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Influences of Short Incubation Periods During Egg Storage on Hatchability, Chick Quality and Breakout Efficiency

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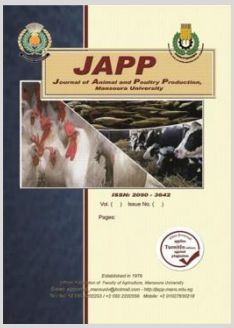

ABSTRACT

This study aimed to explore the effects of short periods of incubation during egg storage (SPIDES) at 4-d intervals for 0, 45, 90, and 135 min on hatchability and chick quality during varied storage durations (1, 2, 3, 4, and 5 weeks). 7500 eggs (62g each) were randomly divied into five groups,each containing 1350 eggs and three duplicates of 450 eggs; 150 eggs were included in each treatment group as a control negative (non-SPIDES). Results reflected that the hatching % decreased when storage incubation eggs over one week. Because the chick quality of the hatching chicks declined with the length of the hatching egg storage period, the hatching results were correlated with the quality of the resulting chicks. The current study's findings indicate that the SPIDES protocol Significantly enhanced hatchability stored for up to five weeks and even for just one week. The results also showed That chick quality improved significantly with SPIDES. In conclusion: Short Periods of Incubation During Egg Storage (SPIDES) every 4 days during storage period has been improved hatchability rate percent, chick quality, and early embryonic mortality stage I (0-3 days) for eggs stored for three weeks or more.

Keywords: Egg storage, SPIDES, hatchability characteristics, embryonic mortality.

INTRODUCTION

Egg storage prior to incubation is a widespread practice in hatcheries,, primarily because of the mismatch between the demand for day-old chicks from broiler farms and the supply of hatching eggs from breeding farms. While long-term egg storage is necessary for poultry operations, it typically has detrimental effects on the quality and performance of post-hatch chicks as well as embryonic development and hatching. Over-7-day egg storage is linked to a decrease in hatchability (Whitehead *et al*., 1985; Lapaõ *et al*., 1999; Fasenko *et al*., 2001a; Tona *et al*., 2003), (Elibol and Brake, 2008; Nasri *et al*., 2020), a longer period of incubation (Mather and Laughlin, 1976; Tona *et al*., 2003), reduced quality of chicks (Tona *et al*., 2003; Reijrink *et al*., 2009), as well as a decline in post-hatch performance (Merritt, 1964; Tona *et al*., 2003). These detrimental effects of egg storage are probably due to the deterioration of egg quality, particularly albumen quality (Lapaõ *et al*., 1999). Because the blastoderm is positioned halfway between the yolk and albumen, modifications to either one can have an impact on the early development of the embryo. Compared to fresh eggs, stored eggs have a higher albumen pH and a lower Haugh unit or albumen height (Benton and Brake, 1996; Lapaõ *et al*., 1999; Silversides and Scott, 2001; van den Brand *et al*., 2008). Consequently, the blastoderm encounters a more alkaline environment, and the very first stages of embryo development take place in albumen with decreased viscosity. Compared to eggs kept for 4th days, hatchability decreases when eggs are set on the day of oviposition (Asmundson and MacIlraith, 1948). Benton and Brake (1996) Theorized that fresh eggs' high albumen viscosity (albumen height), which prevents oxygen from reaching the embryo, is the cause of this. Hatch time is delayed if storage is kept for longer than seven days under standard storage conditions (10–20°C and 50–80% RH) (Mather and Laughlin, 1976; Tona *et al*., 2003) plus a reduction in hatchability (Becker, 1964; Merritt, 1964; Fasenko *et al*., 2001b; Tona *et al*., 2004) as well as chick quality (Byng and Nash, 1962; Merritt, 1964; Tona *et al*., 2003, 2004).

Numerous authors have examined how hatchability and chick quality are affected by short incubation period (Becker and Bearse, 1958; Bowling *et al*., 1981; Fasenko *et al*., 2001a, b; Lourens, 2006; Renema *et al*., 2006). After incubating broiler breeder eggs at 37.5°C for 0, 6, 12, and 18 hours, Fasenko *et al*., (2001b) stored the eggs for an additional 4 or 14 days. The length of the short incubation period increased with a significant advancement in embryonic development. A 4-day egg storage period had no effect on the hatchability of the eggs after short incubation period. After 6 hours of SPIDES, the hatchability of eggs that had been stored for 14 days was noticeably higher than it had been without SPIDES. The positive impact of short incubation period (SPIDES) on the hatchability of broiler breeder eggs was later confirmed by Lourens (2006). After 3, 6, and 9 hours of SPIDES and 14 days of storage, the increase in hatchability compared to the control treatment was 9.2% ($P \leq 0.05$), 11.8% ($P \leq 0.05$), and 6.4% ($P > 0.05$), respectively. Hatchability did not differ significantly between the three treatments (3, 6, and 9 hours).

Therefore, This study investigates the effects of SPIDES protocol at 4-d interval for 0, 45, 90, and 135 min on hatchability traits and chick quality of eggs stored for various periods (1, 2, 3, 4, and 5 weeks).

MATERIALS AND METHODS

Experimental design

A total of 7500 eggs (Ross 308, produced by chickens at 38 weeks old, average weight of 62 g) were sourced from

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Rummana Broiler Breeder Farm. The eggs used in this experiment were carefully inspected for cracks and other abnormality (i.e., round, and rectangular egg, egg with glass cracks, internal cracks……. etc.), and those that were not suitable for hatching were removed. Eggs were stored at 16°C for 4 days in egg trollies. (these storage days is calculated from the total number of storage period, and Virocid® used a spray device to disinfect eggs), Eggs were randomly divided into five storage period groups (n=1500 eggs), each group was subdividedinto four sub-groups including negative control (n=150 eggs, non-SPIDES) and three sub-groups for three SPIDES protocols (450 eggs in each). The main five groups included storage period of 1, 2, 3, 4, and 5 weeks. During each storage period (at 16ºC and 60% RH), the eggs were exposed to short period of incubation (SPIDES) either for 45, 90, or 135 min, at 4-days interval. Number of eggs in main and sub-groups is shown in Table 1. About 8 hours (the time during which the eggs are acclimated on physiological zero "23-25ºC" at setter room before storage) is carried out until the next SPIDES each 4 days.

The hatching machine's operating program (SPIDES) involves setting the temperature of the egg to 90°F, which is equivalent to 32.22°C, with 52% relative humidity, which is equivalent to 84°F wet bulb temperature. Following each SPIDES protocol, the eggs were kept in the control room for eight hours before being moved back to the storage room, where they were kept at 16°C and 60% relative humidity, depending on stored time.

Table 1. Number of eggs used storage groups and SPIDES sub-groups.

SPIDES protocol	Number of eggs in storage groups					Total
	1 wk	2 wk	3 wk	4 wk	5 wk	
0 min (neg. control)	150	150	150	150	150	750
45 min	450	450	450	450	450	2250
90 min	450	450	450	450	450	2250
135 min	450	450	450	450	450	2250
Total	1500	1500	1500	1500	1500	7500

Description of the incubator (Pas reform):

Multiple stage conditions are fixed and depend on the different ages in the same unit where there are 6 to 5 different ages to enter a batch of the machine day after day. The temperature was 99.5°F with relative humidity 85ºF (wet bulb). Eggs were automatically turned 90°every hour until the 19th day of the incubation period, ventilation channels were opened automatically and measured as relative value of the air inlet opening area of the ventilation channels as Referred to in Table 2. After the 19th day, during the last two days of the incubation period, the temperature decreased from 98.3 to 96.3ºF coincided with relative humidity values of 83.4ºF (wet bulb) to 86.5ºF (wet bulb), respectively, for the 19th; 20th and 21st day.

Table 2. Program of multi-stage (Pas reform) incubator.

Temperature ° F	Wet bulb ° F	Ventilation%	Turn angle
99.5	84.5	35-85	90° every hour

Table 3. Program of multi-stage (Pas reform) hatchery.

Age		Temperature	RH ° F	Ventilation
Day	hour	(°F)	(Wet bulb)	(%)
18	00	98.0	84	40-50
19	12	98.0	85	25-25
20	10	98.3	86	25-65
20	16	98.0	88	45-75
20	18	97.0	89	80-100

Hatchability:

Hatchability was calculated as a percent of hatched from total incubated eggs and fertile eggs according to the following equations:

$$\text{Commercial hatchability (\%)} = \frac{\text{Hatched chicks}}{\text{Total eggs set}} \times 100$$

$$\text{Scientific hatchability (\%)} = \frac{\text{Hatched chicks}}{\text{Fertile eggs}} \times 100$$

Embryonic mortality:

Embryonic mortality was classified according to the time of incubation at which it occurred into the following categories.

Table 4. Embryonic mortality category

Category	Time of occurrence from incubation period (days)
Infertile	0
Dead cull	21
Early Dead	0 – 3
	4-7
Mid Dead	8 – 14
Late Dead	15 – 19
Pipped	20
contaminated	0-21

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Statistical analysis

Data were analyzed via a factorial ANOVA using the GLM procedure in SAS (SAS, 2004). The following model was used for statistical analysis:

$$Y_{ijk}=\mu+ S_i+ T_j+(ST)_{ij}+ E_{ijk}$$

Where Y_{ijk} is the k^{th} observation; μ is the overall mean; S_i Is an effect of the i^{th} storage period; T_j is the effect of the j^{th} SPIDES protocol; $(ST)_{ij}$ is the interaction between i the storage period and j the SPIDES protocol; and E_{ijk} is the experimental error, accordingly zero mean and variance=$\sigma^2 e$. Tukey's test was used to identify differences between means at P ≤0.05.

RESULTS AND DISCUSSION

Effects of prolonged Storage and SPIDES on Hatchability Traits.

Hatchability percentages were influenced by storage duration and SPIDES protocol on different storage days is shown in Table 5. The effect of storage period was significant on commercial hatchability% (P<0001) and scientific hatchability% (P<0.0001).

The results showed that the hatching rates of the second, third, fourth, and fifth storage treatments (weeks) decreased by (4.43, 16.81, 27.10, 56.16% respectively, compared to the first storage treatment. The was stored for one week recorded the highest hatching rate (90.39%), whether commercial or scientific. Storage treatments differed significantly from each other in hatching rates, whether commercial or scientific. This is due to storing eggs for prolonged periods, which leads to the active process of apoptosis. This led to an increase in the number of mitotic and necrotic indices rose with longer storage times.

The hatching rates of eggs that were stored for prolonged periods were reflected in the chick's quality, as the highest percentage of chicks of grade A was in favor of eggs that were stored for one week, at a rate of 89.37%, followed by storage transactions (second, third, fourth and fifth weeks), at rates of 83.51, 69.66, 59.25 and 22.30%, respectively.

It was also found that eggs stored for 5 weeks yielded the highest percentage of grad B chicks at a rate of 11.04%, and the lowest percentage of chicks of rank B was in eggs stored for one week at a rate of 0.41%. It was found that there were no significant differences in the percentage of chicks of rank B between the second, third and fourth storage treatments, respectively.

Candling eggs revealed the percentage of fertilization, it was showed that the negative control treatment of all SPIDES treatments achieved the lowest percentage of fertilization significantly lower (94.94%) different from the treatments that were exposed to the SPIDES process and exhibited no significant differences. The decrease in the fertilization rate in the negative control treatments compared to the SPIDES treatments was due to an increase in the number of mitotic and necrotic indices rose with longer storage times. SPIDES exhibited effect because it shields the embryonic cells from necrosis.

This study found that the negative control treatment (without SPDES treatments) Yielded significantly lower hatchability rates. However, the SPIDES treatments, whether 45 minutes, 90 minutes, or 135 minutes enhanced hatchability by 36.36, 35.83 and 33.98%, respectively, Over control group..

Additionally, SPIDES protocols positively impacted chick quality. SPIDES protocol of 45, 90 and 135 minutes, respectively, achieved the best chicks in terms of quality with percentages of (68.14, 69.04 and 68.80%, respectively), and there were no significant differences between them, except that the negative control treatment (without SPIDES) achieved the lowest percentage of chicks in terms of quality and differed significantly with SPIDES treatments.

The chicks of rank (B) differed significantly between the SPIDES treatments and each other and the negative control treatment. The negative control treatment achieved the lowest percentage of chicks of rank (B) 0.89%, followed by the SPIDES treatment of 135 minutes at 2.7%, then the SPIDES treatment of 45 and 90 minutes achieved the highest percentage of chicks of rank (B) (5.31% and 4.22%, respectively) without significant differences between them.

Table 5. Hatchability (%) and chick quality of eggs as affected by storage period and SPIDES protocol.

Effect of	Fertility rate	Hatchability rate %		Chick quality %		
Storage period (WK)	%	Commercial	Scientific	A	B	C
1	97.41	90.39^{a}	92.79^{a}	89.37^{a}	0.41^{c}	0.61
2	97.33	85.96^{b}	88.32^{b}	83.51^{b}	1.82^{b}	0.63
3	97.01	73.57^{c}	75.84^{c}	69.66^{c}	3.13^{b}	0.78
4	96.99	63.29^{d}	65.25^{d}	59.25^{d}	2.94^{b}	1.10
5	97.02	34.23^{e}	35.28^{e}	22.30^{e}	11.04^{a}	0.89
SEM	0.445	1.127	1.073	1.094	0.457	0.237
P-value	0.9321	0.0001	0.0001	0.0001	0.0001	0.5796
		Effect of SPIDES protocol (min)				
0 min (neg. control)	94.94^{b}	38.09^{b}	40.13^{b}	35.86^{b}	0.89^{c}	1.34
45 min	97.53^{a}	74.45^{a}	76.32^{a}	68.14^{a}	5.31^{a}	1.00
90 min	97.39^{a}	73.92^{a}	75.90^{a}	69.04^{a}	4.22^{a}	0.66
135 min	97.25^{a}	72.07^{a}	74.11^{a}	68.80^{a}	2.70^{b}	0.57
SEM	0.417	0.971	0.964	1.119	0.407	0.222
P-value	0.0036	0.0001	0.0001	0.0001	0.0001	0.1449
		Effect of interaction				
1wk*0 min	97.92	90.97	92.91	88.89	0.00	2.08
1wk*45 min	97.28	90.48	93.01	89.57	0.23	0.68
1wk*90 min	96.83	89.80	92.74	89.12	0.68	0.00
1wk*135 min	97.96	90.70	92.59	89.57	0.45	0.68
2wk*0 min	97.83	85.51	87.41	81.88	2.17	1.45
2wk*45 min	96.97	85.08	87.74	83.45	1.17	0.47
2wk*90 min	98.14	86.95	88.60	82.28	3.73	0.93
2wk*135 min	96.74	86.01	88.92	85.31	0.47	0.23
3wk*0 min	94.81	5.19	5.47	0.00	2.22	2.96
3wk*45 min	96.93	79.20	81.71	73.52	4.96	0.71
3wk*90 min	97.16	79.91	82.24	77.07	2.36	0.47
3wk*135 min	97.64	83.45	85.47	80.61	2.36	0.47
4wk*0 min	91.47	0.00	0.00	0.00	0.00	0.00
4wk*45 min	98.30	71.53	72.77	64.72	4.87	1.95
4wk*90 min	97.32	70.32	72.25	65.21	3.89	1.22
4wk*135 min	97.08	67.88	69.92	66.42	0.97	0.49
5wk*0 min	92.06	0.00	0.00	0.00	0.00	0.00
5wk*45 min	98.27	43.70	44.47	26.42	16.05	1.23
5wk*90 min	97.53	40.25	41.27	28.64	10.86	0.74
5wk*135 min	96.79	29.38	30.36	18.77	9.63	0.99
SEM	0.920	1.920	1.880	1.792	0.765	0.440
P-value	0.0240	0.0001	0.0001	0.0001	0.0001	0.0354

$^{a\ and\ e}$: Means within the same column for each factor with different superscripts differ significantly at P ≤ 0.05.

Interaction between storage duration and SPIDES protocol significantly impacted on commercial hatchability percent (P<0.0001), scientific hatchability percent (P<0.0001) and chick quality (A, B and C) (P<0.0001, 0.0001 and 0.0354) of storage period (Table 4). Results of hatchability and chick quality of eggs stored for different weeks (1, 2, 3, 4, and 5 wk)

and exposed to different SPIDES protocols (0, 45, 90, 15 min) illustrated in Fig. 1 revealed the lowest fertility rate percent, hatchability % and chick quality by (non SPIDES) in eggs stored for 1, 2, 3, 4 and 5 wk. This finding indicated that (non-SPIDES) reduce fertility rate percent in eggs stored for prolonged periods up to 5 weeks and even for eggs stored for short period of one week. Therefore, the lowest rate of fertility, hatchability and chick quality was observed in eggs that were kept as a negative control group (non-SPIDES) at different storage periods (Fig. 1).

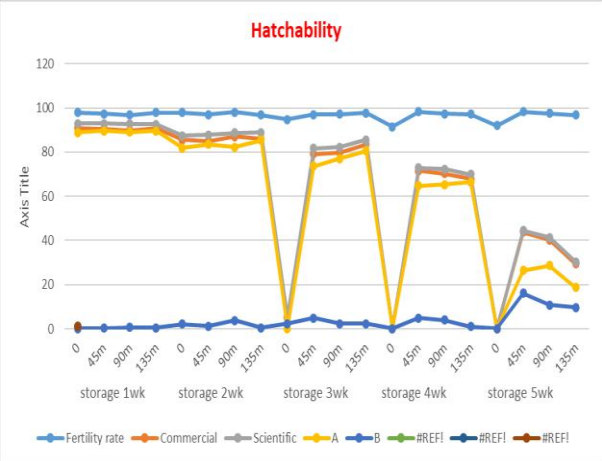

Fig. 1. Hatchability % and chick quality of eggs stored for different weeks and exposed to different SPIDES protocols.

Both positive and negative effects on hatchability percentages were observed in eggs stored before incubation (Brake *et al*., 1993). Numerous studies demonstrated that extending the time eggs were stored before incubation decreased the percentage of eggs that were hatched (Romao *et al*. 2008 and Alsobayel *et al*. 2012). Conversely, other research revealed that eggs kept for a few days had a higher hatchability than those incubated right away after laying (Asmundson and MacLlriath, 1948). Keeping eggs in storage for more than seven days reduced hatchability percentage and chick grade and increased embryonic mortality (Fasenko, 2007; Hamidu *et al*., 2011). Changes in the embryo's or the egg's properties, or both, could have this detrimental effect (Reijrink *et al*., 2010). Furthermore, Marandure *et al*. (2012) discovered that hatchability declined over time when they exposed broiler breeder eggs to warming for 4, 8, and 12 hours. While the storage periods by pre-heating interaction effect was significant on both hatchability and chick weight at hatch, Gucbilmez *et al*. (2013) did not observe this benefit, reporting that heating broiler breeder's eggs for 1 day of a 6-day storage period had no effect on hatchability percentage.

According to Mather and Laughlin (1979), even at low storage temperatures, a prolonged period of storage may reduce hatchability by causing necrosis and regressive changes in the blastoderm. Moreover, Van de ven (2004) suggested that higher albumen pH and decreased albumen viscosity were the primary causes of long-stored eggs' poor hatchability. Fesanko (2007) explained the decline in newly hatched chicks in long-stored eggs by stating that the embryo's growth and metabolism after incubation are delayed, resulting in a slow developmental rate. Furthermore, the length of the egg storage period was found to have a significant impact on the improvement of hatch weight, hatchability percentages, and weight loss during incubation, as indicated by the high computed R2 values of these variables.

Effect of prolonged storage period, SPIDES on break out eggs which unhatched.

Table (6) shows the results of the culled eggs, dead embryos during different incubation periods, pipped (live and dead), and contaminated due to long storage periods. From our results, it became clear that storing hatching eggs for prolonged time, up to 5 weeks or even one week, had a negative effect on the percentage of culled eggs which achieved the highest rate on eggs stored for prolonged periods up to 5 weeks at 65.77% compared to 9.61% for eggs that were stored for one week.

According to the results Table (6), the length of the storage period had a significant negative impact on the percentage of embryonic mortality during the incubation period. For example, eggs stored for 5 weeks had the highest rate of early embryonic mortality from (1-3d) (28.13%), while eggs stored for one week had the lowest rate of early embryonic mortality (5.22%) in the first stage of incubation.

As for early embryonic mortality during the period of (4-7 days), it was found that storing eggs for 5 weeks resulted in an early embryonic mortality rate stage I of (4-7 days) of 3.803% compared to 0.886% for the treatment that was stored for only one week. The storage treatments for two, three or four weeks did not differ significantly between them. There were no significant differences between the experimental treatments in the average embryonic mortality. The experimental treatment for 5 weeks achieved the highest late embryonic mortality rate of 17.002% compared to a late embryonic mortality rate of 2.181 and 3.298%, respectively, for the experimental treatments for one week and two weeks, respectively.

There were no positive or negative effects of storage treatments on dead pipped embryos. As for the live pipped embryos, the storage treatment for 5 weeks achieved the highest rate of live pipped 3.057%, with a significant difference with the other storage treatments.

The 5-weeks storage treatment showed the highest contamination rat (10.142%) , significantly differing from other treatments. Contamination decreased with shorter storage durations. This high contamination rat resulted from alterations in the egg white's microbial barrier, caused by changes in biochemical properties and pH.

From the results shown in Table 6, it was found that the percentage of culled eggs was the highest at a rate of 61.91 for the negative control treatment (without SPIDES). It also achieved the highest early embryonic mortality rate in the first stage (0-3 days) at a rate of 41.964% and late embryonic mortality at a rate of 8.185%, as well as the contamination rate in culled eggs at a rate of 4.315% and differed significantly from the rest of the SPIDES treatments.

Between The effect of interaction storage period and SPIDES protocol on culled eggs was significant ($P<0.0001$) and early embryonic mortality stage I and II ($P<0.0001$), late embryonic mortality ($P<0.0001$), live pipped ($P<0.0001$) and contamination culled eggs of storage period (Table 6). Results of culled eggs, embryonic mortality, pipped and contamination of eggs stored for different weeks (1, 2, 3, 4, and 5 wks) and exposed to different SPIDES protocols (0, 45, 90, 135 min) illustrated in Fig. 2 revealed the highest culled eggs, early embryonic mortality in its two stages%, live pipped and contamination

by (non SPIDES) in eggs stored for 1, 2, 3, 4 and 5 wk. This finding indicated that (non-SPIDES) increased culled eggs, early embryonic mortality% in its two stages, live pipped and contamination in eggs stored for prolonged periods up to 5 weeks and even for eggs stored for short period of one week (Fig. 1).

Table 6. Break out of eggs as affected by storage period and SPIDES protocol on different storage days

Effect of Storage period (WK)	Culled egg %	Embryonic Mortality rate%				Pipped%		contaminated
		Early		Mid	Late dead	Live	Dead	
		Stage I (0-3 day)	Stage II(4-7 day)					
1	9.61^{e}	2.522^{d}	0.886^{bc}	0.409	2.181^{c}	0.204^{b}	0.068	0.750^{c}
2	14.04^{d}	4.842^{d}	0.842^{c}	0.351	3.298^{c}	0.281^{b}	0.070	1.684^{bc}
3	26.43^{c}	11.610^{c}	1.282^{bc}	0.142	7.764^{b}	1.068^{b}	0.000	1.567^{bc}
4	36.71^{b}	19.383^{b}	2.203^{b}	0.514	7.856^{b}	0.881^{b}	0.294	2.570^{b}
5	65.77^{a}	28.113^{a}	3.803^{a}	0.597	17.002^{a}	3.057^{a}	0.075	10.142^{a}
SEM	1.127	0.882	0.359	0.172	0.704	0.280	0.086	0.476
P-value	0.0001	0.0001	0.0001	0.3835	0.0001	0.0001	0.1423	0.0001
Effect of SPIDES protocol (min)								
0 min (neg. control)	61.91^{a}	41.964^{a}	1.488	0.298	8.185^{ab}	0.595^{b}	0.000	4.315^{a}
45 min	25.55^{b}	8.962^{b}	1.517	0.332	8.914^{a}	2.086^{a}	0.047	1.233^{b}
90 min	26.08^{b}	9.862^{b}	2.039	0.569	6.259^{b}	0.759^{b}	0.047	3.936^{a}
135 min	27.93^{b}	10.953^{b}	1.849	0.332	7.018^{ab}	0.522^{b}	0.237	4.267^{a}
SEM	0.971	0.703	0.287	0.137	0.572	0.224	0.069	0.386
P-value	0.0001	0.0001	0.5658	0.5362	0.0075	0.0001	0.1215	0.0001
T_T								
1wk*0 min	9.028	2.083	0.694	0.694	3.472	0.000	0.000	0.000
1wk*45 min	9.524	2.041	1.134	0.454	1.814	0.227	0.227	0.907
1wk*90 min	10.204	2.721	0.907	0.454	2.268	0.000	0.000	0.680
1wk*135 min	9.297	2.948	0.680	0.227	2.041	0.454	0.000	0.907
2wk*0 min	14.493	3.623	0.725	0.000	7.971	0.000	0.000	0.000
2wk*45 min	14.918	5.128	0.932	0.466	2.331	0.466	0.000	2.564
2wk*90 min	13.054	4.895	1.166	0.233	2.331	0.233	0.000	2.331
2wk*135 min	13.986	4.895	0.466	0.466	3.730	0.233	0.233	0.699
3wk*0 min	94.815	47.407	3.704	0.000	22.222	2.963	0.000	13.333
3wk*45 min	20.804	7.565	0.946	0.236	7.801	0.946	0.000	0.236
3wk*90 min	20.095	9.220	1.182	0.236	4.728	1.418	0.000	0.473
3wk*135 min	16.548	6.619	0.946	0.000	6.147	0.236	0.000	0.236
4wk*0 min	100.000	75.194	2.326	0.775	6.977	0.000	0.000	6.202
4wk*45 min	28.467	11.192	1.703	0.487	11.922	0.243	0.000	1.217
4wk*90 min	29.684	12.652	2.433	0.730	6.083	1.217	0.243	3.650
4wk*135 min	32.117	16.788	2.433	0.243	5.839	1.460	0.730	1.703
5wk*0 min	100.000	89.683	0.000	0.000	0.000	0.000	0.000	2.381
5wk*45 min	56.296	19.753	2.963	0.000	21.728	8.889	0.000	1.235
5wk*90 min	59.753	20.741	4.691	1.235	16.543	0.988	0.000	13.086
5wk*135 min	70.617	24.691	4.938	0.741	18.025	0.247	0.247	18.519
SEM	1.920	1.471	0.653	0.314	1.270	0.502	0.157	0.847
P-value	0.0001	0.0001	0.0001	0.6061	0.0001	0.0001	0.1805	0.0001
Effect of interaction								

[a and c]: Means within the same column for each factor with different superscripts differ significantly at P ≤ 0.05.

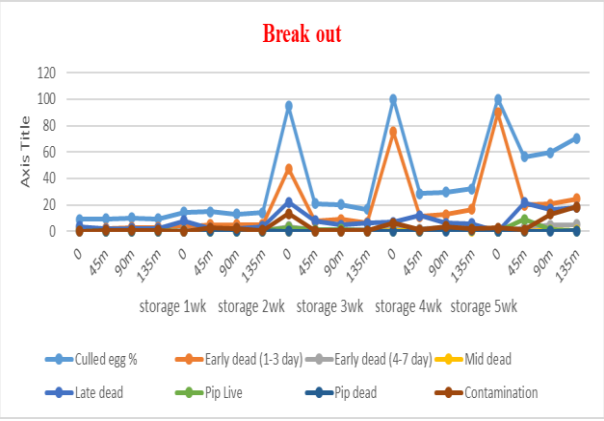

Fig. 2. Break out of eggs stored for different weeks and exposed to different SPIDES protocols.

Reijrink *et al.* (2010) and Gharib (2013) reported similar results, indicating that eggs stored for 10 and 14 days had a significantly higher late embryonic mortality rate than eggs stored for 4 and 7 days. According to Hamidu *et al.* (2010, 2011), prolonged storage has a negative impact on the viability, cell death, and embryo survival of broiler and layer blastodermal cells. There was uncertainty regarding the degree of metabolic imbalance in the embryo caused by extended egg storage and the potential effects of this imbalance on the inhibition of embryonic cell viability, embryo growth, and chick grade. According to Petek and Dikmen (2006), exposing eggs to 38.0°C for 4 and 8 hours considerably raised embryonic mortality when compared to eggs that were not heated.

Increased embryo mortality, which mostly happens on the second and third days of incubation, has an impact on hatchability (Mousa-Balabel and Saleem, 2004). The proteins of the shell membrane may alter while being stored, according to Elibol *et al.* (2002). The interaction between the inner shell membrane and the chorioallantoic membrane may be

impacted by such a change. The central location of the yolk and the equatorial position of the blastoderm in the egg are likely linked to the higher hatchability of eggs stored with the small end up, according to Brake *et al*. (1997). Higher initial embryonic mortality was specifically observed in the negative control treatment (non-SPIDES) as a result of the modifications brought about by the egg storage periods in this study. The effects of storing eggs prior to incubation can diminish the yolk's nutritional value and antioxidant qualities, which are critical for chick hatching (Surai *et al*., 2016). As a result, embryos cannot hatch.

CONCLUSION

Our study provides evidence that long term storage of eggs (28 and 35 days) adversely affects all hatching traits. It is recommended that when storage of eggs more than seven days is urgently important, one should SPIDES protocol eggs for 45 minute every 96 h to minimize the harmful impact of prolonged storage period.

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تأثير فترات الحضانة القصيرة أثناء تخزين البيض على الفقس وجودة الكتاكيت وخروجها

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الملخص

هدفت هذه الدراسة إلى استكشاف تأثير فترات التفريخ قصيرة المدي على فترات ٤ أيام لمدة ٠ و ٤٥ و ٩٠ و ١٣٥ دقيقة على خصائص نسبة الفقس وجودة الكتاكيت للبيض المخزن لفترات مختلفة (١ و ٢ و ٣ و ٤ و ٥ أسابيع). تم تقسيم إجمالي ٧٥٠٠ بيضة بوزن ٦٢ جرامًا إلى خمس مجموعات عشوائيًا، تحتوي كل منها على ١٣٥٠ بيضة وثلاث مكررات كل مكررة ٤٥٠ بيضة؛ وايضا ١٥٠ بيضة في كل مجموعة كنترول كمجموعة تحكم سلبية (بدون فترات التفريخ القصيرة المدي). عكست النتائج أن نسبة الفقس انخفضت عند تخزين بيض التفريخ لمدة أسبوع واحد. نظرًا لأن جودة الكتاكيت المفرخة انخفضت مع طول فترة تخزين بيض الفقس، فقد ارتبطت نتائج الفقس بجودة الكتاكيت الناتجة. تشير نتائج الدراسة الحالية إلى أن تأثير فترات التفريخ القصيرة المدي يحسن معدلات الفقس للبيض المخزن لمدة تصل إلى خمسة أسابيع وحتى لمدة أسبوع واحد فقط. أظهرت النتائج أيضًا التأثير الإيجابي لتأثير فترات التفريخ القصيرة المدي على جودة الكتاكيت الفاقسة.الاستنتاج: لقد أدى استخدام فترات التفريخ القصيرة المدي أثناء تخزين البيض كل ٤ أيام خلال فترة التخزين إلى تحسين نسبة معدل الفقس وجودة الكتاكيت ومرحلة النفوق الجنيني المبكر (٠-٣ أيام) للبيض المخزن لمدة ثلاثة أسابيع أو أكثر.