INTRODUCTION

In many parts of the world, the poultry industry occupies a leading role among agricultural industries, as it is the main supplier of animal protein for human population. Hot weather is a common problem in tropical countries such as Botswana with summer temperatures above 30 °C. The detrimental effects of a hot environment on the performance of poultry have been well documented. Heat results in decreased feed consumption and increased water consumption. As temperature rises, the bird has to maintain the balance between heat production and heat loss, and so will reduce its feed consumption to reduce heat from metabolism. Research demonstrated that feed consumption is reduced by 5% for every 1 °C rise in temperature between 32-38°C. At high temperatures, heat production in birds decreases while heat dissipation increases. The main pathway of heat dissipation for birds under hot environment is respiratory evaporation, especially when ambient temperatures approach the body temperature.

Poultry production in Botswana as in other hot regions suffers significant losses every year because of heat stress, especially from sudden heat waves, which usually occur during summer. For instance, extremely high ambient temperatures were experienced in Botswana in the first quarter of the year 2007, which resulted in economic losses to the poultry farmers. During this period temperatures approached 40 °C most of the time. The value of losses due to heat stress could not be estimated in this paper.

In poultry production, heat stress can be described as acute or chronic. Acute heat stress refers to short and sudden periods of extremely high temperature, whereas chronic heat stress refers to extended periods of elevated temperature. Chronic stress has deleterious effects on birds reared in open-sided houses mainly through reducing feed consumption and increasing water consumption. Most of the reduction in feed consumption is due to reduced maintenance requirement. In broilers, growth rates, feed efficiency and carcass quality are negatively affected. Again, prolonged periods of elevated ambient temperature increase the broilers’ time to reach market weight and increase mortality. In laying hens, heat stress leads to a decline in egg production and egg quality, as well as, shelf life of eggs is shortened. In breeders, high ambient temperature coupled with high humidity decreases fertility resulting in low hatchability. During the heat stress period the increase in body temperature has a negative effect on gamete formation and the fertilization process. The purpose of this paper is to review the effects of heat stress on poultry performance and feeding strategies that can be used by producers to alleviate heat stress.
SOME RESPONSES OF BIRDS TO HEAT STRESS

As ambient temperature increases above comfort zone (also thermoneutral zone, chickens devote less time to walking, standing or resting (Figure 1). When exposed to high temperatures, domestic fowls may splash water on their combs and wattles in order to increase evaporative cooling from these surfaces. Heat stressed birds also spend relatively less time engaging in social behaviour and in changing posture. Also, the wings droop and are held slightly away from the body to enhance cooling. In a natural environment, birds will look for a shady and cool area.

![Heat stressed broilers](image)

**Figure 1** Heat stressed broilers

Birds are heat stressed if they have difficulty in achieving a balance between heat production and body heat loss. Figure 2 shows that at thermoneutral or comfort zone, birds can lose heat at a controlled rate, whereas above critical temperature they lose heat actively by panting. Panting increases with increased ambient temperature. If heat production exceeds maximum heat loss either in intensity or over long periods of time, birds may die. Temperature increase by 4 °C above 41 °C will give rise to death in broilers.
FEEDING STRATEGIES

Minimizing heat stress is a vital part of having a profitable flock. As mentioned earlier, during hot weather birds reduce feed consumption resulting in some nutrients becoming deficient. To encourage feed consumption during heat stress various feeding strategies are employed in many tropical and subtropical environments which are outlined below.

INCREASE NUTRIENT DENSITY OF THE DIET

It is recommended that the energy content of the diet be increased during hot weather. The use of supplemental fat is suggested. Dietary fat increases palatability of feeds and reduces the amount of heat increment that is produced during its utilization in the body.

INCREASE DIETARY PROTEIN

In hot weather the need for maintenance energy is much lower than at an ideal temperature and birds respond by eating less. With the reduction in consumption, there is often a reduction in intake of essential nutrients such as protein, essential amino acids, minerals and vitamins. When this reaches a critical level, the result is reduced egg size, shell thickness and egg production in laying hens.

To ensure that layers do not suffer nutritional stress of hot weather, it is recommended that protein content of feed should be increased from 16% to 17-18%. It is contended that increasing dietary protein content would cover the requirements for isoleucine and typtophan, while methionine and lysine can be supplemented with synthetic compounds provided that they are cheaper than natural sources. There is, however, fear that increasing dietary protein might be detrimental to the bird as more heat is produced during its utilization that may well overload heat dissipation mechanisms (i.e., panting, blood circulation etc.). Therefore, improving overall balance of the diet by amino acid supplementation appears to be more effective than increasing protein intake.
FEEDING CALCIUM CARBONATE OR OYSTER SHELLS

Calcium content of the diet should be adjusted according to anticipated level of intake, such that each bird consumes the right amount per day. For laying hens, top dressing feed with oyster shell or large particulate limestone is beneficial and has the added advantage of stimulating feed consumption. Limestone and oyster chips may be provided at a rate of 625 g per 100 hens.

FEEDING MANAGEMENT

Reduced feed consumption is the main cause of poor performance at high temperatures and the feeding practices suggested below are reported to improve performance of birds under heat stress.

- **Ensure good physical quality of feed** (crumb, pellets or mash) to encourage appetite. If there is enough floor space, extra feeders should be added.

- **Feed should not be stored for longer than two months**, especially in summer to reduce the possibility of mycotoxin build up.

- **Encourage eating at cooler times of the day**, i.e., early morning or in the evening. Feeding birds at cool times enables birds to make up for what they have not eaten during the day. Laying hens increase their calcium intake during the evening as eggshells are normally formed during this time.

- **Remove feed** 4 to 6 hours prior to an anticipated heat stress period. Birds should not be fed or disturbed during the hottest part of the day.

- **Dim the lights while feeding** – using low light intensity during periodic feeding reduces activity that reduces heat load.

SUPPLEMENTS (MINERALS AND VITAMINS)

Imbalances in acid-base balance occur in heat stressed birds. Therefore, inclusion of various compounds in the diet or water is a common practice to alleviate the adverse effects of heat stress. These include sodium bicarbonate (NaHCO₃), potassium chloride (KCl), calcium chloride (CaCl₂), ammonium chloride (NH₄Cl) and vitamin C (ascorbic acid). Sodium zeolite and aspirin are also beneficial in reducing the effects of heat stress in laying hens. In Botswana, the majority of commercial poultry farmers administer Phenix stresspac via drinking water to alleviate effects of heat stress on poultry. Ascorbic acid and NaHCo3 appear to be the most popular electrolytes used in tropical and subtropical poultry production.

Stressors such as disease and heat stress may increase the chickens’ need for vitamin C. During heat stress the chicken is not able to synthesize enough vitamin C to meet physiological demands, hence the need for mineral and vitamin supplementation. Chickens require vitamin C for amino acid and mineral metabolism as well as for synthesis of hormones. Vitamin C is also involved in the synthesis of the sex hormones
such as testosterone, which is essential to the reproductive performance of males. Supplementation of vitamin C in drinking water at 40 milligrams per bird per day is reported to give beneficial effects in broilers. In laying hens, 20 milligrams per litre of water is recommended. Also, aspirin in soluble liquid form can be used for its antipyretic (cooling) effect at the rate of 0.3 grams per litre of water.

Research has shown that sodium bicarbonate at high temperature stimulates water and feed consumption as well as contributing to improved weight gain. Sodium bicarbonate provides an alternative source of sodium that assists with litter control by providing drier litter and a healthier living environment. The addition of 8 grams of sodium bicarbonate to the 100 litres of drinking water (or 35 grams per 25 kilograms) can be useful in heat stressed broilers to stimulate water consumption (Butcher & Miles, 2003. For broiler breeders, 0.05 to 0.30% are reported to give beneficial results (Naseem et al., 2005).

Conclusion

During heat stress feed intake is depressed while water intake is increased. The decline in feed intake leads to poor bird performance. To alleviate the effects of heat stress, dietary manipulations are necessary, as these can help reduce metabolic heat production and maintain nutrient intake. It is also necessary to minimize bird activity during the hottest parts of the day in order to lessen the heat burden.

References

Available from the author on request