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# Effect of Heat Stress on Poultry Production and their Managemental Approaches

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**A B S T R A C T**

Air temperature and relative humidity are two primary environmental factors in terms of THI that determining the heat stress level in livestock. Heat stress has detrimental effects on egg production, egg quality of laying hen and reduced growth rate in broiler production. Exposure of environmental stress during the growing period of broilers has been coupled with undesirable meat quality. Heat stress has adverse effects on behaviour, welfare and immunity of poultry and decreases the egg production resulting in massive economic losses of farmer. The management approaches to minimise the adverse effect of heat stress in poultry production viz., provision of ventilation, density of bird, nutritional manipulation, supplementation of minerals and electrolyte. Controlling the environmental variation is a critical to successful poultry production and welfare.

## Introduction

Poultry production is one of the fastest growing sectors of livestock industry in developing countries. Environmental variation is one of the major factors that affect sustainability of livestock production systems in tropical climate (Sinha *et al.*, 2017a). Heat Stress decline production performance and death of chicken results in adversely affects the return from the enterprise. Heat stress has an adverse effect on egg production, egg weight and shell quality of laying hen (Muiruri and Harrison, 1991; Balnave and Muheereza, 1997; Whitehead *et al.*, 1998). Climatic variables like temperature, humidity, radiation and wind speed that directly affect the mechanism of thermoregulation and rates of heat exchange by all animals (NRC, 1981). Heat stress is a major factor that decreases productivity and reproductive efficiency of livestock due to lower feed intake and negative energy balance (De Rensis and Scaramuzzi, 2003). Chronic heat stress had

lower broiler production due to decline feed digestibility such as proteins, fats, starch (Bonnet *et al.,* 1997). In addition, acute heat stress drastically decreases reproductive performance of hens due to alterations in acid-base balance and ion exchange mechanism (Mahmoud *et al.,* 1996). Increase of temperature will lead to increases etiologic bacteria and parasites around the animals in surrounding environment. Climate change influences the emergence of disease and their transmission due to increases vectors, pathogens.

## Sign of heat stress in poultry

The signs of heat stress in poultry are panting with open mouth, elevated their wings and squatting near to the ground, droopy acting, slowness and lethargic closed eyes, lying down, increased water intake, decreased appetite, drop in egg production, reduced egg size, poor egg shell quality, reduced body weight, and increased cannibalism (Nardone *et al.,* 2010; Dayyani and Bakhtiyari, 2013). Birds are trying to lose heat by gasping and changing the position of their feathers, losing water in their breath and cooling by evaporation through the surface of the lungs. Birds are facing to heat stress conditions, they spend less feeding time during feeding, more time drinking and panting, less time moving or walking and more time resting (Mack *et al.,* 2013).

## Effect of heat stress on poultry production

Heat stress adversely affects the efficiency of broiler production and their meat quality. High environmental temperature and THI value above the critical thresholds level lead to reduced feed intake, lower body weight, and lower feed conversion efficiency (Sohail *et al.,* 2012). Chronic heat exposure adversely affects the meat quality and fat deposition in broilers, but it is breed dependent (Lu *et al.,* 2007). Exposure of bird to high solar radiation is coupled with depression of chemical composition and meat quality in broilers industry (Dai *et al.,* 2012; Imik *et al.,* 2012). Exposure of high temperature during the growing phase of broilers has been related with poor meat characteristics of broiler chicken and loss their quality (Lu *et al.,* 2007; Zhang *et al.,* 2012). Moreover, exposure of heat stress during transportation of birds from production farms to processing centre has been losses meat quality (Dadgar *et al.,* 2010). Exposure of laying hens to climatic stress also resulted in a significant decrease in egg production and egg quality. Various author reported that reducing egg production in hot weather due to decrease in feed intake, reducing the uptake of available nutrients and decreases digestibility of different components of the diet (Allahverdi *et al.,* 2013; Kirunda *et al.,* 2001; Mashaly *et al.,* 2004). So, egg production is inversely correlated with environmental temperature beyond the critical limit. Allahverdi *et al.,* (2013) reported that laying flock in high temperature shows disturbances in acid-base balance in the blood as result of hyperventilation, the birds gasp there is excessive loss of $CO_2$ gas from their lungs. The lowered amount of $CO_2$ in blood causes the rise in blood PH which reduces the level of $Ca^{2+}$ ion in the blood that utilized by the shell gland results poor egg quality (Mahmoud *et al.,* 1996).

## Effect of heat stress on reproduction

Heat stress has a great impact on the reproductive performance and egg quality of birds (Donoghue *et al.,* 1989). High temperature with high relative humidity has more detrimental effect on reproduction of animal. Exposure of White Leghorn hens to high environmental temperature to causes decline in reproductive activity leads to reproductive failure and poor egg quality

(Ebeid *et al.*, 2012). The reduction in reproductive performance of domestic birds coupled with heat stress due to decrease LH levels and hypothalamic gonadotropin-releasing hormone-I content (Donoghue *et al.*, 1989; Etches *et al.*, 1995). Diminishing reproductive performance of poultry in heat stress due to disturbance the thermo-regulatory mechanisms, might be modulated at the level of the hypothalamus and pituitary (El Halawani *et al.*, 1973; Saarela *et al.*, 1977).

## Effect of heat stress on behavioral and physiological responses

Thermoregulation is an important role in maintaining the homeostasis and it is controlled by central, metabolic and endocrine systems. The body mass, confirmation and morphological parameters such as fur color are related to basal metabolic rate, can use of behavioral adjustments (Canals *et al.*, 1989; Cooper *et al.*, 2008). Thermoregulatory capacities of animal play an adaptive role to survive in adverse environment. Under high environmental temperature, birds change their behavioural and physiological responses to maintain their body temperature through seeking thermoregulation. Birds are subjected to under heat stress conditions time spend less in feeding, more in drinking, panting, and wings elevation, move towards cooler surfaces (Mack *et al.*, 2013). In adverse climatic condition, maintaining homeostasis mechanism in birds by heat exchange between environment and air sac through convection, evaporative heat loss, perspiration and vasodilation process (Mustaf *et al.*, 2009; Fedde, 1998).

## Effect of heat stress on the immunolgical responses

Heat stress has negative effects on health status of birds leading to changes in physiology, metabolism, hormonal and immune system. At high temperature decreases synthesis of T and B lymphocytes and suppression of phagocytic activity of blood leukocytes (Kadymov and Aleskerov, 1988). Bartlett and Smith (2003) found that lower levels of total circulating antibodies and lower levels of specific IgM and IgG in broiler under heat stress. Nathan *et al.*, (1976) reported that decrease total WBC and activities of leukocytes subsequent heat exposure. Zulkifi *et al.*, (2000) also supported that heat stress had significantly decline in antibody production. Inflection of the immune response by the central nervous system (CNS), and is mediated by a complex network of nervous, endocrine and immune systems.

## Management approaches to reduce heat stress poultry

To reduce the heat stress in poultry is the multidisciplinary approach. Modification of surrounding environment, ventilation system, bird density and nutritional management to reduces the heat stress in poultry (Dayyani and Bakhtiyari, 2013).

## Modification of surrounding environment

Environmental temperature and relative humidity of the surrounding environment affects the evaporative cooling mechanism in birds. Evaporative heat loss increases in high temperature with wind speed but decreases with increasing humidity (Lin *et al.*, 2005; Sinha *et al.*, 2017b). The surrounding environment is controlled by using various things such as fans, fogger with fan, cooling pads, curtain, static pressure controllers and thermostats. Provision of intermittent light had positive effect that related to lower heat production in poultry (Ketelaars *et al.*, 1986). The orientation of building, insulation and roof overhang are influence the temperature inside the poultry house. Air movement inside

the house is important for efficient ventilation. Use of sprinkler and fogger with fan reduces the temperature inside the house on hot climatic condition (Sinha *et al.,* 2018). Environmentally controlled houses used mechanical ventilation systems and air movement is produced by fans and exhaust fan in the building.

## Ventilation system

Good ventilation system is essential for heat stress management. Removes the moisture loaded air from the poultry house and enter equal amount of fresh air from outside. Ventilation system should be maximized as the air movement assist removal of ammonia, moisture and carbon dioxide from the poultry house and enter fresh oxygen from outside (Butcher and Miles, 2012). Proper ventilation houses can provide consistent airflow patterns. Tunnel ventilation connects moving air of building from inlets to exhaust fans, providing high airflow speed. This fast air movement increases convective heat loss, reducing the body temperature of birds. The air velocity of tunnel ventilation is about 350 feet/minute. Evaporative cooling pads works on the same cooling principle as foggers, air is cooled inside the house when it passes through the cooling pads. Circulation fans are recommended for proper ventilation in a good ventilated house for maximizes air movement over the birds to increase convective cooling. The installation of circulation fans at 1 – 1.5 metre above the floor and tilted downward about 5° angle for producing maximum air over the birds (Daghir, 2008).

## Nutritional management

Reduce the heat stress in poultry by nutritional management approaches. Decrease in feed intake and increase water intake of poultry under hot climate to control the body temperature (Gous and Morris, 2005; Sohail *et al.,* 2012). Feed intake will be reduced by 1.2% for every 1°C rise in the temperature range of 22-32°C and 5% for 1°C rise in the temperature range of 32-38°C. Feeding of laying hens during the evening period has been found to improve laying rate and egg shell quality through increased calcium intake. Vitamins and mineral supplementation has been determine to decrease mortality and improve growth performance of poultry birds during heat stress as because heat stress increases excretion of mineral from body and decreases the serum and liver concentrations of vitamins and minerals (Sahin *et al.,* 2009). Addition of fat and reduction of excess fat in poultry ration are recommended to minimise the adverse effect of heat stress (Ghazalah *et al.,* 2008; Rahman *et al.,* 2002). The addition of fat up to 5 % in the diet increases the energy value of feed constituents and decreases the rate of food passage in the GI tract and thus increase nutrient utilization (Mateos *et al.,* 1982; Daghir, 2008). Supplementation of minerals like ammonium chloride (NH4Cl) sodium bicarbonate (NaHCO3), sodium chloride (NaCl), potassium chloride (KCl) and potassium sulphate (K2SO4) in drinking water of poultry are beneficial effect under heat stress condition (Smith and teeter, 1988; Ubosi *et al.,* 2003; Ahmad *et al.,* 2005). Teeter *et al.,* (1985) reported that supplementation of NH4Cl at 3 and 10 g/kg in poultry feed under high environment temperature had improvement in weight gain up to 9.5 and 25 % respectively. Supplementation of vitamin C under high temperature is most effective to reducing mortality rate in broiler and laying hens (Njoku, 1986; Ahmed *et al.,* 2005). Vitamin C acts as antistressor and growth stimulant in commercial broiler production due to maintenance of normal collagen metabolism (Mahmoud *et al.,* 2004; McDonald *et al.,* 1992). Supplementation of vitamin E during heat stress was beneficial to laying hens, maintain the biological

membranes because protects cells and tissues from oxidative damage induced by free radicals (Whitehead *et al.*, 1998; Sahin *et al.*, 2001).

## Water intake

At high temperatures, chickens consume more water than feed. The reduced water intake is primarily behind the decrease in production. Water intake of birds increases about 7% for every 1°C increase above 21°C (NRC, 1994). Birds performance depends upon water temperature, drinker type, shape and height of water trough under heat stress (May *et al.*, 1997; Daghir, 2009). May *et al.*, (1997) observed that significant decrease in water intake of birds at high ambient temperature from nipple drinkers as compared to bell drinkers.

It is concluded that heat stress adversely affects the commercial poultry production through reduced feed intake and high mortalities. The negative effects of heat stress on broilers and laying hens, reduced growth and egg production to deteriorate egg quality. High environmental temperature increases mortality of poultry due to inhibition of immune responses. Feeding management practices such as changes in energy: protein ratio, wet feeding, feeding time, drinker type and height had improved performance under high environmental temperature.

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