



COMPARISON STUDY AMONG PRE INCUBATION PERIODS BEFORE STORAGE ON ELEVATION OF THE NIGATIVE EFFECTS OF PROLONGED EGGS STORAGE ON HATCHABILITY TRAITS OF SINAI EGGS.

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ABSTRACT: This work was carried out to investigate the impacts of storing fertile eggs for a short (7 days) or prolonged (14 days) time and whether Pre-incubation period before eggs storage (PIPBS) would improve the hatchability traits. A total number of 2400 hatching eggs were collected from Sina strain flock at 32 week-old. Eggs were transported to the hatchery in two groups (1200 eggs each) according to the storage periods for 7 and 14 days. All eggs were stored at 17°C and 75 % relative humidity. All eggs in each group were individually weighed, numbered and randomly distributed into four subgroups (300 eggs each) according to Pre-incubation period before eggs storage (PIPBS) as: non incubation, incubation for 5, 10 and 15 hours before storage at temperature of 37.5°C and 56 % relative humidity.

The results showed that albumen weight percentage, albumen height and Haugh units were significantly decreased but yolk weight percentage, shell weight percentage and albumen pH were significantly increased as egg storage period increased from 7 to 14 days. Also, egg weight loss during storage, first eighteen days of incubation and total egg weight loss percentages, early, late and total embryonic mortality percentage, pip dead percentage, pip life percentage and total incubation time were significantly greater for eggs of the longer storage period (14 day) as compared to the shorter one (7 days) and the reverse was true for the apparent fertility percentage, hatchability percentage of fertile eggs and hatchability percentage of total eggs. In the long storage period (14days), pre-warming of Sina laying hens eggs for 5h prior to eggs storage had higher and significant hatchability percentage of fertile and total eggs compared to the control and other pre-warming eggs for 10 and 15h prior to eggs storage but was still significantly lower than the same level of pre storage incubation in the short stored period (7 days).

It could be conclude that egg storage period should not exceed than 7 days because more than 7 days had decline effect on all studied traits, but if the storage period exceeded than 7 days until to 14 days warning the eggs with 5 hours Pre-incubation before storage could be recommended for improving hatchability percentage of both fertile and total eggs compared to 0, 10 and 15 hours pre-incubation before storage.

Key words: pre incubation, egg storage, hatchability, Sinai strain.

INTRODUCTION

Recently, storing eggs before setting in the hatcheries is a common practice in the poultry industry. The length of storing period varies between a few days and several weeks because it depends on the hen's eggs production, maximum hatchery capacity and both the demand and fluctuating prices of one day old chicks in the market (Reijrink, et al., 2010a). Storing length had impact on embryonic viability and hatchability (Fasenko, 2007 and Bakst et al., 2012). (Fasenko, et al., 2011) found that hatching eggs of most poultry species stored for over 7 d had harmful effects on hatchability. For this, numbers of strategies have been investigated to improve hatchability of eggs stored for more than seven days; one of them is to incubate eggs before storage (Fasenko, et al., 2001). Therefore, the objective of this study was to determine first, the impacts of storing fertile eggs for a short (7 days) or prolonged (14 days) time and second, whether pre incubation warming profiles can enhance the hatchability of eggs stored for certain period of time.

MATERIALS AND METHODS

Experimental design:

A total number of 2400 hatching eggs were collected from Sina strain flock at 32 week-old which maintained under similar environment and management conditions. The eggs were distributed in a 2 x 4 factorial design, two storage periods (7 and 14 days at 17°C and 75 % relative humidity) with four pre-incubation periods before storage (PIPBS) (0, 5, 10 and 15 hours at 37.5°C and 56% relative humidity), representing eight treatments of 300 eggs each, each treatment was divided into 6 replicates of 50 eggs each. All treatments were carried out in a Chick Master incubator. In order to incubate all eggs at the same time, eggs were collected in two groups, one group every week, representing the two storage periods (7 and 14 days).

Therefore, the first group corresponded to eggs stored for 14 days and the second to eggs stored for 7 day. Out of the 1200 eggs obtained in each.

General Management:

Immediately after collection, the eggs were disinfected by fumigation with 7.7g par a formaldehyde/m³ for 15 minutes (Khan et al., 2012). All eggs in each group were individually weighed, numbered and randomly distributed into the treatments. The heating timing started when the temperature reached 37.5°C and the relative humidity 56% inside hatchery. After heating, eggs were kept at room temperature for one hour then eggs stored in a storage room at 17°C and 75% relative humidity for the periods corresponding to the treatments. After storage, eggs were maintained at 25°C and 75 % relative humidity for six hours before incubation then, incubated in a Chick Master incubator for 444 hours (18 days and 12 hours) at average 37.5°C temperature and 56.5% relative humidity. Eggs were turned hourly at 444 hours of incubation. After that, eggs were transferred to a Chick Master ® hatcher at average 36.6°C temperature and 61.2% relative humidity.

Data collected:

1- Egg quality traits:

Prior to commencement of storage and at the end of the storage period, 30 eggs were chosen randomly from each group to evaluate the egg quality traits. External egg quality parameters including, egg weight (g), egg length (cm), egg width (cm), egg shape index according to Romanof and Romanof (1949), shell weight percentage, shell thickness (mm) according to Brant and Shrader (1952), were evaluated. Also, internal egg quality parameters including, yolk weight percentage, albumen weight percentage, yolk height (mm), yolk diameter (mm), yolk index, albumen height (mm), and Haugh units were estimated by

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(Haugh, 1937 and Wells, 1968) and albumen pH using digital pH meter.

2- Egg weight loss:

2-1- egg weight loss pre incubation (during storage):

Fresh hatching eggs were individually weighed then weighed again at the end of storage period to determine egg weight loss that occurred between egg collection and the last day of storage. The egg weight loss was expressed as percentage of the fresh egg weight as follows:

egg weight loss during storage (%) = (egg weight loss (g) / fresh egg weight (g)) × 100

2-2- egg weight loss during incubation:

All eggs were individually weighed at day 18 of incubation to determine egg weight loss occurred between the last day of storage and the end of day 18 of incubation and expressed as a percentage of egg weight in the last day of storage as follows:

Absolute egg weight loss = $W_0 - W_{18}$;

Relative weight loss = $100 \times (W_0 - W_{18}) / W_0$,

Where: W_0 = egg weight at the last day of storage, and

W_{18} = egg weight on day 18 of incubation.

3- Embryonic mortality, fertility and hatchability traits:

At 10 days of incubation all eggs were candled and all clear eggs were removed from the trays in order to determine the apparent fertility. At the end of 18th day of incubation, all eggs were candled again and those with evidence of living embryos were transferred from the setter trays to the hatcher trays. The eggs with evidence of dead embryos were broken to determine the stage of embryonic mortality.

3-1- embryonic mortality:

Embryonic mortality were classified as early (1-7), intermediate (8-14), and late embryo mortality (15-21). Early dead embryos were differentiated by the absence of an egg tooth; the intermediate dead embryos were differentiated by the presence

of an egg tooth, the beginning of feathers and the yolk sac outward the body cavity. The late dead embryos were differentiated by evidence of the yolk sac entering the body cavity and the beak positioned to pip the air cell. Pip dead (piped but dead) and Piped life (piped, still life but could not hatch). Total embryonic mortality was determined as the amount of the all dead embryos. (Gharib, 2013).

3-2 Apparent fertility percentage:

Apparent fertility percentage = (number of fertile eggs / number of total eggs) × 100

3-3 Hatchability percentage of fertile eggs:

Hatchability percentage of fertile eggs = (number of hatched chicks / number of fertile eggs) × 100

3-4 Hatchability percentage of total eggs:

Hatchability percentage of total eggs = (number of hatched chicks / number of total eggs) × 100

3-5 Total incubation time:

After 480 hours of incubation hatching eggs were checked in each treatment every 2 hours of hatching. Hatched chicks were collected and determined the Total incubation time by hours (the time between first hatched chicks and last one) for each replicate in each treatment (Willemsen et al., 2008).

3-6 Chick length:

Randomly selected twenty chicks from each replicates directly after hatch for individual measuring chick length (cm). Chick length was defined as the length from the tip of the beak to the implantation of the nail on the middle toe (Willemsen et al., 2008).

Statistical analysis:

Data were submitted to two way analysis of variance using the general liner model procedure of SAS (2000). The main factors were storage period and pre-incubation periods before storage (PIPBS). Percentage data were subjected to arc sine transformation prior to analysis. Mean

values were compared using Duncan's multiple range test (Duncan, 1955) when significant differences existed. Significance was set at ($P \leq 0.05$).

$$Y_{ijk} = \mu + S_i + H_j + S_iH_j + E_{ijk}$$

μ = Overall mean

S_i = Effect of storage period ($i=1, 2$)

H_j = Effect of pre-incubation periods before storage ($j=1, 2, 3, 4$)

S_iH_j = Interaction between storage period and Pre-incubation periods before storage

E_{ijk} = Residual error.

RESULTS AND DISCUSSION

Egg quality

Egg length, width, shape index and shell thickness were not significantly influenced by egg storage period while albumen weight percentage, albumen height and Haugh units were significantly decreased but yolk and shell weight percentages and albumen pH were significantly increased as egg storage period increased from 7 to 14 days (Table 1 and 2). Because prolonged egg storage period had changes in egg components like 1) water evaporation from the egg increased which impaired albumen quality because water evaporation was principally a loss in albumen weight consequently, albumen height and Haugh units decreased (Lapão et al., 1999); 2) some of this water evaporation were retained in the egg shell which represented in an increase in egg shell percentage. (Jones and Musgrove, 2005); 3) Yolk sac membrane elasticity decreases (changes in the permeability of the vitelline membrane) with storage time (Fasenko, 2007) thereby, yolk weight percentage could be expected to increase because amino acids move through the vitelline membrane from the albumen to yolk (Heath, 1977) and 4) albumen pH increased because after oviposition, carbon dioxide is released from the egg, resulting in an increase in albumen pH (Dawes, 1975).

Likewise these results are in accordance with Kahraman-Dogan et al. (1994) who

reported that changes in albumen quality during storage are described equally well by albumen height and Haugh units which declined as egg storage period increased. Moreover, Trziszka and Smolinska (1982) found that the strength of the vitelline membrane decreased during prolonged storage.

Egg weight loss

In Table (3), mean egg weight loss percentage during storage, first eighteen days of incubation and total egg weight loss percentage were significantly greater for eggs of the longer storage period (14 day) compared to the shorter one (7 day). In the interaction between SP and PIPBS, gradual increase with significant effect in egg weight loss percentage during all studied periods was found as PIPBS increased. Group of eggs which incubated for 15 hours before storage for 14 days had the highest and significant egg weight loss percentage during storage, first eighteen days of incubation and total egg weight loss percentages as compared to the other groups and the lowest one with significant value was recorded for egg group that was not incubated before storage for 7 days. Increasing period of PIPBS means increasing eggs exposure period for the incubation temperature leading to increasing egg weight loss because water vapor pressure increases when period of PIPBS increases. Moreover, prolonged egg storage time caused a decrease in the cuticle quality which may be resulted in increasing water vapor pressure thus, increasing egg weight loss (De Reu et al., 2006). These results are keeping with those found by Reijrink et al. (2009) who observed that storing the commercial Cobb broiler breeder eggs for 3, 5, 8 or 12 days before setting to hatch increased egg weight loss percentage during storage by 0.24, 0.53, 0.74 and 1.28%, respectively ($P < 0.05$). And Reijrink, et al. (2010b) reported that egg weight loss percentage during incubation

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and total egg weight loss percentage was lower for the 4 hours pre incubation than for the 24 hours pre incubation.

Early and late embryo mortality

In Table (4), eggs sorted for 14 days had significantly higher early and late mortality, pip dead, pip life and total embryonic mortality percentages as compared to the other sorted period (7 days). Extended periods of egg storage 1) allow the albumen to degrade excessively. This degradation causes the blastoderm to move into close proximity to the egg shell leading to early embryonic mortality resulted from dehydration during the early stages of incubation (Brake et al., 1993); 2) Increases sensitivity to suboptimal incubation conditions which means that embryos were more susceptible to temperature changes from storage to incubation period, contributing to their higher early embryo mortality. (Silva et al., 2008) and 3) the number of viable embryonic cells is low as a function of long-term storage which may resulted in particular steps in the embryo's development in the onset of eggs incubation period may be impeded because the embryos which, do not have enough cells, unable to make effective use of the available O₂ to break down necessary nutrients in the yolk to release the needed energy for embryonic growth thus, leading to abnormal development or early embryonic death. (Uddin and Hamidu, 2014).

On the other hand, prolonged egg storage leads to reduced embryonic growth in some muscles such as breast muscle (pectoralis major) and hatching (complexus) muscle, which are important for metabolically through mobilize stored glycogen for helping the embryo to penetrate the egg shell and it's membranes during hatching process thus increased late embryonic mortality (De Oliveira et al., 2008).

Inter the same storage period, (Table 4), gradual increase with insignificant values in

early, mid and late mortality, pip dead, pip life and total embryonic mortality percentages were found as PIPBS increased. This increase could be explained by Silva et al. (2008) who reported that increasing eggs exposure period for the incubation temperature before storage then storage temperature then incubation temperature being embryos were more susceptible to temperature changes leading to their higher embryo mortality at all studied periods.

Fertility

The eggs stored for 7 days had significantly higher apparent fertility percentage compared to eggs stored for 14 days (Table 5). Significantly lower percentage of fertility as storage period increased due to an underestimation of fertility because although germinal discs were actually fertile, but embryos which died either during storage or very early during eggs incubation period were misclassified as infertile germinal discs because of the difficulty in distinguishing between infertile germs and eggs whose embryos died either during storage or very early during eggs incubation period thereby, leading to an underestimation of true fertility and an overestimation of infertility (Fasenko, 2007).

This concept is confirmed for Pre-incubation period before eggs storage inter each storage period (Table 5), the reduction in apparent fertility percentage was more pronounced (in significant) in both PRESI-10h and PRESI-15h groups than in the PRESI-5h group may be because both PRESI-10h and PRESI-15h groups had more embryos which died very early during eggs incubation period (early mortality) than in the PRESI-5h group as found in our results in Table (4) thus, misclassified as infertile germinal discs which leading to an underestimation of true fertility and an overestimation of infertility in both PRESI-

10h and PRESI-15h groups compared to PRESI-5h group (Fasenko et al., 2001).

Hatchability

In Table (5), significantly lower hatchability percentages of both fertile and total eggs were detected as storage period increased because prolonged storage eggs leading to changes in egg components like increasing albumen pH and reduction in albumen height and Haugh units (Lapão et al., 1999) which decreased embryonic viability (Arora and Kosin, 1996) because albumen structure is said to be a dominant factor in successful development of the germ from anaerobic to aerobic metabolism, thereby hatchability percentage decreased (Christensen et al., 2001).

In the long storage period (14 days), (Table 5), hatchability percentage was improved after exposing the eggs for pre storage incubation compared to eggs non pre storage incubation (control) but was still significantly lower than the same level of pre storage incubation in the short stored period (7 days) may be because PRESI provides more incubation time for the egg to hatch (Fasenko, et al., 2001), but the changes in the internal egg quality (albumen) due to prolonged eggs stored (14 days) are not prevented by pre storage incubation (Reijrink, et al., 2009). thus, hatchability percentage still significantly lower in each pre storage incubation treatment for the long storage period (14 days) compared to the same level of pre storage incubation in the short stored period (7 days).

In the long storage period (14days), Sinai eggs subjected to warming for 5h prior to eggs storage had higher and significant hatchability percentages of fertile and total eggs compared to the control and other pre-warming eggs for 10 and 15h prior to eggs storage (Table 5), may be because pre-warming of eggs for 5h prior to eggs storage for a long time (14days) allowing the embryos to reach a developmental stage

more suitable to survive the long storage period (14days), which characterized by stopping embryonic development as measured by microscopic staging methods during eggs storage (Fasenko et al., 1992; Bakst and Gupta, 1997), compared to the stages of embryos development that reach to it when pre-warming eggs for 0, 10 and 15h prior to eggs storage for 14 days. These results are in accordance with Fasenko et al., (2001) who demonstrated that PRESI-6h treatment for broiler breeder eggs took the majority of eggs embryos to a development stageXIII (Eyal-Giladi and Kochav, 1976) which hypoblast formation is complete and cell migration and differentiation are minimal (Bellairs, 1986), at this developmental stage, embryos are at a relatively quiescent state which promotes embryos survival to prolonged storage and embryonic death and are better able to withstand developmental arrest during prolonged storage of 14 days (Fasenko et al., 2001). Moreover, these embryos that increased development due to pre storage incubation may be better able to form an effective pH barrier between the inside of the embryo (pH ranges from 7.9 to 8.4; Gillespie and McHanwell, 1987) and its exterior (albumen pH around 9.5 ,because after oviposition carbon dioxide is released from the embryo, resulting in an increase in albumen pH from about 7.6 to 9.5 within a short period of time, whereas the yolk remains slightly acid, at a pH around 6.5.) during early incubation than both the less developed embryo (control) (Reijrink, et al., 2010b) because control treatment did not exposed to any PRESI treatments and thereby its embryonic development at Stage X which characterized by, area pellucida formation is complete (Eyal-Giladi and Kochav, 1976), and the more advanced once because PRESI eggs for12 h or 18 h allowing the majority of eggs embryos to reach an embryonic development Stage 3 or 4 which characterized by, primitive

pre incubation, egg storage, hatchability, Sinai strain.

streak formation is approximately half complete or complete respectively (Hamburger and Hamilton, 1951) with extremely active periods of cellular division, migration and differentiation and do not respond favorably to developmental arrest during 14 d storage resulted in similar hatchability percentages of fertile and set eggs compared to the control group and both of them lower than group PRESI-6h (Fasenko et al., 2001).

Incubation time for a chick to hatch and Chick length

In Table (5), storing the eggs for 14 days represented significant increase of incubation time for a chick to hatch and insignificant shorter chick length compared to eggs stored for 7 days because the embryo will grow from the reduced number of embryos live cells as a result of blastoderm degenerates, presenting vacuoli in the zona pellucida and stains in the yolk when eggs storage period increased (Fasenko, et al., 1992). Also, after long-term of egg storage, embryonic development did not immediately initiate in response to changes of temperature from storage to incubation, (Arora and Kosin 1966), thereby increasing incubation time for a chick to hatch for eggs stored for 14 days compared to others stored for 7 days. Chicks that hatched first are normally longer than chicks that hatch late (Willemsen et al., 2008), thus, chicks from eggs stored for 14 days were insignificantly shorter than others from eggs stored for 7 days. The same trend was found for each one of pre incubation period in long storage period (14 days) which was still longer incubation time for a chick to hatch and shorter chick length compared to the same group of pre incubation period in the short stored period (7 days)), may be because the harmful effects of long storage period (14 days) representing in reduced number of embryos live cells and embryonic development did not immediately initiate in

response to changes of temperature from storage to incubation, as mentioned above by Arora and Kosin (1966) and Fasenko, et al. (1992), are not prevented by pre storage incubation. (Reijrink, et al., 2009).

Inter each one of storage period, Table (5), insignificant decrease of the incubation time for a chick to hatch and insignificant increase chick length for each one of PIPBS compared to control group, may be because as mentioned above buy Hamburger and Hamilton, (1951) and Eyal-Giladi and Kochav, (1976), increasing PIPBS leading to increased (more advanced) stage of embryonic development from Stage X for control group nearly to stage XIII for PIPBS-6, Stage 3 for PIPBS-12 and Stage 4 for PIPBS-18 which may be decreased the incubation time for a chick to hatch for each one of PIPBS compared to control group moreover, chicks that hatched first are normally longer than chicks that hatch late (Willemsen et al., 2008) which might explain why chick length of each one of pre storage incubation groups was higher with insignificant values at the moment of measurement than chick length of the control group. And the best one was PIPBS-5h compared to PIPBS -10h, PIPBS -15h and control groups may be because in the embryonic development stage for PIPBS-5h embryos were survived to prolonged storage and embryonic death and were better able to withstand developmental arrest during prolonged storage of 14d (Fasenko et al., 2001 and Reijrink et al., 2009) compared to PIPBS -10h, PIPBS -15h and control groups whose are at different stages of embryonic development do not respond favorably to developmental arrest during 14 d storage (Fasenko et al., 2001). These results added credence to the conclusion of Boerjan (2010) who found that eggs stored longer than 7 days increased the incubation duration to hatch. Also, Christensen et al. (2002) and Reijrink et al. (2010a) demonstrated that prolonged

storage periods increasing incubation time required for eggs to hatch. It could be concluded that egg storage period should not exceed than 7 days because more than 7 days had decline effect on all studied traits, but if the storage period exceeded than 7 days until to 14 days warning the eggs with

5 hours Pre-incubation before storage could be recommended for improving hatchability percentage of both fertile and total eggs compared to 0, 10 and 15 hours pre-incubation before storage.

Table (1): Effect of storage period and pre-incubation period before storage on external egg quality of Sinai eggs.

Traits	Egg weight (g)	Egg length (cm)	Egg width (cm)	Egg shape index	Egg shell weight (%)	Egg shell Thickness without membranes (mm)
Main treatment effect						
Egg storage period (SP)						
7 days	38.68±0.62	5.74±0.04	4.22±0.03	73.52±0.62	12.49±0.07 ^B	0.366±0.01
14 days	38.64±0.63	5.69±0.05	4.23±0.02	74.34±0.66	13.17±0.08 ^A	0.365±0.02
Pre-incubation period before storage (PIPBS)						
0 hours	39.09±0.61	5.82±0.05	4.31±0.02	74.05±0.63	12.94±0.07	0.358±0.02
5 hours	38.79±0.63	5.70±0.05	4.19±0.03	73.50±0.65	12.87±0.07	0.364±0.02
10 hours	38.53±0.64	5.67±0.04	4.21±0.03	74.25±0.62	12.76±0.08	0.370±0.02
15 hours	38.25±0.63	5.66±0.05	4.20±0.02	74.20±0.64	12.74±0.07	0.371±0.02
SP X PIBS interaction						
7 days × 0 hours	39.14±0.61	5.84±0.05	4.30±0.03	73.63±0.65	12.61±0.07 ^{ab}	0.352±0.01
7 days × 5 hours	38.88±0.62	5.71±0.04	4.16±0.02	72.85±0.64	12.54±0.08 ^{bc}	0.364±0.01
7 days × 10 hours	38.49±0.63	5.73±0.05	4.24±0.03	74.00±0.66	12.41±0.07 ^b	0.371±0.02
7 days × 15 hours	38.22±0.62	5.67±0.05	4.19±0.03	73.90±0.61	12.38±0.07 ^b	0.375±0.02
14 days × 0 hours	39.03±0.63	5.80±0.04	4.32±0.03	74.48±0.63	13.26±0.08 ^a	0.362±0.02
14 days × 5 hours	38.70±0.61	5.69±0.05	4.21±0.02	73.99±0.66	13.20±0.07 ^{ab}	0.364±0.01
14 days × 10 hours	38.57±0.63	5.61±0.04	4.19±0.03	74.69±0.64	13.11±0.07 ^{ab}	0.370±0.02
14 days × 15 hours	38.28±0.62	5.64±0.04	4.21±0.02	74.65±0.65	13.09±0.08 ^{ab}	0.366±0.02
P	<0.005	<0.158	<0.0001	<0.141	<0.942	< 0.0001

*Values are means ± SE.

Means, within columns, for the main treatment effects or the interaction effects have no similar letter(s) are significantly different ($P \leq 0.05$).

Table (2): Effect of storage period and pre-incubation period before storage on internal egg quality of Sinai eggs.

Traits	Egg yolk weight (%)	Egg albumen weight (%)	Egg yolk height (mm)	Egg yolk diameter (mm)	Egg yolk index	Egg albumen height (mm)	Hough units	Egg albumen pH
Main treatment effect								
Egg storage period (SP)								
7 days	34.51±0.32 ^B	53.00±0.39 ^A	14.53±0.06	40.95±0.04	35.48±0.55	5.11±0.17 ^A	78.33±0.86 ^A	8.27±0.62 ^B
14 days	35.07±0.33 ^A	51.76±0.38 ^B	14.77±0.05	41.04±0.03	35.99±0.54	4.23±0.17 ^B	75.26±0.87 ^B	9.42±0.63 ^A
Pre-incubation period before storage (PIPBS)								
0 hours	34.72±0.34	52.34±0.38	14.61±0.05	40.91±0.03	35.71±0.55	4.77±0.17	77.37±0.85	8.71±0.67
5 hours	34.77±0.32	52.36±0.37	14.70±0.04	40.94±0.04	35.90±0.54	4.72±0.18	77.08±0.86	8.92±0.68
10 hours	34.84±0.32	52.40±0.38	14.68±0.05	41.03±0.03	35.78±0.56	4.61±0.17	76.41±0.86	8.91±0.67
15 hours	34.82±0.33	52.44±0.39	14.62±0.06	41.09±0.03	35.58±0.55	4.57±0.17	76.29±0.86	8.86±0.67
SP X PIBS interaction								
7 days × 0 hours	34.41±0.32 ^b	52.98±0.37 ^{ab}	14.40±0.05	40.83±0.03	35.27±0.59	5.18±0.17 ^{ab}	78.84±0.86	8.15±0.65 ^b
7 days × 5 hours	34.46±0.34 ^b	53.00±0.38 ^{ab}	14.64±0.04	40.88±0.04	35.81±0.58	5.16±0.18 ^{ab}	78.52±0.85	8.34±0.64 ^b
7 days × 10 hours	34.62±0.34 ^{ab}	52.97±0.37 ^{ab}	14.58±0.05	40.97±0.04	35.59±0.58	5.08±0.17 ^{bc}	77.95±0.86	8.31±0.65 ^b
7 days × 15 hours	34.55±0.33 ^{ab}	53.07±0.39 ^a	14.50±0.06	41.14±0.03	35.24±0.58	5.03±0.17 ^{bc}	77.99±0.86	8.29±0.65 ^b
14 days × 0 hours	35.04±0.32 ^a	51.70±0.38 ^c	14.82±0.04	41.00±0.04	36.14±0.57	4.36±0.17 ^{bcd}	75.91±0.86	9.25±0.66 ^a
14 days × 5 hours	35.08±0.32 ^a	51.72±0.38 ^c	14.75±0.06	41.03±0.03	35.95±0.59	4.29±0.18 ^{cd}	75.63±0.85	9.51±0.64 ^a
14 days × 10 hours	35.05±0.34 ^a	51.84±0.37 ^{bc}	14.78±0.05	41.08±0.03	35.98±0.57	4.14±0.17 ^d	74.86±0.84	9.49±0.64 ^a
14 days × 15 hours	35.09±0.33 ^a	51.82±0.39 ^{bc}	14.74±0.04	41.04±0.03	35.92±0.57	4.12±0.18 ^d	74.60±0.85	9.44±0.65 ^a
P	<0.002	<0.192	<0.0001	<0.0001	<0.0001	<0.031	<0.197	<0.0001

*Values are means ± SE.

Means, within columns, for the main treatment effects or the interaction effects have no similar letter(s) are significantly different ($P \leq 0.05$).

Table (3): Effect of storage period and pre-incubation period before storage on egg weight loss percentages of Sinai eggs.

Trait	Initial egg weight (g)	Egg weight loss during storage (%)	Egg weight loss (0-18 days) of incubation (%)	Total egg weight loss (%)
Main treatment effect				
Egg storage period (SP)				
7 days	38.68±0.62	1.72±0.09 ^B	11.44±0.21 ^B	13.15±0.26 ^B
14 days	38.64±0.63	2.53±0.11 ^A	12.74±0.23 ^A	15.26±0.23 ^A
Pre-incubation period before storage (PIPBS)				
0 hours	39.09±0.61	1.76±0.11 ^C	11.67±0.24 ^C	13.42±0.24 ^C
5 hours	38.79±0.63	2.05±0.10 ^B	11.80±0.26 ^{BC}	13.84±0.26 ^{BC}
10 hours	38.53±0.64	2.22±0.10 ^B	12.03±0.25 ^B	14.24±0.25 ^B
15 hours	38.25±0.63	2.48±0.09 ^A	12.87±0.26 ^A	15.34±0.26 ^A
SP X PIBS interaction				
7 days × 0 hours	39.14±0.61	1.48±0.12 ^g	11.21±0.23 ^e	12.68±0.26 ^f
7 days × 5 hours	38.88±0.62	1.69±0.14 ^f	11.33±0.24 ^e	13.02±0.25 ^f
7 days × 10 hours	38.49±0.63	1.81±0.13 ^{ef}	11.36±0.24 ^e	13.17±0.25 ^f
7 days × 15 hours	38.22±0.62	1.90±0.14 ^{de}	11.85±0.22 ^d	13.74±0.26 ^{ef}
14 days × 0 hours	39.03±0.63	2.03±0.12 ^d	12.13±0.24 ^{cd}	14.16±0.26 ^{de}
14 days × 5 hours	38.70±0.61	2.41±0.14 ^c	12.26±0.22 ^c	14.67±0.24 ^{cd}
14 days × 10 hours	38.57±0.63	2.63±0.12 ^b	12.69±0.23 ^b	15.31±0.26 ^b
14 days × 15 hours	38.28±0.62	3.06±0.14 ^a	13.88±0.24 ^a	16.93±0.25 ^a
P	<0.005	<0.0001	<0.0001	<0.139

*Values are means ± SE.

Means, within columns, for the main treatment effects or the interaction effects have no similar letter(s) are significantly different ($P \leq 0.05$).

Table (4): Effect of storage period and pre-incubation period before storage on embryonic mortality percentages of Sinai eggs.

Traits	Early mortality 1-7 days (%)	Mid mortality 8-14 days (%)	Late mortality 15-21 days (%)	Pip dead (%)	Pip life (%)	Total embryonic mortality (%)
Main treatment effect						
Egg storage period (SP)						
7 days	7.11±1.14 ^B	2.27±1.04	3.17±1.04 ^B	1.17±0.72 ^B	0.88±0.58 ^B	14.60±1.39 ^B
14 days	12.19±1.16 ^A	2.83±1.03	5.85±1.03 ^A	3.06±0.73 ^A	2.02±0.57 ^A	25.95±1.38 ^A
Pre-incubation period before storage (PIPBS)						
0 hours	9.42±1.09	2.39±1.14	4.42±1.12	2.01±0.88	1.36±0.44	19.60±1.25
5 hours	9.55±1.08	2.47±1.15	4.45±1.11	2.03±0.87	1.40±0.42	19.90±1.26
10 hours	9.70±1.09	2.62±1.15	4.55±1.12	2.14±0.87	1.47±0.43	20.48±1.25
15 hours	9.94±1.09	2.74±1.13	4.63±1.12	2.24±0.87	1.57±0.42	21.12±1.25
SP X PIBS interaction						
7 days × 0 hours	6.97±1.64 ^c	2.03±1.48	3.07±1.34 ^b	1.09±0.92 ^b	0.82±0.48 ^b	13.98±1.84 ^b
7 days × 5 hours	7.08±1.62 ^{cd}	2.15±1.46	3.11±1.36 ^b	1.11±0.92 ^b	0.84±0.46 ^b	14.29±1.83 ^b
7 days × 10 hours	7.14±1.61 ^{cd}	2.39±1.48	3.20±1.34 ^b	1.18±0.92 ^b	0.89±0.47 ^b	14.80±1.84 ^b
7 days × 15 hours	7.27±1.62 ^c	2.52±1.48	3.29±1.34 ^b	1.27±0.93 ^b	0.97±0.47 ^b	15.32±1.84 ^b
14 days × 0 hours	11.87±1.62 ^{ab}	2.74±1.46	5.78±1.35 ^a	2.93±0.92 ^a	1.91±0.47 ^a	25.23±1.82 ^a
14 days × 5 hours	12.01±1.63 ^{ab}	2.79±1.46	5.80±1.36 ^a	2.96±0.91 ^a	1.95±0.48 ^a	25.51±1.83 ^a
14 days × 10 hours	12.26±1.62 ^{ab}	2.84±1.46	5.89±1.35 ^a	3.09±0.91 ^a	2.04±0.48 ^a	26.12±1.83 ^a
14 days × 15 hours	12.61±1.62 ^a	2.95±1.47	5.96±1.35 ^a	3.21±0.92 ^a	2.17±0.46 ^a	26.90±1.83 ^a
P	< 0.0001	<0.68	<0.46	<0.92	<0.01	<0.01

*Values are means ± SE.

Means, within columns, for the main treatment effects or the interaction effects have no similar letter(s) are significantly different ($P \leq 0.05$).

Table (5): Effect of storage period and pre-incubation period before storage on fertility and hatchability traits of Sinai eggs.

Traits	Apparent fertility (%)	Hatchability of fertile eggs (%)	Hatchability of total eggs (%)	Total incubation time (h)	Chick length (Cm)
Main treatment effect					
Egg storage period (SP)					
7 days	87.19±1.28 ^A	81.19±1.46 ^A	73.38±1.51 ^A	516.14±0.54 ^B	15.87±0.04
14 days	83.03±1.27 ^B	72.16±1.47 ^B	61.27±1.52 ^B	518.40±0.54 ^A	15.52±0.03
Pre-incubation period before storage (PIPBS)					
0 hours	86.25±1.41	73.86±1.41 ^C	64.21±1.66 ^C	518.30±0.78 ^{AB}	15.56±0.03
5 hours	85.46±1.41	80.22±1.42 ^A	70.50±1.67 ^A	516.19±0.77 ^C	15.79±0.03
10 hours	84.57±1.40	76.45±1.41 ^B	67.06±1.67 ^B	517.21±0.78 ^{BC}	15.69±0.04
15 hours	84.15±1.41	76.18±1.41 ^B	67.53±1.66 ^B	517.43±0.78 ^{BC}	15.74±0.03
SP X PIBS interaction					
7 days × 0 hours	88.43±1.53 ^{ab}	77.38±1.65 ^c	69.41±1.72 ^c	516.92±1.08 ^c	15.72±0.03
7 days × 5 hours	87.61±1.53 ^{ab}	84.99±1.66 ^a	76.88±1.74 ^a	515.26±1.08 ^c	15.96±0.03
7 days × 10 hours	86.55±1.52 ^{bc}	81.86±1.65 ^b	74.03±1.72 ^b	516.19±1.07 ^c	15.89±0.04
7 days × 15 hours	86.14±1.53 ^{bc}	80.52±1.65 ^b	73.24±1.72 ^b	516.28±1.08 ^c	15.93±0.04
14 days × 0 hours	84.07±1.51 ^{cd}	70.34±1.65 ^d	59.02±1.73 ^e	519.69±1.06 ^a	15.41±0.04
14 days × 5 hours	83.31±1.52 ^{cd}	75.46±1.64 ^c	64.13±1.73 ^d	517.12±1.08 ^{bc}	15.62±0.03
14 days × 10 hours	82.59±1.52 ^d	71.03±1.66 ^d	60.08±1.72 ^e	518.22±1.07 ^{ab}	15.49±0.03
14 days × 15 hours	82.17±1.51 ^d	71.84±1.66 ^d	61.82±1.73 ^e	518.57±1.07 ^{ab}	15.55±0.04
P	<0.0183	0.0001	0.0001	<0.0172	<0.0168

*Values are means ± SE.

Means, within columns, for the main treatment effects or the interaction effects have no similar letter(s) are significantly different ($P \leq 0.05$).

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الملخص العربي

دراسه مقارنه بين فترات مختلفه لتحضين البيض فى المفرخ قبل تخزينه للحد من التأثير السلبي لفترات التخزين الطويلة للبيض على صفات الفقس لبيض سلالة سينا.

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أجريت هذه الدراسة لأختبار تأثير التخزين لفته قصيره (7 أيام) أو طويله (14 يوم) على البيض المخصب و ما هي أفضل فتره لتحضين البيض فى المفرخ قبل تخزينه سوف تعطى أعلى نسبة فقس فى البيض المخصب. أستخدم فى هذه الدراسه عدد 2700 بيضه صالحه للتفريخ تم تجميعها من قطيع أمهات سلالة سينا عند عمر 32 أسبوع. البيض تم نقله الى المفرخ على مجموعتين طبقا الى فترتى تخزين البيض (7، 14 يوم). كل البيض تم تخزينه على درجة حراره 17 درجه مئوية ورطوبه نسبيه 75%. كل البيض فى كل مجموعه تم وزنه وترقيمه فرديا و كل مجموعه تم تقسيمها الى أربع مجموعات أصغر بكل منها (300 بيضه) طبقا الى فتره تحضين البيض قبل تخزينه كالتالى: المجموعه الاولى لم يتم تحضينها فى المفرخ قبل تخزينها (كنترول)، المجموعه الثانيه و الثالثه و الرابعه تم تحضينها فى المفرخ لمدة 5، 10، 15 ساعه على درجة حراره 37.5 درجه مئوية ورطوبه نسبيه 56% قبل تخزينها. وتتخلص أهم النتائج فيما يلى:

- النسبه المئويه لوزن الالبومين، ارتفاع الالبومين و وحدات جودة البيضه (هاوف يونت) أنخفضت بمعنويه بينما النسبه المئويه لوزن الصفار، النسبه المئويه لوزن القشره و pH الالبومين زادت بمعنويه بزيادة فترة تخزين البيض من 7 الى 14 يوم.
- النسبه المئويه للفقء فى وزن البيض اثناء التخزين، 18 يوم الاولى من التفريخ ، النسبه المئويه للفقء الكلى فى وزن البيض، النسب المئويه للنفوق الجنينى المبكر و المتأخر و الكلى، النسب المئويه للكناكيت الناقره الناقره و الناقره الحيه (الغير فاقسه) و الوقت الكلى الازم لعملية الفقس كانت أعلى بمعنويه فى الفتره الأطول لتخزين البيض (14 يوم) بالمقارنه بالفتره الاقصر (7 أيام) و العكس صحيح لصفات النسبه المئويه للخصب الظاهرى، النسبه المئويه للفقس من البيض المخصب و النسبه المئويه للفقس من البيض الكلى.
- فى الفتره الأطول لتخزين البيض (14 يوم) - تحضين البيض فى المفرخ لمدة (5 ساعات) قبل تخزينه كان أعلى بمعنويه فى صفات النسبه المئويه للفقس من البيض المخصب و النسبه المئويه للفقس من البيض الكلى مقارنة بمجموعه الكنترول والمجموعات التى تم تحضين البيض فيها لمدة (10، 15 ساعه) قبل تخزينه و لكن ظل أقل بمعنويه مقارنة بنفس الفتره من تحضين البيض فى المفرخ قبل تخزينه فى الفتره الاقصر لتخزين البيض (7 يوم).
- نستنتج من هذه الدراسه أنه لا يجب تخزين بيض التفريخ لمدته اكثر من 7 أيام لأن ذلك أدى الى تدهور فى جميع الصفات المدروسه. لكن إذا اضطررنا الى تخزين بيض التفريخ لمدته اكثر من 7 أيام و بحد أقصى 14 يوم فإنه يجب تحضين البيض فى المفرخ لمدة (5 ساعات) قبل تخزينه لأنه حسن بمعنويه النسبه المئويه للفقس من البيض المخصب والكلى على حد سواء.