CRIMSON PUBLISHERS
Wings to the Research

Approaches in Poultry, Dairy & Veterinary Sciences

ISSN: 2576-9162

Mini Review

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

FS Nassar* and HR Elsherif

Department of Animal Production, Faculty of Agriculture, Cairo University, Egypt

***Corresponding author:** Farid S Nassar, Department of Animal Production, Faculty of Agriculture, Cairo University, Giza 12613, Egypt

Submission: December 08, 2018; **Published:** December 14, 2018

Keywords: Broiler; Heat stress; Thermotolerance; Embryonic development; Heat-shock protein 70

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.

References

1. Nassar FS, Moghaieb REA, Abdou AM, Stino FKR (2012) Microsatellite markers associated with body and carcass weights in broiler breeders. African Journal of Biotechnology 11(5): 3514-3521.
2. Nassar FS (2017) Productive performance in local chicken after five generations of crossing and selection for high live body weight. Egyptian Poultry Science Journal 37(3): 779-813.
3. Nassar FS, EL Komy EM, Abdou AM (2017) Ovarian morphology and egg quality traits of Egyptian selected strain for egg production compared with commercial laying strains. Brazil J of Poult Sci 19(4): 683-688.
4. Nassar FS (2018) Poultry as an experimental animal model in medical research and pharmaceutical industry. Biomed J Sci & Tech Res.
5. Lin H, Jiao HC, Buyse J, Decuypere E (2006) Strategies for preventing heat stress in poultry. Worlds Poult Sci J 62(1): 71-86.
6. Lu Q, Wen J, Zhang H (2007) Effect of chronic heat exposure on fat deposition and meat quality in two genetic types of chicken. Poult Sci 86(6): 1059-1064.
7. Lara LJ, Rostagno MH (2013) Impact of heat stress on poultry production. Animals 3(2): 356-369.
8. Attia YA, Hassan SS (2017) Broiler tolerance to heat stress at various dietary protein/energy levels. European Poultry Science.
9. Star L, Decuypere E, Parmentier HK, Kemp B (2008) Effect of single or combined climatic and hygienic stress in four layer lines: 2. Endocrine and oxidative stress responses. Poult Sci 87(6): 1031-1038.
10. Felver Gant JN, Mack LA, Dennis RL, Eicher SD, Cheng HW (2012) Genetic variations alter physiological responses following heat stress in 2 strains of laying hens. Poult Sci 91(7): 1542-1551.
11. Attia YA, Al Harthi MA, Elnaggar A (2018) Productive, physiological and immunological responses of two broiler strains fed different dietary regimens and exposed to heat stress. Ita J Anim Sci 17(3): 686-697.
12. Geraert PA, Guillaumin S, Leclercq B (1993) Are genetically lean broilers more resistant to hot climate? Br Poult Sci 34(4): 643-653.
13. Washburn KW, Peavey R, Renwick GM (1980) Relationship of strain variation and feed restriction to variation in blood pressure and response to heat stress. Poult Sci 59(11): 2586-2588.
14. Cahaner A, Pinchasov Y, Nir I, Nitsan Z (1995) Effects of dietary protein under high ambient temperature on body weight, breast meat yield, and abdominal fat deposition of broiler stocks differing in growth rate and fatness. Poult Sci 74(6): 968-975.
15. Tan GY, Yang L, Fu YQ, Feng JH, Zhang MH (2010) Effects of different acute high ambient temperatures on function of hepatic mitochondrial respiration, antioxidative enzymes, and oxidative injury in broiler chickens. Poult Sci 89(1): 115-122.
16. Soleimani AF, Zulkifli I, Omar AR, Raha AR (2011) Physiological responses of 3 chicken breeds to acute heat stress. Poult Sci 90(7): 1435-1440.
17. Attia YA, Al Harthi MA, El Shafey AS, Rehab YA, Kim WK (2017) Enhancing tolerance of broiler chickens to heat stress by supplementation with vitamin E, vitamin C and/or probiotics. Annals of Anim Sci 17(4): 1-15.
18. Yahav S, Rath RS, Shinder D (2004) The effect of thermal manipulations during embryogenesis of broiler chicks (Gallus domesticus) on hatchability, body weight and thermoregulation after hatch. Journal of Thermal Biology 29(4): 245-250.
19. Renaudeau D, Collin A, Yahav S, de Basilio V, Gourdine JL, et al. (2012) Adaptation to tropical climate and strategies to alleviate heat stress in livestock production. Animal 6(5): 707-728.
20. Halevy O, Krispin A, Leshem Y, McMurtry JP, Yahav S (2001) Early-age heat exposure affects skeletal muscle satellite cell proliferation and differentiation in chicks. Am J Physiol Regul Integr Comp Physiol 281(1): R302-R309.
21. Piestun Y, Harel M, Barak M, Yahav S, Halevy O (2009) Thermal manipulations in late term chick embryos have immediate and longer term effects on myoblast proliferation and skeletal muscle hypertrophy. J Appl Physiol 106(1): 233-240.

How to cite this article: FS Nassar, HR Elsherif. Increasing Heat Tolerance in Broiler by Using Thermal Manipulation During Embryonic Development. Appro Poult Dairy & Vet Sci . 5(4). APDV.000616.2018. DOI: 10.31031/APDV.2018.05.000616

22. Collin A, Bedrani L, Loyau T, Mignon Grasteau S, Metayer Coustard S, et al. (2011) Embryo acclimation: an innovative technique to limit mortality during thermal stress in chicken. Inra Prod Anim 24(2): 191-198.

23. Druyan S, Piestun Y, Yahav S (2012) Heat stress in domestic fowl: Genetic and physiological aspects. In: Josipovic S, Ludwig E (Eds.), In Heat Stress-Causes, Treatment and Prevention, Nova Science publications Inc., New York, NY, USA, pp. 1-30.

24. Morita VS, Almeida VR, Matos Junior JB, Vicentini TI, van den Brand H, et al. (2016) Incubation temperature alters thermal preference and response to heat stress of broiler chickens along the rearing phase. Poult Sci 95(8): 1795-1804.

25. Narinç D, Erdoğan S, Tahtabiçen E, Aksoy T (2016) Effects of thermal manipulations during embryogenesis of broiler chickens on developmental stability, hatchability and chick quality. Animal 10(8): 1328-1335.

26. Fernandes JIM, Santos TC, Kaneko IN, Horn D, Leyter JR, et al. (2016) Effect of thermal embryonic manipulation on the quality of male and female broiler meat submitted to thermal stress pre-slaughter. Brazilian J Poult Sci 18(2): 343-350.

27. Loyau T, Hennequet Antier C, Coustham V, Berri C, Leduc M, et al. (2016) Thermal manipulation of the chicken embryo triggers differential gene expression in response to a later heat challenge. BMC Genomics 17: 329.

28. Kisliouk T, Cramer T, Meiri N (2017) Methyl CpG level at distal part of heat-shock protein promoter HSP70 exhibits epigenetic memory for heat stress by modulating recruitment of POU2F1- associated nucleosome -remodeling deacetylase (NuRD) complex. J Neurochemistry 141(3): 358-372.