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Impact of short periods of incubation during egg storage on chick quality of broiler chicken

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Abstract
The purpose of this study was to investigate the effect short periods of incubation during egg storage (SPIDES) with or without turning on long-term storage on chick quality parameters of long stored hatching eggs. A total of 750 broiler hatching eggs from 33.5 weeks old parent stock were divided into five groups: T_1 (Control without SPIDES), T_2 (3 SPIDES without turning), T_3 (3 SPIDES and 3 turning during each SPIDES), T_4 (4 SPIDES without turning) and T_5 (4 SPIDES and 3 turning during each SPIDES). Eggs were stored at 17 °C with 75% relative humidity and SPIDES treated eggs were periodically exposed to 37.7 °C for 3 hours at 5 days interval. All eggs were stored for 21 days and incubated at 22nd day. The SPIDES with turning treatment group eggs were turned by 45º angle on either side of an hourly interval. The results showed significant differences between treatment groups in chick weight, chick yield, chick length, chick width and pasgar score. The T_5 treatment group had significantly (p<0.01) highest chick quality, while other SPIDES treatment groups also demonstrated higher chick quality than control group. SPIDES effectively mitigates the negative impacts of prolonged storage and suggesting its potential for improving chick quality of commercial broiler hatching eggs. In conclusion, SPIDES treatment, particularly with 4 SPIDES at every 5 day intervals during a 21 days storage period with 3 turning during each SPIDES, enhanced over all chick quality parameters.

Keywords: SPIDES, chick weight, chick yield, chick length, chick width, pasgar score

1. Introduction
The quality of day-old chicks is more important for achieving their better performance. Several factors affect chick quality including incubator condition, incubation environment, egg storage condition, storage duration, etc. Normally, the hatching eggs are stored for more than 7 days in commercial hatcheries during adverse conditions like market demand fluctuations, disease outbreaks, etc. which impacts chick quality (Fasenko *et al.*, 2001 [6]; Tona *et al*., 2003 [15]).
Many trials have been conducted to overcome the prolonged storage associated with low chick quality. Some researchers increased the stage of embryonic development by using short period of incubation during egg storage (SPIDES) (Nicholson *et a*l., 2013 [11] and Dymond *et al*., 2013 [3]). The shorter incubation period before storage achieved the hypoblast stage of embryonic development which could improve the incubation results of eggs stored for longer periods of time (Fasenko *et al.* 2001) [6].
The SPIDES introduces a novel approach to maintain the viability of embryos by periodical warming of hatching eggs during long storage (Nicholson *et a*l., 2013 [11] and Dymond *et al*., 2013 [3]). After each warming period, the eggs are returned to cold storage to preserve their freshness. If the eggs are stored for longer days with SPIDES techniques had improved chick quality also (El-Menawewy 2019 [5] and Ebeid *et al.* 2017 [4]). Therefore, the present study is designed to examine the effect of short periods of incubation during egg storage (SPIDES) with or without turning on chick quality of commercial broiler chickens.

2. Materials and Methods
A total of 750 hatching eggs from Vencobb 430Y were collected from 33.5 weeks old parent stock and were used to study the effects of Short Periods of Incubation During Egg Storage (SPIDES) on hatchery performance. The eggs were fumigated with 3X concentration for 20 minutes and stored for 21 days with broad end up position and incubated at 22nd day.

The eggs were divided into five treatment groups of 150 eggs each. The treatment groups are: T_1 (Control without SPIDES), T_2 (3 SPIDES without turning), T_3 (3 SPIDES and 3 turning during each SPIDES), T_4 (4 SPIDES without turning), and T_5 (4 SPIDES and 3 turning during each SPIDES). Each treatment group was further divided into three replicates of 50 eggs each. The eggs were stored at 17 °C with 75% relative humidity and T_2 to T_5 eggs were subjected to heat treatment for every 5 days. T_2 and T_3 eggs were subjected to heat treatment on 5th, 10th and 15th day of storage and T_4 and T_5 eggs were subjected to heat treatment on 5th, 10th, 15th and 20th day of storage. During SPIDES, the eggs were exposed to 100°F±3°F and 55% relative humidity for 3 hours. The SPIDES with turning treatment group eggs (T_3 & T_5) were turned by 45˚ angle on either side of an hourly interval (Table 1).

Table 1: Experimental design

S. No.	Treatment groups	Treatment	No. of broiler hatching eggs per treatment
1.	T_1	Control-Eggs storage without SPIDES	150
2.	T_2	3 SPIDES without turning	150
3.	T_3	3 SPIDES with turning	150
4.	T_4	4 SPIDES without turning	150
5	T_5	4 SPIDES with turning	150
Total			750

After 21 days of storage, all the eggs were incubated in a forced draught setter at 99.8°F and 55% relative humidity from day 1 to 18. Throughout the 21 days of incubation period, standard temperature and humidity conditions were maintained for all treatment group eggs. On 21st day, chicks were removed from the hatcher once 95% of chicks had dried. The chick yield, chick weight, chick length, chick width and pasgar score were recorded during the study period as below.

The chicks were weighed and the per cent chick yield was calculated by using the following formula, Chick yield % = [Average weight of chicks (g) / Average weight of eggs (g)] × 100. On the day of hatch the numbers of chicks hatched out was noted and the hatch weights were recorded to 0.1g accuracy and the mean hatch weight was calculated. The chick length was determined by stretching the chick along with a ruler and measured the length of chicks from beak to the end of the middle toe. Chick width was determined by extending the chick wings fully along with a ruler and measured the width of chicks between the tip of its two wings. During grading, the chicks reflex, navel, legs, beak and belly were checked and each was given a score out of ten. These scores were added up to get the Pasgar score. Top quality chicks is ten points and for each fault one point was subtracted from ten. Maximum score is 10 and minimum score is 5.

Parameters	Characteristics	Scores
Navel	Chicks turn over immediately	10
Reflex	Clean, closed and dry navels	10
Leg	Strong and evenly coloured	10
Beak	Clean, normal coloured nostrils, beak and comb	10
Belly	Sof and smooth	10

The data collected on various parameters were subjected to statistical analysis in Completely Randomized Design (CRD) as per the methods suggested by Snedecor and Cochran (1989) [14] and the means of different treatment groups were tested for statistical significance by Duncan's multiple range test (Duncan, 1955) [2].

3. Result and Discussion

3.1 Chick quality parameters

The results of SPIDES with or without turning on chick weight (g), chick yield (%), chick length (cm), chick width (cm) and pasgar score (points) are presented in Table 2.

3.1.1 Chick weight

The eggs stored for 21 days with 4 SPIDES with turning (T_5) had significantly (p<0.01) higher hatch weight (44.33g) followed by T_4, T_3, T_2 and T_1. The chicks hatched from the egg stored for 21 days without SPIDES (T_1) had significantly (p<0.01) lower hatch weight (41.20g) than rest of the treatments.

The results of Gharib *et al.* (2013) [7], Ebeid *et al.* (2017) [4] and Elmenway (2019) [5] were agreed with our result as they found that the weight of chicks hatched from SPIDES treatment had more weight than chicks hatched from non-SPIDES treatment.

Short periods of incubation during egg storage groups had higher chick weight compare to non-SPIDES group. This shows that SPIDES might increase the number and size of blastoderm cells of embryos results in increased chick weight during hatching.

In contrary, the results of Dymond *et al.* (2013) [3] and Dhotre *et al.* (2023) [1] were not accordance with our results. They found no significant difference on chick weight between SPIDES and non-SPIDES treatment groups. Similarly, the chick weight of this study was not in agreement with the findings of Elkhaiat *et al.* (2024) [10] who found that SPIDES treatment had the lowest chick weight than the non-SPIDES groups.

3.1.2 Chick yield

The T_5 had significantly (p<0.01) higher chick yield per cent (72.57%) than rest of the treatment groups. The lowest chick yield per cent (67.45%) was noticed in control group (T_1).

The findings of Okasha *et al.* (2023) [12] were in accordance with our results. They found that the SPIDES treatment had significantly (p<0.05) higher chick yield than the non-SPIDES treatment.

3.1.3 Chick length

The 4 SPIDES groups (T_4 and T_5) had significantly (p<0.01) highest chick length (18.63 cm). There was no significant difference between SPIDES groups (T_2 to T_5) and T_1 had significantly (p<0.01) lowest chick length (18.15 cm).

The present findings are further validated with the findings of Reijink *et al.* (2010) [17] and Goliomytis *et al.* (2015) [8] who observed that chick length had significantly (p<0.05) decreased with increased storage length. The observation of this study is in line with that of Dhotre *et al.* (2023) [1]. They found that chick length of treatment group with 2 hours

SPIDES had higher chick length (cm) than 1hour SPIDES and non- SPIDES treatment groups.

3.1.4 Chick Width

The 4 SPIDES groups (T_4 and T_5) had significantly ($p<0.01$) higher chick width of 11.60 cm and 11.48 cm, respectively compared to other treatment groups. There was no significant difference between 3 SPIDES groups and control.

3.1.5 Pasgar score

The results showed highly significant ($p<0.01$) difference between treatments in chick pasgar score. The T_5 group had significantly ($p<0.01$) higher chick pasgar score (9.51 points) than other treatment groups. No significant difference noticed in chicks pasgar score between 4 SPIDES without turning (T_4) and 3 SPIDES with turning group (T_3) but they were significantly ($p<0.01$) higher than T_2 and T_1. Further significant difference was noticed between T_2 and T_1. The without SPIDES group (T_1) had significantly ($p<0.01$) lowest chick pasgar score (8.83 points) than other treatment groups.

The results are in accordance with earlier findings of Gharib *et al.* (2013) [7], Ebeid *et al.* (2017) [4], Elmenway (2019) [5], Hamza *et al.* (2020) [9], Dhotre *et al.* (2023) [1] and Okasha *et al.* (2023) [12] who observed that SPIDES treatment groups had significantly ($p<0.05$) higher pasgar score than non-SPIDES treatment group.

The findings of Tona *et al.* (2003) [15] also in accordance with our results, as they found that long stored hatching eggs had significantly ($p<0.05$) lower pasgar score than short term stored eggs. The results Goliomytis *et al.* (2015) [8] were not accordance with our result, as they found that the egg storage duration and pre-incubation did not affect pasgar score of the chicks.

Table 2: (Mean±SE) egg weight (g), chick weight (g), chick yield (%), chick length (cm), chick width (cm), pasgar score (points) as influenced by SPIDES with or without turning

Treatment	Average egg weight (g)	Chick weight (g)	Chick yield (%)	Chick length (cm)	Chick width (cm)	Pasgar score (points)
T_1 (Control- without SPIDES)	61.08±0.07	41.20^{e}±0.15	67.45^{d}±0.28	18.15^{b}±0.14	11.20^{b}±0.05	8.83^{d}±0.01
T_2 (3SPIDES without turning)	61.08±0.08	42.48^{d}±0.07	69.55^{c}±0.21	18.33^{ab}±0.12	11.26^{b}±0.05	9.15^{c}±0.03
T_3 (3 SPIDES with Turning)	61.07±0.07	43.36^{c}±0.05	71.00^{b}±0.16	18.33^{ab}±0.09	11.28^{b}±0.04	9.24^{bc}±0.47
T_4 (4 SPIDES without turning)	61.08±0.08	43.83^{b}±0.04	71.76^{b}±0.10	18.63^{a}±0.42	11.48^{ab}±0.09	9.33^{b}±0.06
T_5 (4 SPIDES with Turning)	61.08±0.08	44.33^{a}±0.05	72.57^{a}±0.18	18.63^{a}±0.16	11.60^{a}±0.10	9.51^{a}±0.02
Significance	NS	**	**	*	**	**

Mean bearing different superscript between rows within a column differ significantly

NS- Non-Significant, *-Significant ($p<0.05$), **- Highly significant ($p<0.01$)

4. Conclusion

The present study concluded that short periods of incubation during egg storage (SPIDES) had significantly effect on chick quality viz. chick weight, chick yield, chick length, chick width and pasgar score. Hence, we can conclude that the SPIDES minimizes the harmful effects on chick quality in long-term stored commercial broiler hatching eggs.

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