.01	0.81 ± 0.01	0.81 ± 0.01	0.82 ± 0.01	0.81 ± 0.01[a]
Average	0.80 ± 0.02[a]	0.80 ± 0.01[a]	0.81 ± 0.01[a]	0.81 ± 0.01[a]	

Note: Different superscripts in the same column and row show significantly different results (P<0.05).

Eggshell Weight and Thickness

The average eggshell weight and thickness value is insignificant (P>0.05). This shows that the weight and eggshell thickness of the eggs used in the study are uniform. This study's eggshell thickness and weight values are insignificant (P>0.05). These results are in line with research by Sudrajat et al. (2019) Regarding the quality of fermented non-conventional feed rations, the eggshell thickness was not significantly different (P>0.05), ranging from 0.36-0.38 mm, and obtaining an average eggshell weight of 9.49% - 10.03% of egg weight. It is also in line with the research done by Khan et al. (2020) Regarding the effect of storage time on eggs' external and internal quality, the eggshell weight was insignificant (P>0.05). Agustina et al. (2017); Asnawi et al. (2017); and Sumiati et al. (2021), report that in the formation of eggshells, the process of absorbing nutrients, especially calcium, is greatly influenced by the chicken's digestive system. Apart from that, it is also influenced by the strain and age of the chicken. Setiawati et al. (2016) Due to the disruption of endocrine gland secretion, the hormones produced are not optimal for controlling calcium in the blood. (Fitriani et al., 2016). Meanwhile, the weight value of the eggshell will increase if the egg weight increases. (Asnawi et al., 2017).

Egg Weight Loss

The average egg weight loss is significantly different (P<0.05). The highest mean value occurs in the P0 day 20 treatment, namely 4.33 ± 1.80, while the lowest occurs in P3, namely 0.93 ± 0.12. In treatments P2 and P3, eggs do not experience significant weight loss starting from days 0, 10, and 20 of storage. In treatments P1 and P2, eggs experience significant weight loss from days 0 to 20 of storage.

The temperature in Tuban Regency is classified as high, with the general conditions observed during the research being an average temperature of 28.85 ± 0.74°C and relative humidity of 50.02 ± 3.52% (data not shown). According to Bilyaro et al. (2021) And to BSN (2008), the optimal storage temperature for eggs is between 4ºC and 7ºC if stored at temperatures above 25ºC (Leandro et al., 2005; Xavier et al., 2008) It will result in a decrease in egg quality. Eggs are changed according to temperature and storage conditions. It results in the degradation of compounds and changes in functional properties, compromising chemical characteristics. (Liu et al., 2016). Therefore, the temperature on Tuban

Recengy might have caused more rapid egg weight loss in the research.

Along the way until consumption, eggs will experience weight loss at room temperature due to the evaporation process of water vapor and H_2O and CO_2 gases. (Eke et al., 2013; Rodrigues Mendes et al., 2014; Djaelani, 2015; Feddern et al., 2017; Hagan & Eichie, 2019). A decrease in egg weight is caused by different storage, temperature, egg size, or eggshell porosity. (Akpinar et al., 2015). As reported in research by Samli et al. (2005) When storing eggs for 10 days, egg weight decreases by 1.66% at a temperature of 21°C. It has been proven that egg coating is made from chicken abdominal oil. In addition, a combination of oil and extract is more efficient in preventing egg weight loss. This research is in line with the opinion of Irmawaty et al. (2022) To a certain extent, fats with more fatty acid content will be able to prevent the evaporation of water and gases such as CO_2, NH_3, and H_2S.

According to (Kim et al., 2006) and Xu et al. (2018), eggs with the thickest layers show the best quality during storage. This research by (G. da S. Oliveira et al., 2022) showed that the results of a layer of cassava starch added with essential oils maintain the internal quality of the eggs during 5 weeks of storage at 20ºC, reducing the eggshell microbiota and effectively keeping it at a low level. Research from Akpinar et al. (2015) also reported that egg coating using propolis with a concentration of 15% can extend shelf life and prevent egg weight loss. Humidity, temperature, eggshell texture, and shelf life influence the decline in egg quality (USDA, 2000).

Egg Index

The egg index parameter was used in this research to indicate that the size and form of the sample egg are uniform. Table 3 shows that the egg indexes used in the research are uniform. The egg index is related to the weight of the eggs produced. The higher the egg weight produced, the greater the egg index obtained. The size of the egg index will influence the diameter, length, and width of the eggs produced, whereas the more significant the egg index, the larger the egg's diameter, length, and width will be. Necidová et al. (2019) Stated that the weight of eggs is determined by the breed of chicken, nutrition, and the age of the chicken. The higher the egg index value, the rounder the egg will be; conversely, if the egg index value is low, the egg will become more oval. (Okatama et al., 2018). Based on the report Yuwanta (2010) Believed that the egg index varies between 0.65 to 0.82. The egg index will decrease progressively with age. At the beginning of egg laying, the egg index is around 0.77, and at the end of laying, it is 0.74. This study is by the references because the egg index values tend to be uniform; this is necessary so that the data obtained during the research can be homogeneous and normally distributed.

Egg Yolk Index and Albumen Index

The albumen index values are not significantly different ($P>0.05$), meaning there is no interaction among the factors of giving teak leaf extract, abdominal oil, and storage time. The longer the storage duration, the lower the albumen index value. Based on the results, even though the exact duration of storage (day 20th), it shows that P2 and P3 have the best albumen index values compared to treatments P0 and P1. It means that the treatment caused albumen index performance in the research but was not associated with the storage period.

Egg yolk index values for different storage periods and treatments produce significant differences ($P<0.05$). The highest average egg yolk index value occurs on day 0 in all treatments. The lowest value is found on the 20th day of storage for treatments P0 and P1. After being stored on the 20th day, the best egg yolk index values are in treatments P2 and P3. In treatments P2 and P3, eggs do not experience a significant decrease in egg yolk index on the 10th and 20th day of storage. The egg yolk index would be decreased during the storage period. This is caused by the last storage period when the egg yolk index shows the lowest value.

Based on SNI (01-3926-2008), the albumen index is divided into quality I (0.134−0.175), quality II (0.0133−0.092), and quality III (0.090−0.050). The albumen index of purebred chickens still shows good quality with increasing concentration (P3), which shows the best results. However, there is a decrease in the albumen index over time during storage. According to (Cornelia et al., 2014)The decrease in the albumen index is due to changes in the albumen's CO2 content, which caused the albumen's pH to become alkaline. The concentration of teak leaf extract and chicken abdominal oil can protect the eggs against decreased albumen index (Table 4). A decrease in the albumen index causes a decrease in the HU value Pires et al. (2019) Which is a parameter of albumen freshness (Drabik et al., 2021).

As the storage time increases, the eggs lose moisture and CO_2 through evaporation. This leads to the rupture of the vitelline membrane, and as a result, the albumen becomes watery, and the albumen index decreases (Khan et al., 2014); (G. da S. Oliveira et al., 2022). This causes the water content in the albumen to increase into the egg yolk, and it becomes runny (Adriaensen et al., 2022). BSN (2008) states that the fresh egg yolk index ranges from 0.33-0.52. The decreasing value of the egg yolk index during storage results from the liquefaction and flattening of the egg yolk. It is associated with the constant permeation of water from the albumen to the yolk through the vitelline membrane driven by osmotic pressure. The osmotic pressure between the albumen and the yolk is related to the decreasing viscosity of the albumen. It is caused by the breakdown of the ovomucin-lysozyme complex (G. da S. Oliveira et al., 2022).

The results show that egg yolk index quality is still in good condition when it is given the treatment of coating with abdominal chicken oil. This is in line with the results of research from (Eke et al., 2013) Regarding the effect of storage on eggshell attributes, eggs coated with oil and eggs stored in the refrigerator can obtain maintained egg yolk index values. Fat can coat and close the eggshells well to prevent the evaporation of gas and water in the eggs. These results show that coating can maintain the quality of the egg yolk index compared to uncoated eggs. Pires et al. (2019). According to Soares et al. (2022), during storage, the egg yolk absorbs water from the albumen, becoming more decentralized and less dense. Thus, covering the eggshell pores with several layers could be a solution to optimize control of this phenomenon. (Ezazi et al., 2021).

Table 4. Interior and physicochemical characteristics of eggs

Day Storage	Treatment				Average
	P0	P1	P2	P3	
Albumen Index (AI)					
0	0.09± 0.02	0.08±0.02	0.08± 0.01	0.09± 0.03	0.09± 0.02^{c}
10	0.04± 0.00	0.05±0.00	0.06± 0.01	0.06± 0.00	0.05±0.00^{b}
20	0.02± 0.00	0.03±0.01	0.04± 0.01	0.04± 0.00	0.04± 0.01^{a}
Average	0.05±0.01^{a}	0.54±0.01^{a}	0.06 ± 0.01^{b}	0.06 ± 0.01^{b}	
Yolk Index (YI)					
0	0.34 ± 0.08^{c}	0.48 ± 0.04^{d}	0.48 ± 0.04^{d}	0.48 ± 0.01^{d}	
10	0.26 ± 0.01^{b}	0.30 ± 0.03^{b}	0.35 ± 0.02^{c}	0.35 ± 0.03^{c}	
20	0.20 ± 0.04^{a}	0.19 ± 0.01^{a}	0.35 ± 0.02^{c}	0.36 ± 0.01^{c}	
Albumen pH					
0	8.03±0.06 ^{ab}	8.23±0.08 ^{b}	7.96±0.21 ^{a}	7.80±0.22 ^{a}	
10	9.15± 0.09 ^{f}	8.81±0.08 ^{de}	8.66±0.21 ^{cd}	8.55 ± 0.22 ^{c}	
20	9.24± 0.07 ^{f}	9.04±0.17 ^{ef}	9.24 ± 0.20 ^{f}	9.13 ± 0.02 ^{f}	
Yolk pH					
0	6.19 ± 0.04^{d}	6.37 ± 0.07 ^{abc}	6.41 ± 0.07 ^{abc}	6.23 ± 0.05^{ab}	
10	6.58 ± 004^{cd}	6.44 ± 0.17^{bc}	6.28 ± 0.09^{ab}	6.77 ± 0,07^{d}	
20	6.80 ± 0.29^{d}	6.81 ± 0.13^{d}	6.77 ± 0,05^{d}	6.76 ± 0.17^{d}	
Water Content of Albumen					
0	85.97±0.59 ^{bcd}	86.10±1.81^{cd}	86.57±1.35^{cd}	87.47±1.24^{d}	
10	86.55±0.26 ^{cd}	86.95±0.65^{d}	86.95±0.22 ^{d}	84.19±0.50 ^{bc}	
20	84.76±0.85 ^{abc}	83.86±1.64 ^{a}	85.92±0.58 ^{bcd}	86.41±0.71 ^{cd}	
Water Content of Yolk					
0	43.77 ± 0.69	44.19 ± 0.17	43.66 ± 1.04	44.19 ± 0.59	43.95 ± 0.62^{a}
10	54.57 ± 2.82	53.26 ± 2.62	48.31 ± 3.00	48.40 ± 2.64	51.14 ± 2.77^{b}
20	62.95 ± 2.87	57.27 ± 1.30	56.21 ± 1.13	56.77 ± 0.65	58.30 ±1.48^{c}
Average	53.76 ± 3.12^{b}	51.57 ± 1.69^{ab}	49.39 ± 1.72^{a}	49.79 ± 1.29^{a}	
Haugh Unit (HU)					
0	96.61±2.38 ^{e}	96.46±2.33 ^{e}	98.64±1.03 ^{e}	98.70±0.56 ^{e}	
10	72.33±2.10 ^{a}	82.51±2.46 ^{bc}	88.20±2.50 ^{cd}	90.02±2.44 ^{d}	
20	66.28±1.77 ^{a}	71.13± 2.40 ^{a}	80.62±3.64 ^{b}	84.70±0.92 ^{bcd}	

Note: Different superscripts in the same column and row show significantly different results ($P<0.05$).

pH Value of Egg Yolk and Albumen

The results of variance analysis show that the pH values of egg yolk and albumen are significantly different ($P<0.05$)—the pH value of both egg yolk and albumen increases during storage. However, albumen's pH is higher than egg yolk's. Regarding albumen pH, after the 10th day of storage, treatment P0 shows the highest pH value, while the pH values of albumen-treated P1, P2, and P3 are not significantly different. After the 20th day of storage, the pH value of egg yolk or albumen is not significantly different among treatments P0, P1, P2, and P3.

The pH value is the degree of acidity used to express a product's acidity or alkalinity level. According to USDA (2000), factors that influence egg pH are shelf life, temperature, and relative humidity during storage. The longer the storage period, the higher the pH (Putri et al., 2016; Feddern et al., 2017). The loss of CO_2 through the eggshell pores causes the concentration of bicarbonate ions in the albumen to decrease. It damages the buffer system, which causes the albumen pH to increase. (Cedro et al., 2009) Moreover, the pH becomes alkaline. (Jazil et al., 2013). Normal albumen has a pH of around 6.5 - 9.5. According to Jazil et al. (2013), the increase in the alkaline pH of albumen is caused by the increase in water content due to dilution, causing the proteins in the eggs to become damaged or denatured. Apart from that, it also impacts increasing changes in the pH of egg yolk. (Mangalisu & Armayanti, 2020; Soares et al., 2021). This process is influenced by storing eggs at room temperature. (Eke et al., 2013). The pH value of egg yolk has a standard number of 6.00 (BSN, 2008). According to (Espíndola et al., 2019)The pH of fresh egg yolk is approximately 6, but according to storage time, it can rise to 6.9. Previous research has documented a maximum increase in egg yolk pH from 6.24 to 7 (Pires et al., 2019).

Spraying abdominal chicken oil is more effective in maintaining the pH of albumen and yolks. This is the opinion of Hadiwiyoto (1983), who stated that by preventing the evaporation of water and carbon dioxide (CO_2) from the egg, there will be no increase in pH. This research is in line with research by (G. da S. Oliveira et al., 2022), which stated that coating eggs with a combination of cassava starch and essential oils can maintain the pH quality of the egg yolk. There is also research from Pissinati et al. (2014) regarding the provision of gelatin and mineral oil coatings, which stated that coatings made from mineral oil are proven efficient in maintaining egg quality during storage. This is because it functions as a coating to cover the pores of the eggshell, thereby inhibiting evaporation and the entry of microorganisms (Xu et al., 2018). The fewer microorganisms in the egg, the slower the egg spoilage during storage (De Reu et al., 2006; Cantu et al., 2019). The results are from previous studies by Caner & Yüceer (2015) and Pires et al. (2019), which reported that different layers can extend the shelf life of eggs about albumen pH.

Water Content of Egg Yolk and Albumen

The results show that the albumen water content value has a significant interaction effect ($P<0.05$), while the egg yolk water content value has no significant interaction effect ($P>0.05$). The albumen water content tends to decrease during the storage process. Treatments P2 and P3 show a smaller decrease in water content values than treatments P0 and P1 after being stored for 20 days. The water content of egg yolk tends to increase during the storage process. The average egg yolk water content value shows that treatment P0 is lower than treatments P1, P2, and P3.

Water content is the percentage of water in a material. The standard water content of albumen is 88% (Caner & Yüceer, 2015; Pires et al., 2019). The water content of laying chicken albumen experiences changes in decreasing or increasing due to the length of the storage process that is carried out (Yuwanta, 2010). P3 treatment can prevent accelerated changes in water content and shows the best results until the 20th day (Table 4).

On the 20th day of storage, the P0 treatment is greater than the P1 treatment. According to Kurniawan et al. (2021) Storing eggs causes the transfer of water from the white to the yolk, resulting in a decrease in quality, marked by changes, including the contents of the egg, which are divided into 2 (yolk and white) and thick, turning into liquid and mixed. Studies conducted by Khan et al. (2014) and (Drabik et al., 2021) They have confirmed that prolonged storage of eggs leads to the evaporation of CO^2 and moisture, causing the vitelline membrane to rupture and the albumen to become watery and mix with the yolk.

The average water content of egg yolks is changed by different treatments during storage (Table 4) at room temperature. The longer the egg yolk water content is stored, the more the water content value increases. Although there is no significant effect ($P>0.05$), the average results

(Table 4) show that spraying with abdominal fat has the best results for maintaining the quality of egg yolk water content. The water content in fresh egg yolk is 47% (Winarno & Koswara, 2002). The increase in water content occurs due to the evaporation process of egg gas and water vapor due to long storage. This is in line with the opinion of Feddern et al. (2017) that high storage temperatures will further speed up the water evaporation process. This will cause the water content to shift from the white to the yolk, and some evaporate from the eggshell.

Haugh unit (HU)

HU has a significant analysis of variance value ($P<0.05$). The HU value tends to decrease during the storage process. The P3 treatment has the best HU value until the 20th day of storage. After being stored for 10 to 20 days, the HU value in the P3 treatment tends to experience an insignificant decrease. In the P0 treatment, after being stored for 10 days, the HU value tends to experience a very significant decrease.

HU is a parameter of albumen freshness because its measurement is based on the weight and height of the albumen. (Kim et al., 2006); (Drabik et al., 2021). Watery albumen results in a decrease in HU and egg quality (Azizah et al., 2017). According to SNI (01-3926-2008), egg quality is divided into: >72 is classified as quality I, 60-72 is classified as quality II, and <60 is classified as quality III. The highest mean egg unit haugh value is P3, namely 98.70 ± 0.56 (day 0) quality I, 90.02 ± 2.44 (day 20) quality I, and 84.70 ± 0.92 (day 20) quality I. These results show that spraying teak leaf extract and abdominal chicken oil can maintain albumen quality.

A high HU indicates the quality of the albumen. The storage time is the main factor influencing changes in the solid structure of albumen (Drabik et al., 2021), especially at room temperature (B. L. Oliveira & Oliveira, 2013). The research results from Saleh et al. (2020) showed that the temperature at which eggs are stored significantly damages the haugh unit—increasing the storage time results in the evaporation of CO_2 and loss of moisture from the eggs, which results in the rupture of the vitelline membrane, resulting in the albumen becoming watery, thereby affecting the Haugh unit value (M. J. A. Khan et al., 2014). The HU of uncoated eggs decreases faster than coated eggs. These results support previous research that the protein/oil layer Caner & Yüceer (2015) may effectively maintain egg albumen quality.

Mechanism of teak leaf extract and chicken abdominal oil in egg storing

The content of saponins, flavonoids, tannins, and alkaloids. Plays the antibacterial mechanism of action of teak leaf extract (Nidavani & Am, 2014). This content can prevent bacteria from entering the egg so that bacteria are minimized. (Warganegara & Restina, 2016). In line with the opinion of Riawan et al. (2017), the working system of antibacterials is that damage to the cell membrane. This inhibits the activity and biosynthesis of specific enzymes needed in metabolic reactions. Bacteria that can be minimized are E. Coli, Salmonella typhi (Kurniati & Kalsum, 2018), Coliform (Febriana & Chaidir, 2023), S. Epidermidis, and S. aureus (Fildza et al., 2017). Tannins in teak leaves can maintain the quality of eggs and chicken abdominal oil, which is useful as a coating to close the pores in the eggshell. According to Lestari et al. (2013)Tanin can cover the pores of the eggshell, thus maintaining its durability.

Abdominal chicken oil can coat and close the eggshells well to prevent the evaporation of gas and water in the eggs. In the opinion of Irmawaty et al. (2022), to a certain extent, fats with increasing fatty acid content will be able to prevent the evaporation of water and gases such as CO_2, NH_3, and H_2S. These results support previous observations that the protein/oil layer. (Caner & Yüceer, 2015) It may be effective in maintaining the quality of egg albumen. This is because the oil functions as a coating to cover the pores of the eggshell, thereby inhibiting evaporation and the entry of microorganisms. (Xu et al., 2018). The fewer microorganisms in the egg, the slower the egg spoilage during storage. (De Reu et al., 2006; Cantu et al., 2019).

CONCLUSION

Regarding the research, a combination of teak leaf extract and abdominal chicken oil can coat and inhibit the evaporation process of water and gases in eggs, thereby maintaining the quality of the egg. Using teak leaf extract and chicken abdominal oil can inhibit egg weight loss and increase air cells. In addition, both egg yolk and albumen quality can be maintained during storage. The best treatment is using the P3 treatment (combination of abdominal chicken oil and teak leaf extract 1:1). So, this research could be the solution to increase the shelf life of eggs using natural resources.

ACKNOWLEDGMENT

The authors thank the student research group in the Animal Science Study Program, which has helped carry out the research from farm to laboratory. This study was supported by the Directorate of Vocational Higher Education (DAPTV), Directorate General of Vocational Higher Education (DIKSI), Ministry of Education, Culture, Research and Technology (KEMDIKBUDRISTEK) through Penelitian Dosen Pemula (PDP) program with Master Contract Number: 104/SPK/D.D4/PPK.01.APTV/III/2024.

REFERENCES

Adriaensen, H., Parasote, V., Castilla, I., Bernardet, N., Halgrain, M., Lecompte, F., & Réhault-Godbert, S. (2022). How egg storage duration prior to incubation impairs egg quality and chicken embryonic development: contribution of imaging technologies. *Frontiers in Physiology*, *13*(902154), 1–12. https://doi.org/10.3389/fphys.2022.902154

Agustina, L., Syahrir, S., Purwanti, S., Jillbert, J., Asriani, A., & Jamilah. (2017). Ramuan herbal pada ayam ras petelur Kabupaten Sidenreng Rappang. *Abdimas*, *21*(1), 47–53.

Akpinar, G. C., Canogullari, S., Baylan, M., Alasahan, S., & Aygun, A. (2015). The use of propolis extract for the storage of quail eggs. *Journal of Applied Poultry Research*, *24*(4), 427–435. https://doi.org/10.3382/japr/pfv043

Asnawi, Ichsan, M., & Haryani, N. K. D. (2017). Nilai nutrisi pakan ayam ras petelur yang dipelihara peternak rakyat di Pulau Lombok. *Jurnal Sains Teknologi & Lingkungan*, *3*(2), 18–27. https://doi.org/10.29303/jstl.v3i2.17

Association Official Analitycal Chemistry [AOAC]. (2005). *Official Method of Analysis* (18th ed.). AOAC Inc.

Aulia, E., Dihansih, E., & Kardaya, D. (2016). Kualitas telur itik alabio (Anas plathyryncos Borneo) yang diberi ransum komersil dengan tambahan kromium (Cr). *Jurnal Peternakan Nusantara*, *2*(2), 79–85.

Azizah, N., Djaelani, A. M., & Mardiati, S. M. (2017). Kandungan protein, indeks putih telur (IPT) dan haugh unit (HU) telur itik setelah perendaman dengan larutan daun jambu biji (Psidium guajava) yang disimpan pada Suhu 27°C. *Buletin Anatomi Dan Fisiologi*, *3*(1), 46–55. https://doi.org/https://doi.org/10.14710/baf.3.1.2018.46-55

Bilyaro, W., Lestari, D., & Endayani, A. S. (2021). Identifikasi kualitas internal telur dan faktor penurunan kualitas selama penyimpanan. *Journal of Agriculture and Animal Science (Agrimals)*, *1*(2), 55–62.

Caner, C., & Yüceer, M. (2015). Efficacy of various protein-based coating on enhancing the shelf life of fresh eggs during storage. *Poultry Science*, *94*(7), 1665–1677. https://doi.org/10.3382/ps/pev102

Cantu, K., Archer, G. S., Tucker, Z. S., & Coufal, C. D. (2019). Effectiveness of duck hatching egg sanitization with the combination of hydrogen peroxide and ultraviolet light. *Journal of Applied Poultry Research*, *28*(2), 301–306. https://doi.org/10.3382/japr/pfy070

Cedro, T. M. M., Calixto, L. F. L., Gaspar, A., Curvello, F. A., & Hora, A. S. (2009). Internal quality of conventional and omega-3-enriched commercial eggs stored under different temperatures. *Brazilian Journal of Poultry Science*, *11*(3), 181–185.

Cornelia, A., Suada, I. K., & Rudyanto, M. D. (2014). Perbedaan daya simpan telur ayam ras yang dicelupkan dan tanpa dicelupkan larutan kulit manggis. *Indonesia Medicus Veterinus*, *3*(2), 112–119.

Datukramat, D. F., Hadju, R., Yelnetty, A., & Tamasoleng, M. (2021). Pengaruh penggunaan larutan kulit pisang goroho (Musa acuminate L) terhadap sifat fisik telur ayam ras. *Zootec*, *41*(1), 174–180.

De Reu, K., Grijspeerdt, K., Herman, L., Heyndrickx, M., Uyttendaele, M., Debevere, J., Putirulan, F., & Bolder, N. M. (2006). The effect of a commercial UV disinfection system on the bacterial load of shell eggs. *Letters in Applied Microbiology*, *42*(2), 144–148. https://doi.org/10.1111/j.1472-765X.2005.01825.x

Djaelani, M. A. (2015). Pengaruh pencelupan pada air mendidih dan air kapur sebelum penyimpanan terhadap kualitas telur ayam ras (Gallus L.). *Buletin Anatomi Dan Fisiologi*, *23*(1), 24–30.

Djaelani, M. A. (2016). Ukuran rongga udara, pH telur dan diameter putih telur, ayam ras (Gallus L.) setelah pencelupan dalam larutan rumput laut dan disimpanan beberapa waktu. *Buletin Anatomi Dan Fisiologi*, *1*(1), 19–23. ejournal2.undip.ac.id/index.php/baf/index

Drabik, K., Próchniak, T., Spustek, D., Wengerska, K., & Batkowska, J. (2021). The impact of package type and temperature on the changes in quality and fatty acids profile of table eggs during their storage. *Foods*, *10*(9), 1–10. https://doi.org/10.3390/foods10092047

Eke, M. O., Olaitan, N. I., & Ochefu, J. H. (2013). Effect of storage conditions on the quality attributes of shell (table) eggs. *Nigerian Food Journal* , *31*(2), 18–24. www.nifst.org

Espíndola, M. H. D. M., Rodrigues, G. D., Dahlke, F., Hauptli, L., Cristofolini, A. C., Pires, P. G. S., & Moraes, P. D. O. (2019). Use of coating based on cassava starch on the quality of free-range eggs stored at room temperature. *Boletim Do Centro de Pesquisa de Processamento de Alimentos*, *37*(2), 59–67. https://doi.org/10.5380/bceppa.v37i2.78307

Ezazi, A., Javadi, A., Jafarizadeh-Malmiri, H., & Mirzaei, H. (2021). Development of a chitosan-propolis extract edible coating formulation based on physico-chemical attributes of hens' eggs: Optimization and characteristics edible coating of egg using chitosan and propolis. *Food Bioscience*, *40*. https://doi.org/10.1016/j.fbio.2021.100894

Febriana, E., & Chaidir, R. R. A. (2023). Aktivitas antibakteri ekstrak daun jati (Tectona grandis) terhadap bakteri Coliform pada produk ikan nila (Oreochromis niloticus). *Jurnal Tambora*, *7*(2), 33–37. http://jurnal.uts.ac.id

Feddern, V., de Prá, M. C., Mores, R., Nicoloso, R. da S., Coldebella, A., & de Abreu, P. G. (2017). Egg quality assessment at different storage conditions, seasons and laying hen strains. *Ciencia e Agrotecnologia*, *41*(3), 322–333. https://doi.org/10.1590/1413-70542017413002317

Fildza, H. F., Rindya, M. A., Masfiyah, & Rina, W. (2017). The test on the activity of ethanolic teak leaves extract (Tectona grandis L f.) in inhabiting the growth of bacteria by in vitro. *Media Farmasi Indonesia*, *12*(1), 1167–1175.

Fitriani, E., Isdadiyanto, S., & Tana, S. (2016). Kualitas kerabang telur pada berbagai itik petelur lokal di balai pembibitan dan budidaya ternak non ruminansia (BPBTNR), Ambarawa. *BIOMA*, *18*(2), 107–113.

Ghareeb, M. A., Shoeb, H. A., Madkour, H. M. F., Refaey, L. A.-G., Mohamed, M. A.-M., & Saad, A. M. (2014). Antioxidant and cytotoxic activities of Tectona grandis Linn. leaves. *International Journal of Phytopharmacology*, *5*(2), 143–157.

Hadiwiyoto. (1983). *Pengolahan Hasil Hewani Daging dan Telur*. UGM Press.

Hagan, J. K., & Eichie, F. O. (2019). Egg quality of two layer strains as influenced by extended storage periods and storage temperatures. *Livestock Research for Rural Development*, *21*(9).

Irmawaty, Putri, A. A. D., Hidayat, M. N., & Kiramang, K. (2022). Kualitas fisik dan protein telur ayam ras dengan virgin coconut oil dan minyak zaitun serta lama penyimpanan yang berbeda. *Jurnal Ilmu Dan Industri Peternakan*, *8*(2), 135–149. https://doi.org/10.24252/jiip.v8v2

Jazil, N., Hintono, & Mulyani, S. (2013). Penurunan kualitas telur ayam ras dengan intensitas warna coklat kerabang berbeda selama penyimpanan. *Jurnal Aplikasi Teknologi Pangan*, *2*(1), 43–47. www.journal.ift.or.id

Kamini, Suptijah, P., Santoso, J., & Suseno, S. H. (2016). Ekstraksi dry rendering dan karakterisasi minyak ikan dari lemak jeroan hasil samping pengolahan salai patin siam. *JPHPI*, *19*(3), 196–205. https://doi.org/10.17844/jphpi.2016.19.3.196

Khan, M. H., Shan, T., Fozia, Mandokhail, N. U., Hassan, S. I., Ihtesham, Y., Binyamin, I., Ahmad, W., & Naz, S. (2020). Effect of different storage time on external and internal characteristics of eggs of hen (Gallus gallus domesticus). *International Journal on Emerging Technologies*, *11*(5), 642–646. https://www.researchgate.net/publication/349502641

Khan, M. J. A., Khan, S. H., Bukhsh, A., & Amin, M. (2014). The effect of storage time on egg quality and hatchability characteristics of Rhode Island Red (RIR) hens. *VETERINARSKI ARHIV*, *84*(3), 291–303.

Kim, S. H., No, H. K., Kim, S. D., & Prinyawiwatkul, W. (2006). Effect of plasticizer concentration and solvent types on shelf-life of eggs coated with chitosan. *Journal of Food Science*, *71*(4), 349–353. https://doi.org/10.1111/j.1750-3841.2006.00008.x

Kurniati, I., & Kalsum, U. (2018). Analisis pertumbuhan Escherichia coli dan Salmonella typhi pada media MacConcey Agar (MCA) dengan penambahan ekstrak daun jati (Tectona grandis L.f.). *Staba*, *2*(1), 7–11.

Kurniawan, D., Soetrisno, E., & Suharyanto. (2021). Pengaruh perendaman telur ayam ras ke dalam air rebusan daun melinjo (Gnetum gnemon L.) terhadap oksidasi, daya buih dan kualitas internal. *Jurnal Ilmiah Peternakan Terpadu*, *9*(3), 311–327. https://doi.org/https://dx.doi.org/10.23960/jipt. v9i3.p311-327

Leandro, N. S. M., De Deus, H. A. B., Stringhini, J. H., Café, M. B., Andrade, M. A., & De Carvalho, E. F. B. (2005). Aspectos de qualidade interna e externa de ovos comercializados em diferentes estabelecimentos na região de goiânia. *Ciência Animal Brasileira v*, *6*(2), 71–78.

Lestari, S., Malaka, R., & Garantjang, S. (2013). Pengawetan telur dengan perendaman ekstrak daun melinjo (Gnetum gnemon Linn). *Jurnal Sains & Teknologi184*, *13*(2), 184–189. https://www.researchgate.net/publication/331534050

Liu, Y.-C., Chen, T.-H., Wu, Y.-C., Lee, Y.-C., & Tan, F.-J. (2016). Effects of egg washing and storage temperature on the quality of eggshell cuticle and eggs. *Food Chemistry*, *211*, 687–693. https://doi.org/10.1016/j.foodchem.2016.05.056

Loffredi, E., Grassi, S., & Alamprese, C. (2021). Spectroscopic approaches for non-destructive shell egg quality and freshness evaluation: Opportunities and challenges. *Food Control*, *129*(108255), 1–10. https://doi.org/https://doi.org/10.1016/j.foodcont.2021.108255

Maharani, N., Aisiyah, S., & Purwaningsih, D. (2021). Formulasi mouthwash ekstrak kulit buah nanas (Ananas comosus (l.) Merr) dengan variasi konsentrasi gliserin sebagai antibakteri terhadap Streptococcus mutans ATCC 25175. *Journal of Pharmacy*, *10*(2), 8–19. https://doi.org/https://doi.org/10.37013/jf.v10i2.137

Malangngi, L. P., Sangi, M. S., & Paendong, J. J. E. (2012). Penentuan kandungan tanin dan uji aktivitas antioksidan ekstrak biji buah alpukat (Persea americana Mill.). *JURNAL MIPA UNSRAT ONLINE*, *1*(1), 5–10. http://ejournal.unsrat.ac.id/index.php/jmuo

Mangalisu, A., & Armayanti, A. K. (2020). Pemanfaatan daun mangrove (Rhizophora mucronata) sebagai pengawet alami telur ayam ras. *Jurnal Agrominansia*, *5*(1), 28–35.

Necidová, L., Bursová, Š., Ježek, F., Haruštiaková, D., Vorlová, L., & Golian, J. (2019). Effect of preservatives on the shelf-life and sensory characteristics of pasteurized liquid whole egg stored at 4°C. *Poultry Science*, *98*(11), 5940–5948. https://doi.org/10.3382/ps/pez378

Nidavani, R. B., & Am, M. (2014). Teak (Tectona grandis Linn.): a renowned timber plant with potential medicinal values. *International Journal of Pharmacy and Pharmaceutical Sciences*, *6*(1), 48–54.

Nuri, Puspitasari, E., Hidayat, M. A., Ningsih, I. Y., Triatmoko, B., & Dianasari, D. (2020). Pengaruh metode ekstraksi terhadap kadar fenol dan flavonoid total, aktivitas antioksidan serta antilipase daun jati belanda (Guazuma ulmifolia). *Jurnal Sains Farmasi & Klinis*, *7*(2), 143–150. https://doi.org/10.25077/jsfk.7.2.143-150.2020

Okatama, M. S., Maylinda, S., & Nurgiartiningsih, V. M. A. (2018). Hubungan bobot telur dan Iideks telur dengan bobot tetas itik dabung di Kabupaten Bangkalan. *Jurnal Ternak Tropika*, *19*(1), 1–8. https://doi.org/10.21776/ub.jtapro.2018.019.01.1

Oktavia, S. N., Wahyuningsih, E., Andasari, S. D., & Normaidah. (2020). Skrining fitokimia dari infusa dan ekstrak etanol 70% daun cincau hijau(Cyclea barbata Miers). *Jurnal Ilmu Farmasi*, *11*(1), 2685–1229.

Oliveira, B. L., & Oliveira, D. D. (2013). *Egg Quality and Technology*. UFLA.

Oliveira, G. da S., McManus, C., Pires, P. G. da S., & Santos, V. M. dos. (2022). Combination of cassava starch biopolymer and essential oils for coating table eggs. *Frontiers in Sustainable Food Systems*, *6*(957229), 1–9. https://doi.org/10.3389/fsufs.2022.957229

Ouchari, L., Boukeskasse, A., Bouizgarne, B., & Ouhdouch, Y. (2019). Antimicrobial potential of actinomycetes isolated from the unexplored hot Merzouga desert and their taxonomic diversity. *Biology Open*, *8*(2). https://doi.org/10.1242/bio.035410

Pan, D., Li, R., Li, Y., Gao, X., Fan, X., Du, Q., & Zhou, C. (2022). Effects of manual washing with three alkaline sterilizing agent solutions on egg quality during storage. *Food Chemistry*, *396*(133722), 1–12. https://doi.org/10.1016/j.foodchem.2022.133733

Pires, P. G. S., Machado, G. S., Franceschi, C. H., Kindlein, L., & Andretta, I. (2019). Rice protein coating in extending the shelf-life of conventional eggs. *Poultry Science*, *98*(4), 1918–1924. https://doi.org/10.3382/ps/pey501

Pissinati, A., Oba, A., Yamashita, F., Da Silva, C. A., Pinheiro, J. W., & Roman, J. M. M. (2014). Internal quality of eggs subjected to different types of coating and stored for 35 days at 25 °C. *Semina: Ciencias Agrarias*, *35*(1), 531–540. https://doi.org/10.5433/1679-0359.2014v35n1p531

Putri, D. A. M., Djaelani, M. A., & Mardiati, S. M. (2016). Bobot, indeks kuning telur (IKT), dan haugh unit (HU) telur ayam ras setelah perlakuan dengan pembungkusan pasta rimpang temulawak (Curcuma xanthorrhiza Roxb). *BIOMA*, *18*(1), 7–13.

Ramadani, A. H., Karima, R., & Ningrum, R. S. (2022). Indonesian Journal of Chemical Research Antibacterial Activity of Pineapple Peel (Ananas comosus) Eco-enzyme Against Acne Bacteria (Staphylococcus aureus and Prapionibacterium acnes). *J. Chem. Res*, *9*(3), 201–207. https://doi.org/10.30598//ijcr

Rêgo, I. O. P., Menezes, L. D. M., Figueiredo, T. C., Oliveira, D. D., Rocha, J. S. R., Lara, L. J. C., Lima, A. L., Souza, M. R., & Cançado, S. V. (2014). Bioactive amines and microbiological quality in pasteurized and refrigerated liquid whole egg. *Poultry Science*, *93*(4), 1018–1022. https://doi.org/10.3382/ps.2013-03694

Riawan, Riyanti, & Khaira Nova. (2017). Pengaruh perendaman telur menggunakan larutan daun kelor terhadap kualitas internal telur ayam ras. *Jurnal Ilmiah Peternakan Terpadu*, *5*(1), 1–7. https://doi.org/http://dx.doi.org/10.23960/jipt.v5i1.p1-7

Rodrigues Mendes, F., Auxiliadora Andrade, M., Souza Santana, E., Ricardo de Sá Costa Leite, P., Juliana Ribeiro Lacerda, M., & Susana Mogyca Leandro, N. (2014). Perda de peso de ovos comerciais sanitizados, contaminados experimentalmente com Pseudomonas aeruginosa. *Global Science and Technology*, *7*(2), 48–55.

Salam, S., Fatahilah, A., Sunarti, D., & Isroli. (2013). Berat karkas dan lemak abdominal ayam broiler yang diberi tepung jintan hitam (Nigella sativa) dalam ransum selama musim panas. *Sains Peternakan*, *11*(2), 84–90.

Saleh, G., El Darra, N., Kharroubi, S., & Farran, M. T. (2020). Influence of storage conditions on quality and safety of eggs collected from Lebanese farms. *Food Control*, *111*(107058), 1–8. https://doi.org/10.1016/j.foodcont.2019.107058

Samli, H. E., Agma, A., & Senkoylu, N. (2005). Effects of storage time and temperature on egg quality in old laying hens. *J. Appl. Poult. Res.*, *14*, 548–553.

Setiawati, T., Afnan, R., & Ulupi, N. (2016). Performa produksi dan kualitas telur ayam petelur pada sistem litter dan cage dengan suhu kandang berbeda. *Jurnal Ilmu Produksi Dan Teknologi Peternakan*, *4*(1), 197–203.

SNI 3926:2008 Telur Ayam Konsumsi, Standar Nasional Indonesia 1 (2008). http://sispk.bsn.go.id/SNI/DetailSNI/14328

Soares, A. C. B., Brito, D. A. P., Soares, S. C. P., Gomes, K. S., Saldanha, G. K. M. S., & Soares, V. da S. (2022). Maintenance of quality of eggs submitted to treatment with propolis extract and sanitizers. *Acta Scientiarum - Animal Sciences*, *44*. https://doi.org/10.4025/actascianimsci.v44i1.53584

Soares, R. de A., Borges, S. V., Dias, M. V., Piccoli, R. H., Fassani, E. J., & da Silva, E. M. C. (2021). Impact of whey protein isolate/sodium montmorillonite/sodium metabisulfite coating on the shelf life of fresh eggs during storage. *LWT - Food Science and Technology*, *139*(110611), 1–6. https://doi.org/10.1016/j.lwt.2020.110611

Sudrajat, D., Priytana, F., & Nur, H. (2019). Kualitas telur ayam yang diberi ransum mengandung pakan non-konvensional terfermentasi. *Jurnal Pertanian*, *10*(1), 16–22.

Sumiati, Erwan, Purnamasari, D. K., Syamsuhaidi, & Suhartini. (2021). Potensi kerabang telur dalam pakan ayam ras telur telur. *JURNAL SAINS TEKNOLOGI & LINGKUNGAN*, 287–296. https://doi.org/10.29303/jstl.v0i0.281

Triawan, D. A., Desenze, T., Notriawan, D., & Emis, G. (2021). Pengawetan telur ayam ras dengan perendaman ekstrak daun jambu biji (Psidium guajava) pada suhu ruang. *Rafflesia Journal of Natural and Applied Sciences*, *1*(2), 90–98. https://doi.org/https://doi.org/10.33369/rjna.v1i2.22521

United States Standards, Grades, and Weight Classes for Shell Eggs, United States Department of Agriculture (2000). www.ams.usda.gov/poultry.

Warganegara, E., & Restina, D. (2016). Getah jarak (Jatropha curcas L.) sebagai penghambat pertumbuhan bakteri Streptococcus mutans pada karies gigi. *Majority*, *5*(3), 62–67.

Warnis, M., Aprilina, L. A., & Maryanti, L. (2020). Pengaruh suhu pengeringan simplisia terhadap kadar flavonoid total ekstrak daun kelor (Moringa oleifera L.). *Prosiding Seminar Nasional Kahuripan I* , 264–268.

Winarno, F. G., & Koswara, S. (2002). *Telur: Komposisi, Penanganan and Pengolahannya*. M-Brio Press.

Xavier, I. M. C., Cançado, S. V, Figueiredo, T. C., Lara, L. J. C., Lana, A. M. Q., Souza, M. R., & Baião, N. C. (2008). Qualidade de ovos de consumo submetidos a diferentes condições de armazenamento. *Arq. Bras. Med. Vet. Zootec*, *60*(4), 953–959.

Xu, D., Wang, J., Ren, D., & Wu, X. (2018). Effects of chitosan coating structure and changes during storage on their egg preservation performance. *Coatings*, *8*(317), 1–11. https://doi.org/10.3390/COATINGS8090317

Yuceer, M., & Caner, C. (2014). Antimicrobial lysozyme-chitosan coatings affect functional properties and shelf life of chicken eggs during storage. *Journal of the Science of Food and Agriculture*, *94*(1), 153–162. https://doi.org/10.1002/jsfa.6322

Yuwanta, T. (2010). *Telur and Kualitas Telur*. UGM Press.