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The effect of different coating materials on quality characteristics of chicken eggs stored at refrigerated temperature for different times

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Abstract

The functional properties of foods can be preserved when they are coated with edible films, especially when the moisture and the transport of O_2 and Co_2 are reduced. Fresh chicken eggs (300) were divided into 4 groups (0=control, 1=gelatin, 2= methylcellulose and 3=casein) and stored at refrigerator temperature for 0, 10, 20 and 30 days. The weight loss percentages during the storage period was less in gelatin coated eggs as compared with other kind of coated and non-coated eggs. The coating materials preserved the Haugh unit over 30 days of storage compared to control There was a proportional relationship between the weight loss of eggs and the heights of albumen and the pH, yolk index values of eggs during the storage time. These results suggest that gelatein coatings (8%) can be used to reduce changes in eggs during storage.

Keywords: Egg quality; gelatein; methylcellulose; casein; coating; chicken eggs

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Introduction

Eggs have long been consumed in a daily diet throughout the world, being a rich source of high-quality protein compared to other food items (Cook and Briggs, 1986). In the egg processing enterprises, the weight of egg shell, albumen and the yolk that form the egg affect the weight and price of the product (Altan et al., 1998). Egg is highly perishable item and prone to deterioration of internal quality if not stored properly. The quality of eggs remains unaffected if stored below 7°C. However, if storage is not sufficient, the deterioration of egg quality occurs. Therefore, an alternative and affective method is required to preserve the internal quality of the egg.

Egg storage affects egg quality particularly albumen (Silversidest and Scott, 2001). During egg storage, the quality of the vitelline membrane declines, making the yolk more susceptible to breaking (Kirunda and McKee, 2000). In the recent years, the advantages of edible film and coating utilization is gaining importance since they maintain the functional properties of foods by decreasing moisture loss and gas transport (O_2 and CO_2), and also, by delaying the process of volatilization of aromatic components (Kester and Fennema, 1986). The application of coatings eggs reduces weight loss and maintains their internal quality such as weight loss, egg white pH and Haugh units.

Early studies examined chicken eggs coated with whey protein concentrate (Wong et al., 1996) and chitosan (Bhale et al., 2003), black seed oil (AL-Hajo et al., 2009) and gelatein (AL-Hajo et al., 2010) and shellac (Musa et al., 2011). Such coating prevents retards the penetration microbes into the shell. As a result, the storage period of the eggs is increased and the economic losses are reduced. It is suggested that even a small improvement in the preserving the quality of fresh egg will enhance the saving of the industry significantly (Yuceer and Caner, 2014).

The objective of this work was to study the application of gelatein, methyl cellulose and casein coating fresh eggs on percentage of weight loss, internal quality like as Haugh units and albumen pH and other adjectives during 30 days of storage at refrigerator temperature.

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Materials and Methods

Three hundred of pre-weight fresh chicken eggs were used in this study. Eggs were taken from the same strain and age of birds. The average weight of the eggs ranged between 49 to 55 g. Eggs were sanitized in 1% sodium hypochlorite solution for 30s (Aileoni and Antunes, 2004). The gelatin, casein, methylcellulose solution were prepared as follow:

For the preparation of gelatin solution, approximately 8 g gelatin was mixed in 50 ml of hot distilled water (90ºC) and stirred until a uniform suspension was obtained. Casein solution was prepared by dissolving 8 g casein in 50 ml of hot distilled water at 60ºC and stirred until a uniform suspension was obtained. In the same way, 3 g methylcellulose was mixed in 50 ml of hot distilled water (90ºC) and stirred until a uniform suspension was prepared. Each of the solution was further mixed with 10% sorbetol (on dry weight basis) as plastizeir for approximately 15 min and adjusted the volume to 100 ml.

Three hundred eggs (75/group) were treated with solution while one group served as a control. Eggs were coated at 32ºC by dipping into the solutions and stored them at 4ºC for 30 days. 28 eggs from each treatment were examined at 10, 20 and 30 for weight loss and egg internal quality.

Weight loss (%) was determined by the following formula.

Weight loss (%) = Initial egg weight (g) – egg weight after storage (g) /Initial egg weight (g) × 100

Egg internal quality was measured with a high precision micrometer that determines albumen height using the Haugh unit formula (Haugh, 1937) as follows:

$$Hu = 100 \text{ Log } (H + 7.57 - 1.7\ w^{0.037})$$

Where: Hu = Haugh units, H = thick egg white height (mm), w = egg weight (g)

The eggs were broken on table with a glass in order to measure the albumen height (Tyler, 1961). Yolk index was measured by dividing yolk height on yolk diameter (AlFayadh et al., 2011).

Statistical analysis

The data were analyzed using Complete Randomized Design. The calculation was performed by the SAS package (SAS, 2001). Duncan multiple range test was used to determine the significant difference (Duncan, 1955).

Results and Discussion

The percentage of weight loss in eggs was affected by coating materials and storage time as shown in Table 1. The egg weight loss increased significantly ($P<0.05$) with increasing storage periods in 30 day for the control and treated groups. It is also clear from the results that coated eggs with 8% gelatin resulted in least weight loss for chicken eggs during the entire period of egg storage as compared with other treatments. The loss in eggs weight during storage may be caused by the evaporation of water and loss of carbon dioxide from the albumen through the shell (Stadelmen, 1986b; Bhale et al., 2003). Tilki and Saatci (2004) noticed that egg weight loss increased with the increasing of days of storage period (0 to 30 days). Musa et al. (2011) declared that the weight loss percentage of chicken eggs depends on whether, there is a coating material or not and also how long the storage time was. AL-Hajo et al. (2009) found that the egg weight loss decreased for coated chicken and quail eggs with black seed oil for 10, 20 and 30 days at 4°C. Gelatin coating may offer a protective barrier against transfer of carbon dioxide and moisture through the egg shell, thus minimizes weight loss and extends the shell life of eggs. Al-Hajo et al. (2010) noticed that the weight loss deceased after coating chicken and quail eggs by gelatein for 10, 20 and 30 days at 4ºC.

Table 2 showed a decrease in egg Haugh unit in non-coated and coated eggs. Further, the coating materials preserved the Haugh unit over 30 days of storage compared to control. The Haugh unit is an expression related to eggs weight and height of the thick albumen and used as a measurement of albumin quality (Stadelmen, 1986 a&b). Excellent egg quality, according to the North-American standard, presents a Haugh unit value of 72 for eggs coated with mineral oil and stored at refrigeration temperature. The major differences between freshly laid eggs and stored eggs are albumen pH and albumen quality (Walsh et al., 1995; Li et al., 1995; Morais et al., 1997). Musa et al. (2011) showed that the Haugh unit decreased from 110.00 to 87.42 after 30 days in eggs coated with 5% shellac solution at 40°C. Al-Hajo et al. (2012) noticed that Haugh unit decreased with increasing storage period (0 to 30 day) in both coated and non-coated chicken eggs which is similar to our results.

Table 3 shows the effect of different coating materials and storage time on albumen height of chicken eggs. Albumen height decreased significantly ($P<0.05$) with advancing storage period. Further, no significant difference was observed in control and treated groups at different storage period except at day 30 where it declined significantly in control group. Additionally, gelatine proved to be the best preserver of the albumin height. The thick albumen may be the primary barrier to gaseous diffusion and maintains albumen quality (Walsh et al., 1995). Egg quality measurements are based on the albumen height of fresh eggs, and are partially determined by the line and age of the hen age (Silversides and Scott, 2001).

Table 1: The effect of coating materials on egg weight loss (%) at different days of storage

	Storage period (days)			
Groups	Initial weight (g)	10	20	30
Control	55.13±0.39	$0.94±0.0^{Ba}$	$3.23±1.9^{Ba}$	$7.29±5.46^{Aa}$
Gelatin	A55.25±1.64	$0.36±0.\ 14^{Ab}$	$0.82±0.14^{Aa}$	$1.24±0.17^{Aa}$
Methylcellulose	A55.39±1.23	$0.56±0.12^{Ab}$	$1.52±0.61^{Aa}$	$2.22±0.88^{Aa}$
Casein	a55.63±1.74	$0.55±0.04^{Ab}$	$1.13±0.61^{Aa}$	$1.75±1.25^{Aa}$

Dissimilar superscripts (capital) in the same row differ significantly (P<0.05); Dissimilar superscripts (small) in the same column differ significantly (P<0.05)

Table 2: The effect of coating materials on Haugh unit for different time period

	Storage period (days)			
Groups	0	10	20	30
Control	$88.27±2.66^{Aa}$	$88.27±2.66^{Aa}$	$85.32±0.29B^{a}$	$82.01±1.14B^{a}$
Gelatin	$90.11±1.71^{Aa}$	$90.11±1.71^{Aa}$	$88.34±1.30^{Aa}$	$87.03±3.84^{Aa}$
Methylcellulose	$89.90±0.18^{Aa}$	$89.90±0.18^{Aa}$	$89.54±0.36^{Aa}$	$86.82±0.20^{Aa}$
Casein	$89.47±1.82^{Aa}$	$89.47±1.82^{Aa}$	$87.56±1.18^{Aa}$	$86.30±1.22^{A}B^{a}$

Dissimilar superscripts (capital) in the same row differ significantly (P<0.05); Dissimilar superscripts (small) in the same column differ significantly (P<0.05)

Table 3: The effect of coating materials on albumen height of eggs stored for different time periods

	Storage period (days)			
Groups	0	10	20	30
Control	$7.49±0.47^{Aa}$	$7.49±0.47^{Aa}$	$7.01±0.01^{ABa}$	$5.63±0.22^{Cb}$
Gelatin	$7.87±0.31^{Aa}$	$7.87±0.31^{Aa}$	$7.49±0.22^{Aa}$	$6.59±0.35^{Aa}$
Methylcellulose	$7.84±0.08^{Aa}$	$7.84±0.08^{Aa}$	$7.34±0.09^{ABa}$	$6.54±0.28^{Ca}$
Casein	$7.84±0.34^{Aa}$	$7.84±0.34^{Aa}$	$7.43±0.20^{Aa}$	$6.59±1.11^{Ba}$

Dissimilar superscripts (capital) in the same row differ significantly (P<0.05); Dissimilar superscripts (small) in the same column differ significantly (P<0.05)

Table 4: Effect of coating materials on albumin pH at different storage period

	Storage period (days)			
Groups	0	10	20	30
Control	$7.38±0.14^{Ba}$	$7.72±0.07^{Aa}$	$7.93±0.15^{Aa}$	$7.95±0.14^{Aa}$
Gelatin	$7.37±0.03^{Aa}$	$7.44±0.06^{Ab}$	$7.45±0.22^{Aa}$	$7.41±0.01^{Ab}$
Methylcellulose	$7.16±0.04^{Ba}$	$7.24±0.22^{Bb}$	$7.76±0.38^{Aa}$	$7.42±0.1^{Ab}$
Casein	$7.08±0.04^{Ba}$	$7.20±0.05^{Ab}$	$7.76±0.36^{Aa}$	$7.43±0.12^{Ab}$

Dissimilar superscripts (capital) in the same row differ significantly (P<0.05); Dissimilar superscripts (small) in the same column differ significantly (P<0.05)

Table 5: Effect of coating materials on yolk index at different storage period

	Storage period (days)			
Groups	0	10	20	30
Control	$0.48±0.01^{Aa}$	$0.45±0.01^{ABa}$	$0.43±0.01^{ABb}$	$0.42±0.01^{Bb}$
Gelatin	$0.51±0.01^{Aa}$	$0.50±0.01^{Aa}$	$0.50±0.02^{Aa}$	$0.46±0.01^{Aa}$
Methylcellulose	$0.51±0.00^{Aa}$	$0.49±0.00^{ABa}$	$0.48±0.01^{ABa}$	$0.45±0.02^{Bab}$
Casein	$0.51±0.02^{Aa}$	$0.51±0.01^{ABa}$	$0.49±0.10^{ABa}$	$0.46±0.01^{Bab}$

Dissimilar superscripts (capital) in the same row differ significantly (P<0.05); Dissimilar superscripts (small) in the same column differ significantly (P<0.05)

The albumen pH of stored eggs in control and experimental groups is shown in Table 4. Albumin pH increased significantly in treated groups and control.

The reduction at 30 day was comparatively lower in treated groups compared to control. In gelatine group, no significant change in pH was found. The gelatein coating had an important effect in controlling the pH of eggs probably by reducing Co_2 loss during storage. The albumen has also a thin layer which behaves as a primary barrier for gas diffusion and it also helps to maintain albumen quality, which could prevent the free diffusion of Co_2 under long storage periods (Stadelman, 1986a). The albumen pH should be considered as a measure of quality because it is not affected by the age or by the line of the hens (Silversides and Scott, 2001). Al-Higo et al. (2009) found that the albumen pH decreased for coated eggs with back seed oil comparable with non-coated eggs.

Musa et al. (2011) noted that there was a proportional relationship between the weight loss of eggs and the pH values of untreated eggs.

Table 5 shows the effect of using different coating materials and storage time on yolk index. The results indicated that yolk index losses were reduced at 20 and 30d of storage period in control and treated groups other than gelatin. At d 30, the best results were obtained in group treated with gelatin. These results revealed that storage time significantly affected yolk index in coated and non-coated eggs. Yolk index is the ratio of yolk height and yolk width and is used as the measure of the egg freshness (Obanu and Mpieri, 1984; Yuceer and Caner, 2014). Further, it indicates a progressive weakening of the vitelline membrane and liquefaction of the yolk caused mainly by diffusion of water from the yolk height (Yuceer and Caner, 2014). The higher the yolk index, the better is the egg quality. Storage period has a significant effect on yolk index decreasing it significantly at 30d of the storage. The results showed that compared to other treatments, gelatin has a positive effect on inhibition the deterioration of the quality of the eggs.

These results indicated that gelatine is qualitatively superior in preserving the quality of the eggs during storage period of 30 days.

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