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EMBRYONIC MORTALITY IN COBB BROILER BREEDER STRAIN WITH THREE EGG WEIGHT AND STORAGE PERIODS AT FOUR PRODUCTION PHASES

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ABSTRACT

The present study was conducted at a commercial hatchery with the objective to evaluate the effects of egg weight and storage period on embryonic mortality (early, mid and late) during incubation of fertile eggs from Cobb broiler breeder strain during 4 production phases(pre-peak; 25-28, peak; 29-36, post-peak; 37-52 and terminal; 53-56th weeks of age), categorized into 3 egg weights (small, medium and large subjected to change in each production phase) and maintained at 3 different storage periods (1, 4- and 7-days)and replicated 6 times. A total 93312 fertile eggs (pre-peak: 11664, peak: 23328, post-peak: 46656 and terminal: 11664) in 4 production phases were incubated in a commercial hatchery. The data were analyzed by ANOVA technique under randomized complete block design in 4×3×3 factorial arrangement and means were compared by using DMR Test. The results of the present study showed that the egg weight categories significantly ($p<0.05$) affected embryonic mortality in all the production phases. The highest early and late embryonic mortality was observed in small egg weight category followed by that of medium and large egg weight categories. Higher mid embryonic mortality was observed in small and large egg weight categories than in medium ones. Storage period was also significantly ($p<0.05$) affected embryonic mortality in all production phases. Higher early, mid and late - embryonic mortality was observed in seven days storage than those of four and one day storage. As for as interaction between egg weight categories and storage periods is concerned, the highest ($p<0.05$) early embryonic mortality was observed in seven days storage with small egg weight category in all production phases, while, the lowest was in one day storage with all the egg weight categories in all the production phases. It may be concluded from the present study that large egg weight category with 1 or 4 days storage period resulted in lower embryonic mortality leading to higher hatchability.

Key words: Broiler breeder strain, early, mid and late embryonic mortality, production phases.

INTRODUCTION

Increasing reproductive efficiency is important in the poultry industry and failure of an egg to hatch; mainly due to infertility and embryonic mortality reduces reproductive efficiency. Therefore, assessment of infertility and embryonic mortality, each of which causes failure of an egg to hatch is of economic interest to the poultry industry (Etches, 1996). Storage of hatching eggs is an indispensable part of hatchery operation, even though storage length and conditions may influence embryonic viability. Hatching performance is influenced by pre-incubation storage conditions, e.g., the length of time eggs are stored (Brake *et al.* 1997). Increasing the number of storage days increases the proportion of embryonic mortality during storage and incubation and thereby increases the probability of failure to hatch (Yoo and Wientjes, 1991; Scott and Mackenzie, 1993; Fasenko, 2007). Whereas, Benton and Brake, (1996) suggested that the low pH of fresh eggs might be detrimental to embryo survival. Scott and Mackenzie, (1993) further explained that each proportion of early or late embryonic mortality increased at different rates for broiler eggs incubated immediately, compared with those incubated after 7 days in storage. The negative effects of prolonged egg storage may be caused by changes in the embryo, in the egg characteristics, or by both (Becker *et al.* 1968; Meijerhof, 1992; Reijrink *et al.* 2008). However, Altan *et al*. (2002) and Onbasilar *et al*. (2007) reported that embryo mortality rate was not affected in eggs stored for 3 or 7 days. Egg weight could influence embryonic mortality rate during incubation (Alabi *et al.* 2012). De Witt and Schwalbach, (2004) observed higher hatchability in large eggs in different breeds, whereas, reduction in reproductive efficiency of broiler breeder with increasing egg weight and other complications due to large eggs have also been reported (North and Bell, 1990; Vieira and Mora, 1990; Joseph and Moran 2005. However, it has been indicated that egg weight did not influence embryonic mortality (Proudfoot and Hulan 1981; Ulmer-Franco *et al.* 2010). The above discussion indicate conflicting evidence on the effect of egg weight and storage time on the embryonic mortality in broiler breeders which necessitated further detailed investigations on this subject. Keeping this in view the present study was planned to explore the effects of different egg weights and storage periods on embryonic mortality during incubation.

MATERIALS AND METHODS

Experimental plan: The present study was conducted at a commercial hatchery with the objective to evaluate the effects of different egg weights and storage periods on embryonic mortality during incubation from fertile eggs categorized into three egg weights and storage periods during four production phases in Cobb broiler breeder strain. For this purposes, eggs during 4 production phases (pre-peak; 25-28, peak; 29-36, post-peak; 37-52 and terminal; 53-56th weeks of age) were categorized into three different weight ranges (small, medium and large; subject to change in each production phase) stored for three different periods (1-day, 4-days and 7-days) and replicated 6 times. A total 93312 fertile eggs; pre-peak: 11664, peak: 23328, post-peak: 46656 and terminal: 11664 eggs in 4 production phase were obtained. During each week of the experiment, a total number of 972 eggs per storage period from three egg weight categories (replicated 6 times, each replicate containing 54 eggs) were used. After categorization according to weight, the eggs were stored in room conditions; temperature 65 – 68ºF and relative humidity 75 – 80percent. Then the eggs were set in fully automatic multi-stage Chick-Master setter machine with standard hatching conditions; temperature 99.5ºF, 50% relative humidity and hourly based turning until 18 – 18.5 days and then were transferred to Hatcher at temperature 98.5ºF and relative humidity 70 % for a period of 2.5 – 3 days.

Statistical analysis: The data thus collected were analyzed using analysis of variance (ANOVA) technique (Steel *et al.* 1997) with Randomized Complete Block Design (RCBD) in 4×3×3 factorial arrangements (SAS, 9.1, 2002-03). The comparison of means was made using Duncan's Multiple Range (DMR) test (Duncan, 1955).

RESULTS AND DISCUSSION

i. Early embryonic mortality: The results of the present study showed that the different egg weight categories significantly ($p<0.05$) affected early embryonic mortality in all production phases (Table1). The highest embryonic mortality was observed in small egg weight category followed by that of medium and large egg weight categories in all production phases except pre-peak. The higher embryonic mortality in small eggs could be attributed to increased embryonic metabolic rate, such as lipid utilization and respiration, with embryonic growth and there might be insufficient nutrients and pores, which could affect the embryo development and its hatching, process (Tona *et al.* 2001). Similar results have also been reported by Alabi *et al.* (2012) and De Witt and Schwalbach (2004) who indicated increased hatchability with increase in egg weight. While, Deeming, (1996) reported increase in embryonic mortality with increasing egg weight. However, Ulmer-Franco *et al.* (2010) observed no effect of egg weight on embryonic mortality during incubation.

Storage periods significantly ($p<0.05$) affected the early embryonic mortality in all production phases in this study (Table 1). Higher embryonic mortality was observed in seven days storage than those of four and one day storage, which, could be attributed to increase in cell death during egg storage leading to decline in embryo viability (Arora and Kosin, 1968; Bloom *et al.* 1998). The results of present study are fully in line with those of Yoo and Wientjes (1991). These results are contrarily with those of Scott and Mackenzie (1993) who reported that early embryonic mortality increased at different rates for broiler eggs incubated immediately, compared with those incubated after 7 days in storage. Interaction between egg weight categories and storage periods, significantly ($p<0.05$) highest early embryonic mortality was observed in seven days storage with small egg weight category in all production phases and the lowest in one day storage with all egg weight categories in all the production phases (Table 1).

ii. Mid embryonic mortality: Egg weight categories significantly ($p<0.05$) affected the mid embryonic mortality in all production phases except terminal phase during the entire experimental period (Table 2). Higher mid embryonic mortality was observed in small and large egg weight categories than in medium category. This could be attributed to lower porosity combined with the thicker shell membrane cuticle and more viscous albumen, which might have not allowed the optimum respiration rate of the embryos from small eggs (Mcloughlin and Gous, 1999). Similar results were also reported by (Tona *et al.* 2001). Higher embryonic mortality in large eggs might be due to the fact that the larger eggs do not allow an optimum rate of ventilation and face more difficulties to remove the surplus heat from the egg (French, 1997), as a result of the decreasing ratio between egg surface and egg content with increasing egg size (Vogel, 1981). The combined effects of lower ventilation rate and high heat production of larger eggs at the end of incubation (Deeming, 1996) may result in increased embryo temperature and, hence, an increase of embryonic mortality (Tona *et al.* 2001). Similarly, Lawrence *et al.* (2004) also reported that the highest embryonic mortality was observed in heavy eggs as compared to light weight eggs. Storage period affected significantly ($p<0.05$) affected the mid embryonic mortality in all production phases except pre-peak in this study (Table 2). The highest mid embryonic mortality was observed in seven days storage followed by four and one day storage in peak phase. While, higher embryonic mortality was observed in seven days storage than those of four and one day in post-peak and terminal phases. This high embryonic mortality in seven days storage could be attributed to increased ratio of non-viable to viable embryonic cells and thus leading to increased number of abnormal or dead embryos in seven days stored eggs, as an optimum number of viable embryonic cells are likely required for initiation of normal growth and development (Fasenko, 2007). Similarly, Fasenko *et al.* (2001) also found that in broiler embryos embryonic mortality increases during incubation with increasing pre-incubation storage time. However, Caglayan *et al.* (2009) reported that long storage periods did not affect embryonic mortality. As far as interaction of egg weight categories and storage periods is concerned, the highest ($p<0.05$) mid embryonic mortality was observed in seven days storage with small egg weight category in all production phases and the lowest was in one day storage with all egg weight categories in all the production phases (Table 2).

iii. Late embryonic mortality: The results of the present study showed that the egg weight categories significantly ($p<0.05$) affected the late embryonic mortality in all production phases (Table 3). The highest embryonic mortality was observed in small egg weight category followed by that of medium and large ones in all the production phases, which could be attributed to insufficient nutrients and shell pores in small eggs leading to detrimental effect on embryo development and

Table 1. Early embryonic mortality (Mean ± SE) influenced by 3 egg weight categories and storage periods at four production phases in Cobb broiler breeder strain.

Phases / *S.O.V		Pre-peak	Peak	Post-peak	Terminal
		Egg weight categories			
♠L		0.23±0.01^{B}	0.42±0.01^{C}	0.48±0.01^{C}	1.30±0.02^{C}
♥M		0.19±0.01^{C}	0.47±0.01^{B}	0.55±0.01^{B}	1.35±0.03^{B}
♣S		0.25±0.01^{A}	0.54±0.01^{A}	0.61±0.03^{A}	1.43±0.03^{A}
		Storage periods			
1-†D		0.18±0.01^{B}	0.37±0.01^{C}	0.43±0.02^{B}	1.30±0.02^{B}
4-D		0.20±0.01^{B}	0.41±0.01^{B}	0.46±0.02^{B}	1.32±0.03^{B}
7-D		0.29±0.01^{A}	0.60±0.01^{A}	0.75±0.01^{A}	1.47±0.03^{A}
		Interaction			
L	**1-D**	0.20±0.01^{cd}	0.32±0.02^{e}	0.34±0.01^{d}	1.25±0.04^{c}
	4-D	0.19±0.01^{cd}	0.40±0.01^{d}	0.39±0.01^{d}	1.24±0.04^{c}
	7-D	0.28±0.01^{b}	0.59±0.02^{b}	0.72±0.02^{a}	1.57±0.02^{a}
M	**1-D**	0.14±0.02^{e}	0.38±0.01^{d}	0.43±0.01^{cd}	1.27±0.03^{c}
	4-D	0.18±0.01^{d}	0.40±0.02^{d}	0.44±0.03^{cd}	1.27±0.04^{c}
	7-D	0.26±0.01^{b}	0.63±0.02^{ab}	0.78±0.01^{a}	1.37±0.05^{bc}
S	**1-D**	0.21±0.01^{cd}	0.40±0.01^{d}	0.52±0.06^{cb}	1.37±0.04^{bc}
	4-D	0.22±0.01^{c}	0.50±0.01^{c}	0.55±0.06^{b}	1.43±0.05^{b}
	7-D	0.32±0.01^{a}	0.67±0.02^{a}	0.75±0.02^{a}	1.47±0.06^{ab}

Different alphabets on means show significant differences ($p<0.05$)
*S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

its hatching process (Tona *et al.* 2001). Mcloughlin and Gous, (1999) also indicated that the lower porosity combined with the thicker shell membrane cuticle and more viscous albumen may not allow the optimum respiration rate resulting in high embryonic mortality. Storage periods significantly ($p<0.05$) affect late embryonic mortality in all production phases during the study (Table 3). Higher late embryonic mortality was observed in seven days storage than under four and one day storage. While, highest late embryonic mortality was observed in seven days storage followed by four and one day in pre-peak phase. These results could be attributed to exposure of eggs to conditions that do not meet the needs of the developing embryo (Kingori *et al.* 2011). Further, as length of storage period increased, there was a decrease in embryo viability and albumen quality, resulting in reduced hatchability, (Deeming, 1993). The results of the present study are in close agreement with those of Fasenko *et al.* (1992) and Brake *et al.* (1997) who stated that egg storage (duration and environmental conditions) may influence embryonic viability leading to increased embryonic mortality and decreased hatching performance. However, Altan *et al.* (2002) and Onbasilar *et al*. (2007) reported that embryonic mortality rate was not affected by eggs storage up to 1, 3 or 7 days. As far as interaction between egg weight categories and storage periods is concerned, the highest ($p<0.05$) mid embryonic mortality was observed in seven days storage with all egg weight categories in all the production phases and the lowest was in one day storage with all egg weight categories in all the production phases (Table 3).

Table 2. Mid embryonic mortality (Mean ± SE) influenced by 3 egg weight categories and storage period at four production phases in Cobb broiler breeder strain.

Phases / S.O.V		Pre-peak	Peak	Post-peak	Terminal
			Egg weight categories		
♠L		0.28±0.02^{A}	0.46±0.01^{B}	0.52±0.01^{B}	1.40±0.03
♥M		0.23±0.01^{B}	0.51±0.01^{A}	0.57±0.01^{A}	1.38±0.03
♣S		0.31±0.01^{A}	0.51±0.01^{A}	0.57±0.01^{A}	1.42±0.02
			Storage periods		
1-D		0.26±0.01	0.42±0.01^{C}	0.46±0.01^{B}	1.33±0.02^{B}
4-D		0.27±0.02	0.48±0.01^{B}	0.46±0.01^{B}	1.33±0.02^{B}
7-D		0.30±0.01	0.63±0.01^{A}	0.68±0.01^{A}	1.55±0.02^{A}
			Interaction		
L	**1-D**	0.27±0.01^{abc}	0.36±0.01^{e}	0.43±0.01^{d}	1.33±0.04^{b}
	4-D	0.30±0.07^{ab}	0.45±0.01^{d}	0.46±0.01^{cd}	1.33±0.03^{b}
	7-D	0.27±0.01^{abc}	0.56±0.02^{b}	0.65±0.02^{b}	1.55±0.05^{a}
M	**1-D**	0.22±0.01^{bc}	0.46±0.01^{cd}	0.57±0.01^{cd}	1.29±0.06^{b}
	4-D	0.21±0.01^{c}	0.51±0.01^{c}	0.46±0.01^{cd}	1.31±0.04^{b}
	7-D	0.27±0.01^{abc}	0.61±0.02^{ab}	0.77±0.02^{a}	1.55±0.04^{a}
S	**1-D**	0.27±0.01^{abc}	0.42±0.01^{d}	0.49±0.03^{c}	1.36±0.03^{b}
	4-D	0.31±0.02^{a}	0.47±0.01^{cd}	0.47±0.01^{cd}	1.36±0.04^{b}
	7-D	0.35±0.01^{a}	0.65±0.02^{a}	0.61±0.02^{b}	1.55±0.04^{a}

Different alphabets on means show significant differences ($p<0.05$)
*S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Table 3. Late embryonic mortality (Mean ± SE) as influence by 3 egg weight categories and storage periods at four production phases in Cobb broiler breeder strain

Phases / S.O.V		Pre-peak	Peak	Post-peak	Terminal
			Egg weight categories		
♠L		2.12±0.05^{C}	2.32±0.02^{C}	2.73±0.02^{C}	3.44±0.03^{B}
♥M		2.25±0.05^{B}	2.45±0.02^{B}	2.84±0.03^{B}	3.52±0.03^{A}
♣S		2.41±0.04^{A}	2.55±0.03^{A}	3.01±0.02^{A}	3.51±0.03^{AB}
			Storage periods		
1-D		2.02±0.05^{C}	2.43±0.02^{B}	2.65±0.02^{B}	3.42±0.02^{B}
4-D		2.21±0.05^{B}	2.43±0.02^{B}	2.64±0.02^{B}	3.38±0.02^{B}
7-D		2.56±0.03^{A}	2.62±0.03^{A}	3.29±0.02^{A}	3.68±0.03^{A}
			Interaction		
L	**1-D**	1.92±0.08^{d}	2.37±0.03^{d}	2.53±0.03^{d}	3.36±0.05^{a}
	4-D	1.97±0.10^{d}	2.39±0.03^{cd}	2.55±0.03^{d}	3.34±0.03^{a}
	7-D	2.49±0.05^{ab}	2.61±0.04^{a}	3.11±0.04^{b}	3.63±0.06^{b}
	1-D	1.87±0.07^{d}	2.43±0.03^{cd}	2.57±0.04^{d}	3.43±0.03^{a}
M	**4-D**	2.27±0.04^{c}	2.38±0.03^{cd}	2.59±0.04^{d}	3.40±0.04^{a}
	7-D	2.61±0.05^{a}	2.59±0.04^{ab}	3.37±0.03^{a}	3.73±0.05^{b}
	1-D	2.27±0.09^{c}	2.50±0.04^{bc}	2.83±0.04^{c}	3.47±0.05^{a}
S	**4-D**	2.39±0.06^{bc}	2.49±0.03^{bc}	2.79±0.03^{c}	3.39±0.05^{a}
	7-D	2.57±0.06^{ab}	2.65±0.05^{a}	3.39±0.03^{a}	3.67±0.04^{b}

Different alphabets on means show significant differences ($p<0.05$)
*S.O.V = Source of variance, ♠L = Large, ♥M = medium, ♣S = Small, †D = Days

Conclusions: Embryonic mortality showed negative relationship with egg weight categories, while it was positively related with egg storage periods. Large egg weight category with 1 or 4 days storage period resulted in lower embryonic mortality leading to higher hatchability.

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