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Thermal acclimation during embryogenesis; effect on pre and post hatch performance of commercial broiler chickens; a review

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Abstract. This work reviews the effect of thermal acclimation (TA) during embryogenesis on the pre and post hatch performance of broiler chickens. Genetic selection and improvements for faster growth and breast muscle production has rendered commercial broiler chickens more susceptible to heat stress. Chickens do not have sweat glands thereby resulting to other methods of stress adaptation such as conduction, convection, radiation, panting, and reduction of feed intake during high temperature periods. This leads to several physiological changes which negatively affect production and welfare performance especially in tropic and humid regions. Epigenetic thermal acclimation during embryogenesis is a strategy that could enhance embryonic development and the adaptive responses of broiler chickens to post hatch environmental stimuli. Epigenetic thermal acclimation involves the exposure of embryos to a certain higher temperature for certain duration of time from embryonic age (EA) 10 or 11 during which the hypothalamus-pituitary-adrenal (HPA) and hypothalamus-pituitary-thyroid (HPT) axis are developed enough to withstand thermal exposure. The available literature revealed that the exposure of embryos to thermal challenge could improve embryonic development, hatchability, and post hatch growth as well as the adaptive response of broiler chickens to post hatch environmental stimuli however, exposure to extreme higher temperature or for a longer duration could negatively affect development. It is therefore concluded that exposure of embryos to a certain higher temperature within a certain embryonic period for a certain duration could be a potential strategy to improve the pre and post hatch performance of broiler chickens.

1 Introduction

The production and consumption of broiler meat has increased drastically over the past decades to meet the protein requirement for worlds the growing population. Chicken meat, egg [1] and other chicken products are the most affordable source of animal protein especially, in developing and undeveloped countries. To meet the continues demand for chicken meat, modern day broiler chickens have been genetically selected for higher feed intake, faster growth rate, higher breast and thigh muscle production. This is also accompanied by higher metabolic rate. This selection for higher performance has reduced the ability of modern day commercial broiler chickens to cope with several post hatch environmental stimuli [2]. The ideal environmental temperature (thermo neutral zone) for an adult broiler chickens ranges between 18-22°C [3]. High ambient temperatures and heat waves due to climate change affect the growth performance and welfare of broiler chickens with substantial economic losses [4-10].

To improve the growth and adaptive performance of broiler chickens to post hatch heat stress, epigenetic thermal acclimation during embryogenesis is one of the techniques being employed by researchers. In chickens and other precocial birds' epigenetic temperature adaptation can be induced by changes in incubation temperature at the end of embryonic development [11-16]. Timing of thermal acclimation is linked to the period of the development of the hypothalamus-pituitary-adrenal and hypothalamus-pituitary-thyroid axis [17, 18]. In this method, eggs are exposed to a certain higher incubation temperature for certain duration of time during a specific period of embryogenesis. This method improves pre and post hatch broiler performance.

Therefore, this work aimed at reviewing the influence of thermal acclimation during embryogenesis on pre and post hatch performance of boiler chickens.

2 Influence of TA on embryonic development and hatching traits

The summary of the findings reporting the influence of thermal acclimation during embryogenesis on embryonic development and hatching traits are presented in Table 1. While some authors observed that TA during embryogenesis improved embryonic weight and hatching traits, others observed no effect of TA on the measured parameters. Other authors also reported decreased hatching traits and embryonic weight when TA was practiced during embryogenesis.

Table 1. Summary of findings reporting some the influence of TA on embryonic development and hatchability of broiler chickens.

Authors	TA Procedure	Embryonic Age/Day (E)	Outcomes
[19]	39°C for 9, 12, and 18h/d	E12–E18	↑EW on E18
[20]	37.5, 36 or 39°C	E13–E21	39°C ↑Hatchability
[21]	39°C for 18 h	E7–E11	↑Hatchability
[22]	39.5°C	E18–E21	↑Hatchability
[23]	38.8°C	ED-10 or ED-13	↑EW
[24]	38.9°C	E7-E14	↓Incubation Duration
[25]	39.5°C for 12h or 24 h/d	E7–E16	12h had No effect on ED; 24h ↓EW
[26]	39.6 °C for 6 h/d	E0–E8 or E10–E18	↓Hatchability
[27]	38.6°C	E3–E6 or E0–E6	↓Hatchability

(↓) Decrease, (↑) Increase, (EW) Embryonic weight, (ED) Embryonic development, (E) Embryonic age, (h) Hour, (d) Day, (TA) Thermal acclimation.

2.1 Influence of TA on post hatch performance of broiler chickens

The summary of the findings reporting the influence of thermal acclimation during embryogenesis on post hatch performance of broiler chickens are presented in Table 2. It was observed that thermal acclimation improved post hatch thermotolerance, immunity, body weight at hatch and slaughter weight as well as improved muscle diameter and weight of pectoral/breast muscle. However, other authors reported that TA decreased body weight at hatch.

Table 2. Summary of the findings reporting some of the effect of TA during embryogenesis on post hatch performance of broiler chickens.

Authors	TA Procedure	Embryonic Age/Day (E)	Outcomes
[28]	39.5°C for 12 h/d	E7–E16	↓BT at hatch
[29]	39°C for 18 h/d	E10–E18	↓BT at hatch
[30]	39°C for 18 h/d	E10–E18	↓BT in 1-d-old chicks
[31]	39°C for 9, 12, 18h	E12–E18	39°C for 18h ↑Thermotolerance
[2]	39.5°C or 41.0°C f or 3h	E8-E10 or E16-E18	↑Thermotolerance. ↑BW at 4d
[32]	38.5°C or 40°C for 6, 9 or 12h	E16, E17 and E18	38.5°C (↑Thermotolerance, ↑WBC). TM↑BW at slaughter
[33]	39.5°C for 3 or 6 h/d	E16-E18	↑BW,↑%PM, ↑MD(13, 25 and 35d)
[34]	39.5°C for 12h or 24h	E7-E16	12h ↑BW at hatch. 24h↓BW and BT at hatch, and slaughter weight
[35]	39.5°C for 12h	E7–E16	↑BMW at optimum and hot conditions. ↑MD

Body temperature (BT), ↑ (Increased), ↓ (Decreased), Myofiber diameter (MD), Pectoral muscle (PM), Breast Muscle Weight (BMW), White Blood Cell (WBC), Percentage (%), Hour (h), Day (d), Body weight (BW), Thermal acclimation.

3 Conclusion

It was concluded thermal acclimation during embryogenesis could improve embryonic development and hatching traits.TM during embryogenesis could also improve post hatch growth performance and thermotolerance of broiler chickens to heat stress. However, extreme higher temperatures and longer duration of exposure could significantly hinder both pre and post hatch performance traits.

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