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Effect of Aloe-Coating Application on Quail Egg Quality During Storage

Ni Ketut Mardewi (Corresponding Author)
Animal Husbandry Study Program, Faculty of Agriculture, Warmadewa University, Denpasar, Indonesia
Email: suriati@warmadewa.ac.id

Luh Suriati
Department of Food Science and Technology, Faculty of Agriculture, Warmadewa University, Denpasar, Indonesia

Ni Made Defy Janurianti
Laboratory of Agricultural Analysis, Faculty of Agriculture, Warmadewa University, Denpasar, Indonesia

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Abstract

Consumption of quail eggs is currently increasing. Quail eggs not only taste good but also contain protein, fat, carbohydrates, and ash. Despite having a shell as a natural protector, quail eggs are very fragile. The surface of the eggshell has small pores that allow the mass transfer. Permeation causes changes in viscosity, weight loss, and albumin liquefaction during storage. Coating application can maintain the internal freshness of eggs by closing the pores to reduce mass transfer and be an anti-microbial. Coating of aloe vera gel (Aloe-coating) is very potential because it contains polysaccharides and bioactive compounds glucomannan and acemannan. The purpose of this study was to determine the concentration of Aloe-coating to maintain egg viscosity and pH and to determine its effect on the quality of quail eggs during storage. The research design used a completely randomized design with a factorial pattern with three repetitions. The concentration of Aloe-coating is the first factor (100%, 75%, 50%, 25%). The second factor is storage time (1, 2, 3, 4 weeks). The observed variables were water content, weight loss, acidity, viscosity, yellow color, egg white height, and Haugh Unit. The research data were analyzed quantitatively using the analysis of variants. The results showed that Aloe-coating had a very significant effect on water content, weight loss, pH, viscosity, yolk color, and quail egg haugh unit. The best concentration of Aloe-coating to maintain the quality of quail eggs is 100%. The use of Aloe-coating can maintain the quality and extend the shelf life of quail eggs.

Keywords: Aloe-coating; Eggshell; Quality; Natural coating; Quail eggs.

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1. Introduction

Quail eggs are a nutritious food that people like today. In addition to their delicious taste, quail eggs also contain protein, fat, carbohydrates, and ash. The disadvantage of quail eggs is very easy to damage. Shortly after being removed from the laying quail, the shell aging process begins to occur and changes its chemical, physical and functional properties such as an increase in pH, albumin depletion, and water evaporation [1]. Delivery of quail eggs from producers to retailers takes time and is often constrained by the short shelf life of 10-14 days. Melati [2], stated that egg quality will decrease if it is stored for too long. The decrease occurred due to the evaporation of CO2 and H2O. Despite having a shell as a natural protector, quail eggs are very fragile. Even with the best handling serious losses can also occur due to shell damage. The decline in commercial quail egg production due to poor eggshell quality (cracked or damaged) has been reported by Argo, *et al.* [3]. For commercial eggs, the eggshell must be strong to prevent failure during packing or transportation.

The surface of the eggshell has small pores that allow the mass transfer. Permeation causes changes in viscosity, weight loss, and albumin liquefaction during storage. The depletion of albumin thickness is an important indicator of the internal quality of eggs caused by changes in pH and the transfer of CO_2 gas through the pores. The pH value of 3.6 affects the ovomucin-lysozyl bond and is responsible for the viscosity of fresh quail eggs. The decrease in viscosity causes albumin to thin and is directly related to shelf life. Packaging and transportation in large quantities are not possible because quail egg shells are very fragile. This causes the quail egg agroindustry to grow slower than chicken or duck eggs. Thus, a handling process is needed to maintain quality and reduce the level of damage to quail eggs so as to produce significant efficiency. Coating or known as the coating can maintain the internal freshness of eggs by closing the pores to reduce mass and moisture transfer and as an anti-microbial [4, 5]. In addition, the coating also acts as a barrier during processing, handling, and storage without damaging the food and improving its quality [6]. Polysaccharides, proteins, and lipids can be used as coatings to prevent mechanical damage to commodities and inhibit the rate of deterioration [7].

Aloe vera gel as a coating (Aloe-coating) is very potential because it contains polysaccharides and bioactive compounds such as glucomannan and acemannan [8]. Aloe vera gel polysaccharides are easy to apply as wax coatings, and are inexpensive [9]. The gel is very good to use in stable conditions. Stability can be maintained with the addition of citric acid, ascorbic, and sorbate additives [10]. The antimicrobial and antioxidant properties of aloe vera gel have been investigated by Rahman, *et al.* [11] and Sanchez-Machado, *et al.* [12]. Aloe vera gel showed better results in reducing weight loss, yolk index, and pH compared to uncoated chicken eggs [6]. No previous studies have provided information on the quality of quail eggs after coating with aloe vera gel during storage. The purpose of this study was to determine the effect of Aloe-coating and determine the best concentration to maintain the quality of quail eggs during storage.

2. Research Method

2.1. Materials and Tools

The material for Aloe-coating uses gel from a two-year-old aloe plant obtained from Taro Village, Tegalalang District, Gianyar Regency, Bali Province, Indonesia. Quail eggs used with a weight range of 12.86 ± 0.725 one day old as many as 300 eggs to be applied with Aloe-coating, were obtained from quail egg producers at Bali Quail Farm in Palasan-Agro Karangasem Bali. Additional ingredients of 1% glycerol, citric acid, ascorbic acid, and potassium sorbate were obtained at the Baratha Chem Shop, Denpasar. The tools used are digital scales (Ohaus,USA) spectral colorimeter (CS-280,US), viscometer fluorimeter (NDJ8S,Indonesia), digital pH meter (Hanna HI8424, Indonesia), sonicator (Q125 misonix, USA), microscope (Leica type ICC50HD, Germany), Hot Plate Magnetic Stirrer (SH-II-4C,Indonesia), oven (Memmert, Germany) dan vernier caliper (Indonesia).

2.2. Experimental Design

The research design used a completely randomized design with a factorial pattern with three repetitions. The concentration of Aloe-coating application consisting of 100%, 75%, 50%, and 25%, is the first factor. The second factor is storage time which consists of 1 week, 2 weeks, 3 weeks, and 4 weeks. The research data were analyzed quantitatively using analysis of variants (ANOVA). If the results of the variance show significant differences, it is continued with the Duncans difference test (DMRT).

2.3. Research Implementation

The manufacture of aloe vera gel coating (Aloe-coating) is preceded by the process of sorting aloe vera leaves that have been left for 24 hours at room temperature [13]. Then washed with running water until the gel is free from yellow zap. The process of stripping and filleting to produce a gel filet using a stainless knife. Homogenization for 5 minutes followed by the addition of 1% glycerol. Addition of additives namely citric acid, ascorbic acid, and potassium sorbate 0.15% each. The agitation process for 10 minutes using a sonicator model Q125 misonix USA to obtain a uniform particle size, followed by heating at a temperature of 70+1°C for 5 minutes. The Aloe-Coating is cooled at room temperature for 1 hour and is ready to use. Quail eggs that were 1 day old were washed with water to remove dirt on the surface of the shell for 3 minutes including brushing and rinsing. Then eggs with normal shells were randomly distributed into each experimental unit consisting of eggs to be coated with Aloe-coating with concentrations of 100%, 75%, 50%, and 25%. Control samples of uncoated eggs were also prepared. After the dry eggs are dipped in the Aloe-coating solution by hand for 1 minute then the coating is repeated at the same time. The next process is drying for 1 hour, after drying it is placed in an open paper pulp container containing 30 eggs per tray. Eggs are stored in a room with a temperature range of 25-28°C for 4 weeks and are observed periodically every week.

2.4. Observation Variables

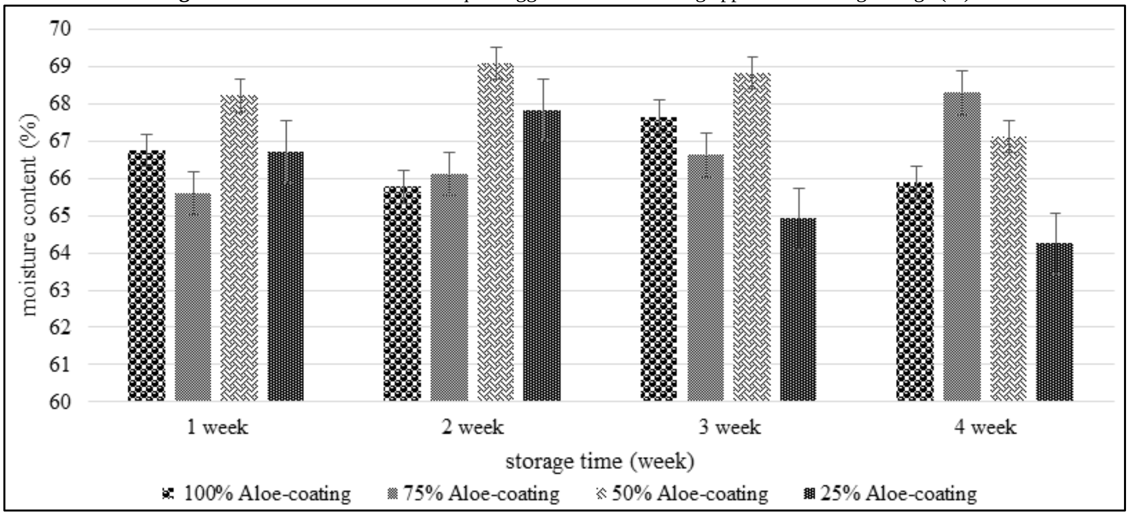
Moisture content was observed using the oven method [14], weight loss using the De-Leo, *et al.* [4] method, and acidity testing based on the AOAC [15]. Albumin viscosity was measured with a viscometer fluorimeter NDJ8S, the viscosity was expressed in millipascal second (mPas). The spindle used is LV-SC4-18 at 30 RPM. Yolk color was measured using a CR-300 chroma meter (Minolta Co. Ltd, Japan) equipped with a DP-300 data processor using CIE L*, a*, b*. The height of the egg white was measured according to the procedure from Andi [16], carried out by placing the broken egg on a flat glass. White height was measured by inserting a toothpick and then measured with a caliper. HU calculation using the formula from Raymond Haugh [17], namely: $HU = 100 \log (H+7{,}57-1{,}7\ W^{0{,}37})$.

3. Result and Discussion

3.1. Moisture Content

The results showed that the Aloe-coating treatment had a very significant difference in the water content of quail eggs. While the long storage treatment showed no significantly different results. Found a significantly different interaction between the two treatment factors. The results of the average water content of the study are shown in Figure 1. The water content of eggs is influenced by the concentration of Aloe-Coating, at a concentration of 100% the water content of eggs is almost the same from the first week to the fourth week of storage, which is 65.88%. At a concentration of 75% Aloe-Coating, the water content of quail eggs increased at four weeks of storage. At 50% Aloe-Coating concentration, the water content of quail eggs was constant until four weeks of storage, which was 67.11%. Meanwhile, at a concentration of 25% Aloe-Coating, the water content of quail eggs decreased significantly starting from the third week. This shows that the concentration of 25% Aloe-Coating has not been able to coat the eggshell optimally so that water evaporation occurs from the contents of the egg through the pores of the eggshell which results in a decrease in the water content of the egg. According to Yuwanta [18], the water composition of a fresh egg is 65.6%, but the percentage of the water content of quail eggs at a concentration of 25% is lower at 64.24%, meaning that there is the evaporation of water from the egg. The concentration of 100% Aloe-Coating showed almost the same moisture content as fresh eggs even though it was stored for four weeks.

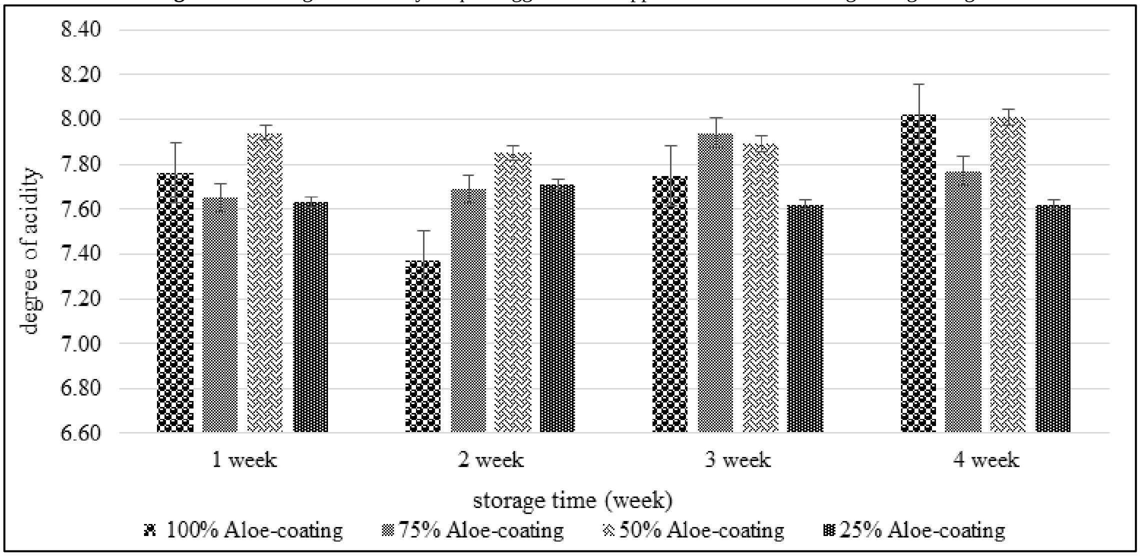
Figure-1. The moisture content of quail eggs with Aloe-coating application during storage (%)



3.2. Degree of Acidity

The results of the acidity of quail eggs coated with Aloe-coating at different concentrations and storage times show very significant differences in results (Figure 2). It was found that there was an interaction between the concentration of Aloe-coating and storage time on the acidity of quail eggs. Further test results showed that the highest degree of acidity of quail eggs stored for one week was 7.94. The acidity value of quail eggs coated with 75% Aloe-coating at 4 weeks of storage is close to the acidity level in the first week. This shows that the 75% concentration of Aloe-coating is able to withstand the evaporation of water and CO_2 from the egg even though it is stored for up to 4 weeks. The increase in the degree of acidity at four weeks of storage is due to the evaporation of water and gases through the pores of the eggshell. In accordance with a report from Indrawan, *et al.* [19] stated that the evaporation of CO_2 and H_2O from the egg causes an increase in the acidity of the egg due to the breakdown of carbonic acid in the egg white which results in a neutral change to alkaline. The pH results of this study are almost the same as the results of research by Joni, *et al.* [20], that the physical quality of quail eggs soaked in gelatine solution and stored in different storage shows a range of acidity degrees from 7.6 to 8.76**.**

Figure-2. The degree of acidity of quail eggs with the application of Aloe-coating during storage



3.3. Weight Loss

The results of the analysis of variance showed that the concentration of Aloe-coating on quail eggs resulted in significantly different mean weight loss. Likewise, the storage time factor resulted in a very significant difference in the average weight loss of quail eggs, but there was no interaction between the coating concentration factor and storage time factor on quail egg weight loss, as shown in Table 1. Further test results (as presented in Table 1), showed that Aloe-coating concentrations of 100% and 75% resulted in a significantly smaller mean weight loss. This is estimated because the Aloe-coating concentration of 100% and 75% is able to cover the fine holes of the eggshell and protect the eggshell from widening the pores, slowing down the evaporation of water and gases from the egg.

The nature of Aloe-coating as a thin and elastic coating material forms a transparent layer on the outside of the eggshell. Aloe-coating is also a preservative and antimicrobial, it can prevent evaporation of water and the release of gases from the egg and prevent the entry of microorganisms that cause egg damage. Helmi, *et al.* [21], reported that the saponin content in aloe vera gel is antimicrobial, able to close the pores of the eggshell so that it inhibits evaporation. Aloe-coating is able to withstand the rate of respiration so that the weight loss is smaller. Further test results showed that the longer the storage, the higher the weight loss of quail eggs (Table 1). This happens because during the storage period there will be a process of evaporation or diffusion of water (H_2O) and carbon dioxide gas (CO_2), ammonia (NH_3), and nitrogen (N_2) from the egg, so that more water and gas evaporates through the pores. egg shell which causes egg weight loss. In line with the opinion of Jazil, *et al.* [22] who state that the longer the shelf life, the decrease in egg weight will increase, which is caused by the continuous evaporation of water and gas from the egg. The average weight loss of quail eggs obtained in this study was almost the same as the results of research by Joni, *et al.* [20] on quail eggs soaked in chicken leg bone gelatine solution which ranged from 3.31% -5.37% in storage for 15 days and 6.24% -15.6% at 30 days storage.

Table-1. Weight loss of quail eggs with Aloe-coating treatment during storage (%)

Concentration (%)	**Storage time (week)**				**Average**
	1	**2**	**3**	**4**	
100	2.88	4.20	7.23	10.14	6.11 b
75	3.08	4.48	7.72	9.90	6.29 b
50	2.80	5.57	8.24	13.00	7.40 a
25	2.61	5.53	8.79	10.73	6.91 ab
Average	2.84 d	4.95 c	7.99 b	10.94 a	

3.4. Viscosity

The results of the analysis of variance showed that the viscosity of quail eggs with Aloe-coating application and shelf life of 1 to 4 weeks showed very significant differences, but there was no interaction between the two treatment factors. Table 2 shows the highest average viscosity value (28.25) at 100% Aloe-coating concentration, this value is very significantly different from other treatments. In the first week of storage, the average value of the viscosity of quail eggs was the highest (31.96), this value was higher than the average of other treatments. The concentration of 100% Aloe-coating on quail eggs stored for 4 weeks showed the highest average viscosity value, meaning that 100% Aloe-coating was able to protect the egg shells from the evaporation of water and gases from the egg. In addition to concentration, another factor that determines egg quality is storage time. Long storage has an impact on declining egg quality. Decreases in quality include egg weight, albumen thickness or egg white, and yolk viscosity [23].

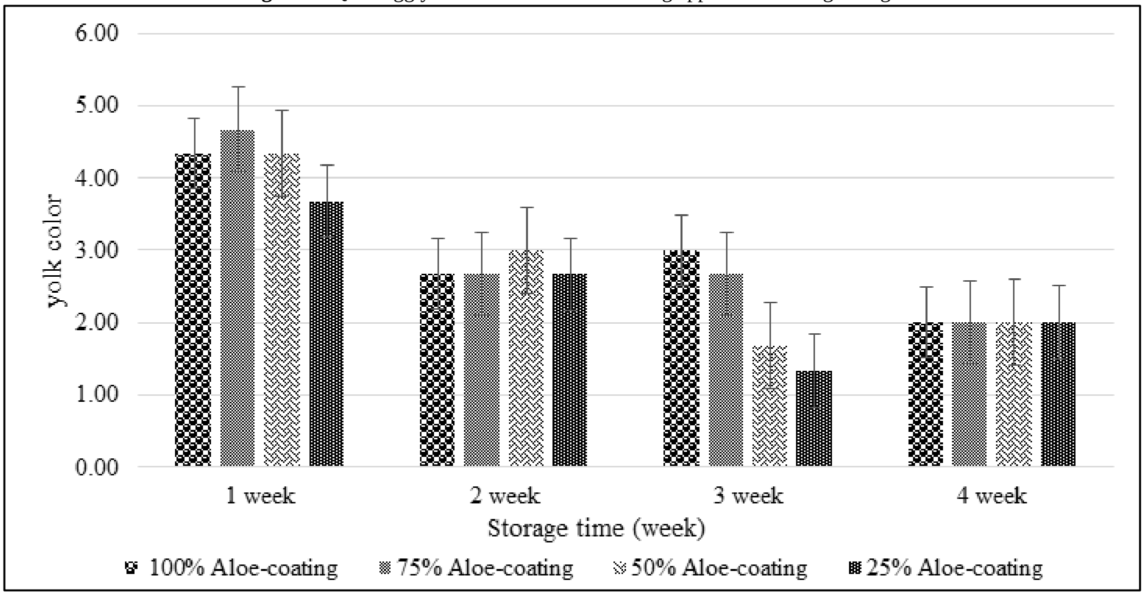
Table-2. The viscosity of quail eggs with Aloe-coating treatment during storage (c.Pas)

Concentration (%)	**Storage time (week)**				**Average**
	1	**2**	**3**	**4**	
100	33.67	27.00	27.16	25.17	28.25 a
75	31.00	25.33	24.67	22.67	25.92 b
50	32.00	21.50	25.83	21.00	25.08 bc
25	31.17	23.83	20.00	19.67	23.67 c
Average	31.96 a	24.42 b	24.42 b	22.13 c	

3.5 Egg Yolk Color

The results of the egg yolk color study are presented in Figure 3 below, showing that the yolk color of quail eggs treated with Aloe-coating concentration showed a significant difference, while the shelf-life treatment showed a very significant difference in the color of quail eggs. There was a significantly different interaction between Aloe-coating concentration treatment and storage time treatment. The results showed that in the 1-week storage period, the color of quail egg yolk which was applied with 75% Aloe-coating showed the highest number (4,67). Egg yolk color generally decreased in the third and fourth weeks of storage, but because it was treated with Aloe-coating concentrations of 100% and 75%, the decrease in quail egg yolk color was not significantly different from the second and first weeks. The main factor determining the color of the egg yolk is the Xanthophyll content in the ration consumed during rearing [24], another factor that causes the color of the yolk to fade is the presence of water seepage that occurs from the egg white into the yolk due to the osmotic pressure of the egg yolk. greater than the osmotic pressure of the egg white. which causes the vitelline membrane that covers the yolk to stretch so that the yolk expands and the yolk color is paler [25]. It is possible that in the Aloe-coating 50% and 25% water seepage from the egg white into the egg yolk has occurred so that the color of the yolk fades.

Figure-3. Quail egg yolk color with Aloe-Coating application during storage



3.6. Height of Egg White

The results of statistical analysis of the effect of treatment on the average height of quail egg white are presented (Table 3). Aloe-coating concentration treatment had a very significant effect and storage time treatment had a significant effect on quail egg white height. No interaction was found between the two treatment factors. Further test results showed that in the first week of storage the average height of egg white was not significantly different at all concentrations of Aloe-coating. At 2 weeks of storage, the mean height of quail egg whites was lower than that of egg whites at 1 week of storage. Treatment with 100% Aloe-coating concentration on quail eggs stored for 1 to 4 weeks gave the highest mean yield of quail egg whites. The height of egg whites at concentrations of 75%, 50%, and 25% aloe-coating decreased during storage time of 2, 3, and 4 weeks, meaning that the concentration of 100% Aloe-coating was able to coat quail egg shells optimally so that the egg white gel formed by Ovomucin due to water binding remains concentrated, strongly supports egg whites and high egg whites can survive. But if the aloe-coating treatment is not able to withstand the evaporation of CO_2 gas through the pores of the eggshell, it will cause physical and chemical changes so that the egg white becomes runny (watery). The more dilute the egg white, the lower the egg white height, and the lower the egg quality [20]. CO_2 gas functions to keep the egg white liquid binder or ovomucin and keep the buffer system from being damaged, so that the egg white viscosity does not decrease resulting in the egg white height being maintained

Table-3. Height of quail egg white with Aloe-Coating treatment during storage (mm)

Concentration (%)	Storage time (week)				Average
	1	2	3	4	
100	2.49	2.90	2.40	2.61	2.60 a
75	2.61	1.99	2.04	2.19	2.21 b
50	2.27	2.14	2.07	1.80	2.07 b
25	2.34	2.04	1.56	1.94	1.97 b
Average	2.43 a	2.27 ab	2.02 b	2.14 b	

3.7. Haugh Unit

The results (Table 4) show that the average Haugh Unit (HU) value of quail eggs with Aloe-coating application at all concentrations stored for 1 to 4 weeks showed no significant difference. The average HU value of quail eggs coated with 100% aloe vera and stored for 4 weeks showed the highest value (77, 15). Haugh Unit is the correlation between egg weight and albumen height [26]. A low haugh unit value indicates a thinner albumen viscosity and a high haugh unit value indicates a thicker albumen viscosity, this is due to the role of albumen ovomucin which forms albumen gel by binding water. A high Haugh unit value describes the more concentrated ovomucin and the better the internal quality of the egg [27]. From the results of the study, the average haugh value of quail egg units treated with 100% concentration of Aloe-coating was the highest. This is because the 100% concentration of Aloe-coating is able to protect the eggshell from gas evaporation and attack by microorganisms. The storage time did not affect the haugh value of the quail egg unit, because all the eggs were treated with Aloe-coating so that they were able to withstand the evaporation process that occurred during storage. According to the USDA, the haugh unit value of research quail eggs include quality A (the haugh unit value ranges from 79 – 55) [18].

Table-4. Hough units of quail eggs with Aloe-coating treatment during storage

Concentration (%)	Storage time (week)				Average
	1	2	3	4	
100	75.85	78.86	76.16	77.74	77.15 a
75	77.38	72.67	73.96	75.25	74.82 b
50	74.20	73.89	74.19	73.28	73.89 b
25	75.24	74.37	70.41	73.61	73.40 b
Average	75.67 a	74.95 a	73.68 a	74.97 a	

4. Conclusion

The conclusion that can be formulated from this study is that the concentration of Aloe coating on quail eggshells has a significant effect on water content, weight loss, pH, viscosity, egg white height, egg yolk warrants, and Haugh Unit. The use of aloe-coating can extend the shelf life of quail eggs. It is recommended to egg breeders and distributors that aloe vera coating can be applied to egg shells with a concentration of 100% to maintain quality and extend shelf life so that marketing is wider and profits can be increased.

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