The Effect of Casein-Chitosan Edible Coating with Garlic Essential Oil Addition on pH, Haugh Unit and Egg Yolk Index Fresh Chicken Egg on Different Storage

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Abstract. Eggs are a source of animal protein needed by the body and contain complete essential amino acids. Chicken eggs are easily damaged or changed so the quality of the eggs decreases with the length of storage. This damage can be prevented by coating. Past studies concluded that edible coating can maintain the quality of chicken eggs. The purpose of this study was to determine the effect of coating chicken eggs using chitosan and casein edible coating with the addition of garlic essential oil. The materials used are fresh chicken eggs, edible coating solution and garlic essential oil. The method used in this study was a laboratory experiment with Completely Randomized Nested Design with 2 treatments and 3 replications. Edible coating with the addition of garlic essential oil is expected to improve egg quality with a long shelf life. The result showed that chicken eggs coated with chitosan casein edible coating with the addition of garlic essential oil 1% for storage time of 0 days, 7 days, 14 days, 21 days and 28 days gave a very significant effect ($P<0,01$) on egg yolk pH, egg albumen pH, haugh unit and egg yolk index.
Keywords: *Edible coating, casein, chitosan, garlic essential oil, egg, different storage*

1 Introduction

Eggs are a source of animal protein needed by the body and contain complete essential amino acids. Eggs are widely consumed by people because they are easy to process, cheap, and contain perfect substances. The nutritional quality of purebred chicken eggs must be maintained at the consumer level so that post-production control of purebred chicken eggs must receive attention. Chicken eggs are easily damaged or changed so the quality of the eggs decreases with the length of storage. Contamination of chicken egg shells by microorganisms originating from broodstock, bedding, livestock processes, processing, handling and storage is the cause of damage to chicken eggs during storage [1].

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This damage can be prevented by coating. One coating that can be used is edible. Edible coating is a natural packaging material for food products that can extend shelf life and is environmentally friendly because it is easily decomposed by microorganisms [2]. The basic ingredients used are casein, chitosan and garlic essential oil. Casein is a protein that is difficult to break down by high heat. Chitosan is a polysaccharide which generally comes from fishery waste such as fish scales, crab shells and shrimp shells. Chitosan functions as a coating on food ingredients to minimize O_2 entering food product ingredients [3]. Garlic (*Allium sativum L*) contains antibacterial, antifungal, hypolipidemic, hypoglycemic, antithrombotic, antioxidant and anticancer compounds [4]. The purpose of this study was to determine the effect of coating chicken eggs using chitosan and casein edible coating with the addition of garlic essential oil. It is hoped that the use of edible coatings made from casein, chitosan and garlic essential oil can be used as coating materials for food products to extend shelf life.

2 Materials and Method

2.1 Material

The materials used are casein (oxoid), chitosan (ocean fresh), gelatin (green valley), garlic essential oil (indoplant), tween, glycerol, acetic acid and distilled water.

2.2 Method

The research method used is a laboratory experiment method that uses a Nested Complete Randomized Design (RAL) consisting of 2 factors, namely the factor of coating fresh chicken eggs with edible coating with 2 treatments 3 times and storage time factors of 0 days, 7 days, 14 days, 21 days and 28 days. The parameters observed were albumin pH, yolk pH, haugh units and yolk index.

2.3 Manufacture of Edible Coating

Manufacture edible coatings by making casein solution and chitosan solution separately. The chitosan solution was made by dissolving 1 g of chitosan with 50 mL of 2% acetic acid (w/v) while stirring for 60 minutes, while the casein solution was made by dissolving 1 g of casein and 40 mL of distilled water (w/v), stirring for 30 minutes. minute. The two solutions were mixed by adding 0.28% glycerol at a temperature ≤ 50°C. The two prepared solutions (casein and chitosan) were mixed together and added with garlic essential oil and 80% tween, then stirred for 120 minutes at a temperature ≤ 50°C. Edible coating solution ready to be coated on eggs.

3 Result and Discussion

3.1 Yolk pH

Table 1 shows the pH of albumin with different storage times. Table 1 shows that treatment without edible coating and edible coating had a very significant effect ($P<0.01$) on the pH of chicken egg yolk. Storage time had a very significant influence ($P<0.01$) on the pH of chicken egg yolk. The lowest average value of yolk pH was at D-0 (6.26), and the highest value was at D-28 (6.91). The longer the shelf life of eggs, the pH of yolk increases. This is due to the evaporation of $C0_2$ causing the buffer system in egg white to decrease due to a dilution in the egg white and a permeation of H_2O from the egg white to the yolk. Evaporation of $C0_2$ causes the buffer system in egg whites to decrease due to a dilution in egg whites and an H_2O permeation from egg whites to egg yolks. [5].

Table 1. value pH yolk with different storage

Treatment	Storage					Average
	D-0	**D-7**	**D-14**	**D-21**	**D-28**	
Without coating	6.24±0.02[a]	6.47±0.04[b]	6.64±0.01[c]	6.65±0.04[c]	7.00±0.11[d]	6.59±0.04
Edible Coating with garlic essential oil	6.27±0.04[a]	6.40±0.04[b]	6.48±0.02[c]	6.72±0.08[d]	6.83±0.11[e]	6.53±0.06
Average	6.26±0.03	6.44±0.04	6.56±0.02	6.69±0.06	6.91±0.11	

The different superscript letters in the same row represent significant differences (P<0.01) among the mean values.

Based on Table 1, edible coating on eggs has a very significant effect on yolk pH (P<0.01). The average pH of yolk from the highest to the highest was eggs not coated by edible coating at 6.59 and eggs coated by edible coating at 6.53. Eggs coated by edible coating have a lower pH because edible coating can withstand the activity and number of bacteria in the egg during shelf life, resulting in an increase in the pH of the yolk. Edible coating can be used as a carrier matrix of active ingredients and food additives such as antimicrobials, antioxidants and flavors to improve the quality of food products [6]. The content of onion essential oil in edible coating also has antimicrobial properties to inhibit bacterial growth increasing pH.

3.2 Albumin pH

Table 2 shows the pH of albumin with different storage times.

Table 2. value pH albumin with different storage

Treatment	Storage					Average
	D-0	**D-7**	**D-14**	**D-21**	**D-28**	
Without coating	8.40±0.06[a]	9.18±0.21[b]	9.36±0.02[c]	9.38±0.03[c]	9.44±0.04[c]	9.15±0.07
Edible Coating with garlic essential oil	8.45±0.11[a]	8.43±0.12[a]	8.37±0.27[a]	8.47±0.10[ab]	8.63±0.05[b]	8.47±0.13
Average	8.43±0.09	8.81±0.17	8.87±0.15	8.93±0.07	9.04±0.05	

The different superscript letters in the same row represent significant differences (P<0.01) among the mean values.

Table 2 shows that the treatment without edible coating and edible coating had a very significant effect (P<0.01) on the pH of chicken egg albumin. Length of storage has a very significant effect (P <0.01) on the pH of chicken egg albumin. The average value of the lowest albumin pH is at D-0 which is 8.43 and the highest is at D-28 which is 9.04. The longer the storage period, the pH of albumin increases. This is due to CO_2 in eggs lost due to the breakdown of bicarbonate ions which results in the concentration of bicarbonate ions in egg whites decreasing resulting in damage to the ovomucin mesh and damage to the buffer system, making albumin alkaline and increasing pH. [7]. Based on Table 2, edible coating on eggs has a very significant effect on albumin pH (P < 0.01). The average value of albumin pH from the highest in a row is eggs that are not coated with edible coating of 9.15 and eggs coated by the edible coating of 8.47. The decrease in pH in coated eggs is because the edible coating used can inhibit the increase in albumin pH because the surface of the egg is covered so that it can prevent CO_2 in the egg from evaporating. Edible coating provides a selective barrier to gas transfer, water vapor and dissolved materials, and can inhibit CO_2 and O_2 gases [8].

3.3 Haugh Unit

Table 3 shows the pH of albumin with different storage times.

Table 3. value pH albumin with different storage

Treatment	Storage					Average
	D-0	**D-7**	**D-14**	**D-21**	**D-28**	
Without coating	104.27±0.89^{a}	72.27±11.64^{b}	62.26±10.57^{c}	54.81±2.67^{d}	43.20±4.10^{d}	68.53±5.97
Edible Coating with garlic essential oil	107.85±1.95^{a}	103.45±2.36^{b}	95.03±6.60^{c}	87.45±4.38^{d}	80.32±3.11^{d}	94.66±3.68
Average	106.06±1.42	87.86±7.00	78.65±8.58	71.13±3.52	61.76±3.61	

The different superscript letters in the same row represent significant differences (P<0.01) among the mean values.

Table 3 shows that the treatment without edible coating and edible coating had a very significant effect (P<0.01) on the haugh unit of chicken eggs. Length of storage had a very significant effect (P<0.01) on the haugh unit value of chicken eggs. The lowest average high unit value is at D-0, which is 61.76, and the highest value is at D-28, which is 106.06. This shows that the longer the storage of the HU value will decrease, this occurs due to the evaporation of water and gases such as CO_2 which causes thick egg whites to become thinner. Based on Table 3, edible coating on eggs significantly affects the HU value. The average value of HU from the highest is eggs coated by edible coating 94.66 and eggs not coated by edible coating at 68.53. The decrease in haugh unit value in chicken eggs coated with edible coating is lower than without coating. The edible coating on chicken eggs can coat the eggshell well to cover the pores of the chicken eggshell to minimize the gas in the egg evaporation which can reduce the quality of chicken eggs during storage. The longer the storage time, the higher the evaporation of CO2 and H2O so that the egg white decreases in viscosity [9]. Dilution of egg white occurs due to changes in its gel structure, due to physico-chemical damage to ovomucin fibers which causes the release of water from the meshes it has formed.

3.4 Egg Yolk Index

Table 4 shows the egg yolk index with different storage times.

Table 4. value egg yolk index with different storage

Treatment	Storage					Average
	D-0	**D-7**	**D-14**	**D-21**	**D-28**	
Without coating	0.45±0.03^{a}	0.38±0.02^{b}	0.25±0.03^{bc}	0.26±0.02^{c}	0.20±0.01^{d}	0.31±0.02
Edible Coating with garlic essential oil	0.43±0.01^{a}	0.46±0.01^{b}	0.44±0.02^{b}	0.42±0.03^{b}	0.37±0.02^{c}	8.47±0.02
Average	0.44±0.02	0.42±0.2	0.35±0.3	0.34±0.03	0.29±0.02	

The different superscript letters in the same row represent significant differences (P<0.01) among the mean values.

Table 4 shows that the treatment without edible coating and edible coating had a very significant effect (P<0.01) on egg yolk index. Length of storage had a very significant effect (P<0.01) on the value of egg yolk index. The lowest mean egg yolk index value was at D-28 which was 0.29 and the highest was at D-0 which was 0.44. The decrease in egg yolk index of chicken eggs coated with edible coating has a better decrease in egg yolk index than eggs without coating. The yolk index of chicken eggs with edible coating ranged from 0.37-0.43. The yolk index of chicken eggs with edible coating is classified as grade II following the standard grade of yolk index value. Based on the Indonesian National Standard (SNI), the yolk index value is divided into three, Grade I with a yolk index value between 0.458-0.521, Grade II with a yolk index value between 0.394-0.457 and Grade III with a yolk index value between 0.330-0.393. Based on Table 4, edible coating on eggs significantly affected the yolk index. The average value of yolk index from the highest to the highest in a row is eggs coated by edible coating 0.42 and eggs not coated by edible coating of 0.31. The longer the storage, the quality of yolk will also decrease due to the weakening of ovumucin fibers which are influenced by an increase in pH so that the vitelin membrane becomes less elastic. The yolk becomes more mushy so that the yolk index decreases, then damages the vitelin membrane, causing the yolk to break [10].

4 Conclusion

The best treatment in this study was eggs coated by edible coating with a shelf life of 28 days. This study shows that edible coating has a significant impact on pH, as well as other quality parameters such as Haugh Unit and egg yolk index. Edible coatings effectively maintain egg quality during storage by protecting against gas evaporation and bacterial activity. In addition, adding garlic essential oil compounds increases the effectiveness of layers. It is recommended to carry out further testing on Edible Coating by increasing the percentage of adding onion essential oil or using other types of essential oil.

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