Review Article

Influence of Heat Stress in Poultry Production and Approaches to Combat It

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Abstract

Temperature and moisture of air are two major environmental factors controlling the heat stress of livestock. The general signs of heat stress in poultry includes open mouth panting while spreading their wings and squatting close to the ground, gasping, lethargic and droopy acting, closed eyes, lying down, decreased appetite, increased thirst, drop in egg production, reduced body weight, increased cannibalism etc. Heat stress during the growth period of broilers has been associated with undesirable meat characteristics and quality loss. The blood biochemical parameters have also been found deviated than the normal values. The immunity of the birds also affected during heat stress. Ventilation, bird density and nutrition are a few areas that play a role in controlling heat accumulation. Nutritional manipulations, such as addition of fat and reduction of excess protein along with vitamin, minerals and electrolyte supplementations have been reported to reduce mortality due to heat stress.

Key words: Heat Stress, Panting, Temperature, Ventilation

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Introduction

The earliest record of poultry in India dates back to 3200 BC and it is believed that today's chicken breeds have originated in India (Daghir, 2008) and supposedly arisen from a common ancestor, the red jungle fowl which is found in the wild in the forests of India and South-East Asia (West and Zhou, 1989). Poultry production has been reported to be the fastest growing in the livestock industry, and more particularly in tropical and sub-tropical regions of the world (Daghir, 2009; Holik 2009). In the recent times, poultry industry is being viewed as a provider of a healthy alternative to red meat and other protein sources (Williams *et al.*, 2006). Although recent poultry crosses improved in all production aspects, environmental challenges still affirmed to exert major impact on meat and egg production (Mahmoud and

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Yaseen, 2005). Stress due to high environmental temperature is widely recognized as one of the primary problems in poultry production (Deeb *et al.*, 2002; Maak *et al.*, 2003 and Aberra and Lengerken, 2005).

It has been observed that temperature and moisture of air are two major environmental factors controlling the heat stress of livestock (Bouraoui *et al.*, 2002; St-Pierre *et al.*, 2003) which results from a negative balance between the net amount of energy flowing from the animal's body to its surrounding environment and the amount of heat energy produced by the animal. It has been suggested that modern poultry genotypes produce more body heat, due to their greater metabolic activity (Debb and Cahaner, 2002; Settar *et al.*, 1999). Lin *et al.* (2006) said that if the thermoregulation mechanism is insufficient to maintain homeothermy, the body temperature begins to rise and eventually cause to death from heat stress. The general signs of heat stress in poultry includes open mouth panting while spreading their wings and squatting close to the ground, gasping, lethargic and droopy acting, closed eyes, lying down, decreased appetite, increased thirst, drop in egg production, reduced body weight, increased cannibalism etc. (Nardone *et al.*, 2010; Dayyani and Bakhtiyari, 2013). Birds subjected to heat stress conditions spend less time on feeding, more time drinking and panting, as well as more time with their wings elevated, less time moving or walking and more time resting (Mack *et al.*, 2013). Mustaf *et al.* (2009) stated that animals utilize multiple ways for maintaining thermoregulation and homeostasis when subjected to high environmental temperatures, including increasing radiant, convective and evaporative heat loss by vasodilatation and perspiration. Birds have an additional mechanism to promote heat exchange between their body and the environment, which are the air sacs. Air sacs are very useful during panting, as they promote air circulation on surfaces contributing to increase gas exchanges with the air, and consequently, the evaporative loss of heat (Fedde, 1998).

Influence of Heat Stress on Reproduction

The exposure of high ambient temperature to White Leghorn hens caused reproductive failure which is characterized by reduction in reproductive activities and egg quality. This is probably due to decline in ovarian function indicated by the decline in plasma gonadal steroids and follicular expression of mRNA for steroidogenic enzymes (Rozenboim *et al.*, 2007). Donoghue *et al.* (1989) stated that the diminished reproductive performance in heat stressed poultry may, in part, be related to increased PRL secretion, which can act through hypothalamic GnRH (Rozenboim *et al.*, 1993) or directly on pituitary gonadotropes (You *et al.*, 1995), causing the suppression of gonadotropin secretion. In males, semen volume, sperm concentration, number of live sperm cells and motility decreased when subjected to heat stress (McDaniel *et al.*, 2004).

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Influence of Heat Stress on Production and Quality of Egg and Meat

Egg production is inversely proportion to high temperature has been noticed by (Allahverdi *et al.,* 2013; Kirunda *et al.,* 2001; Mashaly *et al.,* 2004) which is mainly due to the decreased feed intake, reducing the available nutrients for egg production. Bonnet *et al.* (1997) stated that heat stress not only reduces feed intake but also reduce digestibility of different components of the diet. Allahverdi *et al.* (2013) explained that heat stressed laying flock often shows imbalances in acid-base disturbances in the blood as result of hyperventilation. As birds pant there is excessive loss of CO_2 gas from their lungs. The lowered amount of CO_2 in the blood causes the blood PH to elevate or become more alkaline which reduces the amount of ionized Ca in the blood that utilized by the shell gland. Thus concentration of Ca reduces in plasma and these cause peer egg quality. The decreased plasma Ca concentration due to heat stress causes poor egg quality was also reported by (Mahmoud *et al.,* 1996). Heat stress during the growth period of broilers has been associated with undesirable meat characteristics and quality loss (Lu *et al.,* 2007; Zhang *et al.,* 2012) and further transportation of broilers from farms to processing facilities under high temperature conditions have also been shown to cause meat quality losses (Dadagar *et al.,* 2010; Debut *et al.,* 2005).

Influence of Heat Stress on Immunity

When bird's body temperatures are in thermos-neutral zone, the energy from the feed can be directed to immune system development apart from the growth and reproduction (Daghir, 2008). The altered immune response during heat stress in broilers and layers is through pathways constituting the hypothalamic-pituitary-adrenal and sympathetic-adrenal medullar axes (Lara and Rostagno, 2013). The immunosuppressive effect due to heat stress has been observed in terms of lower liver weights in laying hens (Felver-Grant *et al.,* 2012), reduced relative weights of thymus and spleen in broilers and layers (Quinterio-Filho *et al.,* 2010; Ghazi *et al.,* 2012), reduced bursa weight and decreased lymphocytes number in medulla and cortex of bursa in broilers (Aengwanich, 2008) and lower levels of circulating antibodies in broilers (Bartlett and Smith, 2003).

Influence of Heat Stress on Blood Biochemical Parameters

The blood is functioned as the carrier of nutrients, metabolic wastes and the pathway of humoral transmission. So the blood biochemical parameters would reflect the physiological state of the body (Lin *et al.,* 2000). Decreased haematocrit, haematoglobin and total protein by high temperature were noticed by (Donkoh, 1989) while decreased concentrations of plasma free amino acids and essential amino acids and increased uric acid concentration when subjected to acute heat stress were reported by (Ostrowski-Meissner, 1981). Increased level of free fatty acids and blood glucose level (Lin, 1988), lactic dehydrogenase (Ostrowski-Meissner, 1981; Sharma and Gangwar, 1986), creatine kinase (Hocking *et al.,* 1994), high concentration of corticosterone (Du and Gu, 1995) and triiodothyronone (T3) by Yang (1995)

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were found during heat stressed laying hens. Similarly, declining of plasma K (Belay and Teeter, 1993) and increased level of plasma Cl (Belay and Teeter, 1993) were also stated during exposure to heat stress.

Approaches to Combat Heat Stress

The most important measure to combat hot weather to reduce the amount of heat accumulation in poultry by which birds can bring its body temperature back to normal, will get back on feed and performance will not suffer. Ventilation, bird density and nutrition are a few areas that play a role in controlling heat accumulation (Dayyani and Bakhtiyari, 2013).

Ventilation should be maximized as the air movement facilitates removal of build-up ammonia, carbon dioxide and moisture from the poultry sheds (Butcher and Miles, 2012). The use of circulation fans is recommended for proper ventilation in a natural ventilated house for producing air movement over the birds to increase convective cooling. To maximize air movement over the birds, circulation fans should generally be installed 1 – 1.5 metre above the floor and tilted downward at approximately a 5° angle (Daghir, 2008). In poultry, not only the heat production but also heat loss is related to heat stress. Adequate ventilation is vital for heat stress management in poultry birds. Heat loss by evaporative heat dissipation is linked to relative humidity of the surrounding environment (Lara and Rostagno, 2013). Therefore, high temperature accompanied by high humidity is more detrimental to broiler performance than high temperature with low humidity. The evaporative heat loss increases along with temperature and decreases with increasing humidity (Lin *et al.*, 2006).

Combat through Nutritional Aspects

The dietary vitamin C supplementation can be effective in reducing mortality in laying hens (Ahmed et al., 2005) and broilers (Njoku, 1986) reared under environmental stress. Mahmoud et al., (2004) and Amit Kumar et al., (2015) reported that use of ascorbic acid as antistressor and growth stimulant in commercial broiler production and determine its optimum level in broiler ration under local farm conditions which can ameliorate the chicken's responses to heat stress. Vitamin C is necessary for the maintenance of normal collagen metabolism, where as collagen formation is required for normal structures of bone, egg shell, muscles etc. (McDonald *et al.*, 1992).

Nutritional manipulations, such as addition of fat (Ghazalah *et al.*, 2008) and reduction of excess protein (Rahman *et al.*, 2002) are recommended to reduce the adverse effects of heat stress. The addition of fat to the diet also appears to increase the energy value of other feed constituents and has been shown to decrease the rate of food passage in the GI tract and thus increase nutrient utilization (Mateos *et al.*, 1982). Sahin *et al.* (2009) stated that vitamins and mineral supplementation has been demonstrated to decrease mortality and improve growth of poultry birds during heat stress as because heat stress increases the mineral excretion from body and decreases the serum and liver concentrations of vitamins and

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minerals. Vitamin E is also used in the poultry diet because of the reported benefits of vitamin E supplementation to laying hens during heat stress (Whitehead *et al.*, 1998; Sahin *et al.*, 2001). Vitamin E is known to be a lipid component of biological membranes and is considered a major chain-breaking antioxidant. (Halliwell and Gutteridge, 1989) and protects cells and tissues from oxidative damage induced by free radicals. Panting is accompanied by an increase in water loss so more water has to be consumed by birds during hot, dry water in order to prevent dehydration. Drinking water cooler than body temperature will absorb body heat, which will help with cooling the bird. Adding the electrolyte to the drinking water will replenish vital nutrients that will help balance blood PH levels (Elnagar *et al.*, 2010).

Apart from nutrient supplementation, feeding practices suggested by Moreki, (2008) are reported to improve performance of birds under heat stress which includes good physical quality of feed to encourage appetite, feeds should not be stored for longer than two months to reduce the toxicity, feeding at cooler parts of the day i.e., early morning or in the evening and diming of lights while feeding or using low light intensity during periodical feeding reduces activity that reduces heat load.

Conclusion

The physiological alterations during heat stress includes increased body core temperature, decreased feed intake, increased thirst, altered blood ph and electrolyte imbalances, impaired reproductive functions etc. These can be minimized by supplementing vitamins, minerals, electrolytes and some managemental aspects other than nutrition such as feeding and lighting practices etc. Evaporative cooling, ventilation are the other prospects by which farmers can combat with heat stress.

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