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Mitigating Heat Stress: Challenges and Solutions in Poultry Farming

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Poultry farming has grown in importance globally in recent years. The Food and Agriculture Organisation (FAO) estimates that the world's yearly output of chicken meat was 103.5 million tonnes in 2012, accounting for 34.3% of the world's total meat production (excluding fish). With the lowest carbon footprint per unit of output produced, the chicken meat and egg production system is thought to be the most effective method for producing animal protein. Among agricultural businesses, the poultry industry has long had a prominent position in many regions of the world. (Daghir, 2009). The poultry business is now seen as a source of a nutritious substitute for red meat and other protein sources. (Williams *et al.*, 2006). Livestock has a significant role in the Indian economy. The poultry industry's share in the national economy has remained around 1%, despite a steady increase in the cattle sector. India ranks third in the world for egg production and fifth for beef production. As of right now, we are only obtaining 79 eggs and 3.6 kg of poultry meat per person yearly, compared to the National Institute of Nutrition's recommendation of 182 eggs and 11 kilogrammes of chicken meat per person. (Anonymous, 2019-20).When an animal experiences heat stress (HS), its body temperature rises because they are unable to release extra heat from their bodies into the surrounding air (Sugiharto, 2020). Acute heat stress (HS) in chicken production refers to brief, intense bursts of high temperature, whereas chronic heat stress (HS) is defined as prolonged bursts of elevated ambient temperature. (Kpomasse *et al.*, 2021).

Increasing their respiratory rate is a common strategy used by poultry birds to try and improve latent heat loss, however it appears that this is not enough and more action is needed. raised mortality, decreased feed intake, lower final body weight, decreased meat and egg quality, and raised feed conversion ratios are the outcomes of these profound physiologic, neuroendocrine, and behavioural changes in chickens. Thermal stress has consequently been of the uttermost concern to poultry farmers in light of climate change and the financial losses connected with it; several ways have been attempted to solve this issue. (Lin *et al.*, 2006). Numerous amelioration and mitigation measures used for chicken production have been noted in the literature; this study aims to bring these results together, look at their shortcomings, and offer suggestions for improvement.

Thus, the current review's objectives are to evaluate various intervention options to lessen the harmful impacts of HS on poultry as well as to evaluate the effects of HS on poultry performance and health. Additionally, this evaluation will go over the benefits and drawbacks of each technique and recommend the one that will work best to reduce HS in the production of chicken.

Models of Poultry's Body Heat Regulation

Because they generate and release heat to keep their body temperature approximately constant, birds are homeothermic. There is no absolute body temperature in birds since their internal body temperature varies more than that of mammals. The range of variability in mature chickens is 105°F to 107°F (40.6°C to 41.7°C). A newly hatched chick's body temperature is around 103.5°F (39.7°C), and it rises every day until it achieves a steady temperature, which occurs after three weeks of life. The body temperature of smaller breeds of chickens is greater than that of bigger kinds. Due to their greater muscular mass and likely higher metabolic rate, male hens have a somewhat higher body temperature than female hens. The body temperature rises with activity. For instance, hens maintained in cages have a lower body temperature than those on the floor.

Thermoregulatory mechanism of poultry

Domesticated gallinaceous animals, such as chickens, have a noticeably higher internal body temperature (41.2°C to 42.2°C) than people and cattle (36°C to 39°C). The temperature at which enzymes (enzymic proteins) become denatured, or destroyed, due to a loss of configuration or form and chemical activity, determines the top temperature limit that live cells and tissues may withstand before gradually ceasing to function. Poultry have far less tolerance than other animals when they are under heat stress and soon perish at higher temperatures since this begins to happen about 46°C. On the other hand, if chickens are properly re-warmed, their real body temperature can drop as much as 20°C below the typical range and they will still recover totally. Poultry are not suited or inclined to high ambient air temperatures. Although there is some direct water diffusion through the skin tissue, they are unable to benefit greatly from natural evaporative cooling since they lack sweat glands in their skin. Poultry appear to have relatively restricted alternatives for heat loss under heated temperatures, since only the head appendages (e.g., comb) are particularly rich in blood veins and able to function as sites for direct loss of heat. It is evident that domestic chickens have a lower heat tolerance than cold tolerance, and they are far more likely to die from heat stress (hyperthermia) than from low temperature stress (hypothermia). Incredibly efficient at keeping birds cool. In cold weather, feathers provide excellent insulation; in hot weather, they prevent heat loss. (Bhadauria *et al*. 2016).

Heat Stress in Poultry

Stressors are described as "an agent that produces stress at any time," while stress is defined as the "nonspecific response of the body to any demand" (Selye, 1976). Therefore, stress is an animal's or an organism's biological reaction to external stimuli that upset its homeostasis, or normal physiological equilibrium. For both developing broilers and laying hens, the ideal temperature range for performance/thermonuclear zone is between 18 and 22 degrees Celsius. (Charles, 2002). When in the "thermoneutral zone," poultry birds do not experience heat stress since their body temperatures are maintained at a steady level and they shed heat at a regulated pace through regular activity. The quantity of heat energy produced by the bird and the net amount of energy moving from its body to its surroundings, however, are negatively correlated when the thermoneutral zone is violated because heat stress is the outcome. (Figure).

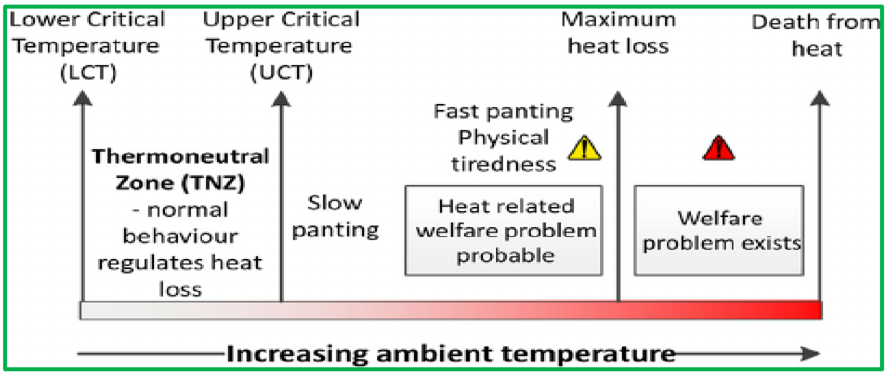

Figure : Different ambient temperature zones for poultry (Source: DEFRA, 2005)

Effect of heat stress on poultry production

- When temperatures are high, birds adjust their behaviour and physiological homeostasis in an attempt to find thermoregulation, which lowers body temperature. Most bird species respond to heat stress in a similar way, while there may be some individual differences in the strength and duration of these reactions. According to a recent research (Mack *et al.*, 2013), When faced with extreme heat, birds tend to spend more time sleeping, less time walking or moving, more time spreading their wings, and less time feeding. They also drink more and pant more frequently.In broilers exposed to heat stress, Aengwanich (2008) found decreased bursa weight in conjunction with a reduction in the number of lymphocytes in the bursa's cortex and medulla. Regarding genetic and cellular pathways, our knowledge of the immunological response to heat stress in chicken is currently lacking.
- Environmental stress (like heat stress), which is perhaps one of the most frequent problems in many agricultural systems worldwide, can also have an impact on the productivity of flocks of laying hens. The majority of the negative impacts of heat stress on production are most likely caused by decreased feed intake, which lowers body weight, feed efficiency, egg output, and egg quality. (Deng *et al*. 2012, Mashaly *et al*. 2004).
- In males, decreased semen volume, sperm concentration, number of live sperm cells and motility is reported in response to heat stress resulting in impaired fertility (Joshi et al., 1980; McDaniel et al., 1995).

Mitigation strategies

- During intense heat waves, a poultry's habitat and home design play a critical role in lowering heat stress (HS). It is crucial to ensure that air enters and exits the poultry house easily as a consequence. The detrimental effects of HS might be reduced by making sure that there is an easy movement of air into and out of the house (Nawab *et al*., 2018; Pawar *et al*., 2016). Open-style homes with adequate shade, sufficient air circulation and water input are essential in hot and muggy climates. The east-west orientation of the home is recommended (Oloyo & Ojerinde, 2020).
- A great deal of focus has been placed on the role that diet plays in reducing the symptoms of HS, with cold water being the first and most readily modified. According to earlier research, drinking cold, fresh water may lessen the symptoms of HS. (Teeter & Belay, 1996).
- Numerous different additions have been attempted in addition to standard components like vitamins and minerals, which are frequently included in meals for cattle. In heat-stressed birds, mannan-oligosaccharides and probiotic supplements were utilised to counteract negative effects. (Sohail et al., 2011)
- The selection of animals based on the heattolerant capacity for improving performance parameters should be practiced for improving the progeny

Conclusion

It is essential to offer innovative intervention techniques to lessen the impacts of stress since the growth of the chicken business in tropical and subtropical countries correlates with a slow but steady rise in global warming and temperature. Owing to the low heat tolerance of poultry, heat stress (HS) negatively affects the physiological and endocrinological systems of the birds, induces immunological dysregulation, and lowers the birds' health and productivity, all of which result in significant financial losses for the poultry industry. A number of intervention techniques have been employed in recent years to address the harmful effects of HS in poultry.

References

1. Aengwanich W (2008). Pathological changes and the effects of ascorbic acid on lesion scores of bursa of Fabricius in broilers under chronic heat stress. Res. J. Vet. Sci. 1: 62-66. http://dx.doi.org/10.3923/rjvs.2008.62.66.
2. Anonymous. Department of animal husbandry, dairing and fisheries, Ministry of agriculture and Farmers Welfare, Govt. of India 2018-19.
3. Bhadauria, Pragya; Keshava; Mamgai, Preeti; Murai, Ashish and Jadoun, Y.S. (2016) Management of heat stress in poultry production system. ICARAgricultural Technology Application Research Institute, Zone-1, Ludhiana141 004 (INDIA)
4. Charles DR (2002). Responses to the thermal environment. In: poultry environment problems, a guide to solutions (Charles, D.A. and Walker, A.W. Eds.), Nottingham University Press, Nottingham, United Kingdom. Pp. 1-16.
5. Daghir NJ (2009). Nutritional strategies to reduce heat stress in broilers and broiler breeders. Lohmann Info. 44: 6-15.
6. DEFRA (Department for Environment Food and Rural Affairs, UK) 2005. Heat Stress in Poultry-Solving the problem (www.defra.gov.uk)
7. Deng, W.; Dong, X.F.; Tong, J.M.; Zhang, Q. The probiotic Bacillus licheniformis ameliorates heat stress-induced impairment of egg production, gut morphology, and intestinal mucosal immunity in laying hens. Poult. Sci. 2012, 91, 575–582.
8. Joshi PC, Panda B, Joshi BC (1980). Effect of ambient temperature on semen characteristics of White Leghorn male chickens. Indian Vet. J. 57: 52-56.
9. Kpomasse, C. C., Oke, O. E., Houndonougbo, F. M., & Tona, K. (2021). Broiler production challenges in the tropics: A review. Veterinary Medicine and Science, 7, 831–842.
10. Lin H, Jiao HC, Buyse J, Decuypere E. Strategies for preventing heat stress in poultry. *Worlds Poult Sci J*. (2006) 62:71–86. doi: 10.1079/WPS200585.
11. Mack, L.A.; Felver-Gant, J.N.; Dennis, R.L.; Cheng, H.W. Genetic variation alter production and behavioral responses following heat stress in 2 strains of laying hens. Poult. Sci. 2013, 92, 285–294.
12. Mashaly, M.M.; Hendricks, G.L., III; Kalama, M.A.; Gehad, A.E.; Abbas, A.O.; Patterson, P.H. Effect of heat stress on production parameters and immune responses of commercial laying hens. Poult. Sci. 2004, 83, 889–894.
13. McDaniel CD, Bramwell RK, Wilson JL, Howarth B (1995). Fertility of male and female broiler breeders following exposure to an elevated environmental temperature. Poult. Sci. 74: 1029-1038. http://dx.doi.org/10.3382/ps.0741029.
14. Nawab, A., Ibtisham, F., Li, G., Kieser, B., Wu, J., Liu, W., Zhao, Y., Nawab, Y.,Li, K., Xiao, M., & An, L. (2018). Heat stress in poultry production:Mitigation strategies to overcome the future challenges facing theglobal poultry industry. Journal of Thermal Biology, 78, 131–139.
15. Oloyo, A., & Ojerinde, A (2020). Poultry housing and management in poultry—An ādvanced learning. In A. Ali Kamboh (Ed.). IntechOpen.
16. Pawar, S., Sajjanar, B., Lonkar, V., Kurade, N., Kadam, A., Nirmal, A.,Brahmane, M., & Bal, S. (2016). Assessing and mitigating the impactof heat stress in poultry. Advances in Animal and Veterinary Sciences, 4, 332–341.
17. Selye H (1976). Forty years of stress research: principal remaining problems and misconceptions. Can. Med. Assoc. J. 115: 53-56.
18. Sohail, M. U., Rahman, Z. U., Ijaz, A., Yousaf, M. S., Ashraf, K., Yaqub, T., & Rehman, H. (2011). Single or combined effects of mannan-oligosaccharides and probiotic supplements on the total oxidants, total antioxidants, enzymatic antioxidants, liver

enzymes, and serum trace minerals in cyclic heat-stressed broilers. Poultry Science, 90(11), 2573–2577. https://doi.org/10.3382/ ps.2011-01502.
19. Sugiharto, S. (2020). Alleviation of heat stress in broiler chicken using turmeric (Curcuma longa)—a short review. Journal of Animal Behaviour and Biometeorology, 8, 215–222.
20. Teeter, R. G., & Belay, T. (1996). Broiler management during acute heat stress. Animal Feed Science and Technology, 58(1–2), 127–142.
21. Williams AG, Audsley E, Sandars DL (2006). Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Main Report. Defra Research Project IS0205. Bedford: Cranfield University and Defra. www.defra.gov.uk.