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Effect of some natural coating of table egg on shelf life during refrigerator storage

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Abstract

Two experiments were carried out at the College of Veterinary Medicine, University of Baghdad during the period from 02 / 11 / 2022 to 05 / 02 / 2023, aimed to compare between three coating table egg which were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its quality characteristics, egg components percentage and microbial counts during Zero, 1, 2, 4 weeks of refrigerator storage. A total of 160 fresh table eggs (Brown shell eggs) were collected from a retail stores in Fallujah city. These eggs were separated in half for two experiments (80 egg per experiment). After egg collection 80 eggs of each experiment were immediately distributed into four groups of treatments: T1: 20 eggs were uncoated egg as control group. T2: 20 eggs were Starch coated egg. T3: 20 eggs were Carboxy methyl cellulose coated egg. T4: 20 eggs were Agar coated egg. All eggs were dried and refrigerator storage immediately after treatment. Results revealed that the processes of coating table eggs at the beginning of the experiment contributed to a significant increase in egg weight compared to control treatment eggs, and the highest weights were especially in eggs coated with CMC and Agar treatments, and this is due to the formation of a relatively thick layer of covers around the egg shell. When the storage age advanced to 1, 2, 4 weeks, there were a decrease in the weights of eggs and all interior quality for all treatments, but the percentage of decrease was significantly in the eggs of the control treatment, Then comes the coated treatment with starch, while the decrease were not significant for the two coated treatments using CMC and Agar. Also, coating processes with starch, CMC and Agar did not allow to increase total bacterial count and coliform bacterial count significant on egg shell compared with control treatment. In conclusion, coating table egg is very imported to extending shelf life of table eggs during storage and we recommended CMC and Agar as coating materials.

Keywords: Table egg, Natural coating, Refrigerator storage, Shelf life.

Introduction

Table eggs are food with high nutritional value, and it is one of the best sources of animal protein, especially egg whites, due to its high biological value, which is equal to 100%, and its containment of many vitamins and mineral elements, in addition to its multiplicity of functional characteristics and uses in wide food and industrial fields, from one side. Finally, eggs are perishable foods if kept in poor conditions (EPC, 2005; IFASE, 2005; Al-Obaidi and Al-Shadeedi, 2022).

The table eggs are a perishable food like meat and milk, it is of the best quality and its chemical, microbial and functional characteristics after it is laid directly by the hen and begins to deteriorate and decrease in quality with the passage of time. Therefore, since the beginning of the last century, work has been done to devise many methods of preserving and storing eggs to increase the period of preservation and storage while preserving it from deterioration or damage. Eggs are one of the best natural sources of high quality proteins, vitamins, antioxidants, carotenoids, and phospholipids (Lesnierowski and Stangierski, 2018). Chicken eggs are most widely consumed by humans as table eggs because they are a reasonable source of high quality protein and contain diverse nutrients (Al-Nasser et al., 2007).

Aging and deterioration of an egg begins once the egg is laid, characterized by changes in functional properties. The effect of an egg coating material on the eggshell depends on temperature and storage time (Yüceer and Caner, 2014). The coating biomaterials used in the egg production industry may be classified as lipid, protein, or polysaccharide based materials (Stadelman and Cotterill, 1995; Cindric et al., 2007). Polysaccharide based coatings are commonly used due to the fact of their high flexibility, thinness, and high transparency. Polysaccharides have been synthesized from microbes (Chaisuwan et al., 2020), lactic acid bacteria (Surayot et al., 2014), and purple glutinous rice bran (Surin et al., 2020).

Coating with oil, immersion in liquids, refrigeration, and dry packing are other examples of methods used to maintain egg quality. The most common forms of lipid used in edible coatings are waxes (Cindric et al., 2007). A study investigated the ability of numerous coating materials, such as mineral oil, waxes, shellac, and chitosan, to cover the pores of eggshells and maintain egg quality (Caner, 2005). Many natural products are incorporated into coating materials for eggshells to prolong the shelf life of eggs. These materials included the water resistance of egg coating materials using mineral oil (Torrico et al., 2014), soybean oil (Wardy et al., 2011), fatty acids (Suppakul et al., 2010), and shellac (Caner et al., 2005).

Al-Shadeedi (2010) aimed to evaluate the coating of table eggs with some types of medicinal natural oils and the effect of this on the quality, chemical, microbial and functional characteristics of eggs after storage for 1, 2, 4 and 8 weeks under room conditions and under refrigerator conditions. natural or medicinal oils reduced the deterioration in the qualitative, chemical, microbial, and functional traits after storage for 1, 2, 4, and 8 weeks compared to treated eggs the control.

Waxes are an edible natural with hydrophobic properties (Atta et al., 2019) and are a suitable to improve the water resistance of coating materials. Waxes exist in a solid state at ambient temperature and transform to a liquid state at higher temperatures, while low-molecular-weight (Mw) waxes are in a liquid state at room temperature. Important considerations while preparing egg coating material for prolonging egg shelf life include safety, mechanical properties, water resistance, migration, and production cost of the egg-coating material. Many formulations with different properties have been tested: an edible CS/CMC/fatty acid blend used as an egg coating material has been reported (Homsaard et al., 2020).

Temperature control and storage under refrigerated conditions are effective methods to preserve egg quality (Nongtaodum et al., 2013). Albumin height and egg weight can be used to calculate the Haugh unit (HU) value, which indicates albumen quality (Morsy et al., 2015). An HU value of approximately 80 indicates a fresh egg of high quality. The HU is influenced by storage time (Yüceer et al., 2016). Egg quality depends on weight loss due to the fact of moisture penetration. When egg weight is high, profitability is also high, owing to reduced water loss (Caner, 2005; Kim et al., 2006; Biladeau and Keener, 2009; Jones et al., 2018). Polymer solution blending is an effective method for preparing egg coating materials.

Biopolymer materials are blended with a gelling agent and a water resistant polymer. Some edible biopolymers have been used to prepare egg coatings including hydroxypropyl methylcellulose (HPMC) (Suppakul et al., 2010). Rice protein and Brazilian green propolis were used to prepare an additional egg coating material that delayed the loss of egg quality by preventing moisture loss (Pires et al., 2019; 2021).

A chitosan/beeswax/essential oil blend prevented bacterial growth and extended the shelf-life of eggs (Sun et al., 2021). Starch with an added agent that prevents microbial growth has also been reported (Thajai et al., 2021). Furthermore, pulsed-light technology has been used to prevent bacterial contamination and extend egg shelf life (Wang et al., 2021). However, blending waxes with starch and methyl cellulose to prepare egg-coating materials has not been reported before.

Oliveira et al. (2022) coated table eggs with cassava starch+Ginger essential oil (CS+GIN), cassava starch+Lemongrass essential oil (CS+LEM), and cassava starch+Tahiti lemon essential oil (CS+TAH). The count of total aerobic mesophilic bacteria on coated eggshells at 0 and 35 days of storage were similar to each other and significantly lower compared to uncoated eggs in that order. On the 35^{th} day, coated eggs showed similar Haugh unit (HU) values between them and significantly higher than uncoated eggs. Cassava starch coatings added with essential oils preserved the internal quality of the eggs during storage for 5 weeks at 20◦C, reducing the eggshell microbiota and effectively keeping it at low levels during storage.

The aim of this study: First experiment was to compare between three coating table egg with were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its quality characteristics and egg components percentage during Zero, 1, 2, 4 weeks of refrigerator storage. Second experiment was to compare between three coating table egg with were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its microbial counts during Zero, 1, 2, 4 weeks of refrigerator storage.

Materials and Methods

Period of the study: Two experiments were carried out during the period from 02 / 11 / 2022 to 05 / 02 / 2022, to compare between three coating table egg which were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its quality characteristics, egg components percentage and microbial counts during Zero, 1, 2, 4 weeks of refrigerator storage.

Egg collection: A total of 160 fresh table eggs (Brown shell eggs) were collected from a retail stores in Fallujah city. These eggs were separated in half for two experiments (80 egg per experiment).

First experiment: First experiment was to compare between three coating table egg with were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its quality characteristics and egg components percentage during Zero, 1, 2, 4 weeks of refrigerator storage. This study was carried out during the period from 02 / 11 / 2022 to 30 / 12 / 2022. After egg collection 80 eggs were immediately distributed into four groups of treatments :

T1: 20 eggs were uncoated egg as control group.

T2: 20 eggs were Starch coated egg.

T3: 20 eggs were Carboxy methyl cellulose coated egg.

T4: 20 eggs were Agar coated egg.

All eggs were dried and refrigerator storage immediately after treatment.

Storage periods: All washed eggs were refrigerator storage for 1, 2 and 4 weeks. Al each period 5 eggs from each treatment were randomly collected and individually weight and interior quality parameter were studied.

Egg weight: Egg weights were recorded for each egg separately and for each treatment, and after each storage period, a digital Sartorius balance scale was used for this purpose, measuring to two orders of grams before and after the start of packaging.

Internal egg quality characteristics: All studied egg quality (internal) traits were measured for all collected eggs individually and according to the method indicated by Stadelman and Cotterill (1995) which included egg weight, white high, yolk high and yolk diameter.

White Height, Yolk Height and Yolk Diameter: The white height was measured by using digital Vernier scale for the white of each egg, from the midpoint between the edge of the outer white and the yolk membrane, and the diameter and height of the yolk were also measured by using the digital Vernier scale.

Egg components percentage: After breaking the egg and separating the yolk from the white, by carefully lifting the yolk with a tablespoon so as not to contaminate it with the white, and placing the yolk on filter paper, where it was rotated on the paper to get rid of the white, if any, and the shell was dried by leaving it until the next day at room temperature, then the weights were recorded each of the yolk and shell (with the membranes and with the presence of the covers), and extracted the weight of the white by the difference method, then the percentage of the three components was extracted by applying the following equations

Second experiment: Second experiment was to compare between three coating table egg with were Starch, Carboxy Methyle Cellulose (CMC) and Agar on its microbial counts during Zero, 1, 2, 4 weeks of refrigerator storage. This study was carried out during the period from 02 / 01 / 2023 to 05 / 02 / 2023. After egg collection 80 eggs were immediately distributed into four groups of treatments :

T1: 20 eggs were uncoated egg as control group.

T2: 20 eggs were Starch coated egg.

T3: 20 eggs were Carboxy methyl cellulose coated egg.

T4: 20 eggs were Agar coated egg.

All eggs were dried and refrigerator storage immediately after treatment.

Storage periods: All washed eggs were refrigerator storage for 1, 2 and 4 weeks. Al each period 5 eggs from each treatment were randomly collected and individually and bacterial counts were tested.

Bacterial counts: All bacterial count tests were conducted in the laboratory of the Milk Hygiene at the College of Veterinary Medicine / University of Baghdad, and were done on three replicates of eggs for each treatment and after each storage period. The eggs were placed in nylon bags containing 100 ml of sterile peptone water (Accumix company) at sterile conditions and decimal dilution were done using 10 ml screw caped bottles. The culture media used in bacteriological examinations were sterilized at 121 °C for 15 minutes and under a pressure of 15 pounds / square inch. As for the different glassware, they were sterilized in an electric oven at 180°C for three hours.

Total bacterial count: Total bacteria were counted using the pour-plate method mentioned by Harigan and McCance (1976), by transferring (1 ml) of each decimal diluent with a sterile pipette into two empty and sterilized Petri dishes (Duplicate) and directly added to each dish. (15 ml) of the sterile culture medium (Nutrient Agar, Accumix company) kept in a water bath at (46 °C), then the culture medium is mixed with the dilution of the bacterial suspension well by rotating the dishes towards the right and towards the left with stirring it each time and after the culture medium hardened, the dishes were preserved inverted in the incubator at (37°C) for 24 hours, after which the growing colonies were counted in dishes containing (30-300) colonies, and the number of bacteria was estimated by multiplying the number of colonies by the reciprocal of dilution to extract the number in one milliliter.

Coliform bacterial count: coliform bacteria were counted using the pour-plate method mentioned by Harigan and McCance (1976) to estimate the numbers of coliform bacteria by transferring (1 ml) of each decimal diluent with a sterile pipette into two empty and sterilized Petri dishes (Duplicate) and directly (15 ml) of sterile culture medium (MacConkey Agar, Accumix company) kept in a water bath at (46°C) is added to each plate, then the culture medium is mixed with the dilution of the bacterial suspension well by rotating the plates towards the right and towards the left with stirring each time and after the medium hardens The culture dishes were kept upside down in the incubator at (37°C) for 24 hours after which the growing colonies were counted in the dishes containing (30-300) colonies, and the numbers of bacteria were estimated by multiplying the number of colonies by the reciprocal of dilution to extract the number per milliliter.

Statistical analyses: Data were analyzed by using the General Linear Model Procedure of SAS (2001). Means were compared by the Duncan's Multiple Range test at 5% probability (Steel and Torrie, 1980).

Results and Discussion

First experiment:

Egg weight: Figure (1) shows that the weight of the egg for the four treatments at the start of the experiment (zero time) was 48.5, 48.52, 47.78, and 46.82 gm for the four treatments which were control, starch coating, CMC coating, and Agar coating respectively. When the storage period advances to one week in the refrigerator, the average egg weight reached 46.1, 47.1, 48.7, and 48.01gm. When the storage period in the refrigerator advanced to two weeks, the average egg weight reached 44.58, 46.28, 47.88, and 47.4gm, and when the storage period advanced to four weeks in the refrigerator, it was observed that The egg weight for the four treatments is 41.46, 43.84, 47.28 and 46.99gm for the four treatments which were control, starch coating, CMC coating, and Agar coating respectively.

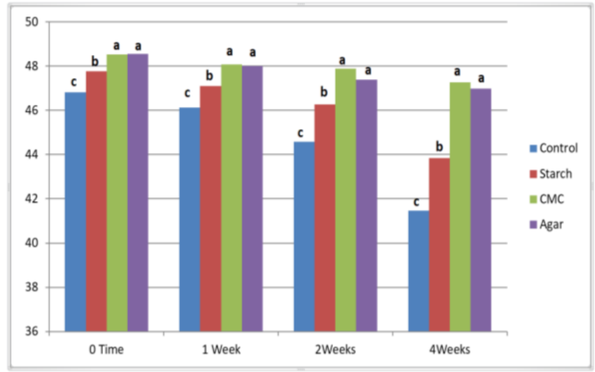

Figure (1) Egg weight for the four treatments during refrigerator storage

Interior quality: It is clear from Table (1) that the average of yolk height values for the four treatments, at Zero time of storage in the refrigerator, were 14.84, 14.98, 15.10, and 14.92 mm for the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively. The diameter of the yolk was 33.70, 33.54, 33.78, and 33.44 for each of the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively. As a result, the values of the yolk index were 0.44, 0.44, 0.44, and 0.44, respectively. Whenas the white high were 3.75, 3.73, 3.76, and 3.71mm for the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively

Table (1): Effect of coating materials on interior table egg quality at Zero time of refrigerator storage.

Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	14.84 ±0.31a	33.70 ±0.85a	0.44 ±0.02a	3.75 ±0.68a
Starch	14.98 ±0.34a	33.54 ±0.83a	0.44 ±0.02a	3.73 ±0.74a
CMC	15.10 ±0.37a	33.78 ±0.87a	0.44 ±0.02a	3.76 ±0.66a
Agar	14.92 ±0.32a	33.44 ±0.87a	0.44 ±0.01a	3.71 ±0.69a
Significant	N.S.	N.S.	N.S.	N.S.

Table (2) indicated that when the period of storage of eggs in the refrigerator progressed to one week (1 week), it caused a decrease in the yolk height values, which recorded 14.1, 14.43, 14.60, and 14.51 mm for each of the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively. The yolk diameter for the four treatments was 34, 33.87, 33.72, and 33.78. As a result, the yolk index values were 0.41, 0.42, 0.43, and 0.42 for each of the four treatments, respectively. It was also noted that the values of white height were 3.12, 3.51, 3.59 and 3.48 for the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively.

Table (2): Effect of coating materials on interior table egg quality after 1 week of refrigerator storage.

Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	14.01 ±0.38c	34.00 ±0.81a	0.41 ±0.01b	3.12 ±0.71c
Starch	14.43 ±0.34b	33.87 ±0.83b	0.42 ±0.02a	3.51 ±0.69b
CMC	14.60 ±0.35a	33.72 ±0.81c	0.43 ±0.02a	3.59 ±0.70a
Agar	14.51 ±0.37a	33.78 ±0.84c	0.42 ±0.01a	3.48 ±0.69b
Significant	*	*	*	*

Table (3) revealed that the average of yolk high decreased after storage in the refrigerator for a period of two weeks (2 weeks) for each of the four treatments, which were 13.67, 14.50, 14.11, and 14.70 mm for control, starch coating, CMC coating, and Agar coating respectively. The values of yolk diameter were 36.31, 35.30, 34.60, and 35.14 mm for each of the four treatments, respectively. Also we found that the values of the yolk index were decreased to 0.37, 0.40, 0.41, and 0.40 for each of the four treatments, respectively. As for the values of white high, they were 3.3, 3.28, 3.37, and 3.31 for each of the four treatments, respectively.

Table (3): Effect of coating materials on interior table egg quality after 2 weeks of refrigerator storage.

Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	13.67 ±0.40c	36.31 ±0.87a	0.37 ±0.02b	3.03 ±0.68c
Starch	14.05 ±0.37b	35.03 ±0.83b	0.40 ±0.02a	3.28 ±0.71b
CMC	14.11 ±0.39a	34.06 ±0.86c	0.41 ±0.01a	3.37 ±0.72a
Agar	14.07 ±0.41a	35.14 ±0.85c	0.40 ±0.01a	3.31 ±0.70b
Significant	*	*	*	*

Table (4) shows that the yolk high decreased more after storage in the refrigerator for a period of four weeks (4 weeks), so that the average values of the yolk high were 13.27, 13.80, 13.97, and 13.85 mm for each of the four treatments, which were control, starch coating, CMC coating, and Agar coating respectively. As for the diameter of the yolk, its values were 37.53, 35.74, 34.63, and 35.89 mm for each of the four treatments, respectively. Also it was found that the values of the yolk index were 0.35, 0.38, 0.40, and 0.38 for each of the following four treatments, respectively. As for the values of white high, they were 2.84, 3, 3.16, and 3.5 mm for each of the following four treatments, respectively.

Table (4): Effect of coating materials on interior table egg quality after 4 weeks of refrigerator storage.

Treatments	Yolk high (mm)	Yolk diameter (mm)	Yolk index	White high (mm)
Control	13.27 ±0.42c	37.58 ±0.86a	0.35 ±0.01c	2.84 ±0.70c
Starch	13.80 ±0.44b	35.74 ±0.87b	0.38 ±0.02a	3.00 ±0.71b
CMC	13.97 ±0.44a	34.63 ±0.88c	0.40 ±0.01a	3.16 ±0.69a
Agar	13.85 ±0.40a	35.89 ±0.87c	0.38 ±0.01a	3.05 ±0.70b
Significant	*	*	*	*

Egg components: It is indicated from Table (5) that the weight of the egg yolk for the control treatment was 14.2gm, constituting 29.94 %, while the weight of the shell was 4.56gm, or 9.94 %. As for the egg white, it weighed 25.44g, constituting 54.24 % and the weights of the components of starch-coated eggs were 14.16 and 15.12. and 26.91 gm for the three components, yolk, shell and white, with a ratio of 29.64, 10.72, and 56.32 %, respectively. As for the weights of the components of CMC coated eggs, they were 14.30, 5.47, and 27.67 gm for the three components, (yolk, shell and white), with a percentage of 29.47, 11.27, and 57.3 %, respectively. Also the same table revealed that the weights of the egg components of Agar coated egg were 14.21, 5.25, and 27.45 gm for the three components, with a percentage of 29.26, 10.81, and 56.53 %, respectively.

Table (5): Effect of coating materials on table egg components at Zero time of refrigerator storage.

Treatments	Yolk weight (gm)	Yolk percentage (%)	Shell weight (gm)	Shell percentage (%)	White weight (gm)	White percentage (%)
Control	14.02 ±0.93a	29.94 ±1.13a	4.56 ±0.21a	9.74 ±0.47a	25.44 ±1.21a	60.32 ±2.65a
Starch	14.16 ±0.87a	29.64 ±1.12a	5.12 ±0.25a	10.72 ±0.44a	26.91 ±1.18a	59.64 ±2.66a
CMC	14.30 ±0.91a	29.47 ±1.10a	5.47 ±0.27a	11.27 ±0.47a	27.67 ±1.23a	59.26 ±2.63a
Agar	14.21 ±0.92a	29.26 ±1.13a	5.25 ±0.23a	10.81 ±0.45a	27.45 ±1.20a	59.93 ±2.68a
Significant	NS	NS	NS	NS	NS	NS

Table (6) shows that, after one week of egg storage in the refrigerator (1 week), the weight of the egg yolk of the control treatment reached 14.33 g, while the weights of the components of cellulose-coated eggs (CMC) were 14.36, 5.48, and 27.64 g for the three components: yolk, shell, and white. They were 29.87, 11.40 and 57.50 percent, respectively The weights of the components of eggs coated with AGAR were 14.30, 5.27, and 27.42 grams for the three components, yolk, shell, and white, with a percentage of 29.79, 10.98, and 57.11 percent, respectively.

Table (6): Effect of coating materials on table egg components after 1 week of refrigerator storage.

Treatments	Yolk weight (gm)	Yolk percentage (%)	Shell weight (gm)	Shell percentage (%)	White weight (gm)	White percentage (%)
Control	14.33 ±0.92a	31.07 ±1.17a	4.59 ±0.20c	9.95 ±0.45c	25.35 ±1.18c	54.97 ±2.57c
Starch	14.28 ±0.90a	30.32 ±1.12b	5.14 ±0.19b	10.91 ±0.42b	26.89 ±1.20b	57.09 ±2.61b
CMC	14.36 ±0.90a	29.87 ±1.15c	5.48 ±0.19a	11.40 ±0.43a	27.64 ±1.21a	57.50 ±2.60a
Agar	14.30 ±0.91a	29.79 ±1.14c	5.27 ±0.21b	10.98 ±0.42b	27.42 ±1.20a	57.11 ±2.58b
Significant	NS	*	*	*	*	*

We find from Table (7), and after two weeks of storing the eggs in the refrigerator (2 week), the weight of the yolk of the control treatment reached 14.97 gm, with a percentage of 33.58 %, while the weight of the shell were 4.70 gm, with a percentage of 10.55 %, while the weight of the white reached 24.90 gm, with a percentage of 58.11 %, and the weights of the components of starch-coated eggs were 14.64, 5.20 and 26.44 gm for the three components (yolk, shell and white), and their percentages were 31.63, 11.25 and 57.12 % respectively. As for the weights of the components of cellulose-coated eggs (CMC), they were 14.90, 5.67, and 27.31 gm for the three components, and their percentages were 31.12, 11.84, and 57.4 %, respectively. Agar-coated egg components weighted 14.93, 5.36 and 27.11 gm for the three components, with a percentage of 31.50, 11.30, and 57.20 %, respectively.

Table (7): Effect of coating materials on table egg components after 2 weeks of refrigerator storage.

Treatments	Yolk weight (gm)	Yolk percentage (%)	Shell weight (gm)	Shell percentage (%)	White weight (gm)	White percentage (%)
Control	14.97 ±0.87a	33.58 ±1.16a	4.70 ±0.18c	10.55 ±0.43c	24.90 ±1.23c	55.87 ±2.55b
Starch	14.64 ±0.90b	31.63 ±1.14b	5.20 ±0.20b	11.25 ±0.46b	26.44 ±1.19b	57.12 ±2.59a
CMC	14.90 ±0.89a	31.12 ±1.18c	5.67 ±0.19a	11.84 ±0.44a	27.31 ±1.22a	57.04 ±2.60a
Agar	14.93 ±0.91a	31.50 ±1.16b	5.36 ±0.22a	11.30 ±0.48b	27.11 ±1.20a	57.20 ±2.57a
Significant	NS	*	*	*	*	*

Table (8) shows that after storage the eggs for four weeks in the refrigerator (4 week), it was observed that the weight of the yolk of the control treatment was 14.83 gm, with a ratio of 41.46 %, while the weight of the shell was 4.66 gm, with a ratio of 11.23 %, while the weight of the whites was 23.41 gm, with a ratio of 56.46 %. It was found that the weights of the components of starch-coated eggs were 14.74, 5.23, and 24.89 gm for the three components, and their percentages were 33.62, 11.93, and 56.77 %, respectively. Also it was found that the weights of the components of CMC coated eggs were 14.97, 5.69 and 26.25 gm for the three components and their percentages were 31.66, 12.3 and 55.28 %, respectively. Whereas the weights of the components of Agar coated eggs were 14.98, 5.41 and 25.7 gm for the three components, with a ratio of 31.88, 11.51, and 53.35 %, respectively.

Table (8): Effect of coating materials on table egg components after 4 weeks of refrigerator storage.

Treatments	Yolk weight (gm)	Yolk percentage (%)	Shell weight (gm)	Shell percentage (%)	White weight (gm)	White percentage (%)
Control	14.83 ±0.87a	41.46 ±1.24a	4.66 ±0.20c	11.23 ±0.47c	23.41 ±1.19d	47.31 ±2.53c
Starch	14.74 ±0.87a	33.62 ±1.21b	5.23 ±0.20b	11.93 ±0.47a	24.89 ±1.22c	54.45 ±2.61b
CMC	14.97 ±0.87a	31.66 ±1.18c	5.69 ±0.19a	12.03 ±0.47a	26.25 ±1.19a	56.31 ±2.57a
Agar	14.98 ±0.87a	31.88 ±1.21c	5.41 ±0.20a	11.51 ±0.47b	25.07 ±1.18b	56.61 ±2.58a
Significant	NS	*	*	*	*	*

Second experiment:

Bacteria count: It is clear from the Table (9) that the number of total bacteria on the surface of eggs at the start of the experiment ranged between 168 X 10^2 and 15 X 10^2 , and when storage progressed to one week, the number of total bacteria reached 112 X 10^3, 159 X 10^2, 30 X 10^2, 86 X 10^2 for the four treatments, which are control, starch, CMC and agar respectively, the numbers of bacteria continued to increase on the surface of the egg shell with the progression of the storage age by two and four weeks, reaching their number at the fourth week 182 X 10^4, 45 X 10^3, 167 X 10^2, 158 X 10^2.

Table (10) shows that the numbers of coliform bacteria were at their lowest numbers, and the number ranged between 14 X 10^2 and 9 X 10^2, and when storage progressed, their numbers began to increase for all treatments, and they were the highest for the first treatment (control). Upon reaching the fourth week, the numbers of bacteria reached 142 X 10^4, 246 X 10^2, 110 X 10^2, 98 X 10^2, which indicates a high number of bacteria in the control group

Table (9): Effect of coating materials on table egg total bacterial count after refrigerator storage (cfu/egg).

Treatments	Zero time	1 week	2 weeks	4 weeks
Control	68 X 10^2	112 X 10^3	209 X 10^3	182 X 10^4
Starch	49 X 10^2	159 X 10^2	228 X 10^2	45 X 10^3
CMC	15 X 10^2	30 X 10^2	89 X 10^2	167 X 10^2
Agar	31 X 10^2	86 X 10^2	91 X 10^2	158 X 10^2
Significant	NS	*	*	*

Table (10): Effect of coating materials on table egg total coliform count after refrigerator storage.

Treatments	Zero time	1 week	2 weeks	4 weeks
Control	14 X 10^2	165 X 10^2	171 X 10^3	142 X 10^4
Starch	16 X 10^2	78 X 10^2	119 X 10^2	246 X 10^2
CMC	9 X 10^2	23 X 10^2	58 X 10^2	110 X 10^2
Agar	11 X 10^2	21 X 10^2	47 X 10^2	98 X 10^2
Significant	NS	*	*	*

The results of this research indicate that the processes of coating table eggs at the beginning of the experiment contributed to a significant increase in egg weight compared to control treatment eggs, and the highest weights were in eggs coated with CMC and Agar treatments, and this is due to the formation of a relatively thick layer of covers around the egg shell (Surayot et al., 2014; Chaisuwan et al., 2020; Rachtanapun et al., 2021a,b; Oliveira et al., 2022).

When the storage age advanced to one week, there was a decrease in the weights of eggs for all treatments, but the percentage of decrease was significantly high in the eggs of the control treatment, and the decrease continued when stored for two and four weeks. Then comes the coated treatment with starch, while the decrease was not significant for the two coated treatments using CMC and Agar. This is due to the role of coating in preventing the exit of moisture and CO_2 gas from the inside of the egg to the outer environment through the pores around shell of egg. In this study, coating processes contributed to preserving moisture and CO_2 gas inside the egg, so egg deterioration will decreased (Stadelman and Cotterill, 1995; Al-Shadeedi, 2010; Al-Obaidi and Al-Shadeedi, 2022).

The results shown in Table (1) no significant differences in egg characteristics (yolk height, yolk diameter, yolk index, and white height) at the start of the experiment (zero time), and this is due to homogeneity when buying eggs and randomly distributing them into the different treatments before the study. When storing eggs for a week (Table 2), showed a deterioration in the internal qualitative characteristics of control eggs compared to eggs that did not differentiate between them significantly. The deterioration of control eggs continued after storage for two and four weeks in refrigerator (Table 3 and 4), as the height of the yolk and the index of the yolk and the height of the white decreased, and the diameter of the yolk increased with a significant (P<0.05) difference from the rest of the coating treatments, and this is due to the presence of open pores in the egg shell, which are naturally present (North, 1984; Stadelman and Cotterill, 1995), and which naturally allow the exit of moisture and CO_2 gas, which leads to a decreased in egg pH and causing to deterioration in the quality of the egg white and an increase in the liquefaction of the gelatinous texture of the whites, and this will release and migration of bounded water from the whites to the egg yolk with much greater extent than what happened in coated egg which preserved moisture and CO_2 gas and did not deteriorate the gelatinous texture of the whites (Tanabe and Ogawa, 1975; Silversides and Scott, 2001). Our results and statistical analyses revealed that the best treatment was egg coating using (CMC), which achieved the highest quality of the egg even after storage for four weeks significantly (P<0.05) is results agree with Caner (2005); Kim et al. (2006); Biladeau and Keener (2009); Jones et al. (2018).

Studies indicate that table eggs are completely free of microorganisms the moment they leave the hen's body, but they soon begin to become contaminated through contact with the outer surface of the egg with the external components. The degree of contamination of the egg shell surface depends on several external factors related to field management or egg production halls, including the degree of cleanliness of the nests. Laying eggs, the number of times the eggs are collected, the nests are polluted by droppings, the temperature inside the halls, and the number of microorganisms on the surface of the eggshell on a clean table ranges between 30 and 300 cfu per egg. These numbers increases with the passage of time and the increase in egg contamination with chicken droppings. The correct principle in the production of table eggs Is the production of clean eggs (North, 1984; Stadelman and Cotterill, 1995).

The count of microorganisms on egg shell are in the form of different species and genus on the surface of eggs, most of which are mesophilic bacteria, so reducing the growth of these organisms on the surface of the egg shell, USDA (2000) suggests preserving eggs or storing them in refrigeration to maintain their shelf life for the longest possible period.

The problems of microorganisms on the surface of the egg shell are represented in the penetration of these microorganisms into the egg period and its membranes through the open holes In the egg shell and access to the internal contents of the egg, the first of which Is the egg white, and thus the rotting and spoilage of the eggs. And coliform bacteria on the surface of the eggshell, packaging treatments, especially CMC and agar, since cellulosic material Is difficult to digest and decompose by microorganisms, and agar is a more complex carbohydrate substance that most microorganisms cannot analyze easily. Therefore, we find that the use of packaging materials, especially CMC and agar, has contributed Significantly in increasing the viability of eggs during storage in the refrigerator. These results agree with Al-Shadeedi (2010); Chaisuwan et al. (2020); Rachtanapun et al. (2021a,b); Oliveira et al. (2022).

Conclusions

1. Coating material solutions are available in the local market, easy to use, and low coast.
2. The coating process was easy to apply with coated used materials.
3. The concentration of CMC solution material was relatively high or thick and It can be diluted to lower concentrations to get rid of the thickness of the coated layer.
4. Difficulty in mixing and dissolving the substance (CMC) and it has a high density.
5. The coating treatments (starch, CMC, agar) contributed to improving all the qualitative characteristics of eggs and prolonging the storage period.
6. The processes of coating table eggs with the four used treatments in this study lead to an increase in the shelf life of table eggs during storage in the refrigerator.

Recommendations

1. We recommend using starch, agar or CMC coating of table eggs to increase the shelf life of eggs during refrigeration.
2. We recommend using CMC material with the best concentration of 0.5 % to increase the shelf life of table eggs during storage.
3. We recommend conducting other studies for coating table eggs with starch, CMC and agar when stored under ambient or room conditions.
4. We recommend using mixture of coating materials to coating table eggs to increase the shelf life during storage.

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