



Increasing Heat Tolerance in Broiler by Using Thermal Manipulation During Embryonic Development



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Mini Review

There has been a great increase in the demand, during the past years, for poultry production including meat and egg production associated with its low cost, good nutritional profile and suitability for further processing. This growing demand in poultry products has led to progressive increases in genetic selection not only for producing fast-growing birds [1,2] and increase egg production from egg type chicken [3] but also to use of poultry and chick embryos in medical research and pharmaceutical industry [4]. Therefore, it is necessary to know the environmental factors that affect poultry production efficiency and growth performance.

High temperature is critical environmental stressor leading to economic losses in the poultry production [5,6]. This stressor causes negative effects on growth performance, immunosuppression, and livability, contributing thus to a decrease in productivity. Furthermore, exposure the growth period of broilers to heat stress has been associated with poor meat characteristics and quality loss [7,8].

In addition, genetic backgrounds of different chickens may affect their response to heat stress [9,10], but broilers are the most sensitive birds to high environmental temperatures than other domestic animals [11,12]. Moreover, selective breeding or domestication is producing individuals that are more susceptible to stress rather than more resistant [13,14]. Also, the resistance to heat stress of strains selected for rapid growth is lower than that of slow-growing strains and the continuous selection for fast growth seems to be associated with increased susceptibility of broiler chicken to heat stress [15,16].

Broiler chickens are heat sensitive animals. However, their cardiovascular and respiratory organs, and hence their capacity to lose heat via thermoregulatory pathways, have not increased in the same proportions as muscle mass through the 60- year selection

process [17]. As poultry production is now widely developed in countries with hot climates, it is of interest to find new rearing strategies to enhance their thermotolerance [18]. One strategy is to increase the incubation temperature of embryos cyclically in order to induce long-term changes in thermotolerance [19].

Manipulation of environmental conditions during embryonic development has long-lasting effects on the resulting phenotypes, including physiological modifications needed to develop heat tolerance [17]. Thus, thermal manipulation during incubation may be a potential mechanism to modulate performance, health, and well-being during later life. In fact, several studies have observed effects of thermal manipulation during incubation on various chicken characteristics posthatch, including higher muscle growth [20,21], and improved heat tolerance when chickens are thermally challenged [22,23].

Exposure to high temperature during late embryonic development has long-lasting effects on the thermoregulatory system of broiler chickens through affecting the heat tolerance of these chickens [24]. On the other hand, the thermal manipulation of the hatching eggs, especially between the 10 and 18th day of incubation, considerably reduced the quality of the chicks. Acclimation treatments of high temperature on the eggs, of cross-bred flocks, should not be made for a long term; instead, short-term treatments should be made by determining the stage that generates epigenetic adaptation. In addition, thermal manipulation applied during the final stage of incubation did not affect the meat yield or meat quality of broilers submitted to heat stress [25].

Also, Thermal manipulation broilers, developed more specific pathways than control group, especially involving genes related to metabolism, stress response, vascularization, anti-apoptotic and epigenetic processes [26]. Also, Thermal manipulation broilers

greatly modified the overall muscle expression profile compared to control group, probably partly due to epigenetic modifications and active RNA splicing. Metabolic process and stress-responsive pathways were particularly affected in thermal manipulation birds displaying low body temperatures under heat exposure by improving physiological adaptation processes and preserving cell integrity in the muscle. Also, exposure to high temperature during late embryonic development has long-lasting effects on the thermoregulatory system of broiler chickens by affecting the heat tolerance of these chickens [27].

Also, thermally manipulated eggs and broilers, developed more specific pathways than control group, especially involving genes related to metabolism, stress response, vascularization, anti-apoptotic and epigenetic processes [28]. Also, thermal manipulation of broilers greatly modified the overall muscle expression profile compared to the control group. This is probably partly due to epigenetic modifications and active RNA splicing. Metabolic process and stress-responsive pathways were particularly affected in thermal manipulation birds displaying low body temperatures under heat exposure by improving physiological adaptation processes and preserving muscle cell integrity. On the other hand, thermally manipulated broilers, methylation level of a distal part of the heat-shock Protein 70 (HSP70) promoter may reflect heat-stress related epigenetic memory and may be useful in differentiating between individuals that are resilient or vulnerable to stress in broiler chickens.

On the other hand, the thermal manipulation, especially between the 10 and 18th day, considerably reduced the quality of the chicks [28]. Acclimation treatments of high temperature on the eggs from cross-breeding flocks should not be made long term; instead, short-term treatments should be made by determining the stage that generates epigenetic adaptation. In addition, thermal manipulation applied during the final stage of incubation did not affect the meat yield or meat quality of broilers submitted to heat stress [27].

Conclusion

Meat type chickens are the most heat sensitive animals which might affect the performance of meat production cycle from day one to market age, causing economic losses. Also, new rearing strategies should be introduced to enhance their thermotolerance. Thus, increasing the incubation temperature during broiler embryogenesis was the best choice to induce long-term changes in thermotolerance and recognize an epigenetic adaptation in broiler during life cycle. Moreover, the sensitivity of broilers to heat may be solved in the near future according to next developments in biotechnological methods which may be used the editing of genome to address this problem.

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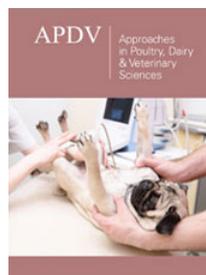
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