

Effect of Pre-Hatch Cold Conditioning on Hatchability, Embryonic Malformations and Mortality Pattern of Vanaraja Chicken

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Abstract

Six hundred Vanaraja hatching eggs were incubated in forced draft incubator in three groups of 200 eggs each. Group I(T1) was incubated normally while as group II(T2) and III(T3) were subjected to cold conditioning on days 5th and 18th respectively by holding them at room temperature for 1 hour. On 18th day of incubation candling was done. The infertile eggs were broken to check at which stage growth was arrested (early, mid and late embryonic mortality). The hatchability was also determined as HTES (Hatchability on Total Eggs Set) and HFES (Hatchability on Fertile Eggs Set). On the day of hatch, unhatched eggs were broken to find out the stage of mortality and no. of crippled chicks were also calculated. The data was analysed and results thus obtained showed no significant difference in any of the groups with respect to fertility, hatchability (HTES and HFES), no. of crippled chicks and total embryonic mortality. But early, mid and late embryonic mortality within a particular group showed significant difference with late embryonic mortality being highest within the group as well as between the groups with the highest late embryonic mortality in T3 group.

Keywords: Cold conditioning, Fertility, Hatchability, Vanaraja

Introduction

Incubation temperature is one of the most important single physical factors determining or influencing chicken embryo development and hatchability (Decuypere and Michels, 1992). According to Nichelmann and Tzschentke (2002), the development of the thermoregulatory system of precocial birds is characterized by a prenatal phase in the development of the thermoregulatory system, which is characterized by endothermic reactions with a low efficiency. During this perinatal period of chickens, a time window of opportunity occurs for imprinting of physiological control systems. This imprinting is probably related to neural imprinting at the microstructural level (i.e., in terms of synaptic plasticity) and also to environment-induced modifications of gene expression. Perinatal epigenetic temperature adaptation may be used as a tool for adapting poultry embryos or hatchlings to subsequent climatic conditions (Tzschentke and Plagemann, 2006; Tzschentke, 2007). In chickens and other precocial birds, epigenetic temperature adaptation can be induced by changes in incubation temperature toward the end of embryonic development (Minne and Decuypere, 1984; Tzschentke and Nichelmann, 1997; Collin *et al.*, 2007; Piestun *et al.*, 2009; Shinder *et al.*, 2009; Tzschentke and Halle, 2009) and also by post-hatch thermal conditioning (Yahav and Hurwitz, 1996; Shinder *et al.*, 2002). Ambient temperature (T_a) is the most important environmental factor in this context (Horowitz, 2002).

However, these reactions ultimately have an influence on the efficiency of the thermoregulatory system (Nichelmann and Tzschentke, 2002; Moraes *et al.*, 2003). Therefore, they may support adaptivity to postnatal environmental conditions and play a role in epigenetic temperature adaptation processes (Nichelmann and Tzschentke, 2002). Interestingly, near the end of incubation, embryonic reactions to changed environmental conditions change from being uncoordinated, non-adaptive reactions (aspecific reactions) to coordinated, adaptive reactions (specific reactions; Tzschentke *et al.*, 2004). Hence, it is hypothesized that these characteristic reaction patterns at the end of incubation could be used as a physiological tool to help characterize this critical period in the development of the thermoregulatory system (Tzschentke and Plagemann, 2006). In addition, the end phases in the ontogeny of the hypothalamus-pituitary-thyroid axis and hypothalamus pituitary-adrenal axis, which are important in metabolism, the thermoregulatory response, and the stress response, as well as being major factors in the hatching process (Decuypere *et al.*, 1991), are situated in this same period near the end of incubation.

Incubation temperature manipulation is currently being studied as a tool to induce epigenetic temperature adaptation to increase thermotolerance post-hatch (Tzschentke and Plagemann, 2006; Tzschentke, 2007). The key element in inducing epigenetic temperature adaptation is finding the right time frame, frequency, duration, and amplitude of temperature manipulation. Many studies have focused on intermittent temperature manipulations during late incubation, ranging from 3 to 12 h/d (Moraes *et al.*, 2003; Yağın and Siegel, 2003; Collin *et al.*, 2007; Piestun *et al.*, 2009). In addition, most studies have investigated only temperatures that are higher than standard incubation temperatures. A recent study by Shinder *et al.*, (2009) reported preliminary results of repetitive acute cold exposure of chick embryos late in incubation on hatchability, hatchling weight, and acquisition of cold resistance postnatally. Therefore, this study aimed to investigate the effect of thermal manipulations applied during early and late incubation on fertility and hatchability of Vanaraja eggs, embryonic mortality pattern, if any, and the condition of the hatch.

Material and Methods

A total of six hundred Vanaraja hatching eggs (average weight 40-50 grams) collected from the breeder flock of approximately 35 weeks of age over a period of one week were incubated in forced draft incubator (20 Oct. to 12 Nov. 2018) with automatic control for temperature, humidity and turning in the hatchery of Division of L.P.M., F.V.Sc & A.H., SKUAST-K in three groups of 200 eggs each. Group I was incubated normally while as group II and III were subjected to cold conditioning by taking out the eggs from the incubator on days 5th and 18th respectively and held at room temperature for one hour and the room temperature recorded was 15 to 16°C.

On 18th day of incubation candling was done to remove infertile eggs and fertile eggs were transferred to the hatcher. The infertile eggs so discarded were broken to check at which stage growth was arrested (early, mid and late embryonic mortality). The hatchability was also determined as HTES (Hatchability on Total Eggs Set) and HFES (Hatchability on Fertile Eggs Set). On the day of hatch, unhatched eggs were also broken to find out the stage of mortality and no. of crippled chicks were also calculated separately.

Results and Discussion

The data was analysed and results thus found are summarised in Tables 1 and 2. No significant difference was found in any of the groups with respect to fertility and hatchability (HTES and HFES) i.e. cold exposure given during incubation period on days 5th and 18th didn't affect fertility or hatchability of the eggs.

There was no significant difference between the control group (T₁) and cold conditioned groups (T₂ and T₃) with respect to total embryonic mortality. But early, mid and late embryonic mortality within a particular group showed significant difference with late embryonic mortality being highest within the group. Late embryonic mortality differed significantly between the groups as well with the highest late embryonic mortality in T₃ group.

With respect to data pertaining to the no. of crippled chicks, no significant difference was found between the groups.

Table-1: Effect of Cold exposure on Fertility and hatchability of Vanaraja eggs

Groups	Fertility (%)	Hatchability (%)	
		HTES	HFES
T ₁ Control - No Cold exposure	82.35	35.78	43.45
T ₂ - Cold exposure on day 5 th	85.46	40.03	46.85
T ₃ - Cold exposure on day 18 th	86.11	38.40	44.59

Table-2: Effect of Cold exposure on embryonic mortality pattern and condition of hatch of Vanaraja eggs

Groups	Embryonic mortality (%)				Crippled Chicks (%)
	Total	Early	Mid	Late	
T ₁ Control - No Cold exposure	33.82	12.32 ^A	26.81 ^B	60.87 ^{aC}	7.53
T ₂ - Cold exposure on day 5 th	33.66	11.17 ^A	24.27 ^B	64.56 ^{aC}	3.67

Note: Percentage values of late embryonic mortality across different groups bearing different small case superscript differ significantly. Values of early, mid and late embryonic mortality in a particular group bearing different upper case superscript differ significantly.

Discussion

Our results are in agreement with Nyuiadzi *et al.*, (2017) who studied the effects of the interaction of cold incubation temperatures (36.6°C for 6 hours/day at days 10-18 or 15°C for 30 minutes at days 18 and 19) and cool ambient temperatures until 21 days of age on performance and body temperature and concluded that fertile hatchability rates were not different among incubation conditions. Similar results were reported by Aminoroaya *et al.*, (2016) who studied the effects of cyclical lower incubation temperature (36°C for 3 hours) at different embryonic ages (12-14 days and 15-17 days) on the hatchability and found that there was no negative effect on hatchability. Shinder *et al.*, (2011) tried to fine-tune previous acute cold exposure treatments (15°C for 30 min on days 18 and 19 of incubation and cold treatment similar to former but with 60-min exposures) of broiler embryos during late embryogenesis to improve lifelong cold resistance and performance. Upon hatching, hatchability, body weight, and body temperature were recorded. No treatment effect on hatchability was observed. Our results, however, are in contrast with the findings of Levenick and Kondra (1973) who analysed the effects of short periods of low temperature (3.8°C) stress at 17 days of incubation on hatchability of chicks. Hatchability was significantly reduced in 5 and 8 hour group. Buckland (1970) studied the effect of cold stressing 17 day old chicken embryos. He reported that exposing them to 11.3°C and 5.2°C for the same time period (8 hours) showed significant decrease in hatchability. The difference in results could be due to difference in temperatures of cold shock and duration of cold shock. The response of embryo to cold stress during the incubation period depends upon the age of the embryo at which it was exposed to cold stress, duration of exposure, temperature, and also incubator conditions (Aminoroaya *et al.*, 2016).

With respect to total embryonic mortality our findings agree with those of Flores *et al.*, (2017) who studied the effect of thermal stimulation in embryos from Cobb genetic strain under commercial scale and reported that cold stimulation did not cause embryo mortality. The standard embryonic mortality observed in all the three groups could be as a result of inadequate management of the fertile egg production (egg management, genetic strain, and the age

of female breeders) (Macari *et al.*, 2013). But with respect to higher late embryonic mortality are in contrast with Nakage *et al.*, (2013) who determined the effects of incubation temperature (34.5; 35.5; 36.5; 37.5 and 38.5°C), on embryonic mortality using daily incubation of partridge (*Rhynchotus rufescens*) eggs and reported that early embryonic mortality increased at low temperatures (<35.5°C), whereas intermediate and late embryonic mortality increased at high temperatures (>36.5°C). The findings of Primmatt *et al.*, (1988) also contradict our study, who reported that embryo survival was lower at early stages of development when incubation temperature is set to at extremes of the temperature range in partridge embryos. Thus, it was concluded that the mortality at early stages is higher at low temperatures.

Suraz *et al.*, (1996) tried to estimate phenotypic correlations between incubation characteristics, and to evaluate the effects of cold stress and genotype during incubation on chick weight, egg weight loss, hatching time, and embryonic mortality. Embryonic mortality was significantly increased under continuous (single period) cold stress, but not under intermittent cooling (6 h every 48 h). The results thus indicated that embryos from cooled eggs lose more weight during incubation and that the neonatal chicks are more susceptible to dehydration during holding time, and have a longer incubation period, and a greater embryonic mortality. Levenick and Kondra (1973) analysed the effects of short periods of low temperature stress at 17 days of incubation on embryonic development. Examination of embryos that failed to hatch revealed a high incidence of malpositions and abnormal hatching muscles. Malpositions of embryos were found at 18 days of incubation while there was edema and hemorrhage of muscles observed at 19.5 days of incubation.

Since no significant difference among the different treatment groups with respect to crippled chicks was observed it can be concluded that cold exposure didn't have negative influence on the condition of chicks at the time of hatch. Usually crippled chicks are a result of high incubation temperatures (Romanoff, 1936) which is here not the case. The possible reasons therefore for the crippling of chicks could be related to other trouble shooting problems in the hatchery like improper setting of eggs or improper nutrition of breeders, etc.

Conclusion

It was concluded that cold conditioning during early or late incubation period neither does affect fertility nor hatchability of eggs. There is no significant difference observed with respect to total embryonic mortality pattern or the quality of chicks. But as far as late embryonic mortality is concerned, significant difference was seen between as well as among the various treatment groups.

Conflict of Interests

There is no conflict of interest.

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