Egypt. Poult. Sci. Vol. (39) (IV): (791-808) (2019) (**1910-1048)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF HEAT TREATMENTS DURING HATCHING EGGS STORAGE ON HATCHABILITY TRAITS AND CHICK QUALITY

M. A. Elmenawey

Dep.of Anim.Prod., Fac. of Agric., Cairo Univ., Giza, Egypt

Corresponding author: M. A. Elmenawey Email: elmenawey7@yahoo.com

Received: 22/09/2019 Accepted: 29 /10/2019

ABSTRACT: The purpose of this study was to investigate the efficacy of short periods of incubation during egg storage (SPIDES) on hatchability, embryonic mortality, incubation time and chick quality of broiler breeder hatching eggs stored for 15 days. A total of 15510 hatching eggs were collected from 49-wk-old Arbor Acres broiler breeders flock. Eggs were divided into four groups. First group was stored for 5 days without heat treatment (Fresh eggs). Second group was stored for 15 days and heated one time at the fifth day of storage (SPIDES1). Third group was stored for 15 days and heated two times, on fifth and tenth days of storage (SPIDES2). Forth group was stored for 15 days without heating, a negative control. Heat treatment was at 32^{o}C and 55 – 60% relative humidity for 6 hours.

Results indicated that prolonged storage reduced hatchability, and visible fertility of untreated eggs. Heat treatments improved early embryonic mortality, hatchability and visible fertility. When eggs were exposed two times to heat treatment the hatchability was significantly improved as compared to those exposed one time only. Incubation time of the negative control was significantly increased as compared to the fresh eggs group or both heat treatment groups. No differences were observed between groups in live pipped or culled percentages. Relative yolk sac weight of newly hatched chicks increased significantly with the length of the pre-incubation storage period. However, both heat treatments restored this percentage to that of the fresh eggs. Chick quality traits (Tona score, chick weight, relative chick weight and chick length\weight) of the negative control group had lowest values as compared to other groups. However, SPIDES treatments slightly improved chick qualities.

In conclusion, the present study revealed that SPIDES is an effective method to ameliorate the detrimental effects of long storage period on hatchability and chick quality.

Keywords: Broiler hatching eggs-egg storage-hatchability-embryonic mortality-chick quality.

INTRODUCTION

The operation and control of any hatchery is essential the improvement of quality day old chicks. Various management practices and handling of hatching eggs from egg lay to hatching have influence on the hatchability. Pre-incubation storage condition; temperature, humidity and turning together with the age of breeding flock have been the most common variables used to manipulate the fertility, livability and consequently affect the quality of day old chicks (Koka, 2002).

Storage of hatching eggs is a common practice in broiler and layer parent and grandparent hatcheries to coordinate hatchery activities and the anticipated demand (Dymond et al., 2013 and Van Roovert-Reijrink et al., 2018). Additionally, commercial hatcheries sometimes need to increase the storage duration due to variations in the supply of hatching eggs and the market demand for day-old broiler chicks.

Hatching eggs stored for more than a few days will not hatch as well as eggs set when they are 3-5 days old. Stored hatching eggs have earlier embryo mortality. However, the embryos that survive tend to be slower to develop and slower to hatch. When hatching eggs are stored for more than 7 days, hatchability decline (Lapao et al., 1999; Fasenko et al., 2001a; Ates et al., 2004; Fasenko, 2007; Reijrink et al., 2008, 2010; Marandure et al., 2012; Dymond et al., 2013; Goliomytis et al., 2015 and Alex Addo et al., 2018), abnormalities and mortality increases (Van de Ven, 2004), chick quality decreases (Tona et al., 2003, 2004; Reijrink et al., 2008, 2010; Marandure et al., 2012; Dymond et al., 2013 and Goliomytis et al., 2015), and incubation time increases (Christensen et al., 2002; Ates et al., 2004; Reijrink et al., 2010; Dymond et al., 2013 and Rocha et al. 2013).

A farm yard hen will lay one egg in her nest every day until her clutch is complete. Each time she returns to the nest to lay an egg, the older eggs already in the nest will be warmed, effectively providing them with a short period of incubation. Trials have shown that mimicking the natural process in the nest by introducing Short Periods of Incubation during Egg Storage (SPIDES) can help maintain good hatchability in stored eggs (Aviagen, 2017). Several pre-incubation remedies had been studied to reduce the negative effects of prolonged hatching egg storage for more than 7 days on hatchability and chick quality. Pre-storage incubation (Meir and Ar, 1998; Fasenko et al., 2001a,b; Gucbilmez et al., 2013 and Van Roovert-Reijrink et al., 2018) or SPIDES (Nicholson et al., 2011; Dymond et al., 2013 and Van Roovert-Reijrink et al., 2018) have demonstrated to reduce negative effects of prolonged egg storage.

The optimal time and numbers of SPIDES can be different for eggs stored over short and long intervals of time because embryo viability relies upon egg storage duration (Reijrink et al., 2010).

The objective of this study was to assess the effect of SPIDES on hatchability, embryonic mortality, incubation time and chick quality, when eggs were stored for a prolonged time.

MATERIAL AND METHODS

A total of 15510 hatching eggs were obtained from a 49-wk-old Arbor Acres broiler breeder flock. The parent stock was housed in floor closed house system.

Immediately after eggs were collected, they were disinfected by fumigation with 10 grams paraformaldehyde/m^3 for 20 minutes. Only eggs with no visible signs of, dirty shells, cracks, hairlines, abnormal shape shells and discoloration were chosen and transferred to the hatchery. They were stored for 5 or 15 d under 16^{o}C and 75-80% relative humidity, without turning. A total of 15510 hatching eggs were divided into four groups. The first group (3630 eggs) was stored for 5 days without heat treatment (Fresh eggs). The second group (3960 eggs) was stored for 15 days and heated one time on the fifth day of storage (SPIDES1). The third group (3960 eggs) was stored for 15 days and heated two times, at the fifth and tenth days of storage (SPIDES2). The forth group (3960 eggs) was stored for 15 days with no heating, and served as negative control. Each group was subdivided into twenty replicates (165 eggs each). To arrive the storage durations of 5 and 15 days, the eggs of the second, third and fourth groups were first collected and stored for 10 days, after that the eggs of the first group were collected and stored. All groups were then stored for additional 5 days before incubation.

Heat treatment:

Eggs were heated at a temperature of 32^{o}C and 55-60% relative humidity for 6 hours. Once were reached 32^{o}C, they were cooled back to the cold storage egg room. The SPIDES1 group was heated one time only on the fifth storage day, while the SPIDES2 group was heated two times (at the fifth and tenth storage days). The first and fourth groups were kept without heat treatment as fresh eggs and negative control, respectively.

Egg quality characteristics:

To estimate the change in egg quality throughout the storage period, two samples (165 eggs each) were randomly selected at the 0 and 5 days from the first group and four samples (165 eggs/sample/group) were selected at the 0, 5, 10 and 15 days from rest of the groups. The quality traits include the following: Albumen height (Wilgus and Van Wagenes, 1936), Yolk index (Funk, 1948), Shell thickness (Brant and Sharder, 1952). The whole egg and it is components (egg shell, albumen and yolk) were weighed to the nearest gram. Yolk mottled was visually detected. Yolk color was evaluated visually by means of usual DSM Yolk Color Fan (Bovskova *et al.*, 2014).

Incubation and Hatching conditions:

After the period of storage, 3300 eggs from each group were divided into twenty replicates (165 eggs each) and placed together in a Chick Master Incubator (single stage system) that provided 37.7^{o}C and 55 – 60% relative humidity in the setter. At 18th day of incubation, eggs were candled to determine visually infertile and stage of embryonic mortality. The percentage of egg weight loss was calculated at 18 days of incubation. The visible fertility and different embryonic mortality stages were calculated as a percentage of set eggs. Eggs with living embryos were then transferred to the Hatcher that provided 36.5^{o}C and 75% relative humidity throughout the last three days of incubation.

External pipping and incubation duration:

Between 468 and 520 hours of incubation, the number of external pipped egg and hatched chicks were checked every 2 hours to calculate the external pipping and

incubation time for each Hatcher basket. Hatchability was calculated as a percentage of set eggs and of fertile eggs for each Hatcher basket as follow:

- Visible fertility (%) = Number of fertile eggs/total number of eggs set X 100.
-Hatchability of eggs set (%) = Number of chicks hatched/total number of eggs set X 100.
-Hatchability of fertile eggs (%) = Number of chicks hatched /total number of fertile eggs X100.
-Early embryonic mortality (%) = Number of dead embryos during early phase (0 to 7 days of incubation) / total number of eggs set X100.
-Blood ring (%) = Number of embryos with blood rings/total number of eggs set X100.
-Black eye (%) = Number of embryos with black eye/total number of eggs set X100.
-Middle embryonic mortality (%) = Number of dead embryos during middle phase (8 to 14 days of incubation) / total number of eggs set X100.
-Late embryonic mortality (%) = Number of dead embryos during late phase (15 to 21 days of incubation) / total number of eggs set ×100.
-Pipped dead eggs (%) = Number of dead pipped eggs / total number of eggs set ×100.
-Pipped live eggs (%) = Number of live pipped eggs / total number of eggs set ×100.

Chick Quality:

At the day of hatch, five chicks from each replicate (100 chicks /group) were randomly chosen to determine chick quality. Chicks were weighed to the nearest gram, chick length was determined as the length from the tip of the beak to the implantation of the nail of the middle toe (Willemsen *et al.*, 2008). Chick length/chick weight and Tona score were determined according to criteria set by Tona *et al.* (2003). Chicks were then sacrificed and the residual yolk was removed, weighed and expressed as relative weight (grams of yolk/100 grams of live body weight).

The embryonic mortalities were determined at three phases: Early dead, blood ring and black eye during 1 – 7 days of incubation, middle dead during 8 – 14 days of incubation and late dead during 15 – 21 days of incubation. Pipped eggs (dead and live) were determined at day 21 of incubation.

Statistical Analysis:

One – Way analysis of variance for the data was done, using the SAS General Linear model procedure (SAS Institute, 2004). The main effect was short period of incubation during egg storage. To acquire a normal distribution all the data in percentage form were converted using arc-sine transformations before to analysis. Mean value were compared using Duncan's Multiple Rang Test, (Duncan, 1955) when significant differences existed. The significance level was set at 5%.

RESULTS AND DISCUSSION

The current results (Table1) showed that neither the length of pre-incubation storage period nor SPIDES treatment affect the measured of internal or external egg quality traits during storage period. Similar results were observed by Silva *et al.* (2008). They reported that internal and external egg qualities of hatching eggs were not different among three different collection days, hatching eggs were collected in three five-day intervals throughout 14 days.

The yolk color of fresh eggs was significantly the lowest as compared with the other groups (Table 2). No significant differences were observed between yolk indexes of all groups at zero or after five days of storage. However, at ten and at fifteen days of storage, the negative control group had significantly the highest yolk index as compared with the two SPIDES groups. The significant differences between SPIDES group were only observed at day fifteen, where the SPIDES1 group had higher value than the SPIDES2 one. No significant differences were observed between mottled yolks% of all groups at the different days of pre-incubation storage period (Table 2). Jones and Musgrove (2005) indicated that the yolk sac membranes elasticity decreases with longer storage duration; this resulted in decreasing the yolk index.

The results of albumen height at zero and at the fifth day of pre-incubation storage (Fig. 1) indicated that, there were no differences between studied groups. However, at the tenth day, both SPIDES groups had significantly lower albumen height than that of the negative control group with no difference between the two heated groups. On the other hand, at the fifteenth day the fresh eggs group had significantly higher albumen height than the heat treated groups. The SPIDES1 group had significantly higher than the SPIDES2 group. Lapão *et al.* (1999) and Rocha *et al.* (2013) reported that albumen height decreases with longer storage duration.

Table (3) presents the relative egg weight loss during storage and incubation periods. Total weight loss increased when pre-incubation storage period was extended to fifteen days. However, both SPIDES treatments did not affect the absolute or relative egg weight loss. Previous research by Silva *et al.* (2008) and Reijrink *et al.* (2010) indicated that water evaporation form hatching eggs increased when storage period was extended for long periods.

Previous research also indicated that the pre-incubation eggs storage for a long period, leads to increased water loss during storage (Egbeyale *et al.,* 2013). Egg weight loss during storage increased regularly with a rate around 0.77 grams/per week, in chicken eggs (Silversides and Villeneuve, 1994). Samli *et al.* (2005) stored chickens eggs at 15ºC for 2, 5 and 10 days and observed 0.27%, 0.51% and 0.66% egg weight loss during storage, respectively. Fasenko *et al.* (2001 a,b); Petek and Dikmen (2004 and 2005) stated that, egg weight losses during storage were significantly affected by the length of egg storage. Egg weight losses during 15-day storage were by 72% higher than in 5-day storage.

On the other hand, the results of Romao *et al.* (2008) and Egbeyale *et al.* (2013) showed that egg weight loss during incubation was inversely influenced by the length of pre-incubation storage periods. Most of the water content of the egg is initially in the albumen. It declines continuously during incubation as a result of water loss to the ambient air and movement to the compartments (Romanoff, 1967).

In general, the results showed that the embryonic mortality rates were depending on the duration of pre-incubation storage period and the number of heat treatment times (Table 4). The early and total early embryonic mortality were significantly higher when pre-incubation storage period

extended to 15 days. However, the results also, showed that both SPIDES treatments significantly decreased the early embryonic mortality as compared to the negative control group. Fasenko *et al.* (2001b) stated that, in broiler embryos, when hatching eggs were stored for 14 days, the embryonic metabolism and developmental was delayed, and irreparable damage to the embryo may occur, and thus resulting in increased embryonic mortality at early and late stages of incubation. They also observed that the total embryonic mortality increased from 10.7% in 4-d stored eggs to 27.7% in 14-d stored eggs.

Our results showed that, the blood rings percentages of the fresh and SPIDES2 groups were similar and significantly lower than both other group. Similar pattern was observed in the late embryonic mortality. On the other hand, no differences were observed between black eyes, mid embryonic mortality rate, live pipped and culls of chicks of the different groups. As expected the total embryonic mortality rates increased sharply with the extension of the storage period. The dead pipped percentage of the negative control group was significantly higher than any of the other groups.

Fresh eggs and negative control groups had significantly lower contamination rates than the SPIDES groups. Our results are in agreement with those reported, on hatching broiler breeder's eggs, by Fasenko *et al.*, 2001a & b; Fasenko, 2007; Silva *et al.*, 2008; Hamidu *et al.*, 2011 and Alex Addo *et al.*, 2018. They observed lower hatchability and higher embryonic mortality percentages of embryos stored for 14 days as compared to 4 days of storage. They interpreted these results to the delayed or slow embryonic development after normal incubation temperatures was provided.

In the present study, the SPIDES treatment partially ameliorated the deleterious effects of pre-incubation storage period on the total embryonic mortality when the storage period was extended more than five days. This amelioration was depending on the number of the heat treatment times (13.15% in SPIDES1 versus 10.15% in SPIDES2). The more the heat exposure times, the less embryonic mortality was observed. The ultimate goal of broiler breeder producers is to achieve the highest hatchability and produce high quality chicks. In general, the apparent fertility and hatchability sharply declined when pre-incubation storage period was extended to 15 days without heat treatment (Table 5). It is agreed upon that egg storage beyond 7 d is associated with a decline in hatchability (Fasenko *et al.,* 2001a,b; Tona *et al.,* 2004 and Egbeyale *et al.,* 2013). Elibol *et al.* (2002); Petek *et al.* (2003) and Schmidt *et al.* (2009) also, reported that long egg storage decreased the apparent fertility.

The improvement in visible fertility was similar in both SPIDES group, but when eggs were exposed to heat two times (SPIDES2) the hatchability percentages were significantly higher as compared to those counterparts exposed one time only (SPIDES1).

To reduce the negative effects of prolonged egg storage on hatchability and chick quality, several pre-incubation treatments have been studied. Prestorage incubation (Fasenko *et al.,* 2001a,b) or short periods of incubation during storage (SPIDES) (Nicholson *et al.,* 2011; Dymond *et al.,* 2013; Reijrink *et al.,* 2018) have reduced

the negative effects of prolonged egg storage. Previous research, speculated that an embryo needs a minimum number of viable cells to continue embryo development and grow successfully at the onset of incubation (Fasenko, 2007; Reijrink *et al.,* 2008 and Hamidu *et al.*, 2011).

Also, several authors observed a drop in embryo blastodermal cell number and viability through apoptosis and necrosis pathway (Hamidu *et al.,* 2010; Reijrink *et al.*, 2010 and Dymond *et al.,* 2013). Bakst *et al.* (2016) demonstrated that apoptosis occurs in the normal morpho-differentiation of the embryo, but it also increases as a response of the embryo to the stresses of prolonged cool egg storage. Dymond *et al.* (2013) reported that cell viability increased following each SPIDES treatment relative to control eggs. The increase in the number of viable cells following each pre-incubation heat treatment suggests the SPIDES treatment most likely reduces storage-induced cell death, either via advancement of the embryo through the developmental progression or an overall increase in viable cells at any given developmental stage.

The results presented in Table (5) showed that external pipping time decreased by 10 hours in the negative control group and by 4 hours in both heat treated groups as compared to the fresh eggs group. On the other hand, the incubation time was significantly less, by almost 12 hours, in the fresh eggs group and by 10 hours in both heated groups as compared to the negative control group. Reijrink *et al.* (2010) stated that prolonged egg storage increased incubation duration. They also, reported that chicks from the 4-d stored eggs hatched after 486.3 h of incubation whereas, their counterparts from the 14-d stored eggs hatched after 493.8 h of incubation. The storage of eggs for more than a week is known to slow the embryo growth and increase embryonic abnormalities and mortality due to the degradation of viscosity of egg albumen (Van de Ven, 2004).

The relative yolk sac weight (RYSW), of the newly hatched chicks, was significantly higher with the prolonged pre-incubation storage period (Table 6). However, the heat treatment returned the percentage to that of the fresh eggs group. The results of Atta *et al.*, (1998) explained that RYSW, of newly hatched chicks, increased considerably with the length of the pre-incubation storage period. It reached significantly higher weight when the storage period was prolonged to ten or fifteen days. However, as expected, opposite results were obtained for chick free yolk sac weight, where the fresh eggs group had the highest value (Table 6). Wolanski *et al.* (2004) and Lourens *et al.* (2005) showed that it is possible to determine the negative effects of prolonged egg storage on chick quality at hatch with a quantitative method, such as yolk-free body mass.

The chick quality traits (chick weight, chick length) of the fresh eggs group and both SPIDES groups had significantly higher values than the negative control group (Table 6). On the other hand, the opposite results were obtained for the chick length/weight ratio. This is expected since the hatched chicks from the fresh eggs group. Also, tona score of fresh eggs group was significantly the highest, while SPIDES groups were intermediate and significantly different from the negative

control group (Table 6). The previous investigations demonstrated that egg storage beyond 7 d is associated with a decline in chick quality (Tona *et al.,* 2003, 2004 and Reijrink *et al.*, 2010).

In general, our results indicated that the SPIDES treatment could alleviate the negative effects of prolong storage period on the embryonic survival, hatchability percentage and chick quality. These are in agreement with previous reports (Fasenko *et al*., 2001a & b; Petek and Dikmen, 2004; Silva *et al*., 2008; Hamidu *et al.*, 2011 and Alex Addo *et al.*, 2018). They explained that the improvement in the embryonic mortality, incubation yield and chick quality in pre-incubation heating eggs, may be related to the embryos stage and total number of viable embryonic cells, prior to incubation. According to Reijrink *et al*. (2010) the pre-incubation heating of eggs increased the stage of embryonic development, the total number of embryonic cells, as well as the total number of viable embryonic cells. Reijrink *et al*. (2009) showed that the ability of an embryo to survive prolonged storage period may depend on the cell activity at a particular stage of development but may also depend on the number of viable embryonic cells.

CONCLUSION

The present study reveals that SPIDES is an effective method to ameliorate the detrimental effects of long storage periods of hatching eggs on hatchability and chick quality traits. Data from the present experiment suggested that the SPIDES2 was more effective than SPIDES1.

Table (1): External and interior egg quality traits at day one of storage period

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	***Probability***
Egg Weight (g)	64.24±0.20*	64.04±0.14	63.96±0.15	63.98±0.14	0.6064
Shell Weight (g)	7.43±0.06	7.42±0.05	7.55±0.08	7.46±0.08	0.0527
Relative Shell Weight (%)	11.58±0.10	11.59±0.07	11.82±0.12	11.66±0.11	0.0544
Albumen Weight (g)	37.16±0.22	37.04±0.18	36.74±0.19	36.92±0.17	0.4472
Relative Albumen Weight (%)	57.77±0.20	57.79±0.18	57.38±0.20	57.67±0.21	0.3991
Yolk Weight (g)	19.65±0.09	19.58±0.08	19.67±0.09	19.61±0.08	0.8757
Relative Yolk Weight (%)	30.65±0.17	30.62±0.16	30.79±0.16	30.68±0.16	0.8875
Shell Thickness (μm)	328.56±0.74	328.39±0.94	330.00±0.76	330.11±0.97	0.3293

* No significant differences were observed between the treatments groups for any of the traits studied.

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5^{th} day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5^{th} and 10^{th} day of storage and Negative control eggs were stored for 15 days without heating.

Table (2): Effects of extended storage period and short period of incubation during egg storage (SPIDES) on Yolk traits

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	***Probability***
Yolk Color Index	7.16±0.05^{b*}	7.58±0.04^{a}	7.54±0.05^{a}	7.56±0.07^{a}	0.0001
Yolk Index (%)					
0 Day of Storage	44.53±0.14	44.33±0.09	44.44±0.10	44.52±0.09	0.5495
5 Days of Storage	43.15±0.13	43.03±0.12	43.21±0.09	43.23±0.13	0.6456
10 Days of Storage	--	40.76±0.12^{b}	40.80±0.05^{b}	41.24±0.08^{a}	0.0001
15 Days of Storage	--	38.96±0.06^{b}	38.41±0.07^{c}	39.45±0.11^{a}	0.0001
Yolk Mottled (%)					
0 Day of Storage	2.22±1.10	2.22±1.10	2.77±1.23	2.22±1.10	0.9808
5 Days of Storage	5.56±1.71	5.56±1.71	5.00±1.63	5.00±1.63	0.9905
10 Days of Storage	--	6.67±1.86	7.22±1.93	6.67±1.86	0.9339
15 Days of Storage	--	7.78±2.00	8.33±2.07	8.33±2.07	0.7159

* Means with different superscripts, within trait, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

Table (3): Effects of extended storage period and short period of incubation during egg storage (SPIDES) on egg weight loss during storage and incubation periods

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	**Probability**
Fresh Egg Weight (g)	64.40±0.32	64.05±0.29	64.05±0.25	64.10±0.26	0.7839
Egg Weight after Storage (g)	64.11±0.29^{a*}	62.87±0.26^{b}	62.85±0.23^{b}	62.91±0.23^{b}	0.0012
Egg Weight Loss During Storage (g)	0.29±0.037^{b}	1.18±0.048^{a}	1.20±0.027^{a}	1.19±0.032^{a}	0.0001
Egg Weight Loss During Storage (%)	0.46±0.055^{b}	1.84±0.068^{a}	1.87±0.037^{a}	1.85±0.043^{a}	0.0001
Egg Weight Loss During Incubation (g)	7.71±0.10^{c}	7.85±0.03^{bc}	7.90±0.04^{ab}	8.03±0.04^{a}	0.0018
Egg Weight Loss During Incubation (%)	11.96±0.15^{b}	12.26±0.07^{a}	12.33±0.08^{a}	12.53±0.07^{a}	0.0012
Total Egg Weight Loss (g)	8.00±0.11^{b}	9.03±0.07^{a}	9.10±0.04^{a}	9.22±0.06^{a}	0.0001
Total Egg Weight Loss (%)	12.41±0.15^{b}	14.09±0.08^{a}	14.20±0.07^{a}	14.39±0.08^{a}	0.0001

* Means with different superscripts, within trait, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

Table (4): Effect of extended storage period and short period of incubation during egg storage (SPIDES) on different embryonic mortality rates

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	***Probability***
Early Mortality (%)	0.21±0.09^{c*}	4.57±0.14^{b}	4.51±0.11^{b}	7.39±0.32^{a}	0.0001
Blood Ring (%)	1.73±0.23^{b}	2.67±0.16^{a}	1.64±0.23^{b}	2.64±0.40^{a}	0.0071
Black Eye (%)	1.48±0.19	1.97±0.27	1.39±0.15	2.06±0.26	0.0828
Total Early Mortality (%)	3.42±0.34^{d}	9.21±0.36^{b}	7.54±0.30^{c}	12.09±0.63^{a}	0.0001
Mid Mortality (%)	0.61±0.11	0.82±0.19	0.55±0.15	1.09±0.25	0.1496
Late Mortality (%)	1.94±0.31^{b}	3.12±0.32^{a}	2.06±0.17^{b}	2.39±0.24^{ab}	0.0117
Total Embryonic Mortality (%)	5.97±0.52^{d}	13.15±0.61^{b}	10.15±0.38^{c}	15.58±0.88^{a}	0.0001
Dead Pipped (%)	0.33±0.11^{b}	0.40±0.11^{b}	0.33±0.10^{b}	0.82±0.15^{a}	0.0126
Live Pipped (%)	0.39±0.13	0.49±0.13	0.43±0.12	0.52±0.14	0.9084
Culls (%)	0.94±0.12	1.15±0.16	1.27±0.20	1.49±0.22	0.1925
Contamination (%)	0.55±0.09^{c}	1.45±0.08^{a}	1.39±0.10^{ab}	1.15±0.10^{b}	0.0001

* Means with different, superscripts, within trait, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

Table (5): Effects of extended storage period and short period of incubation during egg storage (SPIDES) on hatchability traits

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	***Probability***
Visible Fertility (%)	90.36±0.44^{a*}	88.97±0.92^{a}	89.51±0.85^{a}	83.61±0.94^{b}	0.0001
Hatchability of Eggs Set (%)	82.18±0.80^{a}	72.33±1.39^{c}	75.94±1.25^{b}	64.06±1.54^{d}	0.0001
Hatchability of Fertile Eggs (%)	90.93±0.65^{a}	81.18±0.90^{c}	84.74±0.70^{b}	76.49±1.22^{d}	0.0001
External Pipping Time (hrs)	491.20±0.43^{a}	487.55±0.29^{b}	487.40±0.33^{b}	481.49±0.21^{c}	0.0001
Incubation Time (hrs)	503.80±0.31^{b}	505.10±0.38^{b}	505.05±0.31^{b}	515.00±0.66^{a}	0.0001

* Means with different superscripts, within trait, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

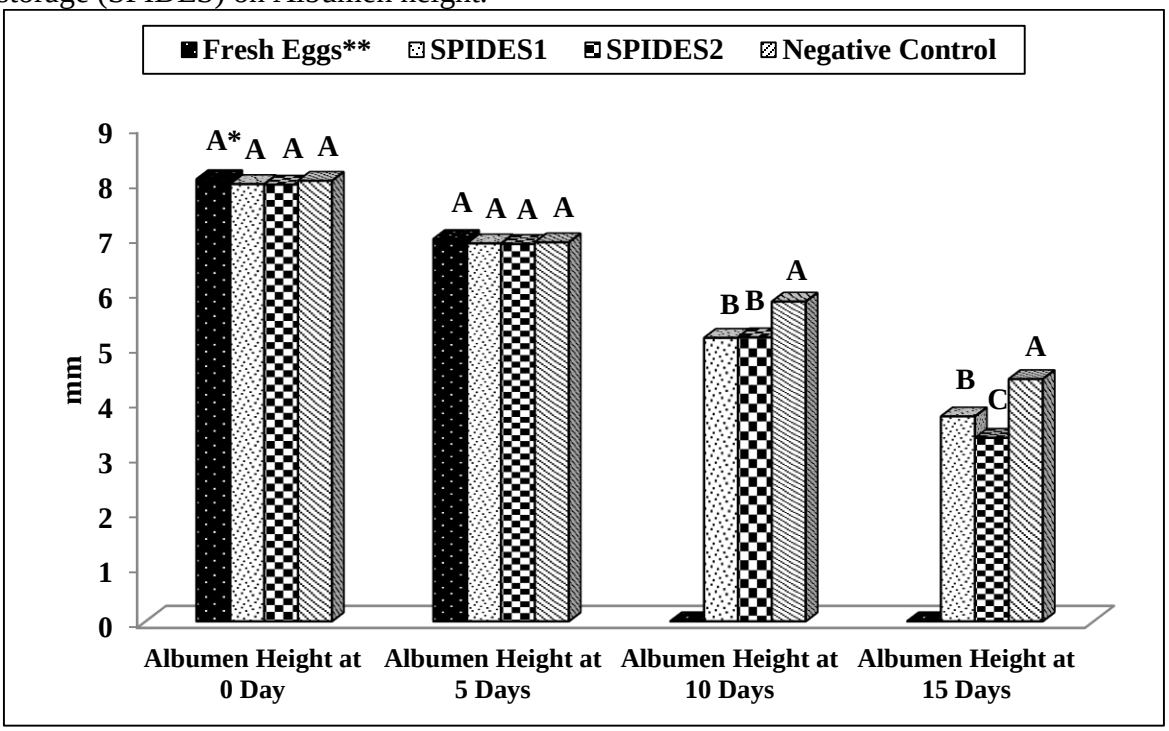
Table (6): Effects of extended storage period and short period of incubation during egg storage (SPIDES) on chick quality traits

Traits	Treatments				
	Fresh Eggs**	**SPIDES1**	**SPIDES2**	**Negative Control**	***Probability***
Chick Weight (g)	43.40±0.27^{a*}	42.80±0.31^{a}	42.95±0.23^{a}	41.65±0.28^{b}	0.0002
Chick/Egg Weight (%)	67.39±0.19^{a}	66.81±0.27^{a}	67.05±0.19^{a}	64.97±0.30^{b}	0.0001
Chick Length (cm)	19.81±0.10^{a}	19.71±0.08^{a}	19.76±0.06^{a}	18.72±0.09^{b}	0.0001
Chick Length/Weight	0.456±0.002^{ab}	0.461±0.004^{a}	0.460±0.003^{a}	0.450±0.003^{b}	0.0407
Yolk Sac Weight (g)	5.73±0.03^{b}	5.78±0.03^{b}	5.68±0.03^{b}	6.14±0.05^{a}	0.0001
Relative Yolk Sac Weight (%)	8.90±0.04^{bc}	9.03±0.04^{b}	8.87±0.07^{c}	9.58±0.06^{a}	0.0001
Chick Weight Free Yolk Sac (g)	37.67±0.24^{a}	37.02±0.30^{a}	37.27±0.24^{a}	35.51±0.27^{b}	0.0001
Chick Weight Free Yolk Sac (%)	58.49±0.19^{a}	57.79±0.28^{a}	58.18±0.21^{a}	55.40±0.32^{b}	0.0001
Tona Score	92.30±0.28^{a}	90.55±0.37^{b}	90.65±0.29^{b}	88.75±0.27^{c}	0.0001

* Means with different superscripts, within trait, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

Figure (1): Effects of extended storage period and short period of incubation during egg storage (SPIDES) on Albumen height.



* Means with different letters, within days, are significantly different ($P \leq 0.05$).

** Fresh eggs were stored for 5 days without heating, SPIDES1 eggs were stored for 15 days and exposed to heat on the 5th day of storage, SPIDES2 eggs were stored for 15 days and exposed to heat on the 5th and 10th day of storage and Negative control eggs were stored for 15 days without heating.

REFERENCES

Alex Addo, J.A. Hamidu, A.Y. Ansah, and K. Adomako, 2018. Impact of egg storage duration and temperature on egg quality, fertility, hatchability and chick quality in naked neck chickens. Int. J. Poult. Sci. 17: 175-183.

Atta A.M, S.M.T El-tantawy, A.A. Attallah and F.R. Mohamed, 1998. The influence of parent age and pre-incubation storage conditions on relative organs weight and maternal antibody of broiler chicks. Egyptian J. Anim. Prod. 35: 653-664.

Ates, C., O. Elibol, and J. Brake. 2004. The effect of storage period of eggs on hatching time and broiler performance. Proc. of XXII World's Poult. Congr., Istanbul, Turkey.

Aviagen, 2017. How to improve the hatchability of stored eggs. Improve hatchability by using Short Periods of Incubation During Egg Storage (SPIDES).

http://eu.aviagen.com/assets/Tech/Center-NS-2017-EN.pdf

Bakst, M.R., G.R. Welch, R. Fetterer, and K. Miska, 2016. Impact of broiler egg storage on the relative expression of selected blastoderm genes associated with apoptosis, oxidative stress, and fatty acid metabolism. Poult. Sci. 95: 1411–1417.

Bovšková H., K. Míková, and Z. Panovská. 2014. Evaluation of egg yolk colour. Czech J. Food Sci. 32: 213–217.

Brant, A.W., and H.L. Shrader. 1952. How to measure egg I.Q. (interior quality). Bureau of Animal Industry, Agriculture Research Administration, U.S. Dept. of Agric. Circular P.A. 202.

Christensen, V.L., M.J. Wineland, G.M. Fasenko, and W.E. Donaldson. 2002. Egg storage alters weight of supply and demand organs of broiler chicken embryos. Poult. Sci. 81:1738–1743.

Duncan, D.B. 1955. Multiple range and multiple F testes. Biometrics, 11: 7-42.

Dymond, J., B. Vinyard, A.D. Nicholson, N.A. French, and M.R. Bakst. 2013. Short periods of incubation during egg storage increase hatchability and chick quality in long-stored broiler eggs. Poult. Sci. 92:2977–2987.

Egbeyale L.T., M.K. Bosa,O.M. Sogunle, and O.O. Adeleye, 2013. Effect of pre-incubation storage periods on weight Loss, embryonic development, and hatchability of pullet eggs. The Pacific J. of Sci. and Tech. 14:417-424.

Elibol, O., S.D. Peak, and J. Brake, 2002. Effect of flock age, length of egg storage, and frequency of turning during storage on hatchability of broiler hatching eggs. Poult. Sci. 81:945-950.

Fasenko, G.M. 2007. Egg storage and the embryo. Poult. Sci. 86:1020–1024.

Fasenko, G.M., F.E. Robinson, A.I. Whelan, K.M. Kremeniuk, and J.A. Walker. 2001a. Prestorage incubation of long-term stored broiler breeder eggs: 1. Effects on hatchability. Poult. Sci. 80:1406–1411.

Fasenko, G.M., V.L. Christensen, M.J. Wineland, and J.N. Petitte. 2001b. Examining the effects of prestorage incubation of turkey breeder eggs on embryonic developmentand hatchability of eggs stored for four or fourteen days. Poult. Sci. 80:132–138.

Funk, E.M. 1948. The relation of yolk index determined in natural position to the yolk index as determined after separating the yolk from the albumen. Poult. Sci. 27: 367-371.

Goliomytis, M., T. Tsipouzian, and A.L. Hager-Theodorides. 2015. Effects of egg storage on hatchability, chick quality, performance and immunocompetence parameters of broiler chickens. Poult. Sci. 94:2257–2265.

Gucbilmez, M., S. Ozlu, R. Shiranjang, O. Elibol, and J. Brake, 2013. Effects of pre-incubation heating of broiler hatching eggs during storage, flock age, and length of storage period on hatchability. Poult. Sci. 92: 3310–3313.

Hamidu, J.A., A. Rieger, G.M. Fasenko, and D.R. Barreda, 2010. Dissociation of chicken blastoderm for examination of apoptosis and necrosis by flow cytometry. Poult. Sci. 89: 901–909.

Hamidu, J.A., Z. Uddin, M. Li, G.M. Fasenko, L.L. Guan, and D.R. Barreda, 2011. Broiler egg storage induces cell death and influences

embryo quality. Poult. Sci. 90: 1749–1757.

Jones, D.R. and M.T. Musgrove, 2005. Effects of extended storage on egg quality factors. Poult. Sci. 84:1774-1777.

Koka, T.D. 2002. Effect of storage and pre heating during storage on hatchability, Poult. Sci. 81: 21-23.

Lourens, A., H. van den Brand, R. Meijerhof, and B. Kemp, 2005. Effect of eggshell temperature during incubation on embryo development, hatchability, and posthatch development. Poult. Sci. 84:914–920.

Lapão, C., L.T. Gama, and M. Chaveiro soares. 1999. Effects of broiler breeder age and length of egg storage on albumen characteristics and hatchability. Poult. Sci. 78:640–645.

Marandure T., G.H. Matondi, G.B. Nyamushamba, and B. Ganyani. 2012. Effect of duration of pre-heating broiler breeder eggs on hatchability, egg weight and chick uniformity post hatch. Res. J. Agric. Environ. Manage. 1: 1-5.

Meir, M., and A. Ar. 1998. Pre-incubation warming as a means of lengthening storage time of fertile eggs. Pages 825–829 in Proc. 10th Eur. Poult. Conf., Israel, June 1998. World's Poult. Sci. Association, Beekbergen, the Netherlands.

Nicholson, D., N. French, V. Kretzchmar, D. Goyne, and A. Hogg, 2011. Hatch benefits of short periods of incubation during egg storage. Avian Biol. Res. 4:145.

Petek M., H. Baspinar, and M. Ogan, 2003. Effects of egg weight and length of storage period on hatchability and subsequent growth performance of quail. S. Afric. J. Anim. Sci., 4: 242–247.

Petek M. and S. Dikmen, 2004. The effects of prestorage incubation of quail breeder eggs on hatchability and subsequent growth performance of progeny. Anim. Res., 53: 527–534.

Petek M. and S. Dikmen, 2005. The effects of pre-storage incubation on hatching success of poultry and game bird eggs. Incubation and Fertility Research Group. In: WPSA Working group 6 (Reproduction), Meeting 6th–7th September 2004, University of Lincoln, Lincoln, UK. Avian Poult. Biol. Rev., 16 (Abstracts), 63–64.

Reijrink, I.A.M., C.W. van der Pol, R. Molenaar, and H. van den Brand, 2018. Effect of warming profile at the onset of incubation on early embryonic mortality in long stored broiler eggs. Poult. Sci. 97: 4083–4092.

Reijrink, I.A.M., D. Berghmans, R. Meijerhof, B. Kemp, and H. Van Den Brand. 2010. Influence of egg storage time and pre-incubation warming profile on embryonic development, hatchability, and chick quality. Poult. Sci. 89:1225–1238.

Reijrink, I. A. M., R. Meijerhof, B. Kemp, E. A. M. Graat, and H. van den Brand, 2009. Influence of pre-storage incubation on embryonic development, hatchability, and chick quality. Poult. Sci. 88:2649–2660.

Reijrink, I.A.M., R. Meijerhof, B. Kemp, and H. Van Den Brand. 2008. The chicken embryo and its micro environment during egg storage and early incubation. Worlds Poult. Sci. J. 64:581–598.

Rocha, J., N. Baiao, V. Brabosa, M. Pompeu, M. Fernandes, L. Lara, C. Matias and J. Batista, 2013. Negative effects of fertile egg storage on the egg and the embryo and suggested hatchery management to minimize such problems. World's Poult. Sci. J. 69: 35–44.

Romanoff, A.J., 1967. Biochemistry of the Avian Embryo. John Wiley and Sons: New York, NY.

Romao, J.M., T.G.V. Moraes, R.S.C. Teixeira, V.M. Cardoso, and C.C. Buxade, 2008. Effects of egg storage length on hatchability and weight loss in incubation of egg and meat type Japanese quails. Braz. J. Poult. Sci. 10:143–147.

Samli, H.E., A. Agma, and N. Senkoylu, 2005. Effects of storage time and temperature on egg quality in old laying hens. J. of Appl. Poult. Res. 14: 548–555.

SAS Institute Inc. 2004. SAS/STAT® 9.1 User's Guide. SAS Institute Inc., Cary, NC.

Schmidt, G.S., E.A.P. Figueiredo, and M.G. Saatkamp, 2009. Effect of storage period and egg weight on embryo development and incubation results. Braz. J. Poult. Sci., 11(1): 1–5.

Silva, F.H.A., D.E Faria, K.A.A. Torres, D.E. Faria Filho, A.D.D. Coelho and V.J.M. Savino, 2008. Influence of egg pre-storage heating period and storage length on incubation results. Brazilian Journal of Poult. Sci. 10:17-22.

Silversides, F.G. and P. Villeneuve, 1994. Is the Haugh unit Correction for Egg Weight Valid for Eggs Stored at Room Temperature? Poult. Sci. 73: 50–55.

.

Tona, K., F. Bamelis, B. De Ketelaere, V. Bruggeman, V.M.B. Moreas, J. Buyse, O. Onagbesan, and E. Decuypere, 2003. Effects of egg storage time on spread of hatch, chick quality, and chick juvenile growth. Poult. Sci. 82:736–741.

Tona, K., O. Onagbesan, B. De Ketelaere, E. Decuypere, and V. Bruggeman, 2004. Effect of age of broiler breeders and egg storage on egg quality, hatchability, chick quality, chick weight, and chick posthatch growth to forty-two days. J. Appl. Poult. Res. 13:10–18.

Van de Ven L., 2004. Storage of hatching eggs in the production process. Int. Hatch. Pract. 18: 27–31.

Van Roovert-Reijrink, I.A.M., C.W. Van [er Pol, R. Molenaar, and H. Van Den Brand, 2018. Effect of warming profile at the onset of incubation on early embryonic mortality in long stored broiler eggs. Poult. Sci. 97: 4083–4092.

Wilgus H.S., and A. Van Wagenen, 1936. The height of the firm albumen as a measure of its condition. Poult. Sci. 15: 319-321.

Willemsen, H.N., N. Everaert, A. Witters, L. De Smit, M. Debonne, F. Verschuere, P. Garain, D. Berckmans, E. Decuypere, and V. Bruggeman, 2008. Critical assessment of chick quality measurements as an indicator of post hatch performance. Poult. Sci. 87:2358–2366.

Wolanski, N.J., E.J. Luiten, R. Meijerhof, and A.L.J. Vereijken, 2004. Yolk utilization and chick length as parameters for embryo development. Avian Poult. Biol. Rev. 15:233–234

المخلص العربى

تأثير المعاملات الحرارية خلال تخزين بيض التفريخ على صفات الفقس وجودة الكتكوت

محمد عبد الرحمن المناوى

قسم الإنتاج الحيوانى – كلية الزراعة – جامعة القاهرة – الجيزة – مصر

أجريت هذه الدراسة بغرض بحث فاعلية فترات قصيرة من التحضين خلال تخزين بيض التفريخ على نسبة الفقس – النفوق الجنيى – مدة التفريخ – جودة الكتكوت الناتج من بيض التفريخ المخزن لمدة 15 يوم.

تم إستخدام عدد 15510 بيضة تفريخ تم جمعه من قطيع أمهات تسمين آربور إيكرز عمر 49 أسبوع. وقد تم تقسيم البيض إلى 4 مجموعات:

المجموعة الأولى: تم تخزين البيض لمدة 5 أيام بدون معاملات حرارية (بيض طازج).

المجموعة الثانية: تم تخزين البيض لمدة 15 يوم وتم معاملتها حراريا مرة واحدة فى اليوم الخامس من التخزين.

المجموعة الثالثة: تم تخزين البيض لمدة 15 يوم وتم معاملتها حراريا مرتين فى اليوم الخامس و اليوم العاشر من التخزين.

المجموعة الرابعة: تم تخزين البيض لمدة 15 يوم بدون معاملات حرارية وتم إستخدامها مجموعة مقارنة.

وقد كانت المعاملة الحرارية على 32 ^{5}م و 55 – 60% رطوبة نسبية لمدة 6 ساعات.

أوضحت النتائج أن إطالة فترة التخزين قد أدت إلى تقليل نسبة الفقس والخصب المرئى للبيض غير المعامل. أدت المعاملة الحرارية إلى التحسن فى معدلات النفوق الجنينى ونسبة الفقس والخصب المرئى. عندما تم تعريض البيض للمعاملة الحرارية مرتين بالمقارنة قد تحسنت نسبة الفقس بمثيلاتها التى تم تعريضها مرة واحدة.

وقد زادت مدة التفريخ معنويا فى مجموعة الكنترول مقارنة بمجموعة البيض الطازج ومجموعتى المعاملة الحرارية. لم يلاحظ أى إختلافات بين المجاميع فى الناقر الحى ونسبة الكتاكيت الفرزة.

لوحظ زيادة معنوية فى نسبة وزن كيس الصفار فى الكتاكيت حديثة الفقس مع طول فترة التخزين قبل التفريخ، لكن المعاملة الحرارية يمكنها إستعادتها كتلك التى فى البيض الطازج. كانت قيم صفات جودة الكتكوت (مقياس تونا – وزن الكتكوت – الوزن النسبى للكتكوت – طول الكتكوت/وزن الكتكوت) هى الأقل معنويا فى مجموعة الكنترول مقارنة بالمجموعات الأخرى ولكن مجموعات المعاملات الحرارية حسنت هذه القيم وإحتلت موقع متوسط بين المجاميع.

الخلاصة: أوضحت الدراسة الحالية أن الفترات القصيرة من التحضين خلال تخزين بيض التفريخ هى طريقة فعالة لتخفيف التأثيرات الضارة لفترات التخزين الطويلة على بيض التفريخ وجودة الكتكوت.