Effect of using three types of vinegar on the quality and Shelf Life of table egg

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https://doi.org/10.59658/jkas.v10i4.1298

Received:
Sept. 11, 2023

Accepted:
Oct. 28, 2023

Published:
Dec. 15, 2023

Abstract

The current investigation was conducted to study the effectiveness of apple, grape and lemon vinegar coating in the shelf life of table eggs stored under room and refrigerator conditions for eight weeks. Two –hundred and forty table eggs from broiler breeder 57 weeks old were taken in the field and divided into eight treatments in two conditions, each including four treatments. T1 (control group) 60 eggs, T2 (apple vinegar) 60 eggs, T3 (lemon vinegar) 60 eggs and T4 (grape vinegar) 60 eggs were studied for eight weeks to evaluate egg quality characteristics after each two weeks and internal chemical compounds in the last week. The result showed a significant (P≤0.01) improvement of egg weight (g) in T2 and T3 in refrigerator conditions compared toT1, which recorded the lowest egg weight and decreased egg weight loss. Moreover, albumin height (mm) was increased while albumin diameter decreased, and yolk index significantly (P≤0.01) increased in refrigerator conditions. Additionally, air cells were significantly (P≤0.01) decreased in all vinegar-sprayed eggs, particularly in apple and grape treatments in both conditions. Three types of vinegar significantly (P≤0.01) improved moisture content by about 4%, and 2% in refrigerator condition. Results in this study indicate that using 5% of apple, lemon and grape vinegar solution of coating table egg extends egg-shelf life from one month to two months and more without negatively affecting the quality and quantity of eggs.

Keywords: Table egg, vinegar, egg-shelf life, egg quality.

Introduction

Eggs are extremely subject to internal quality degradation. The storage temperature significantly impacts the rate at which eggs lose internal quality [1]. They may be kept in their original condition for several weeks without losing their unique characteristics [2]. Additionally, in dry regions such as Iraq, one of the challenges to increasing output

is maintaining the egg quality by choosing the best storage type and duration. Several physical and chemical changes occur inside an egg when it is being stored [3].

On the other hand, storing egg for a long time without treatments may lead to changes in the density of the albumen, an increase in the diameter of the yolk, an expansion of the air cell, and the absorption of off flavors and odors [4]. Due to the permeable nature of eggshells, eggs are incredibly perishable. It impacts the quality, shelf-life, selling, distribution, and storage of eggs and the food products made from them. An efficient and affordable approach to protect the internal quality of eggs is egg coating. Generally acknowledged as Safe (GRAS) substance, edible egg coating is acknowledged as being safe [5].

Table eggs' qualitative, chemical, functional, and microbiological features are influenced by the environment variables such as the bird's age, food, season, temperature, transportation, storage time, and heat exposure [6]. An egg's internal composition and structural changes start as soon as it is laid. The quality changes in albumen and yolk and egg weight loss are controlled by the exchange of carbon dioxide and moisture through the shell. Even the most carefully maintained storage conditions can only slow down the rate of deterioration because it is an in-progress, irreversible process [7].

On the other hand, cooling of eggs is meant to improve their shelf life and prevent spoiling, it additionally decreases the possibility that the internal portion will become infected by organisms that cause disease and deterioration. To compare egg storage at ambient temperature and egg storage in the refrigerator, on the one hand, and egg preservation, on the other, it is crucial to understand how temperature affects the quality control of the internal composition of eggs [8]. Vinegar is a natural product recognized for its acetic acid, which has sanitizing effects. Researchers have identified vinegar naturally occurring in various fruits and fermented meals. It is commonly used as a sanitizing technique [9].

To the best of our knowledge, no literature information offers a thorough analysis of the edible coating components used to extend the shelf life of eggs. This study aimed to determine how three different vinegar coatings affected the shelf life of table eggs that were kept at ambient temperature and in the refrigerator for eight weeks.

Materials and Methods

Three different types of vinegar (Apple. Grapes, and Lemon) with a concentration of 5% were applied to the 57-week-old table eggs. The 240 table eggs were distributed into eight treatments with two conditions for eight weeks, as the table below:

Table (1): The experimental design of the study

Room temp. condition	Refrigerator condition
30 eggs control group	30 eggs control group
30 eggs coated with apple vinegar	30 eggs coated with apple vinegar
30 eggs coated with lemon vinegar	30 eggs coated with lemon vinegar
30 eggs coated with grape vinegar	30 eggs coated with grape vinegar

Study traits; the external egg quality parameters were recorded every two weeks: egg weight (g), egg shape index, egg-breaking strength (g/cm^2), albumin height (mm), yolk height (mm), yolk diameter (mm), yolk weight (g), shell weight (g), yolk index, haugh unit, and air space (mm).

Hu = 100 log (H – 1.7 W0.037 + 7.57) Where Hu = Haugh unit, H = white height (mm), W = egg weight (g.)

Air space was recorded after the egg shells were removed from the internal content.

Internal egg chemical composition: protein%, fat%, moisture%, Ca, Cu, Fe, Se, and Zn (ppm).

Statistical analysis:

The data was analyzed by using the SAS package programmers [10]. The collected data were subjected to variance analysis (ANOVA). The data were analyzed by using the Nested design. Duncan Multiple Range Test [11] was used to determine the less significant differences between treatments with probably P<0.01 and P<0.05.

$$Yijk = \mu + Ti + \beta(i)j + eijk$$

Results and Discussion

Results of external egg quality as affected by coating table eggs with three types of vinegar in two different conditions and showing its effect on egg shelf life are given in table (2). The results indicate no significant difference between the interaction among treatments. However, the effect of the three vinegar types significantly changed each treatment's external quality. Egg weight inT1 62.32 in refrigerator temp. recorded higher significance (P≤0.05) than T1 58.83 in room temp. Egg shape index T1, T2 in room temp. and T4 in refrigerator temp. Significantly (P≤0.01) increased, as well as egg breaking strength (g/cm^2) T1 and T4 recorded higher significant (P≤0.05) differences than other treatments.

Table (3) shows the effect of coating table eggs with three types of vinegar on internal egg quality parameters. According to the result, the interaction between treatments, in albumin height (mm) T1 and T2, Yolk diameter (mm) T1, haugh unit T4, yolk height (mm) and yolk index T2, T4 recorded the high value and significantly (P≤0.01) difference from others. While shell wt. (g) did not show significant differences among treatments. Besides, the air cellT1 recorded the largest significant (P≤0.01) difference from T4, which is recorded as the smallest air cell. Concerning the effect between treatments in two different conditions, albumin height in all treatments was better than T1 in room temperature, and yolk height and yolk index in all treatments in refrigerator condition were better than room temp. Yolk diameter T2 in room temperature, and air cell in all treatments in the two conditions were significantly (P≤0.01) improved compared to control groups. Moreover, yolk wt. in T2 and shell weight (g) in T1 at room temp. Condition significantly (P≤0.01) improved and compared with other treatments.

Our findings agreed with those of [5, 12, 13, and 14] when recorded that packaging eggs with different materials and different storage conditions significantly improved egg quality and extended the shelf life of eggs. Regarding storage conditions, similar results were reported by [13, 14] when observed egg weight loss when stored at environmental temp. 22 **°C** over a four-week storage period 4.67%. However, their values for eggs were refrigerated at +4 **°C** for the same length of time 0.48%. Additionally, [16] stated that egg weight losses of all vinegar groups were significantly lower ($P<0.05$) than untreated groups.

Previous research has documented that chicken egg coating with different materials could increase its shelf-life in both table and hatching eggs [1, 16, 17]. The health-promoting qualities of vinegar are linked to its high nutrient and bioactive ingredient content, as well as antioxidant activity, which reduces the number of microbes on the surface of eggs. Apple vinegar in particular worked as a protective factor in this study [18]. According to the previous study, adding 1.0% buffered vinegar to carbon dioxide packing may increase the shelf life of retail chicken portions without impairing their quality or sensory characteristics [19].

The researchers documented that egg quality decreased with increasing storage time [3, 6]. Our results showed that refrigerated storage and three kinds of vinegar coating had the greatest impact on maintaining egg quality factors, particularly haugh unit and yolk index, which are primary indicators of egg quality [17]. The results concluded that a slight change of haugh unit while the yolk index significantly ($P\leq0.01$) improved with vinegar coating. Likewise, the results of this study demonstrated that air cells were strongly influenced by storage time and that returning to vinegar could help air cells function better in this application as a cold preservation layer [20].

The results in this study observed that weight loss leading to an increase of the air cell are caused by the diffusion of water through the eggshell. The eggshell's permeability depends on the shell's thickness, number of the pores and the quality of the cuticle. Since shell thickness declines with hen age and egg weight, the factors are usually reported as causes of weight loss and increased size of air cell egg shell thickness decreased significantly with increasing hen age [3]. The main fresh air cell size is 4-5 mm depending on egg size and storage conditions 6 °C, air cell size will gradually expand after three weeks of storage [2].

In this study, despite storage conditions, apple, grape, and lemon vinegar have been shown effective in closing the pores, and maintaining air cells and the egg's internal contents [18]. Recently, vinegar acts as a preserving material by sealing the holes on the surface of eggs, it aid of stabilize eggs for several weeks by reaming the albumin and yolk.

Table(2):Effect of coating table eggs with three types of vinegar in two conditions on external egg quality parameters

Items		Egg Wt. g	Egg shape index	Egg-breaking strength (g/cm2)
P value		N.S	N.S	N.S
Interaction				
	T1	61.40 ± 0.85	71.5 ± 4.56	378.13 ± 14.59
	T2	61.02 ± 0.68	73.67 ± 3.58	360.38 ± 19.31
	T3	60.49 ± 0.78	73.69 ± 6.43	364.53 ± 17.02
	T4	61.56 ± 0.89	72.98 ± 5.30	347.06 ± 12.66
Treatments				
P value		*	**	*
Room temp.	T1	58.83±1.17 ^{b}	74.50±2.33 ^{a}	401.13±14.73 ^{a}
	T2	60.12±1.36 ^{ab}	74.06±3.12 ^{a}	330.31±29.97 ^{ab}
	T3	61.28±0.88 ^{ab}	72.69±1.84 ^{b}	381.81±11.3 ^{ab}
	T4	60.38±1.2 ^{ab}	72.44±5.11 ^{b}	392.88±20.17 ^{a}
Refrigerator	T1	62.32±1.12 ^{a}	73.64±4.98 ^{ab}	362.25±20.14 ^{ab}
	T2	63.14±1.19 ^{a}	69.18±3.23 ^{c}	338.69±15.22 ^{ab}
	T3	61.89±1.07 ^{ab}	72.94±5.23 ^{ab}	314.43±34.73 ^{b}
	T4	60.98±0.78 ^{ab}	74.37±2.98 ^{a}	378.69±19.7 ^{ab}

*Two conditions. 1- Room temperature 24-20 °C. 2- Refrigerator condition 4 °C. T1= control group, T2=apple vinegar, T3= lemon vinegar and T4=grape vinegar. $^{a-c}$ Means within columns with different superscripts significantly differ. ** (P<0.01), * (P <0.05), N.S non-significant. ± Standard error.

Table(3): Effect of coating table eggs with three types of vinegar in two conditions on internal egg quality parameters

Items		Albumin height mm	Yolk height mm	Yolk diameter mm	Yolk Wt. g	Shell weight g	Haugh unit	Yolk index	Air cell mm
Interactions									
P value		**	**	**	N.S	N.S	*	**	**
T1		2.09±0.03^{a}	11.00± 0.14^{c}	47.74± 0.50^{a}	21.52± 0.18	5.88± 0.11	59.60± 1.00^{b}	23.30± 0.60^{c}	7.22± 0.40^{a}
T2		2.04±0.04^{a}	14.03± 0.28^{a}	46.18± 0.54^{b}	21.69± 0.19	5.94± 0.12	57.95± 0.90^{c}	30.38± 0.80^{a}	5.29± 0.41^{bc}
T3		1.65±0.11^{c}	12.62± 0.31^{b}	46.88± 0.71^{ab}	21.37± 0.16	6.10± 0.10	59.85± 1.10^{b}	26.91± 1.50^{b}	5.64± 0.45^{b}
T4		1.98±0.02^{b}	14.34± 3.46^{a}	46.40± 0.55^{b}	21.49± 0.22	6.10± 0.10	61.20± 1.00^{a}	30.90± 1.30^{a}	5.00± 0.58^{c}
Treatments									
P value		**	*	**	**	*	**	**	**
Room temp.	T1	1.55± 0.1^{c}	10.00± 0.39^{b}	49.46± 0.62^{ab}	21.86± 0.28^{b}	6.35± 0.20^{a}	60.87 ± 0.94^{ab}	20.21± 0.29^{d}	7.44± 0.61^{a}
	T2	1.63± 0.1^{bc}	10.06± 0.36^{b}	50.80± 0.60^{a}	22.65± 0.22^{a}	5.60± 0.12^{b}	57.22 ± 0.59^{c}	19.80± 0.56^{d}	5.77± 0.51^{b}
	T3	1.74± 0.1^{b}	10.98± 0.29^{ab}	48.35± 0.58^{c}	21.44± 0.37^{bc}	6.09± 0.11^{ab}	58.86 ± 0.36^{c}	22.76± 1.46^{c}	4.36± 0.54^{c}
	T4	2.06± 0.0^{a}	11.15± 0.23^{ab}	47.76± 0.78^{c}	21.49± 0.19^{bc}	6.03± 0.16^{ab}	61.50 ± 0.71^{a}	23.34± 0.51^{c}	5.18± 0.61^{bc}
Refrigerator	T1	2.14± 0.0^{a}	11.54± 0.22^{ab}	44.36± 0.59^{d}	21.03± 0.24^{c}	6.00± 0.15^{ab}	59.49 ± 1.19^{b}	26.00± 0.36^{b}	6.62± 0.43^{ab}
	T2	2.13± 0.0^{a}	13.70± 0.26 ^{ab}	44.61± 0.48^{d}	21.10± 0.20^{c}	6.05± 0.14^{ab}	59.90 ± 1.11^{b}	30.71± 0.85^{a}	4.44± 0.61^{c}
	T3	2.10± 0.03^{a}	13.69± 6.85^{a}	44.17± 0.32^{d}	21.13± 0.17^{c}	5.95± 0.17^{ab}	60.83 ± 0.82^{ab}	30.90± 1.60^{a}	5.37± 0.51^{b}
	T4	2.09± 0.04^{a}	13.86± 0.30^{ab}	44.91± 0.48^{d}	21.45± 0.21^{bc}	5.99± 0.10^{ab}	59.30 ± 1.11^{b}	30.86± 1.87^{a}	4.26± 0.54^{c}

*Two conditions. 1- Room temperature 24-20 °C. 2- Refrigerator condition 4 °C. T1= control group, T2=apple vinegar, T3= lemon vinegar and T4=grape vinegar. $^{a-c}$ Means within columns with different superscripts significantly differ. ** (P<0.01), * (P <0.05) , N.S non-significant. ± Standard error.

The effect of coating table eggs with three types of vinegar on the chemical composition of table eggs is presented in table (4). Depending on the result, the vinegar coating effect significantly affects egg moisture %, particularly T2 (lemon vinegar) in refrigerator temp. recorded higher significance (P≤0.01) and led to remaining moisture content less (weight loss) than others, while moisture % in T1 (control group) in room temp. decreased and significantly (P≤0.01) different than others. Concerning Ca mg/100g in T1 and T2 significantly (P≤0.01) was recorded higher than other

treatments. However, between treatments, protein%, fat%, Cu, Fe, Se, and Zn (ppm) effect is non-significant.

Our result is the same as Those (14, 17 , 21) who suggested that Eggshells' pores nature allows moisture and carbon dioxide to escape when it is claimed that the moisture content of eggs dropped at room temperature when they were not coated with materials. Since eggs contain about 80% water by weight, this is primarily cause rapidly evaporating water loss through the hundreds of pores on the surface of the eggshell. Thin albumen develops during egg preservation as the gelatinous structure of the thick albumen gradually deteriorates due to ovomucinlysozyme contacts. Certainly, the three types of vinegar work as a preservation coating material [22]. Application 5% 0f apple, grape and lemon natural vinegar solutions as natural substances for spraying and coating table eggs in room and refrigerator temperature did not have a significant effect on egg quality on the interaction between treatments in the two conditions, while a significantly improved in each treatment, particularly albumin height (mm), yolk index and air cell (mm). Additionally, coating with three types of vinegar significantly retained internal moisture from losing and vaporing by closing the pores on the surface of the eggshell and led to extending the shelf-life of eggs for two months and more in the refrigerator than at room temperature conditions

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Table (4): Effect of coating table eggs with three types of vinegar in two conditions on the chemical compounds of the egg.

Items		Protein %	Fat%	Moisture%	Ca mg/100gm	Cu ppm	Fe ppm	Se ppm	Zn ppm
	P. V.	N.S	N.S	**	**	N.S	N.S	N.S	N.S
Room temp.	T1	12.1± 0.200	14.2± 0.208	82.6± 0.372 ^{d}	56.6± 0.423 ^{a}	0.071± 0.002	2.43± 0.193	0.356± 0.095	1.12± 0.086
	T2	11.5± 0.577	14.1± 0.577	86.6± 0.577 ^{b}	55.4± 0.577 ^{a}	0.067± 0.006	1.22± 0.577	0.355± 0.335	1.11± 0.289
	T3	11.4± 0.577	13.8± 0.577	84.6± 0.577 ^{c}	53.4± 0.577 ^{b}	0.066± 0.006	1.21± 0.577	0.354± 0.335	1.06± 0.289
	T4	11.3± 0.577	13.6± 0.577	85.7± 0.577 ^{c}	52.5±0 .577 ^{bc}	0.062± 0.006	1.14± 0.577	0.354± 0.335	1.06± 0.289
Refrig.	T1	11.1± 0.577	13.4± 0.577	86.6± 0.577 ^{b}	52.4± 0.577 ^{bc}	0.061± 0.006	1.12± 0.577	0.351± 0.335	1.06± 0.289
	T2	10.8± 0.577	13.1± 0.577	88.2± 0.577 ^{a}	52.1± 0.577 ^{bc}	0.059± 0.006	1.12± 0.577	0.349± 0.335	1.06± 0.289
	T3	10.7± 0.577	12.4± 0.577	86.5± 0.577 ^{b}	51.4± 0.577 ^{c}	0.058± 0.006	1.08± 0.577	0.344± 0.335	1.06± 0.289
	T4	10.4± 0.577	12.9± 0.577	87.5± 0.577^{ab}	50.8± 0.577 ^{c}	0.057± 0.006	1.04± 0.577	0.025± 0.335	1.06± 0.289

*Two conditions. **1-** Room temperature 24-20 **°C**. **2-** Refrigerator condition 4 **°C**. T1= control group, T2=apple vinegar, T3= lemon vinegar and T4=grape vinegar. $^{a-c}$ Means within columns with different superscripts significantly differ. ** (P<0.01) , N.S non-significant. ± Standard error.

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