Assiut Vet. Med. J. Vol. 60 No. 143 October 2014

THE EFFECT OF DIFFERENT PRESERVATION METHODS ON EGG QUALITY AND VALIDITY

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ABSTRACT

Received at: 16/9/2014

Accepted: 21/10/2014

Fresh commercial hen eggs of poultry farms were collected and preserved by cooling, pasteurization, and oiling. Other eggs were cracked and divided into 3 groups that undergo freezing (egg white, egg yolk with salt and egg yolk with honey). The results demonstrated that storage of eggs at 4 °C preserved the internal quality in all egg samples (100%) till the end of the 3rd week and extended the shelf life of 20% of eggs by at least 5 weeks longer than observed by the other preservation methods. As the storage time increased, the total bacterial and total yeast and mold counts of frozen egg products decreased gradually to be undetected by the 5th and 3 rd week of storage at freezing temperature (-18°C), respectively. Finally, all these methods helped to extend shelf life of eggs specially refrigeration. Frozen egg products can last even longer specially egg yolk with honey.

Key words: *Egg preservation, Freshness, Total bacterial count, total yeast, mold count.*

INTRODUCTION

Eggs have been considered to be highly nutritious containing high levels of vitamins and minerals. Applegate (2000) reported that eggs contribute only 1.3% of the total calories in the American diet but substantial amount of high quality protein, foliate and riboflavin as well as number of other nutrients in excess of the caloric contribution.

The physical appearance of an egg makes the first impression upon the consumer. If the product does not meet perceived expectations, consumer confidence diminishes. The structural quality of the shell egg is important to the processor because eggs that are structurally sound will arrive to the consumer in the best condition. Furthermore, high interior quality is of importance to egg products manufacturers because it allows for better separation of components without cross over contamination, especially when produce albumen products (Jones and Musgrove, 2005).

Freshness is a major contribution to the egg quality. The internal quality of eggs begins to deteriorate after they have been laid due to loss of moisture and carbon dioxide via the eggshell pores (Nongtaodum *et al.*, 2013). The shell of the egg is porous to admit the passage of air in and out, but it is coated with a mucilaginous matter which prevents the entrance of bacteria unless it is very old, wet, softened by moisture, rubbed off or otherwise the keeping quality of the egg is much reduced. Therefore, eggs should not be washed, held in damp musty places, or handled more than necessary, and should be marketed or preserved as soon after laying as possible. These facts explain why many methods of preservation have not been entirely successful, and suggest that the methods employed should be based upon the idea of protecting and rendering more effective the natural coating of the shell, so that air bearing the germs that cause decomposition may be completely excluded (Byron, 1917).

Refrigeration is very effective in preserving egg quality. Surface coating is an alternative method to preserve egg quality, although it is much less effective than refrigeration (Nongtaodum *et al.*, 2013). During the first half of the 20th century, storing eggs in refrigerated warehouses was a common practice. Preservation was later improved with the introduction of carbon dioxide into the cold storage atmosphere. Today, very few, if any, cold storage eggs find their way to the retail market. Cold Storage temperatures < 8°C inhibit the growth of most microorganism and related mesophiles and slow the loss of internal quality (Humphrey, 1994).

Eggs can also be stored separately but to freeze yolks by themselves a little salt or sweetener (depending on whether or not you plan to use the eggs for cooking or baking) will have to be added to keep them from

becoming too thick to use. Adding 1/4 teaspoon of salt per cup or 1/2 tablespoon of honey or sugar per cup of egg yolks will help keep them from being unusable after being thawed. Egg whites suffer from no such tendency to gel and can be frozen individually by putting them in an ice cube tray. Once the whites are frozen, pop it into a bag or freezer container and can be stored for up to one year. To use your frozen eggs, thaw them overnight in a refrigerator. Three tablespoons of thawed whole egg is the equivalent of one large fresh egg (Jessica Ferguson, 2009).

MATERIALS and METHODS

Collection of samples:
75 fresh commercial hen eggs of poultry farms were collected for cooling, pasteurization, and oiling (25 eggs for each). Another 75 fresh eggs cracked and divided into 3 groups (egg white, egg yolk with salt and egg yolk with honey).

Preservation methods:
Whole eggs were preserved by the following methods according to (Ninette and Peggie, 1971)

1- Coolig:- It was done by holding eggs in refrigerator at 4-5°C

2- Pasteurization:- The eggs were subjected to moist heat (water bath) at 57°C for 15 min. and stored in refrigerator at 4-5°C.

4- Oiling:- A thin film of odorless, tasteless mineral oil sprayed on eggs and stored at room temperature 25°C.

Water Loss Measurements
Five eggs from each group (cooling, pasteurization and oiling) were weighed at each sampling time. The same eggs were weighed until the eggs were deteriorated. After the study, the percentage of water loss was calculated (ASABE, 1988).

Storage quality evaluation according to the tests of freshness of the eggs (David *et al.*, 1997)
1- A fairly deep bowl filled with water and carefully the egg lowered into the water. A very fresh egg will immediately sink to the bottom and lie flat on its side. The egg should also feel quite heavy. As the egg starts to lose its freshness and more air enters the egg, it will begin to float and stand upright. The smaller end will lie on the bottom of the bowl, whilst the broader end will point towards the surface. The egg will still be good enough to consume, however, if the egg fully floats in the water and does not touch the bottom of the bowl at all, it should be discarded, as it will most likely be bad. A bad egg will also feel extremely light in weight and give off a pungent smell.

2- The second method to test the eggs freshness is by breaking the egg onto a flat plate, not into a bowl. The yolk of a very fresh egg will have a round and compact appearance and it will sit positioned quite high up in the middle of the egg. The white that surrounds it will be thick and stays close to the yolk. A cloudy act of coloring to the egg white is a sign of extra freshness, as this "cloudiness" is in fact carbon dioxide, which is present when the egg is laid. Over time, the egg white will become more transparent, as the carbon dioxide dissipates. A less fresh egg will contain a flatter yolk, that may break easily and a thinner white that spreads quite far over the plate.

3- Candling the eggs by holding the egg from the small end where the large end was up to a light and the air space should be no more than 3/26 of an inch. The yolk should not be distinctly visible and movement should not easily be detected when the egg is turned quickly. In an older egg, the air space will be greater and the yolk will move freely when the egg is manipulated. Additionally, once an egg is cracked open, a firm, high sitting yolk with a tight surrounding white is a good sign of a fresh egg as opposed to a flattened and pale yolk with a runny white.

Cracked eggs were divided into 3 groups and preserved at freezing temperature (-18°C) for 6 weeks. The first group contained egg whites which froze individually by putting them in an ice cube tray. Once the whites are frozen, it put into a bag or freezer container. To use the frozen egg whites, it thawed overnight in a refrigerator. The second group contained egg yolks with salt which obtained by adding 1/4 teaspoon of salt per cup of egg yolks. The third group contained egg yolks with honey which obtained by adding1/2 tablespoon of honey per cup of egg yolks. A little salt or sweetener (depending on whether or not you plan to use the eggs for cooking or baking) will have to be added to keep them from becoming too thick to use.

Microbiological evaluation:-
Egg whites, egg yolk with salt and egg yolk with honey subjected for:

1 - Determination of the total bacterial count using standard plate count media and incubation at 37°C for 48h (A.P.H.A., 1992).

2 - Determination of the total yeast and mold count using Malt extract agar and incubation at 26°C for 5-7days (Harrigan and Mc Cance, 1976).

RESULTS

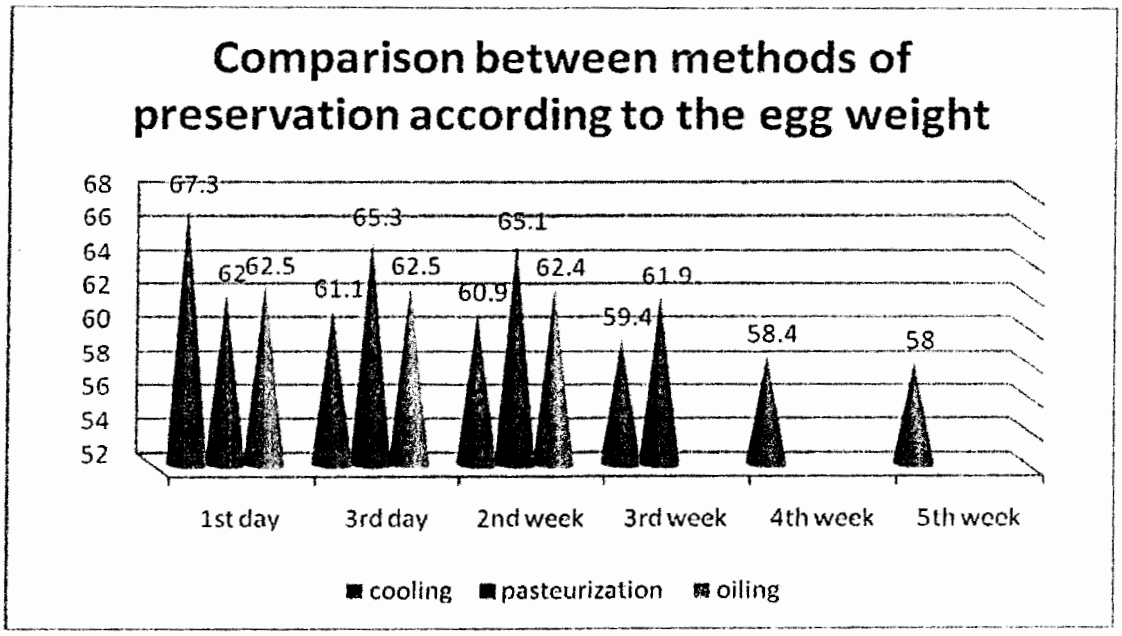

Figure 1: Comparison between different methods of egg preservation according to the egg weight.

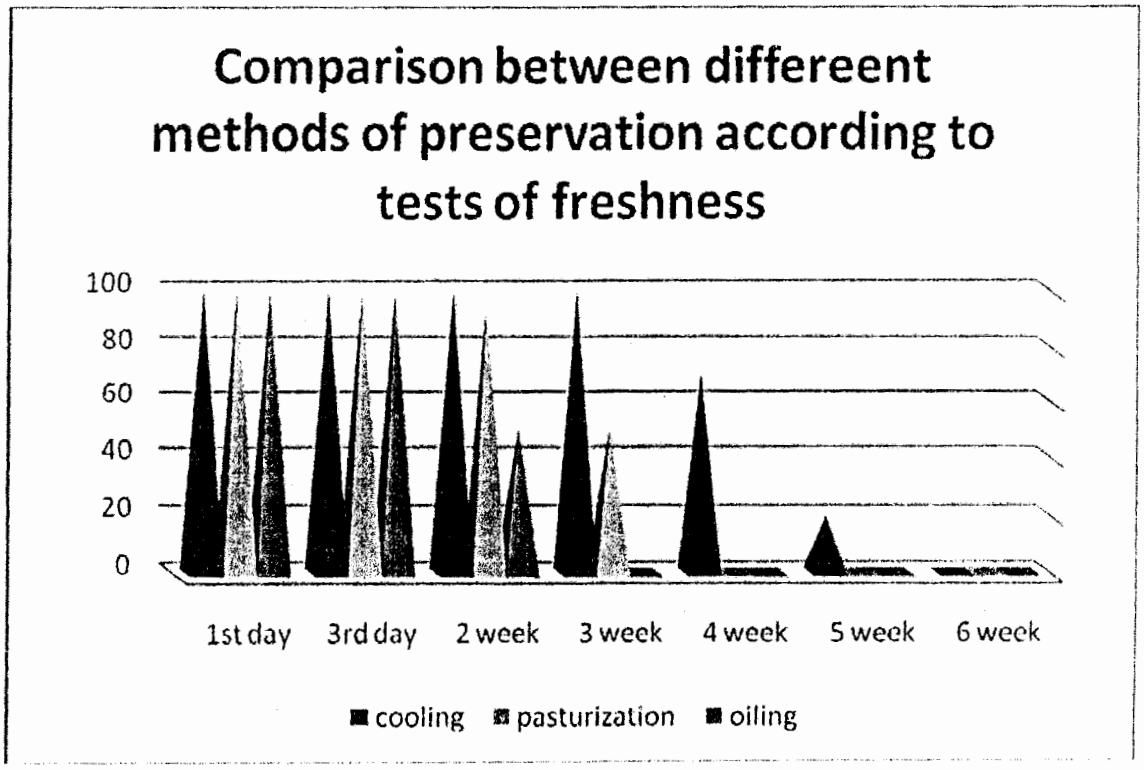

Figure 2: Comparison between different methods of egg preservation according to tests of freshness

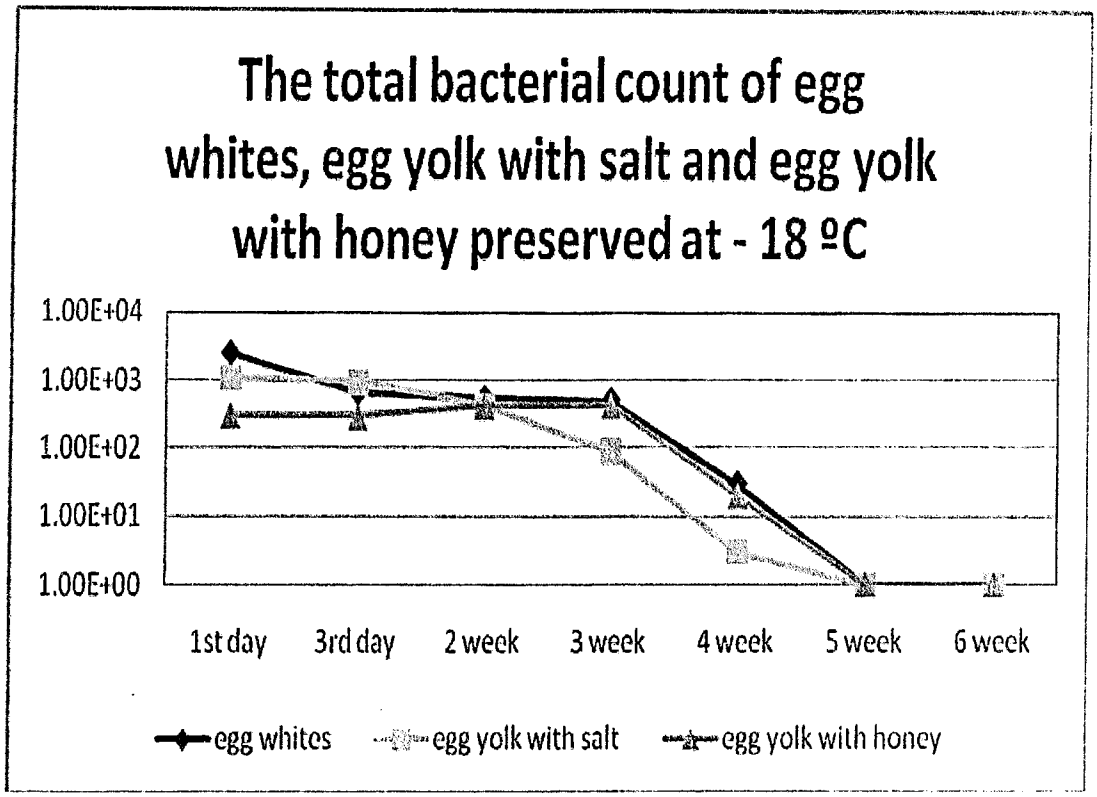

Figure 3: The total bacterial count of egg whites, egg yolk with salt and egg yolk with honey preserved at–18 °C.

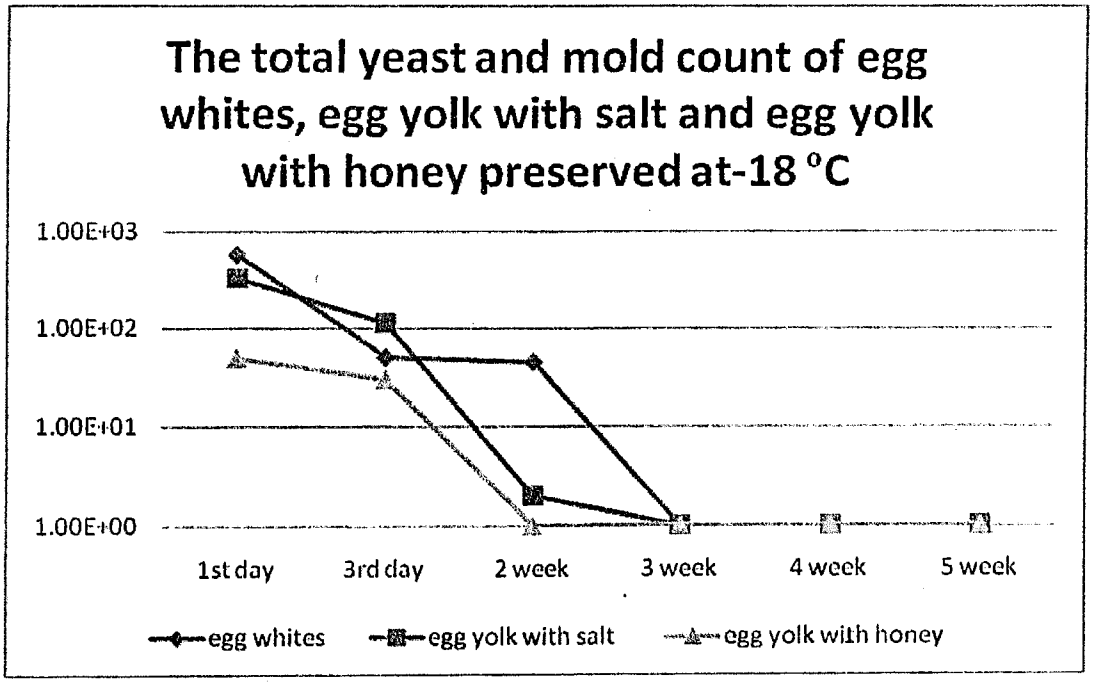

Figure 4: The total yeast and mold counts of egg whites, egg yolk with salt and egg yolk with honey preserved at–18 °C.

DISCUSSION

Eggs are highly perishable and susceptible to internal quality deterioration when stored above 7 °C. Refrigeration of eggs may be seldom practiced in some developing regions of the world. Therefore, an alternative method, that is inexpensive yet effective, to preserve the internal quality of eggs and to prevent microbial contamination is needed (Ryu *et al.,* 2011). Furthermore, Attempts to eliminate these egg-borne pathogens from laying flocks to overcome vertical transmission have not been very successful.

Different methods of preservation in this study were evaluated, freezing the whole eggs in the shell lead to the eggshell cracked and the eggs will burst so, the tests of freshness could not be applied. Jessica Ferguson (2009) stated that the entire egg can freeze by beating it (as if you were making scrambled eggs) and then storing it in an airtight freezer container where it will keep for about one year. Moreover, frozen eggs cannot be refrozen, for proper thawing, frozen eggs thawed in the refrigerator and not thawed at room temperature.

The results demonstrated that storage of eggs at 4 °C preserved the internal quality in all egg samples (100%) till the end of the 3rd week, the percentage of egg weight loss was 13.7% and extended the shelf life of 20% of eggs by at least 5 weeks longer than that observed by the other preservation methods (Fig. 1 and 2). Shin *et al.* (2012) found that shell egg quality tended to be preserved better at below 2.2 °C. Moreover, the USDA recommends storing eggs in a refrigerator at about 40 F degrees, mainly to reduce the chances that any bacteria on the shell will multiply and cause a risk of illness (USDA 2005).

Pasteurization of eggs resulted in preservation of 50 % of egg samples stored for 3 weeks and minimized the weight loss by 0.2% (Fig. 1 and 2). This pasteurization process produced little or no adverse effect on the physico-chemical, interior and functional properties of eggs and retarded multiplication of naturally occurring microflora in eggs during 15 days of storage at ambient conditions (35- 36°C and 2% RH) (Shenga *et al.,* 2010). In a similar study carried out by Hank *et al.* (2001), no adverse effect was observed in the albumen quality between pasteurized (55°C, 3 h) and unpasteurized egg during 8 weeks of refrigeration (4°C) storage.

According to the U.S. Department of Agriculture, shell eggs can be pasteurized by a processor if FDA accepted the process for the destruction of Salmonella. Pasteurizing eggs in their shells is achieved through patented processes that involve a series of warm water baths, and it is very difficult to pasteurize shell eggs at home without cooking the contents of the egg (USDA, 2005). After pasteurization, the eggs are coated with food-grade wax to maintain freshness and prevent environmental contamination and stamped to distinguish them from unpasteurized eggs (Zeldes, 2009).

In the present study, all oil coated eggs had longer shelf life than non coated eggs, it deteriorated at the 3rd week of storage at 25°C. Similarly, Torrico *et al.* (2011) stated that mineral oil coatings minimized the weight loss (0.5%) and preserved the albumen and yolk quality of eggs for at least 3 weeks longer than those observed for non coated eggs at 25 °C. Nongtaodum *et al.* (2013) found that edible oil (coconut, palm, rice bran, and soybean) coating could preserve internal quality of eggs (maintaining grade A) at least 4 weeks longer than noncoated eggs. The oil replaces the natural bloom, the protective coating on the outside of the egg, which is removed during washing. Storage at room temperature may lead to increase the bacterial growth and accelerate the time of deterioration. This study demonstrated that cooling was considered a more practical option and of low cost compared with other preservation methods.

In order to appreciate fully the care necessary in preserving eggs, a little should be known of their structure, keeping qualities, and some of the common causes of spoiled or bad eggs. Most eggs when laid contain very few or no bacteria that would cause decomposition, and the entrance of these micro-organisms usually takes place because of carelessness or neglect on the part of those handling the eggs. One of the chief sources of infection is dirty or damp nests (Sparks, 1994 and Solomon *et al.* 1994). It was noted from Figure (3) that all the 3 groups of egg whites, egg yolk with salt and egg yolk with honey samples had microbial growth. The total bacterial count was 2.5×10^3, 1.07×10^3 and 3×10^2 cfu/ g in these samples, respectively. As the storage time increased, the count decreased gradually to be undetected by the 5th week of storage at freezing temperature (-18°C). Ansah *et al.* (2009) demonstrated that the least mean total viable count of $34.3x10^5$ cfu/g from the egg contents of market samples which were above the recommended ICMSF value ($10x10^5$ cfu/ g) (ICMSF, 1996).

Yeasts and molds can grow on or in eggs, causing spoilage. Freezing of egg whites, egg yolk with salt and egg yolk with honey decreased the total yeast and mold count from 5.7×10^2, 3.3×10^2 and 4.9×10 to undetectable level by the 3rd week, respectively (Figure 4). Presence of yeasts and molds in both the shell and in the content of eggs may be due to the fact that the spores of fungi get into eggs almost as soon as they are laid. Etches, (1992), reported that, as eggs stay longer, their resistance reduced enabling yeast and molds to penetrate into the egg content. Warm and moist litters, poor condition in the farmhouses

and retail outlets were reported to be sources of fungi growth and sporulation (Arthur and Osei-Somnah, 2001). Low counts of aerobic plate count, yeast and mold count in stored egg products subjected to more severe thermal treatment have also been reported (Modi *et al.*, 2008).

Previous research has demonstrated that time and temperature is important factors that need to be controlled to achieve safe, high-quality eggs. Freezing eggs by these methods eliminates the bulk of the shell and prevent the gelatin formation (gummy texture) while still preserving eggs for future use. The only disadvantage of adding salt and sugar to these products is that it may limit use in other specific food products.

This study undertook to evaluate the impact of refrigeration and pasteurization for reducing illnesses and identified several data gaps and research needs, including a quantitative study of cross-contamination during egg product processing and characterization of egg storage times and temperatures (i) on farms and in homes, (ii) for eggs produced off-line, and (iii) for egg products at retail.

Finally, these methods of preservation help to extend shelf life. Refrigerated eggs have a 6 weeks shelf life if held at 4°C. Frozen egg products (egg whites, egg yolk with salt and egg yolk with honey) can last even longer as the total bacterial and total yeast and mold counts being undetectable by the 5th and 3rd respectively.

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تاثير الطرق المختلفة لحفظ البيض على مدى جودته وصلاحيته

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يعتبر البيض من الأغذية ذات القيمة الغذائية المرتفعة حيث يحتوي على مستويات عالية من الفيتامينات والمعادن. هناك طرق عديدة لحفظ البيض تستخدم لمنع فساده منها التبريد، البسترة والتجميد، والغمس فى الزيت وذلك بالنسبة للبيضة الكاملة كما تستخدم طرق اخرى لحفظ محتوى البيض بعد كسره او حفظ البياض والصفار كل على حدة وذلك بإضافة قليل من الملح أو التحلية وذلك حسب الرغبة لاستخدام البيض فى أغراض الطهي أو صناعة الحلويات. ويمكن تخزينها لمدة تصل إلى سنة وقبل الاستخدام يوضع البيض المجمد في الثلاجة حتى الذوبان. ويقدر ثلاث ملاعق من البيض المذاب ما يعادل بيضة واحدة كبيرة. تم جمع عينات من بيض الدجاج الطازج من مزارع الدواجن وتم تعرض البيض الكامل لطرق مختلفة من الحفظ مثل التبريد، البسترة والتجميد، والغمس فى الزيت. أما محتوى البيض (بعد كسره) فقد قسم إلى ٣ مجموعات من المنتجات المجمدة (بياض البيض، صفار البيض مع الملح وصفار البيض مع العسل). أظهرت النتائج أن تخزين البيض عند درجة حرارة الثلاجة (٤ درجة منوية) أدى الى الحفاظ على الجودة الداخلية في جميع العينات (١٠٠٪) حتى نهاية الأسبوع الثالث وزيادة صلاحية ٢٠٪ من عينات البيض لمدة ٥ أسابيع أطول من التي تعرضت لها العينات بالطرق الأخرى. أما بالنسبة لمنتجات البيض المجمدة فمع زيادة فترة التخزين لوحظ ان العدد الكلي للبكتيريا والعدد الكلى للفطريات والخمائر انخفض تدريجيا حتى اختفى عند الأسبوع الخامس والأسبوع الثالث على التوالي من التخزين في درجة حرارة التجميد (-١٨°C). أخيرا، ساعدت كل هذه الطرق لزيادة فترة صلاحية البيض الكامل وخصوصا التبريد. كما اظهرت الدراسة أن منتجات البيض المجمدة يمكن أن تستمر لفترة أطول وخاصة مع اضافة العسل الى صفار البيض.