The Effect of Storage Periods on the Quality Characteristics, Fatty Acid Profile and Protein Patterns of Table Eggs

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ABSTRACT

The present study was carried out to detect the effect of different storage temperature and duration on the chemical, physical and functional properties of table eggs. Eggs characterization and proximate analysis showed that the moisture content of fresh whole egg, egg white and egg yolk was found to be 72.95, 87.69 and 49.65 %, respectively. The protein content of the whole egg, white and yolk was 49.17, 93.12 and 33.21 % (on a dry weight basis). Egg-yolk and whole egg were found to contain a fat content of 59.46 and 41.96%, respectively, while egg white was almost free of fat being 0.16%. The ash content of whole eggs, white and yolk was 5.06, 5.12 and 2.38%, respectively. The weight of fresh eggs was 45.55 ± 2.41 g and decreased to a range of 42.01 g to 38 g after 21 days of storage at incubation temperature. During the storage period at different conditions, a significant reduction ($P \leq 0.05$) in the yolk index value was found. The albumin pH of the fresh egg was 6.86 and decreased by storage for 21 days at different conditions. The peroxide value increased from 0.704 to 0.84, 1.02, and 1.31 meq O_2/kg oil for eggs stored for 21 days at refrigeration, ambient temperature, and incubation, respectively. The results illustrated that the foam capacity of eggs decreased with further storage. However, eggs stored at refrigeration had considerably higher foam capacity than those stored at ambient temperature and incubation at 32 °C. The results indicated that the foam of eggs stored at refrigeration was more stable than that stored at both ambient temperature and in the incubator. Oleic acid was the major fatty acid in fresh eggs accounting for 46% of the total fatty acids, whereas palmitic and linoleic acids represent 24.8 and 15.5% of the total acids. The SDS-PAGE proteins pattern showed five dominant polypeptide components and four minor bands in the egg proteins.

Keywords: Egg storage, Yolk index, Fatty acid profile, Protein pattern, Egg quality.

INTRODUCTION

Egg is one of the most nutrient-rich and complete foods known to man. Customers have known the high nutritive value of table eggs for a long time as eggs are a good source of high-quality protein, phospholipids and bioactive compounds (Lesnierowski and Stangierski, 2018). Eggs are considered a principal food item for human consumption as they provide most of the nutrients suggested by the recommended daily allowance (RDA) (Basmacioglu and Ergul, 2005). Recently, more and more eggs are being produced in large commercial operations all over the world. The amount of eggs which exceeds the fresh egg consumption is used for the egg processing industry for local use or for export. Also, eggs could be defective in some way that lowers their grade as shell eggs, but they were not affected in the quality of the content and hence were used for processing of egg products.

Freshness is a major contributor to the egg quality. In times of high feed prices and high egg prices, it is necessary to maintain the quality of eggs as much as possible and storage becomes very necessary for maintaining the egg quality when market consumption of eggs is low due to its high prices. The storage conditions influence the internal quality of the egg. The quality traits of an egg are those that directly affect its acceptability to the consumers (Rath *et al.,* 2015). During the storage of eggs, some noticeable changes occur, the most important of which is an increase in the air cell, the flattening of the yolk, and the thinning of the albumen surrounding the yolk. Both environmental conditions and genetic factors affect egg production. Especially, in some Egypt governorates. Eggs are often stored in farm shadow areas and under ambient conditions, from the farm to the market and the consumer. During this period between storage and consumption, there is a rapid loss in quality. As the principal table egg quality affecting factors are both storage conditions and storage temperature, high storage temperature and dehydration have been identified as egg degrading factors in the study of Hasan and Aylin (2009).

The major changes that occur in eggs during storage are the notable increase in the size of air cells due to loss of moisture and the common increase of pH due to the escape of carbon dioxide. pH increases from 7.6 to 9.7, increase the percentage of thin white, thus egg white loses its shape and runs easily and water passes from white to yolk and the thus fluid content of yolk increases. So egg deterioration during storage has been attributed to the water movement and migration from thick albumen to other albumen layers, egg shell is porous but coated with a mucilaginous matter that

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prevents bacteria from entering unless it is very old, dampened by moisture, rubbed off or otherwise the keeping quality of the egg is much reduced (Shittu and Ogunjinmi, 2011). Therefore, eggs must be marketed as soon as possible after they are laid, and they must not be washed or stored in damp places.

The functional properties of eggs that are affected by processing methods and storage conditions should be considered to preserve the quality of frozen and dehydrated products. On the other hand, the functional properties of liquid egg products are not affected to the same extent by processing as compared to the dried or frozen products.

The present work aimed to study the effect of storage duration and temperature on some physical, chemical, and functional changes of table eggs.

MATERIALS AND METHODS

Materials

Ninety fresh, free from feather balady table eggs were obtained from Alexandria laying hens strain chicken, fed 100% vegetarian feed of Alexandria University Agricultural Faculty Farm, Abeas, Alexandria in May 2023.

The eggs were prepared for retail markets and consumers. Eggs were sorted for surface cracks and breakage. Eggs were free of cracks and fractures. All eggs were pleased and stored in cardboard viols holding 30 eggs each. Thirty eggs per stored temperature were used for egg internal and external quality analysis. The three tested temperature storage were, at room or ambient temperature (22 ± 2 ◦C), refrigeration storage at 8 ºC and in a 32 ◦C adjusted incubator for 21 days. The eggs were randomly assigned for weekly investigation. Egg internal, chemical, functional and microbial quality tests were measured in the randomly selected eggs at 7, 14 and 21 days of different temperature storage by week intervals. The tested treatments were at ambient temperature, refrigeration and 32 ◦C incubation storage.

On the same day of collection the egg samples were tested for physical, chemical and functional quality parameters as zero time storage.

Methods

External and internal quality traits: Egg shell colour parameters {L*(lightness), a*(red intensity), and b*(yellow intensity)} were measured using Hunter Lab Ultra Scan, VIS model, colorimeter (USA). The instrument was standardized during each sample measurement with a black and white tail. The mean of three readings of each colour index of the Hunter scale (L*, a*, b*) was recorded. The instrument was standardized during each sample measurement with a black and white tail. Egg weight was recorded using four number SF-400 digital balances. yolk height was measured using a digital tripod micrometer accurate to 0.01 mm. The Yolk index was calculated from the following equation:

Yolk index= yolk height/ yolk diameter (Narushin, 1997).

Yolk height, yolk diameter and yolk index were determined in the eggs at 7, 14 and 21 days of storage by week intervals.

Chemical methods:

Proximate chemical composition: Moisture content, crude protein and total ash were determined according to the AOAC (2012) methods. Total lipids of fresh and stored eggs (yolk) were extracted according to the method of Folch *et al.* (1957). pH value of egg albumin using a digital Metler Toledo Mp 230 pH meter, were determined in storage intervals.

Fat oxidation parameter:

Peroxide value (PV) as meq O_2/ kg oil of fresh and stored eggs was determined according to AOAC (2012).

Fatty acid profile analysis: Fat from fresh and stored eggs was extracted and fatty acids methyl esters were prepared according to the method of Radwan (1978), two drops of the yolk fat were taken and dissolved in 5 ml benzene (GC grade) and 7 ml of 1% H_2SO_4 in methanol were added in screw cap tube (25 ml) then the mixture was heated at 90◦C in oven for 90 min. Two ml of distilled water were added and shaken well until the mixture was separated into two layers. The upper layer was taken and passed on sodium sulfate anhydrous to eliminate the excess moisture after that the filtrate was passed through a microfilter of 0.22 µl to be ready for injection in the GC column.

Gas chromatographic analysis was carried out using ACME model 6100 GC (Young LIN Instrument Co., Korea) fitted with a split injector and FID detector. Nitrogen was used as the carrier gas with a flow rate of 0.5 ml/min. The component was separated on a 30 m SP-2380 fused—silica capillary column with 0.25 mm i.d. and 0.2 µm film thickness (Supelco, Belleonte, PA) and the detector temperature was set at 260◦C. The injector temperature was set at 220◦C and in split mode (split ratio 1:80). The column was initially maintained at 140◦C for 5 min, and the temperature was subsequently increased to 240◦C at rate of 4◦C/min. The fatty acid composition was determined by comparing it with the fatty acid methyl esters standard.

Sodium dodecyl sulphate-polyacrylamide gel electrophoresis

Sample preparation: Samples of fresh and stored eggs were used for the preparation of acetone dry powder. A weight of 50 ml of each was stirred with cold acetone 1:5 (v/v) for one hour and then centrifuged. The

supernatant was removed and the precipitate was treated twice with cold acetone. The precipitate was then stirred with diethyl ether and then centrifuged, air dried in order to prepare a fat-free sample and kept at refrigeration until used for protein electrophoresis (Guilmineau *et al.*, 2005).

Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) was used to track the changes in egg protein fractions as affected by storage durations and temperature. Under reducing conditions, 12.5% SDS-PAGE was performed using a discontinuous buffer system as described by Laemmli's (1970). Briefly, the fresh egg and, at the end of storage periods.20 mg of powder from each sample was dissolved in 1 ml of reducing sample buffer and then boiled for five minutes. Then, the samples were cooled to room temperature, and 10 µL of each was applied to the gel. After electrophoresis, proteins were visualised using Coomassie Brilliant Blue R-250 (1%). SDS-PAGE was performed using a Mini-PROTEAN electrophoresis cell (Bio-Rad Laboratories, Hercules, CA, USA).

Functional properties:

Foam capacity and foam stability: The foam capacity and foam stability of homogenized whole liquid egg were determined. Twenty grams of sample were blended by an electric blender (Molinex, Germany) for 3 minutes. The mixture was poured into a graduated measuring cylinder and the total volume was recorded after 30 seconds. The foam capacity was calculated as the difference between the total volume and the volume of the initial whole liquid eggs and expressed as a percentage increase in volume. The foam stability was determined at 15, 30, 60, and 120 minutes after pouring into the cylinder (Lomakina and Mikova, 2006).

Statistical Analysis: All data were analyzed by a general linear model procedure (GLM) using the SAS statistical analysis software package (SAS, 2004). The statistical analysis was performed using one-way ANOVA. Means were compared by Duncan's test at the significance level of $P \leq 0.05$ (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate chemical composition and colour

The chemical composition of whole eggs, egg white and egg yolk is presented in Table (1). The moisture content of fresh whole egg, egg white and egg yolk was found to be 72.95, 87.69 and 49.65 %, respectively. The egg white showed a higher protein content than that of whole egg and yolk. The protein content of the whole egg, white and yolk was 49.17, 93.12 and 33.21 % (on a dry weight basis), respectively, compared with the results reported by Senbeta *et al.* (2015).

Egg-yolk and whole egg were found to contain a fat content of 59.46 and 41.96%, respectively, while egg white was almost free of fat being 0.16%.The ash content of whole eggs, white and yolk were 5.06, 5.12 and 2.38%, respectively.

Colour measurements: Eggshell colour is one of the most important egg quality characteristics. The colour of eggshell, white and yolk are presented in Table (1). Egg colour is a criterion is due to the certain strains of chickens. Yellowness represented the main fraction of the actual colour of the fresh egg yolk.

The external and internal qualities of eggs.

The results of both the external and internal quality of eggs are shown in Table (2).

Table 1. Proximate chemical composition and colour of fresh whole egg, egg white and egg yolk

Character	Whole egg *	Egg white	Egg yolk
1-Proximate composition (%) On a dry weight basis			
Moisture content	72.95	87.69	49.65
Crude protein	49.17	93.12	33.21
Total Fat	41.96	0.16	59.46
Total ash	5.06	5.12	2.38
**Total carbohydrates	3.81	1.58	4.95
2-Colour			
Lightness (L*)	83.96	37.82	51
Redness (a*)	5.33	-0.69	2.5
Yelloness (b*)	16.9	11.93	29.33

* whole egg in colour character = the eggshell colour
**Calculated by difference

Table 2. The effect of storage duration and conditions on some physical and chemical egg quality and freshness parameters

Duration (days)	Storage conditions	Egg weight (g)	Yolk height (mm)	Yolk Index	Albumin pH	PV (meq O_2/ kg oil)
0		**45.55±2.41^{a}**	**19.76±0.18^{a}**	**0.43±0.04^{a}**	**6.86±0.02^{e}**	**0.70±0.02^{i}**
7	Refrigeration	43.99±1.29^{b}	16.70±0.08^{b}	0.36±0.04^{b}	6.95±0.14^{de}	0.74±0.04^{h}
	Ambient temp.	42.34±2.31^{dc}	15.28±0.32^{c}	0.34±0.14^{c}	7.14±0.02c^{de}	0.86±0.06^{f}
	Incubation at 32 ◦C	43.06±1.90^{c}	13.00±0.01^{e}	0.30±0.90^{d}	7.20±0.04c^{de}	0.88±0.01^{e}
14	Refrigeration	42.90±1.80^{c}	15.21±0.005^{c}	0.34±0.02^{c}	7.04±0.08^{de}	0.79±0.05^{g}
	Ambient temp.	40.14±2.16^{e}	13.32±0.28^{e}	0.31±0.70^{d}	7.39±0.11^{cd}	0.91±0.03^{d}
	Incubation at 32 ◦C	40.13±2.20^{e}	6.71±0.12^{g}	0.16±0.03^{f}	7.97±0.04^{b}	0.95±0.08^{c}
21	Refrigeration	42.01±2.01^{d}	14.60±0.08^{d}	0.33±0.01^{c}	7.55±0.67^{bc}	0.84±0.03^{f}
	Ambient temp.	39.51±2.36^{e}	12.15±0.08^{f}	0.28±0.04^{e}	7.97±0.13^{b}	1.02±0.03^{b}
	Incubation at 32 ◦C	38.00±1.65^{f}	5.95±0.49^{h}	0.17±0.01^{f}	9.32±0.28^{a}	1.31±0.01^{a}

Different letters in columns indicate significantly different values at P≤0.05.

Physicochemical characteristics of eggs.

Eggs weight: The results illustrated that there was a significant (P≤ 0.05) loss of weight of eggs during the investigated period which was 21 days of storage. The weight of fresh eggs was 45.55 ± 2.41 g and decreased to a range of 42.01 to 38 g after 21 days of storage at incubation temperature. This may be due to the increase in shell pores as the egg ages. The temperature of the storage plays an important role in the loss of moisture from the egg by evaporation. The increase in shell pores facilitates moisture and gas loss from the eggs. Carbon dioxide and water are produced as a result of the breakdown of carbonic acid in egg white. Carbon dioxide escapes through the pores of the shell and the egg white loses its thickness and becomes watery, leading to a loss in weight of the whole egg. Higher weight loss is occurs in eggs stored at ambient or ambient temperature and stored in an incubator compared to those stored under refrigeration. This is due to the dryness and shrinkage of the cuticle that clog the pores in the shell of eggs stored in the incubator and the ambient or ambient temperature condition, thus, facilitating the escape of carbon dioxide and moisture as a result of the increased size of the shell pores. However, cooling the eggs prevents drying of the cuticle and prevents the loss of very little carbon dioxide and moisture (Scott and Silversides, 2001).

Table (2) showed that, During 21 days of storage, the yolk changed from a spheroid shape to a round flabby shape mass. The yolk height decreased from 19.76 mm to 5.95 mm, and the yolk index value decreased from 0.43 to range 0.33 to 0.17 at incubation conditions.

Yolk Index (YI) as a measure of egg freshness indicates the progression of liquefaction of the yolk caused by diffusion of water from the albumen (Scott and Silversides, 2001). As the yolk index is an indication of the freshness of the egg, the higher the index, the more desirable the egg quality. The yolk index of fresh eggs varies between (0.30-0.50) with a mean value of 0.42. There was a significant reduction in the yolk index values during the period of storage (P ≤ 0.05) at different tested conditions. The results show that the high YI value of fridge storage suggests better preservation in egg quality than other tested storage conditions or temperatures to achieve the freshness goal. The egg content deterioration was noticed and markedly detected at 21 days of storage in 32 ◦C incubation, the egg white became watery and the yolk lost its structure and diffused into the white easily.

pH value: pH of albumin is an indicator of chemical changes in eggs with storage conditions. The freshness of the egg's albumen is measured using albumin pH (Scott and Silversides, 2001). The result showed that there was a significant increase in the albumin pH of eggs during storage (P ≤0.05). The albumin pH of the fresh egg was 6.86 and decreased by storage for 21 days at different conditions. Table (2) shows the changes in pH at various temperatures over 21 days of storage. Albumin pH gradually increased in eggs at refrigeration, ambient temperature and 32°C incubation. Particularly, eggs albumin pH at 32 °C was increased from 7.20 in the first 7 days of storage to 9.32, in the third week. The egg stored in the incubator and those stored under ambient conditions have a higher pH when compared to those that are refrigerated.

Decomposition of carbonic acid, which releases carbon dioxide through the pores of the eggshell, may cause the pH of the albumin to increase. The albumin viscosity also decreases during storage due to the hydrolysis of albumin with the change in acidity, as reported by Soares *et al.* (2021).

Peroxide value: Storage of eggs under different conditions leads to changes in peroxide value as shown in Table (2). On the other hand cold storage of eggs showed a slight change in the peroxide value as compared with storage at ambient temperature and at incubation. The peroxide value increased from 0.704 to 0.84, 1.02, and 1.31 meq O_2/kg oil for eggs stored for 21 days at refrigeration, ambient temperature, and incubation; respectively.

Wang *et al.* (2017) found that increasing storage time resulted in a significant decrease in egg quality. The storage temperature also affected the lipid oxidation and lipolysis significantly.

Foaming properties of Eggs:

Foaming or whipping, which means the capacity to form stable foams with air, is an important functional property of eggs in several products. Aeration is important in bakery products, particularly with some types of cakes. Foaming properties include whip ability or foam ability and foam stability. Foam expansion or foam capacity is measured by the maximum volume increase of liquid eggs by allowing the incorporation of air, by whipping or aeration.

Proteins form and stabilize foam due to their amphilic behavior (Onimawo and Akubor, 2005).The reduction in foam capacity after storage could be due to a reduction in the surface tension, from the inhibition of flexible protein molecules of the eggs (Akinyede and Amoo, 2009). Foam contributes to the texture of bakery products and ice cream.

Table (3) shows the foaming capacity and foam stability of eggs during storage at ambient temperature, refrigeration and 32^{O}C. The results illustrated that the foam capacity of eggs decreased with further storage. However, eggs stored at refrigeration had considerably higher foam capacity than those stored at ambient temperature and at 32◦ C. The volume was 300% at the beginning of storage and decreased to 245 and 270% for the eggs stored at ambient temperature and refrigeration for 21 days, respectively.

The decrease in foam capacity created by storage was correlated with the degree of the deterioration that occurred in the physicochemical properties of egg contents during storage which involved thinning of the thick egg white, enlargement of yolk and weakling of yolk membrane as reported by Lomakina and Kamila (2006) who found that the loss of foam volume in whipping tests of eggs was traced to the breakdown of the natural fat emulsion of fresh eggs. Conditions that damage the egg white proteins and lipoproteins usually resulted in an adverse effect on the functional properties of the egg.

Foam stability was determined after time intervals of 15 to 120 minutes. The results shown in Table (3) indicated that the foam of eggs stored at refrigeration was more stable than that stored at both ambient temperature and in the incubator. No considerable changes in the foam stability of eggs were observed even after 21 days of refrigeration storage as compared with those stored at ambient temperature and at incubation where the foam was less stable as shown in Table (3). The stability of the foam decreased with the long as the foam was in general, less stable after 60 and 120 minutes than at 15 and 30 minutes as illustrated in Table (3). Generally, both foam capacity and foam stability are important characteristics of eggs used in bakery products. The incorporation of a great number of small gas cells in food leads to a foam or sponge structure which improve the texture consistency and appearance of bakery products, especially sponge cake. Production of foam structure requires a suitable surface active agent as a whipping agent, and sufficient energy of beating or whipping, according to Lomakina and Kamila (2006).

Fatty acid profile:

As the egg yolk is considered of great nutritional importance and is high in USFAs, which makes it more susceptible to oxidation, as indicated by Hayat *et al.* (2010).

Table (4) shows the fatty acid composition of fresh and stored eggs at different conditions. The results indicate that the fresh egg is rich in mono- unsaturated fatty acids (MUFAs) which represent 50.7% of the total fatty acids. Oleic acid was the major fatty acid, accounting for 46% of the total fatty acids, whereas palmitic and linoleic acids represent 24.8 and 15.5% of the total acids. Small amounts of stearic acid (5.9%) and palmitoleic acid (4.0%) were also present. The data in Table (4) indicated that most of the saturated fatty acids (SFAs) present was palmitoleic acid (24.8%), whereas, myristic, stearic, eicosanoic and behenic acid represented only 0.5, 5.9. 0.5 and 1.6% respectively.

During storage periods under different conditions, the total SFAs varied between 33.6 and 37.6%. On the other hand MUFAs at the different conditions of storage periods ranged from 45.9 to 50.7% Further the total PUFAs ranged between14.4 and15.7 % at the different conditions. Similar results were found by Cherian *et al.* (2002) who found that, the total SFA ranged from 35.2 to 35.5% between different hens- fed treatments. The previous study also concluded that the total MUFA ranged from 45.8 to 48.4 and the total PUFA ranged between 18.9 to 17.2%.

Table 3. Changes in foam capacity and foam stability of eggs during storage at different conditions

Storage period (days)	Eggs stored at refrigeration						Eggs stored at room temperature						Eggs stored incubation					
	Foam capacity		Foam stability (ml) after				Foam capacity		Foam stability (ml) after				Foam capacity		Foam stability (ml) after			
	Volume increase		15	30	60	120	Volume increase		15	30	60	120	Volume increase		15	30	60	120
	ml	%	min				ml	%	min				ml	%	min			
0	60	300	59	57	56	54	60	300	59	57	56	54	60	300	59	57	56	54
7	60	300	59	57	56	54	55	275	54	52	49	47	55	270	50	48	42	38
14	57	285	56	54	52	50	51	255	48	44	43	40	50	250	45	42	38	36
21	54	270	53	52	50	49	49	245	44	41	38	36	50	240	40	36	34	32

Table 4. Effect of storage conditions on the fatty acid profile of fresh and stored eggs

Fatty acid	Fresh	Refrigeration	Ambient	Incubation
Saturated fatty acids (SFA)				
Myristic acid C14:0	0.5	0.5	0.4	0.4
Pentadecanoic acid C15:0	0.1	0.1	0.1	0.0
Palmitic acid C16:0	24.8	25.2	25.3	25.5
Margaric acid C17:0	0.2	0.2	0.2	0.2
Stearic acid C18:0	5.9	6.7	7.4	8.6
Eicosanoic acid C20:0	0.5	0.5	0.4	0.4
Behenic acid C22:0	1.6	1.9	2.2	2.5
Total SFAs	33.6	35.1	36.0	37.6
Mono-unsaturated fatty acids(MUFA)				
Myristoleic acid C14:1	0.1	0.1	0.1	0.0
Palmitoleic acid C16:1	4.0	4.0	3.8	3.6
Oleic acid C18:1	46.0	43.2	24.5	41.9
Eicosenoic acid C20:1	0.5	0.5	0.4	0.4
Total MUFAs	50.7	47.8	46.8	45.9
Polyunsaturated fatty acids (PUFA)				
Linoleic acid C18:2	15.5	15.4	14.5	14.4
Linolenic acid C18:3	0.2	0.2	0.1	0.0
Total PUFAs	15.7	15.6	14.6	14.4
Others *	0.0	1.5	2.5	2.1
Saturated/Unsaturated	0.51	0.55	0.58	0.62

*Others= unidentified (Unknown)

Slight changes can be noticed in the fatty acids profile of the stored eggs due to storage duration and temperature. Douny *et al.* (2014) found that no significant changes were found in the fatty acids profile of eggs stored at different temperatures. Liang *et al.* (2020) reported that the main fatty acids in normal eggs were palmitic, oleic, linoleic and stearic acids. The fatty acid composition was not significantly affected by the storage period. The proportion of PUFAs in the eggs stored at 4 ^{o}C was higher than that of the eggs stored at 25 ^{o}C. On the other hand, Mohiti-Asli *et al.* (2008) reported that MUFAs and PUFAs were significantly decreased during storage at room temperature or in incubation.

SDS-PAGE:

The SDS-PAGE electrophoretic patterns of fresh egg samples at the end of storage at different times are illustrated in Fig. (1).

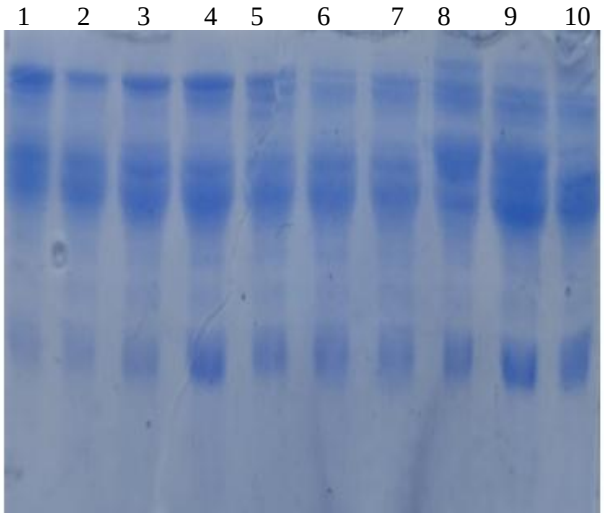

Fig. 1 SDS-PAGE (12.5% T) of egg proteins, lane 1 fresh egg, lanes 2-4 in the first week(at refrigeration, room temperature and incubation, respectively), lanes 5-7 in the second week and lanes 8-10 in the third week

SDS-PAGE showed five dominant polypeptide components and four minor bands in the egg proteins (Fig.1). Ovalbumin was identified by comparison with the results of Raikos *et al.* (2006). It also appeared as the largest band on the gel, as expected, because it is the most abundant protein in egg white (54%) (Li-Chan *et al.*, 2017). The other protein bands detected in the egg protein correspond to conalbumin, clusterin, and lysozyme and could be attributed to LDL and HDL proteins of the plasma fraction of the yolk (Raikos *et al.*, 2006). This speculation is based more on their relative proportions in egg white and egg yolk (Mahon *et al.*, 1999). Some other proteins were also separated by SDS-PAGE. The effect of storage time and temperature on the egg protein fractions was very limited, as there were no major differences in proteins separated by SDS-PAGE.

Long *et al.* (2023) demonstrated that eggs stored at higher temperatures and for a longer period lead to increased denaturation of albumin protein and decreased egg quality compared to those stored at lower temperatures.

Conclusion

The present study can inform the use of cold storage at 8 ºC which has been found to provide the desired quality of eggs during storage. In addition, storing eggs at a lower temperature extends their shelf life depending on the storage conditions.

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الملخص العربي

تأثير فترات التخزين على خصائص الجودة والأحماض الدهنية وأنماط البروتين لبيض المائدة

فاتن فاروق عبد السلام ، رمضان شحاتة عطية ، سامح علي عوض

اجريت هذه الدراسة لتقييم تأثير ظروف التخزين المختلفة للبيض من درجة الحرارة والزمن على الخواص الكيميائية والفيزيائية والوظيفية. أوضح التركيب الكيميائي التقريبي للبيض أن محتوى الرطوبة في كلاً من البيض الكامل والبياض والصفار كان ٧٢,٩٥ و٨٧,٦٩ و٤٩,٦٥ % على التوالي. محتوى البروتين في كلاً من البيض الكامل والبياض والصفار كان ٤٩,١٧ و٩٣,١٢ و ٣٣,٢١ % على التوالي (على أساس وزن جاف) كما وجد أن محتوى الدهن الكلي في البيض الكامل وفي الصفار كان ٥٩,٤٦ و ٤١,٩٦ % على التوالي بينما كان البياض تقريباً خالي من الدهن (٠,١٦ %). وكان محتوى الرماد في البيض الكامل والبياض والصفار ٥,٠٦ و٥,١٢ و ٢,٣٨ % على التوالي. كان وزن البيض الطازج ٤٥,٥٥ جم وانخفض بالتخزين لمدة ٢١ يوم إلى مدى تراوح من ٤٢,١ إلى ٣٨ جم وذلك عند التخزين في الحضان. لوحظ وجود انخفاض معنوي في قيمة معامل الصفار خلال فترة التخزين تحت الظروف المختلفة. وجد أن قيمة pH البيومين البيض الطازج ٦,٨٦ وانخفضت خلال التخزين. وارتفعت قيمة البيروكسيد من ٠,٧٠٤ إلى المدى من ٠,٨٤ إلى ١,٣١ مليمكافئ أكسجين/كجم دهن في البيض المخزن لمدة ٢١ يوم. كما اوضحت النتائج أن الخواص الوظيفية للبيض الممثلة في سعة الرغوة انخفضت بالتخزين كما لوحظ أن البيض المخزن بالتبريد كان له سعة رغوة أعلى من البيض المخزن في درجة حرارة الغرفة أو الحضان. كما اشارت النتائج إلى أن البيض المخزن بالتبريد كان له رغوة ثابتة عن البيض المخزن في درجة حرارة الغرفة وفي الحضان. أوضحت نتائج الأحماض الدهنية أن الحمض الدهنى الأوليك يمثل ٤٦% من الأحماض الدهنية للبيض الطازج أما كلا من البالمتيك و اللينوليك يمثلا ٨و٢٤ و ١٥,٥% على التوالي. و أوضحت نتائج فصل بروتينات البيض بالهجرة في المجال الكهربي وجود ٥ حزم سائدة من مكونات عديدات الببتيدات و ٤ حزم صغرى من بروتينات البيض.