Heat Stress Management Practices in Poultry

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Abstract— Higher production performance and larger feed efficiencies in modern day poultry have made them highly vulnerable to heat stress. Ambient conditions, especially high temperature in combination with high relative humidity in poultry shed leads to heat stress in poultry birds and in turn reduces their productivity and increases mortality significantly. India, being predominantly a tropical country, the day time temperatures during summer reaches as high as 45°C at many places. The capital and operational cost of conventional evaporative air cooling system is very high as compared to the investment standards of poultry management in India. Apart from this, poultry sheds are generally located in rural areas where schedule power cuts are normal affair. Hence, majority of the poultry operators do not use proper cooling system which makes them susceptible to the adverse effects of temperature on production cost and hence profits. The present work is focused on study of low cost practices for cooling poultry birds through operational interventions. This study will help to plan for reducing mortality, improve productivity and thereby increase profit for the farm owner.

Key words: Heat stress, poultry management, poultry industry

I. INTRODUCTION

The problem of heat stress in poultry birds is seasonal and of variable duration but it has significant economic impacts. As birds body temperature rises, feed consumption, growth rate, feed efficiency, egg shell quality and survivability decline. Many solutions have been proposed, but no sure cure exists for this dilemma [3]. As the poultry production is growing in tropical and sub-tropical regions of the world, there is a need to review the management practices and find out suitable long term strategy to deal with problem of heat stress.

Birds are 'heat stressed' if they have difficulty achieving a balance between body heat production and body heat loss [6]. High ambient temperatures combined with high humidity may lead to very harmful effects in commercial broilers. Further it was observed that during periods of heat stress, broiler has to make major thermo-regulatory adaptations in order to prevent death from exhaustion. Full genetic potential of broilers is not often achieved due to all these reasons [8]. The adverse effects of heat stress includes high mortality, decreased feed consumption

Two approaches are adopted in general for management of heat stress in chickens. First deals with reducing the metabolic heat generation in the chicken's body while the second approach relates to increasing the heat dissipation in chickens by use of different cooling techniques. Practices aimed at reducing metabolic heat are more complex and less well understood []. There is a third Theraptic approach which also is used in some cases to deal with negative effects of heat stress. Different practices following these approaches are involved in poultry management which is discussed below.

II. LITERATURE SURVEY

Heat stress is developed in birds during hot weather. DEFRA report in ref [6] states that birds are 'heat stressed' if they have difficulty achieving a balance between body heat production and body heat loss. Also this can occur at all ages and in all types of poultry.

Butcher *et al* observed in ref [8] that high ambient temperatures can be devastating to commercial broilers and when it is combined with high humidity, they can have more harmful effects. Thus heat stress interferes with broiler comfort and suppresses productive efficiency. Further the team observed that during periods of heat stress, broiler has to make major thermo-regulatory adaptations in order to prevent death from exhaustion. Full genetic potential of broilers is not often achieved due to all these reasons.

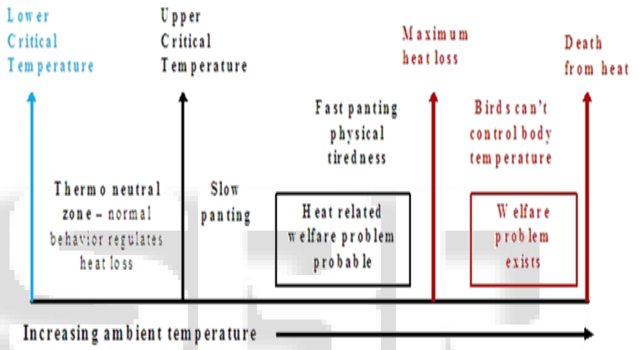

Fig. 1: Thermo-neutral zones

As illustrated in figure 1 by DEFRA report, between the lower and upper critical temperature, birds can lose heat at a controlled rate using normal behavior. There is no heat stress and body temperature is held constant. According to John Watt [13], this range lies between 21 to 26.7 ºC. When 'upper critical temperature' ie 26.7 ºC is exceeded, birds must lose heat actively by panting. Panting is a normal response to heat and is not initially considered a welfare problem. But as the temperature increases further the rate of panting increases. Beyond 29.4 ºC, birds reduce their feed consumption and as temperature cross 32.2 ºC, the egg size and production decreases in layers. Watt observes that beyond 35 ºC, hens start losing weight. If heat production still increases beyond 'maximum heat loss' by the bird's body, either in intensity (acute heat stress) or over long periods (chronic heat stress), birds will die. As per Watt's observations, birds start dying beyond 37.8 ºC ambient temperature. DEFRA report observed that body temperature of the broiler must remain very close to41 ºC (106 ºF). If body temperature raises more than 4 ºC above this, the bird will die. As per Watt, body temperature of broiler is 41.7 ºC. It is important to note that a welfare problem is likely to occur somewhere between the 'upper critical temperature' and 'maximum heat loss', i.e. before bird losses occur [6]. Teeter et al have observed through experiments that 32 ºC and 50% relative humidity are the benchmarks for beginning of heat stress in hot environments [3].

Medlin et al [12] has stated in their patent report that poultry houses must be ventilated and cooled to prevent the mortality of the poultry when the sum of the ambient temperature and the relative humidity inside the poultry house exceeds a known value. It is generally accepted that when the sum of the ambient temperature, measured in degrees Fahrenheit, and the relative humidity exceeds about 180, the poultry can easily suffer mortality. Most poultry farmers agree that it is necessary to reduce the ambient temperature inside the poultry house when the sum of the ambient temperature and the relative humidity exceeds about 160. To this end, it is desirable to maintain the ambient temperature inside the poultry house at or below about 82 degrees Fahrenheit i.e. 27.7 ^{o}C. It can be seen that where relative humidity is less, little higher temperatures could be acceptable as comfortable for birds.

As mentioned in DEFRA report, heat is produced by metabolism within the body, which includes maintenance, growth and egg production. 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 amount of activity and exercise. Gupta et al has noticed that metabolic rates are high in modern day poultry due to their high growth rates and this further aggravates the situation during heat stress [9]. Heat is also added from the roof, walls, working litter and electric bulbs used in the shed.

According to Lara et al, heat stress leads to certain behavioral and physiological effects, suppresses the immune response and thus ultimately affects the poultry production [10].

Yahav et al stated that the main environmental factors affecting performance of broiler chicken are ambient temperature, relative humidity and air velocity. At high temperatures, it is important to maintain body energy and water balance. Further they observed that birds, as homeotherms, can balance body energy by reducing heat production, increasing evaporative heat loss (via panting) and increasing sensible heat loss (convection and radiation) or a combination of these [7].

DEFRA report has explained the ways by which birds lose heat in normal ways. These are discussed below.

Radiation- Heat will be lost from the body by radiation if the surrounding surfaces are below bird surface temperature. Conversely, hot walls and roofs may radiate heat to the bird surfaces. In short, it is difficult for birds to lose heat by the way of radiation if the ambient temperatures are higher.

Convection- Heat loss will occur from the natural rise of warm air from around a bird's hot body. Providing moving air can assist convection, but only if the air moves fast enough to break down the boundary layer of still air that surrounds the body. Gupta et al had found that exhaust fan and ceiling-fan both have significant effect on the comfort and production efficiency of broiler chicks during hot humid season. Further they found that exhaust fan system was more efficient than cooling fan system [9].

Conduction- Heat will transfer from one surface in contact with another surface, for example, if the birds are seated on litter that is cooler than their bodies, then they lose heat to the litter as long as it is cooler than the bird's body. However, the litter immediately under the birds soon assumes a temperature close to that of the body. Birds also lose heat to cooler surfaces like walls; cement blocks which are cooler than bird's body via conduction.

Further DEFRA reports that, after the birds can no longer maintain its body heat balance by one of these three methods, it must use "evaporative heat loss", or panting. Evaporative heat loss, whilst essential to the bird, does not contribute to heating the house.

Evaporation is very important at high temperatures as poultry does not sweat but depend on panting for losing extra heat. This is only effective if the humidity is not too high. Hot, humid conditions are therefore much more stressful than hot dry conditions [6].

Yahav et al observed that panting is an evaporative kind of heat loss and is a much higher energy cost pathway for heat loss than sensible heat loss. Panting further affects blood acid-base balance and body water balance thus adversely affecting the ability to maintain body temperature in a normothermic range. Importance of air velocity at high ambient temperatures lies in its effect on body energy and water balance.

Yahav et al further observed that any shift from evaporative to sensible heat loss may reduce maintenance energy and thus increase the amount of energy available for growth. Sensible heat loss can also prevent hyperthermia caused by dehydration, which results from severe panting. Unbalanced energy and water budgets are detrimental to broiler performance. At high ambient temperatures, optimal air velocity may enable cooling to be partially shifted from the evaporative to the sensible pathway and so to improve both water and energy balance [7]. This means that evaporative cooling should be used as next option to ventilation and high air speeds for cooling.

III. FIELD SURVEY

Field data was collected showing mortality of birds over last one year at a layer farm located at Daund in Pune district of Maharashtra. The flock size is 13000 birds and the bird variety is White leg horn BV 300.

Month/year	Mortality	Percentage	Reason
18 Apr to 30 Apr 2015	90	0.71	Summer + Dehydration
May '15	87	0.70	Summer + Dehydration
June '15	130	1.00	Summer + Entritis
July '15	64	0.50	Summer + Entritis
Aug '15	33	0.26	
Sept '15	35	0.26	
Oct '15	24	0.22	
Nov '15	32	0.26	
Dec '15	27	0.28	
Jan '16	54	0.42	
Feb '16	37	0.27	
March '16	70	0.54	Summer
Apr '16	331	2.62	Summer

Table 1: Field data showing monthly mortality in layers.

The data in above table clearly shows that the problem of heat stress is seasonal and summer heat has distinct effect on the mortality of birds. The mortality increases significantly in the months of March, April, May and June which are typically summer months.

It is observed that the effect of heat stress is amplified as we move towards the continental part of the country. Mainly north, central and south central parts of India covering Uttar Pradesh, Madhya Pradesh, Maharashtra, Telangana, Andhra Pradesh and Karnataka which is major area with poultry farms and has higher average summer temperatures and wide diurnal temperature ranges.

IV. HEAT STRESS REDUCTION STRATEGIES

Different strategies are adopted to keep the level of heat stress in the poultry birds at lower level. Some of them are discussed below.

A. *Feeding Practices:*

Lower feed intake is associated with major economic losses in chickens [4]. To improve the feed intake, measures such as running automatic feeders more frequently, shaking the feeders manually, feed pelleting, providing lighting for long hours and using high nutrient density diets are being employed by poultry farmers. But during the period of heat stress, reduction in feed intake is the natural response of chickens to reduce metabolic heat of body so these measures to increase it could prove to be counterproductive.

Effects of fasting on tolerance of young chicks to acute heat stress were first investigated by McCormick et al [5]. It was observed that fasting induced in the chicks 24, 48 or 72 hours before exposure to acute heat stress increased their chances of survival during a 6 hour acute heat stress exposure test by almost double than the survival rate in non-fasted chicks. But such longer periods were non-practical and hence fasting techniques were not used widely in poultry industry in those days. But the more recent data and studies in ref [3] has established the benefits of feed restrictions in alleviating negative effects of heat stress.

Time of feed withdrawal related to stress initiation	Ambient temperature (ºC) at feed withdrawal	Survival (%)	
		Experiment-1	Experiment-2
24 hrs before	26.7	92.0^{a}	-
12 hrs before	26.7	86.7^{a}	81.7^{a}
6 hrs before	26.7	80.0^{a}	70.0^{ab}
3 hrs before	26.7	-	67.7^{ab}
Stress initiation	32.2	-	60.2^{bc}
2 hrs after	35.0	-	48.7^{cd}
3 hrs after	36.7	-	49.0^{cd}
4 hrs after	38.8	-	48.7^{cd}
Not withdrawn	-	51.6^{b}	45.2^{d}

Table 2: Effect of feed withdrawal time on ability of broilers to survive acute heat stress

^{a}- heat stress defined as an environment providing 32.2 ºC and 55% relative humidity, ^{abcd} means within a column with unlike subscripts differ.

B. *Nutritional Practices:*

Nutritional strategies involve maintenance of dietary protein level and amino acid compositions. Heat stress affects protein deposition in the birds. this leads to reduction in the protein deposition. This can be restored by high protein diet but it affects the growth of birds at high temperature.

On the other hand, decreasing dietary protein level increases the negative effects of heat stress. Also, low protein diet is harmful as birds will try to fulfill the requirement of protein by eating more feed and thus increasing heat production as well as fat deposition.

Supplementation of essential amino acids is helpful in reducing the heat stress and thereby reduces the harmful effects of hot weather in birds.

Emission of ammonia increases with the increasing levels of ambient temperature. This disturbs the capacity of birds to manage effectively the body temperatures. [1]

Enhanced respiration rate during the period of heat stress disturbs the acid-base balance of the birds. It could be restored by providing supplements of KCL or NaCl or K_2SO_4 which will enhance the growth and survival of birds. [3]

Supplements of Vitamin A, Vitamin C and Vitamin E also help in reducing the heat stress in birds. [1]

The electrolyte and water balance is disturbed sue to panting and hyperventilation. This leads to respiratory alkalosis suppressing the growth in broilers. Electrolyte supplementation through diet is beneficial for broiler chickens. Providing sodium bicarbonate through diet improves shell quality in layers. It also improves consumption of water and improves heat tolerance of birds.[3]

C. *Environmental Practices:*

The light and dark schedule alters the fluctuations in heat production in birds. If lighting is provided intermittently, then feed efficiency and performance of broilers is improved. Broilers under 1L:3D light schedule produces less heat during early and late age.

Humidity affects heat loss from body during the period of acute heat stress. High humidity levels especially during higher atmospheric temperatures obstruct the heat loss through panting. So it is important to regulate humidity in poultry house especially during the hot and humid conditions [1].

Drinking water consumption is affected by the temperature of the water. Lower temperatures improve water consumption and helps in heat dissipation during acute heat stress. [3] Use of nipple waterers for drinking water supply helps in improving water consumption as well as controlling humidity in the poultry house.

D. *Management Practices:*

Facility design focusing on providing natural ventilation and avoiding direct sunlight are helpful in reducing heat stress in the birds.

Fasting before beginning of hot periods is beneficial in reducing metabolic heat production and thereby reducing effects of acute heat stress. It also improves survivability of birds during heat stress.

Heat conditioning in the early age is beneficial in improving the heat tolerance ability of the broilers. Feed restriction is a sure method of reducing the harmful effects of heat stress but it has to be done in a very controlled manner.

E. Cooling Practices:

Options available on the side of reducing metabolic heat generation are less understood and more complex. So it is imperative to use cooling options in case of acute heat stress for improving heat dissipation from the bird's body. It involves provision of ventilation in the first place. It is of two types, first using exhaust fans to replace inside stale air with outside fresh air and secondly using ceiling fans to increase the circulation of inside air as well as increasing the air speed. But any type of ventilation has a limitation that it cannot reduce the temperature inside the poultry house more than the ambient air temperature. If it is desired to cool the house further, evaporative cooling is one of the most generally used option. It uses misting nozzles or organic pads for providing evaporation of water. This sucks heat from the ambient air for evaporation and thus lowers the inside air temperature [11].

V. Conclusion

Higher production performance and larger feed efficiencies in modern day poultry have made them highly vulnerable to heat stress. Certain modifications in management practices and operational interventions can be helpful in reducing adverse effects of heat stress in chickens. Thermo-tolerance can be improved in chickens by feeding, nutritional, environmental and certain cooling practices. This will improve the production and reduce mortality in chickens and ultimately improve profits for farmers.

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