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The Effect of Using Edible Coating Whey Protein Isolate and Chitosan with the Addition of 0.1% Sodium Tripolyphosphate on the Quality of Chicken Egg

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Abstract— *Chicken eggs are one of the most widely consumed livestock products in the world. Chicken eggs have high nutritional value needed by humans, but chicken eggs are easily damaged or changed during storage. Packaging using natural packaging materials such as edible coatings can be used to maintain the quality of chicken eggs during storage. This study aims to assess the quality of chicken eggs during 21 days of storage at room temperature with whey protein isolate and chitosan edible coating with the addition of 0.1% sodium tripolyphosphate. The materials used are fresh chicken eggs and edible coating whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate. The research method used was a completely randomized design (CRD) using 4 treatments and 4 repetitions with T0 being chicken eggs with coatings stored on the first day, T1 with 7 days storage, T2 with 14 days storage, and T3 with 21 days storage. Data were analyzed by Analysis of Variance (ANOVA) and continued by Duncan's Multiple Range Test (DMRT). The results showed that eggs coated with edible coating whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate had a very significant effect (P<0.01) on the haugh value of egg units, egg white pH, egg yolk pH, foaming power. eggs, and total contamination of Salmonella sp. Edible coating of whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate can maintain the quality of chicken eggs during storage at room temperature*.

Keywords— *Edible coating, Whey Protein Isolate, Chitosan, Sodium tripolyphosphate, Chicken eggs*.

I. INTRODUCTION

Eggs are a food that has been widely consumed by people in the world. Eggs are easily broken. The fragile nature causes economic losses also related to the decrease in interior quality and microbial contamination during egg storage. Fresh eggs are eggs that have just been laid by the mother duck in the nest, fresh eggs have a short shelf life. Fresh eggs if left in the open air (room temperature) only last between 10-14 days, after that time the eggs experience changes towards damage such as evaporation of water content through the pores of the egg shell which results in reduced egg weight, changes in chemical composition and dilution of the egg contents. Edible coatings can be used as a barrier to transfer moisture, gas, and egg odors during storage. In previous research, edible coating is a thin layer that can be eaten and can be used to preserve meat (Apriliyani, et. al. 2020). Edible coating is a thin layer that can be eaten and applied in liquid form on the surface of the product by spraying, dipping, basting or other methods (Pascall and Shin, 2013). Edible coatings are easy to apply and have many beneficial benefits. These benefits include preventing the entry of air from outside, preventing the increase in product moisture, increasing sensory perception of consumers, increasing preferences, protecting products from microbial exposure and extending the shelf life of a product. The ingredients for making edible coatings in this study were whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate. Whey protein isolate is one of the proteins found in milk. Whey protein as an edible base ingredient can produce an edible coating that is transparent, flexible, odorless, and has aroma retaining properties from the food product it is coated with (Al Awwaly, et al., 2010). The next material used for the manufacture of edible coatings is chitosan. Chitosan has been widely used as a material for making biodegradable films and food preservatives that are resistant to microbes, the antibacterial properties of chitosan come from the polymer structure which has positively charged amine groups, while other polysaccharides are generally negatively charged or neutral (Perinelli, et al., 2018). The addition of 0.1% sodium tripolyphosphate to the edible coating is used as a crosslink agent. Sodium tripolyphosphate is one of the materials that can be used as a cross linking agent that changes the starch structure to make it stronger and can be used as a reagent that can strengthen the bond between amylose and amylopectin (Akbar, et al., 2014). Edible coating is an effort that can be used to maintain egg freshness and egg quality during storage. Edible coating is a thin layer that can be consumed and can provide a barrier against oxygen, microorganisms or external sources, moisture and dissolved substances in food (Saleem, et al., 2021). This coating aims to extend the shelf life of food products such as chicken eggs. The aim of this study was to examine the quality of chicken eggs during 21 days of storage at room temperature by coating whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate.

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II. MATERIAL AND METHOD

Research Materials

The materials used are edible coatings made from whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate and one day old fresh chicken eggs from the Teaching Farm of the Faculty of Animal Husbandry, University of Brawijaya Malang.

Experimental Design and Treatment

Laboratory experiment method and Completely Randomized Design (CRD) were used in this study with four treatments and four replications as follows:
T0: egg coating treatment with 0 days storage
T1: egg coating treatment with 7 days storage
T2: egg coating treatment with 14 days storage
T3: egg coating treatment with 21 days storage

Preparation of edible coatings

Making edible coatings is done by modifying the ingredients and manufacturing process (Fabra, et al., 2013). The process of making edible coatings is carried out by dissolving chitosan using 2% acetic acid with a ratio of 2 grams of chitosan: 100 ml of 2% acetic acid and dissolving whey protein isolate using distilled water with a ratio of 2.5 g whey protein isolate : 100 ml of distilled water. Sodium tripholyphospate solution is prepared by dissolving sodium tripholyphospate in distilled water with a ratio of 0.05 gram sodium tripholyphospate:50 ml of distilled water. The whey protein isolate solution, chitosan solution, and sodium tripholyphospate solution were then homogenized together and heated at ≤ 50°C for 30 minutes. Add 25µl of 80% tween. Tween 80 1% as a surfactant in edible coatings. The solution was heated using a magnetic stirrer at ≤ 50°C for 2 hours.

Application of edible coating to chicken eggs

Chicken eggs are cleaned before being coated. The coating process is done by dipping the egg into the edible coating solution. Immersion was carried out three times. The coated eggs were placed on the egg tray and waited for 0 days, 7 days, 14 days and 16 days.

Variable analysis

Haugh units of chicken eggs (Shan, et. al., 2020)

Haugh units are measured by measuring the height of the egg white and yolk which is done by carefully breaking the egg on a flat glass surface. The tool used is a ruler or caliper for haugh unit calculations. Egg white height and egg weight are measured using a scale. Haugh Unit calculations are as follows:

HU = 100 log (H + 7.57 – 1.7 W0.37)

Description:
H = albumin height (mm)
W = egg weight (grams)
HU = haugh units

Egg white pH and pH chicken egg yolk (Araujo Soares, et. al., 2021)

The pH of the yolk and the pH of albumin were measured using a pH meter. About 2 grams of sample was homogenized in 20 ml of distilled water. The pH meter was standardized using pH 4 and 7 buffers. The pH meter was rinsed with distilled water. Dry the pH meter using a tissue or cloth, dip the pH meter into the egg white and egg yolk samples.

Chicken egg foaming

Test was carried out using the procedure from Ozer and Agan (2020). The foaming test procedure was carried out by breaking the eggs and beating with a mixer in a 600 ml beaker glass at medium speed for 5 minutes. Foaming power is calculated using the formula:

Foaming Power=F2-F1/(F1)x 100%

Description:
F1 = Initial Volume
F2 = Volume of foam formed after shaking

Total contamination of Salmonella sp. on chicken eggs (Rahman, et. al. 2019)

Testing for total Salmonella sp in samples of chicken eggs taken from the egg shell and the inside of the egg. The egg sample is broken and the egg contents are put into a sterile beaker glass to homogenize by stirring until the egg whites and yolks are mixed evenly. The media that will be used is prepared, namely Salmonella Shigella Agar (SSA) selective media. Part of the egg shell was wiped using a sterile cotton swab, from the sample on Salmonella Shigella Agar (SSA) medium. Isolation was also carried out on the egg content of 1 ml from each dilution (10-1, 10-2, and 10-3), put in two different sterile petri dishes. Incubated in an incubator at 370C for 2 x 24 hours.

Collections and Data Analysis

Research data was collected and analyzed using Analysis of Variance (ANOVA). If there are results that show a significantly different effect or very significantly different between treatments, then proceed with Duncan's Multiple Range Test (UJBD).

III. RESULT AND DISSCUSSION

Haugh units of chicken eggs

The results of the analysis of Haugh units of chicken eggs with edible coating whey protein isolate and chitosan with the addition of 0.1% sodium tripholyphospate are presented in table 1.

TABLE 1. Haugh units of chicken eggs

Group	%
T_0	99,386±3,603^{c}
T_1	84,857±4,882^{b}
T_2	73,062±28,528^{b}
T_3	37,752±12,751^{a}

Data present: ^{a,b,c} Different superscripts show highly significant differences (P<0.01) to the haugh unit of chicken eggs coated with an edible coating.

Based on Haugh analysis of chicken egg units coated with whey-chitosan protein isolate edible coating with the addition of 0.1% sodium tripolyphosphate, it had a very significant effect (P<0.01) on the haugh units of chicken eggs during storage. The Haugh average of chicken egg units coated with an edible coating of whey-chitosan protein isolate with the addition of 0.1% sodium tripolyphosphate during storage was 99.386% -37.752%. The longer storage shows a decrease in the Haugh unit value in fresh eggs. The decrease in Haugh units in

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eggs occurs due to the dilution of egg white which results in the evaporation of CO2 gas so that the pH rises and accelerates the breakdown of ovomucin. Ovomucin is a glycoprotein in the form of fibers and can bind water to form a gel structure (Sirait, 1986). Based on the analysis of the average haugh unit of chicken eggs during the study, coating the edible coating of whey-chitosan protein isolate with the addition of 0.1% sodium tripolyphosphate could slow down the decline in haugh units of chicken eggs stored at room temperature for 21 days. Coating edible coating on chicken eggs can coat the eggshells well so that they cover the pores of the chicken eggshells thereby minimizing the gas inside the eggs evaporating which can reduce the quality of the chicken eggs during storage. Freshly laid eggs or fresh eggs have a haugh unit value of 100 (Purwati, et al., 2015). According to Chang-Ho, et al. (2014), that the Haugh Unit (HU) value is an indicator of the freshness of eggs which consistently decreases with increasing length of egg storage at room temperature.

pH albumin of chicken egg

The results of the analysis of the pH albumin of chicken egg with edible coating coating of whey protein isolate and chitosan with the addition of 0.1% sodium tripholyphospate are presented in table 2.

TABLE 2. pH albumin chicken egg

Group	pH albumin
T_0	8,23±0,13[a]
T_1	8,66±0,25[b]
T_2	8,72±0,11[bc]
T_3	9,07±0,24[c]

Data present: [a,b,bc,c] Different superscripts show very significant differences (P<0.01) to pH chicken egg white with edible coating coating.

The edible coating is better at maintaining the pH albumin quality of chicken egg during storage. The results of the analysis of the pH of chicken egg albumin by coating whey-chitosan protein isolate edible coating with the addition of 0.1% sodium tripolyphosphate had a very significant effect (P<0.01) on the pH of chicken egg albumin during 21 days of storage at room temperature. Chicken eggs covered with edible coating on the first day of storage had an average egg pH albumin of 8.23 and increased with storage time. The average pH albumin value of chicken egg during 7 days storage was 8.66, 14 days storage was 8.72, and 21 days storage was 9.07. Edible coatings that coat chicken eggs can cover the surface of the eggs so that they can reduce the release of CO_2 through the pores which act as a barrier. In accordance with the statement of Mostafavi and Zaeim (2020) that edible coatings can function as a barrier, carrier for food additives, such as having medicinal properties, antimicrobial, flavoring, and nutrition. The length of storage of chicken eggs affects the pH value because during storage the edible coating coating on the chicken eggs also reduces the pH albumin value of the egg. According to Idris (1984) normally during storage there will be an increase in the pH albumin value of chicken egg due to the decomposition of carbonate salts in eggs into CO_2 and H_2O which come out through the shell.

pH of chicken egg yolk

The results of the analysis of the pH yolk of chicken egg with edible coating of whey protein isolate and chitosan with the addition of 0.1% sodium tripholyphospate are presented in Table 3.

TABLE 3. The pH yolk of chicken egg

Group	pH egg yolk
T_0	8,23±0,13[a]
T_1	8,66±0,25[b]
T_2	8,72±0,11[bc]
T_3	9,07±0,24[c]

Data present: [a,b,bc,c] Different superscripts show very significant differences (P<0.01) to pH yolk of chicken egg with edible coating.

The results of the analysis of the pH yolk of chicken egg by coating whey-chitosan protein isolate edible coating with the addition of 0.1% sodium tripolyphosphate had a very significant effect (P<0.01) on the pH yolk of chicken egg during 21 days of storage at room temperature. The average pH yolk of chicken egg coated with an edible coating of whey-chitosan protein isolate with the addition of 0.1% sodium tripolyphosphate during 21 days of storage was 6.03-6.32. Based on the pH yolk value of fresh egg, it can be said that chicken egg yolks with edible coating and without coating are still close to the pH yolk of fresh egg. Normal pH yolk in chicken egg according to Todja, et al. (2019) that is between 6.0-6.9. Storage time also affects the increase in the pH yolk of chicken egg. Evaporation of CO_2 and water present in eggs affects the pH albumin and the pH yolk. The pH becomes alkaline because the water and CO_2 in the egg are decreasing. The increase in the pH yolk of the egg is due to high evaporation of CO_2 which increases the degree of acidity of the egg albumin and yolk (Xu, et. al., 2018).

Foaming power chicken egg

The results of chicken egg foaming analysis by coating whey protein isolate and chitosan with the addition of 0.1% sodium tripholyphospate are presented in Table 4.

TABLE 4. Chicken egg foaming power

Group	%
T_0	439,00±14,72[c]
T_1	399,50±34,07[b]
T_2	366,50±47,17[b]
T_3	309,00±33,67[a]

Data present:[a,b,c] Different superscripts show a very significant difference (P<0.01) to the foaming power of chicken eggs with an edible coating.

Foaming power is the ability of egg albumin to form foam when shaken. The value of foaming power is usually expressed as a percentage of the weight of egg albumin (Stadelman and Cotterill, 1995). The results of the analysis of the foaming power of chicken eggs by coating whey protein-chitosan isolate edible coating with the addition of 0.1% sodium tripolyphosphate had a very significant effect (P<0.01) on the foaming ability of chicken eggs during storage. The average foaming power of chicken eggs coated with edible coating whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate was 439.00% -309.00%. Coating of whey protein and chitosan isolate edible coating with the addition of 0.1% sodium tripolyphosphate was able to maintain foam during 21 days of storage at room temperature. One of the basic ingredients used in the manufacture of edible coatings is chitosan. Chitosan is a natural coating that is edible and can be used as an ingredient for coating food which has a function as a barrier against moisture and oxygen in a product (Henriette, et al., 2010). Under untreated conditions, the eggs will experience a decrease in pH during a long storage period which will affect the foaming power of the eggs. Storage time will affect chicken egg albumin. The longer the storage of chicken egg whites will experience dilution. Watery egg whites result in smaller surface tension so that air enters more quickly and affects the egg's foaming power. Foaming and stability are influenced by several factors, namely egg age, storage temperature, pH, egg quality, shaking time and additional ingredients added (Winarno and Koswara, 2002).

Contamination of Salmonella sp. in chicken eggs

Contamination of *Salmonella sp.* Chicken eggs with edible coating of whey protein isolate and chitosan with the addition of 0.1% sodium tripholyphospate are presented in table 5.

TABLE 5. *Salmonella sp.* contamination. chicken eggs

Group	Salmonella sp.
T_0	-
T_1	-
T_2	-
T_3	-

Eggs are a livestock product with high nutritional value and are easily damaged. Chicken eggs consist of three main components, namely the egg shell (8-11% of egg weight), egg white (58% of egg weight), and egg yolk (31% of egg weight) (Purwadi, et al., 2017). The main components of the egg can functionally protect the contents of the egg from physical, chemical and microbiological damage. Microbiological damage to eggs is caused by bacteria, including *Salmonella sp.* an important requirement for the quality of products of animal origin such as chicken eggs is that they are free of microbiological pathogens, including free from Salmonella. The eggs used in this study were 0 day old eggs with good quality, the eggs had a fairly thick shell and did not experience cracks. The eggs that have been taken are immediately washed clean to avoid bacterial contamination that occurs before treatment. Based on the results of a study on *Salmonella sp.* contamination on chicken eggs by coating whey-chitosan protein isolate edible coating with the addition of 0.1% sodium tripolyphosphate, it produced negative results on chicken eggs during 21 days of storage. It is suspected that the coating of edible coatings can keep *Salmonella sp.* bacteria contaminated during storage. Coating the edible coating on the chicken eggs makes the chicken egg shells coated and the edible coating sticks to the egg shells and covers the pores of the chicken egg shells, resulting in closed entry points for microbes so that the microbes are difficult or unable to enter the eggs to damage the contents of the chicken eggs. Edible coatings that are antimicrobial have the potential to prevent pathogen contamination in various foodstuffs (Campos, et. al., 2011).

IV. Conclusion

Chicken eggs coated with edible coating whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate can slow down the deterioration of chicken eggs during 21 days of storage in terms of the haugh value of egg units, egg white pH, egg yolk pH, egg foaming power, and total contamination of Salmonella sp. It is recommended to carry out further tests of edible coatings made from whey protein isolate and chitosan with the addition of 0.1% sodium tripolyphosphate as a coating for chicken eggs on the nutritional content of chicken eggs with coating.

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