

QUALITY OF TABLE EGGS AND THEIR PRODUCT AS AFFECTED BY STORAGE TEMPERATURE

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Abstract

Quality of table eggs and their product was investigated during storage for 40 days at two different temperatures $4\pm1^{\circ}\text{C}$, and $37\pm1^{\circ}\text{C}$. The results showed that the weight loss for eggs was increased with increasing storage periods; however, refrigerated storage markedly reduced the weight loss of eggs compared with that stored at high temperature 37°C . The average weight loss of the refrigerated egg sample was 3% compared to 23% for the sample stored at 37°C respectively at the end of the storage period. The results showed that there was an increase in pH of eggs during storage along with the storage period. The increment was much higher for the sample stored at high temperature 37°C . The storage time has a relatively great negative effect on the albumen foaming capacity and foam stability. Same trend was noticed by applying storage at high temperature 37°C compared with refrigerated storage. The data showed that the sensory evaluation values were highly affected by both storage temperature and storage time. The effect of temperature was much higher than the time.

Key words: Table eggs, storage, quality, foaming capacity and foam stability

INTRODUCTION

Eggs are an excellent source of nutrients including high quality protein, vitamins and minerals. They are, after all, designed to support life. They are consumed globally and their production represents an important segment of the world food industry. Egg albumen is used in many food formulations as a foaming ingredient. The foaming properties of a foaming material are evaluated by its foaming capacity, foam stability and foam viscoelasticities. The foaming properties, in return, determine the use of the foaming material in a food product. Improving the foaming properties of egg albumens could substantially expand its use in a variety of food products [8]. Unlike external quality, the internal quality of eggs starts to decline as soon as they are laid by hens. Thus, although factors associated with the management and feeding of hens can play a role in internal egg quality, egg handling and storage practices also have a significant

impact on the quality of eggs reaching consumers. Albumen quality is not only an important indicator of egg freshness; it is also significant for the egg processing industry. Albumen quality is a standard measure of egg quality, and it is influenced by genetic factors and environmental factors such as storage temperature and time [13]. Eggs are highly perishable and can rapidly lose their internal quality due to the loss of moisture and carbon dioxide through pores of the eggshell as a result of improper storage methods. During storage, loss of moisture and carbon dioxide via the shell pores causes negative quality changes in albumen and yolk as well as weight loss of eggs [16]. The quality of eggs and their stability during storage are largely determined by their physical structure and chemical composition.

Temperature, humidity, air movement and storage times can all have adverse effects on interior quality. These factors, if not controlled, can cause loss of moisture in eggs. In some developing countries of the world, refrigeration of eggs may be seldom practiced, and coating of eggs is an alternative and effective method to preserve their internal quality. Several factors

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affecting the internal quality of eggs during storage include initial egg quality and storage conditions [17]. The most profound factor that affects the quality deterioration rate of eggs is storage temperature. Loss of water through the porous shell will mean loss of weight. Albumen pH is not affected by hen age or strain and can be used to measure egg freshness without this bias. pH is a useful means for describing changes in albumen quality over time during storage. Significant increases in yolk pH were observed with increasing storage time [20], [13].

Most of the changes in egg quality in terms of albumen height, albumen pH, yolk index, specific gravity, and air cell size are attributed to moisture loss by evaporation through the shell pores and the escape of CO₂ from albumen [12]. Maintaining fresh egg quality from producer to consumer is one of the major problems facing those engaged in marketing eggs.

In many countries as the third world and poor countries, egg preservation is a serious problem. The common practice is to store under an ambient condition due to lack of refrigeration facilities and erratic power supply.

Quality changes of eggs during storage are affected by various factors and one of them could be storage temperature [18].

The objective of this investigation is to study the effect of storage temperature on the quality of table eggs and their product.

MATERIAL AND METHODS

Freshly laid table eggs (two days intervals) were purchased from a local poultry farm (Minia, Egypt) and were used for the study. The eggs were cleaned, manually and divided into two groups (150 egg each). One group was stored in the refrigerator at 4±1°C, while the other was kept at 37±1°C for the whole storage period (40 days). At zero time and every ten days intervals, samples were taken to determine the following:-

Determination of the total weight loss:
Weight loss (%) of the whole egg during storage was calculated as follows:-

$$\left\{ \frac{\text{initial whole egg weight (g) at day 0} - \text{whole egg weight (g) after storage}}{\text{initial whole egg weight (g) at day 0}} \right\} \times 100.$$

The weight of whole eggs was measured with a balance (TS400S, Ohaus Corp., Florham Park, NJ, USA). Ten measurements per treatment were taken [19].

Determination of albumen pH: Albumin pH was calculated after separation from the yolk. Both thin and thick albumen were mixed thoroughly prior to measuring pH with a pH meter (IQ150, IQ Scientific Instruments, San Diego, Calif., U.S.A.). Three replicates (5 eggs/ replicate) per each treatment (15 eggs total/treatment) were taken [3].

Determination of foaming capacity and foam stability: Foam capacity was measured using a modified method by [15]. Approximately 60 g of albumen from 2 eggs for each treatment were used in foam testing. Mixing for two minutes was done using a Kitchen Aid K45SS model (Kitchen Aid Company, St. Joseph, MI). The volume of the foam was recorded after 30 second and foam capacity (FC) was expressed as percentage volume increase as the following equation:

$$\text{Volume increase (\%)} = \frac{\text{volume after whipping (ml)} - \text{volume before whipping (ml)}}{\text{volume before whipping (ml)}} \times 100$$

Foam volumes were recorded at 30 sec., 5, 10, 30, 60, 90, 120, 150, and 180 min intervals to study the foam stability of the samples. The foam stability (FS) was determined according to the method of [10] and [4] by measuring the (FC) at 5, 10, 30, 60, 90, 120, 150 and 180 minutes. The (FS) was expressed as percentage between (FC) at 60 minutes and the real corresponding (FC) at 30 seconds according to the following formula:

$$FS_{\text{at 60 min}} = \left(\frac{FC_{\text{at 60 min}}}{FC_{\text{at 30 min}}} \right) \times 100.$$

Sensory evaluation: Sensory evaluation for the color, flavor, texture, and overall quality was done in order to determine consumer acceptability for the cake made from the table eggs stored at two temperatures 4°C and 37°C. A numerical hedonic scale which ranged from 1 to 10 (1 is very bad and 10 for excellent) was used for sensory evaluation [7].

RESULTS AND DISCUSSIONS

Eggs provide a unique, well-balanced source of nutrients for people of all ages. However, eggs are highly perishable and their internal quality starts to deteriorate immediately after they have been laid due to loss of moisture and carbon dioxide through the pores on the shell surface. These losses through the shell cause the pH of albumen to rise, and this changes the structure of the albumen protein. In addition, evaporation of moisture and movement of water within the egg occur during the storage period. This movement results in enlargement and decreased viscosity of the yolk, weakening of the vitelline membrane, and consequent flattening of the yolk when the egg is broken. [2], and [6]. Therefore, a protective treatment against transfer of moisture and carbon dioxide is needed to preserve the egg quality. Quality changes of eggs during storage are affected by various factors and one of them could be storage temperature.

Effects of storage temperature on weight loss: Changes in weight loss of the eggs

stored for 40 days at two different temperatures (4°C and 37°C are presented in (Fig. 1). Overall, the weight loss was increased with increasing storage periods; however, refrigerated storage markedly reduced the weight loss of eggs compared with that stored at high temperature 37°C. This may be as a result of the presence of the shell spores which makes it easier for moisture and gases to escape from the eggs. The breakdown of carbonic acid in the egg white produces carbon dioxide and water. The carbon dioxide escapes through the shell pores and the egg white loses in thickness and becomes watery and this results in loss of weight of eggs. Keeping the eggs at high temperature 37°C might increase the size of the shell pores and make it easier for carbon dioxide and moisture to escape from the eggs. The results come in agreement with what was found by [5], [18] and [3].

After the end of storage period, the average weight loss of the refrigerated egg sample was 3% compared to 23% for the sample stored at 37°C respectively.

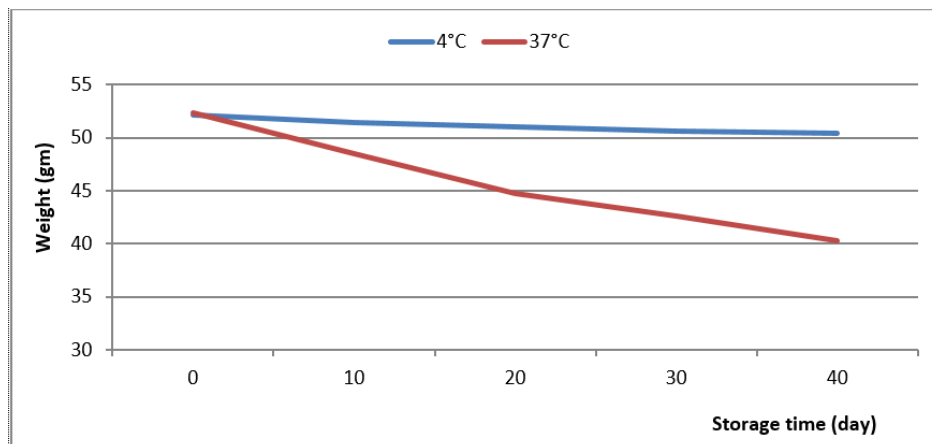


Fig. 1 Effect of storage temperature and time on the weight loss of table eggs

Change in albumen pH of eggs during storage: The result of the changes in the albumen pH of eggs during storage is presented in (Fig. 2). The albumen pH of the fresh eggs for all treatment was measured to be 8.15 before storage. The results showed that there was an increase in pH of eggs during storage along with the storage period. The increment was much higher for the

sample stored at high temperature 37°C compared with those stored at refrigeration. The rise in the albumen pH of the eggs may be caused by the loss of carbon dioxide from the egg through the pores in the shell. From the above results one could say that there was an observed interaction between storage time and temperature for the egg albumen pH. These

findings are in agreement with results reported by other researchers [14], [13], and [1].

After twenty days of storage at 37° C a yellow color has been observed in the albumen. The dense of the yellow color increased with the increasing of storage time. This could be due to a partially leakage of the yolk into the albumen as a result of the

weakening of the membrane surrounding the yolk. Some researchers found a change of the thick egg albumen into the thin during storage at high temperature which caused a decrease in the viscosity of egg white. Some other researchers have noted that the membrane surrounding the yolk becomes weak as storage duration increases [11].

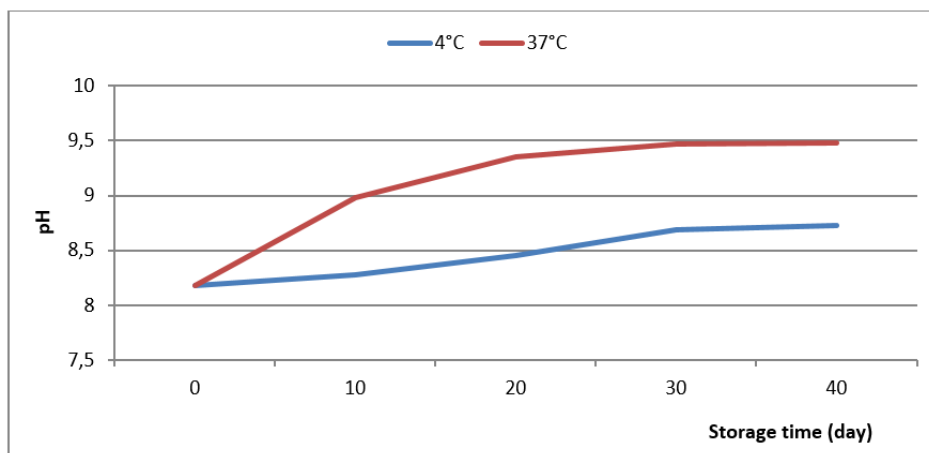


Fig. 2 Effect of storage temperature and time on the albumen pH of table eggs

Effect of storage time and temperature of foaming capacity and foam stability of egg albumen: Egg albumen has excellent food foaming properties. Such properties are determined by the ability to rapidly adsorb on the air-liquid interface during whipping or bubbling, and by its ability to form a cohesive viscoelastic film by way of intermolecular interactions [9]. Foaming properties are evaluated by foaming capacity and foam stability. Table (1), illustrated the effect of storage temperature and time on the foam

capacity and foam stability of the table eggs albumen. The results showed that storage time has a relatively great negative effect on the albumen foaming capacity and foam stability. Same trend was noticed by applying storage at high temperature 37° C compared with refrigerated storage. From the obtained results, one could say that the increase in the pH values of egg albumen as a result of the storage time and temperature has a negative effect on the foaming capacity and foam stability of egg albumen.

Table 1 Effect of storage temperature and time on the foam capacity and foam stability of table eggs albumen

Time of stability (min.)	% Foam capacity at 4° C*					% Foam capacity at 37° C*				
	Storage time (days)					Storage time (days)				
	0	10	20	30	40	0	10	20	30	40
0.5	78	75	73	71	68	78	70	60	48	33
5	76	75	73	70	66	75	61	51	37	24
10	68	65	61	57	53	68	60	46	30	20
30	62	58	54	50	49	61	53	42	30	20
60	55	52	50	44	40	53	47	40	27	17
90	50	48	46	43	39	50	44	40	25	17
120	46	41	37	34	31	45	37	31	19	17
150	42	38	35	32	29	41	31	28	17	16
180	39	36	33	30	28	38	31	26	15	14
**FS_{60min}	70.51	69.33	68.50	61.97	58.82	67.95	67.14	66.67	56.25	51.52

* Values are average of three determinations.

**FS_{60min} = (FC_{60 min} / FC) × 100

Effect of storage time and temperature of eggs on the sensory evaluation of their product: The sensory evaluation for the cake made from the eggs stored at two different temperatures 4°C and 37°C for 40 days is presented in (Table 2). The data showed that the sensory evaluation values were highly affected by both storage temperature and storage time. The effect of temperature was much higher than the time. The data showed that the cake samples made from eggs stored

at 37°C had the lowest values of evaluation for color, flavor, texture and overall acceptability, compared with the cake made from eggs stored at 4°C. The storage temperature affected the color, flavor and albumin for eggs which had negative effects on flavor and texture for the cakes produced. Due to the bad effect of the storage temperature on the foaming capacity and foam stability, the texture of the cake was lumpy not spongy as desired.

Table 2 Sensory evaluation of cake made from table eggs stored at two different temperatures for 40 days*

Storage time	Temp.	Color	Flavor	Texture	Overall acceptability
Zero time	4°C	9±0.8	9±0.5	9.5±0.2	9±0.4
	37°C	9±0.8	9±0.5	9.5±0.2	9±0.4
20 days	4°C	9±0.3	9±0.15	9±0.25	9±0.1
	37°C	7±0.6	7±0.5	7±0.75	7±0.3
40 days	4°C	8.5±0.3	8.5±0.6	8.5±0.5	8.5±0.5
	37°C	6±0.2	6±0.2	5±0.4	6±0.3

CONCLUSIONS

Eggs stored under high temperature (37±1°C) had faster rate of decline in quality indices as compared to those that were refrigerated. The refrigerated eggs had almost similar quality preservation indices. Therefore, in the tropics and most developing nations of the world, application of cold storage of eggs can be practiced to ensure retention of good quality eggs.

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