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Strategies to Minimize Heat Stress in Broiler and Layer Chickens

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Abstract

Heat stress is one of the most important thermal environmental factors challenging broiler and layer production throughout world. Negative effects of heat stress on broilers and layer production range from reduced growth and egg production to reduced egg quality. Heat stress is more in chickens with high production performance and more feed conversion efficiency. Prolonged exposure to hot weather will lead to imbalance of acid-base equilibrium in body, decreases blood supply to visceral organs, water imbalance and immune suppression in birds. Use of balanced nutrition reduces the negative effects of heat stress by maintaining feed intake, electrolytic and water balance. Supplementation of micronutrients such as vitamins and essential minerals is necessary to fulfill the special needs during heat stress. Increase in birds' thermotolerance by early heat conditioning or feed restriction seems to be one of the most important management methods in enhancing heat resistance of layer and broiler chickens.

Keywords: *Heat stress, broiler, layer, production*

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INTRODUCTION

The intricacy to achieve a balance between body heat production and body heat loss leads to heat stress in broiler and layer chickens. Heat stress has severe and economical effects on chickens and occurs due to high relative humidity and low air speed. The unfavorable effects of heat stress comprises of high mortality, decreased feed consumption, poor body weight gain and meat quality in broiler chickens whereas poor laying rate, egg weight and shell quality in laying hens [1–3]. In broilers and turkeys, it can also lead to poor feed conversion. Major factors which increase the susceptibility of birds for heat stress include genetics, feather cover, high stocking density, acclimation, drinking water temperature and availability. Heat production is affected by body weight, species and breed, level of production, level of feed intake, feed quality and to a lesser extent by the amount of activity and exercise. If the stocking density is too high for the size of house and ventilation equipment then due to addition of more metabolic heat addition to house air, temperature may rise perilously. Feather cover and size of comb and wattles are characteristics of the birds which affect heat loss.

According to Deeb and Cahaner (2001) [4], enormity of the decrease in body weight and body weight gain at high temperature (30°C) appears to be associated with high growth rate at normal environment (25°C). Fast growing broilers produce more heat and effect of heat stress is more prominent in commercial broiler stocks and broilers with high growth potential compared to the slower-growing chickens [5–7] reported that during high temperature fast growing broilers have more mortality as compared to slower growing broilers. The rise in environmental temperature more than upper critical limit in birds cause opposite response and produce various effects like blood circulation to skin, comb, wattles and upper respiratory tract increases two to four times. Consequently blood flow to liver, intestine, kidneys is reduced and birds stretch the body and take lying position closer to litter material and nearer to water pots or cooler. Water consumption increases by 1.2 to 3.2 times as per outside temperature and birds start panting (increase in respiratory and heart rates).

TOLERANCE TO HOT WEATHER CONDITIONS

Broiler and layer chickens can tolerate to some extent steady change of season to summer but if temperature rises suddenly, it results in heavy mortality. It is also reported that chicks exposed to higher brooding temperature during first few days are able to tolerate heat stress better in later life. Relative humidity in air greatly influences tolerance to heat stress. High temperature and relative humidity form a lethal combination for broiler and layer chickens (Table 1) and these conditions exist in coastal regions of India.

Table 1: *Effect of temperature and relative humidity on broiler and layer chickens.*

Environmental temperature (°C)	Environmental relative humidity (RH)	Consequence
20–26	Up to 40%	Optimum
26–30	40 - 75%	Harsh
30–40	Up to 45%	Progressively extreme
30–40	65% and above	Impossible

SIGNS AND SYMPTOMS OF HEAT STRESS

There is depressed appetite and more water consumption. Respiration rates increases even beyond 250 breaths/minutes in severe cases and panting and gasping is quite common. Birds look lethargic and keep their eyes closed, legs and wings outstretched. Birds try to lose heat by adjusting their feather position. Extremely pale comb and wattles and prostration are also common. There is drop in egg production, decreased egg size, egg weight and poor shell quality. During heat stress loss in body weight and increased cannibalism is also there. Laying hens are susceptible to heat exhaustion. Egg layers also require large amounts of calcium to avoid soft eggshells. When hot, hens may not eat as much so calcium consumption is low.

Prolonged exposure to hot weather will lead to following harmful effects.

a. Imbalance of Acid-Base Equilibrium in the Body of Birds*:* Loss of carbon dioxide (CO_2) because of continuous panting which results in increased blood pH or alkalosis in birds. Kidneys maintain acid-base balance by renal exchange of bicarbonates with chloride ion. This results in increased excretion of bicarbonates in urine and retention of chloride in plasma and that leads to systemic acidosis. Thus in heat stress initial alkalosis changes to systemic acidosis and birds dies due to acid shock. Diets containing ammonium chloride (0.3–1%) and sodium bicarbonate (1–2%) are useful in heat stress because ammonium chloride reduces blood pH and sodium bicarbonate prevents excessive acidosis. Electrolytes are also excreted in urine along with bicarbonates because bicarbonates are negatively charged and Na and K ions which are important electrolytes being positively charged are excreted with bicarbonates. Loss of electrolytes affects the water balance or acid-base Imbalance in the body of birds.

b. Blood Supply to Visceral Organs Decreases leads to poor weight gain, higher FCR (due to impaired digestion and assimilation) and enteritis.

c. Imbalance of Water in the Body of Birds*:* Normally water intake and water formed by oxidative metabolism in body is equal to the water loss through urine, faeces, respiration and evaporation. However, water loss is more through urine and respiration in heat stress and this leads to dehydration or decrease in extra cellular fluid level, fall in blood volume, blood pressure and rise in plasma osmolality. In this condition body releasing Renin from kidney cells and that increases thirst in the body. Vasopressin or anti diuretic hormone is released from pituitary gland which reduces urine output by increasing water resorption in renal tubules. There is less retention of water in cells is less because of loss of electrolytes and organic osmolytes (Betain, Sorbitol, Inositol), although birds drink more water. Negative water balance prevents internal cooling and hence there is further rise in body temperature. Water balance in the body cells against extra cellular osmotic gradients can be maintained through supplementation of osmolytes and electrolytes.

d. Decrease Immunity or Immune Suppression*:* In hot weather there is release of corticosteroids from adrenals and also depletion of plasma Vitamin C and reduction in lymphocyte count. The effect is immune suppression.

POST-MORTEM LESIONS

These include congestion of carcass, mucoid exudate in nostrils and mouth. In dead birds autolytic changes set in fast and post mortem examination of fresh carcasses may have engorgement of subcutaneous capillaries, congestion of abdominal and breast muscles, congestion of trachea, combs and wattles.

DIAGNOSIS

Diagnosis of heat stress can be done on the basis of signs and symptoms such as temperature recording. Efflux of Creatinine kinase from cells to plasma is there due to increase in intracellular calcium concentration. Elevation of plasma creatinine kinase is indicator of heat stress in chickens. But it is not necessary to conduct routine laboratory tests to diagnose heat stress condition.

PREVENTIVE MEASURES TO MINIMIZE HEAT STRESS

Housing Management

Houses of optimal height and insulation, painted white to reflect heat, evaporative coolers, plays a very important role in reducing heat stress. Well located and well laid out broiler and layer farms, with trees and lawns around and getting good breeze will have lesser problems in summer season. In addition, roof insulation plus increased ventilation by fans would help to withstand moderate hot weather. In extremely hot weather, these measures are not sufficient and evaporative cooling systems like sprinklers, foggers, or pad cooling are necessary. These systems work very well especially if relative humidity is low and temperature inside houses can be brought down by 10 to 15°C. Apply of fans without use of evaporative cooling system may be dangerous in intense hot weather conditions since it is only hot air that is blown in to the chicken house. In extremely hot weather condition, in deep litter system, if we can increase the quantity or number of earthen pot, it reduces heat stress to some extent.

Feeding Management

Feeding during cooler hours may be beneficial because digestion leads to production of heat. Feed withdrawal from 9 am to 4.30 pm is very effective in reducing heat stress mortality in birds. There is production of nearly 7% additional heat in the body due to feed intake and digestion which is maximum 4 to 5 hours after feed intake. This should not coincide with hottest part of the day (1 to 3 pm). Birds fasted in the day compensate intake in the night time.

Following feeding interventions should be adopted to manage heat stress in birds as follows:

- Increase the energy level of the diet (2850 kcal ME/kg minimum) ideally by incorporation of fats or oils. Limit the use of fibrous ingredients if possible. According to Zhou and Yamamoto (1997) [8], there is increase in heat production with feeding level.
- Reduce crude protein component (17% CP maximum) while maintaining daily intakes of methionine (360 mg) and lysine (720 mg). According to Temin *et al.* (2000) [9], decreased protein synthesis cannot be restored by high dietary protein level in broiler and layer chickens. High dietary protein levels at high temperature reduce both growth rates as well as meat yield in fast growing commercial broiler chickens [5].
- Fat should be increased by 2 to 3% at the cost of carbohydrates without changing metabolisable energy (ME). Fats are good in summer because their heat increment value is lowest, give better cooling effect in body because of higher water content and fat stimulates feed consumption.
- Mineral-vitamin premix is important component in feed of layer and broiler feed. Maintain daily intakes of calcium (3.5 g) and available phosphorus (400 mg). In an experiment conducted by Kucuk *et al.* (2003) [10], zinc supplementation resulted in an improved live weight gain, feed efficiency and carcass traits.
- Vitamin C: There is increased demand for vitamin C by adrenal glands for controlled production of hormones required for gluconeogenesis because of release of corticosteroids in heat stress. In heat stress there is also reduced synthesis and partial depletion of vitamin C. Inclusion of vitamin C at 200-400 g/ton of feed is recommended in summer months. If incorporated in feed of chicken then no need to give in water again. Vitamin C supplementation increase carcass quality and carcass CP content as well as reducing

carcass crude fat content in chicken [11]. Ferket and Qureshi (1992) [12] reported vitamin supplementation to be beneficial for the performance and immune function of heat-stressed chickens.

- Antioxidants: In heat stress there is excessive oxidative metabolism and release of free radicals in the body. Free radicals damage all types of biological molecules and cells of vital organs. Vitamin E captures and neutralizes free radicals and its inclusion at 50 to 100 ppm in feed is advisable. Vitamin C also has antioxidant property.
- Toxin binders: In wet summer, there is rapid growth and toxin formation in feed. Good quality toxin binders at higher dose should be used in feed.

Cold Water

Cool water should be supplied continuously to birds. Watering space should be doubled. Overhead tanks and pipe system should be properly covered to keep the water cool. Providing fresh cool water (5°C) in noon time is very effective for internal cooling of body and reducing symptoms of stress. Branton *et al.* (1986) [13] and Balnave and Oliva (1991) [14] reported that supplementation of electrolytes in water increases water consumption and in turn tolerance to heat stress. Increased water consumption in chickens has no negative effect on the meat quality [15, 16].

Stocking Density

Adequate ventilation should be provided as per number of birds housed. Stocking densities should not be exceeded more than recommended numbers and during hot weather stocking density should be less in shed as well as during transport to avoid overcrowding. The house structure should be sufficiently insulated to avoid solar heat radiations. There should be proper maintenance and regular testing of emergency ventilation equipments. Summer heat places enough stress on birds so unnecessary activities should be avoided during the hottest time of the day to minimize stress.

Vaccination Time

Strict cold chain should be maintained during transport storage and administration of vaccines. Vaccination should be carried out during cool hours. Immunostimulants like avetotal (combination of levamisole, fructose, electrolytes and vitamins) should be given for three days following each vaccination.

CONCLUSION

Summer is an exigent season to chickens farming. Higher production performance and feed conversion efficiency in chickens directly proportional to the heat stress or more susceptible to heat stress. There is no single solution to hot weather problems and heat stress management requires a series of interventions. Installation of evaporative cooling system on farms, withdrawal of feed during hot part of day, provisions of fresh cool drinking water with vitamin C, electrolytes and sodium bicarbonate are important measures to be taken to minimize the major losses and increases the broiler and layer production at farms.

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