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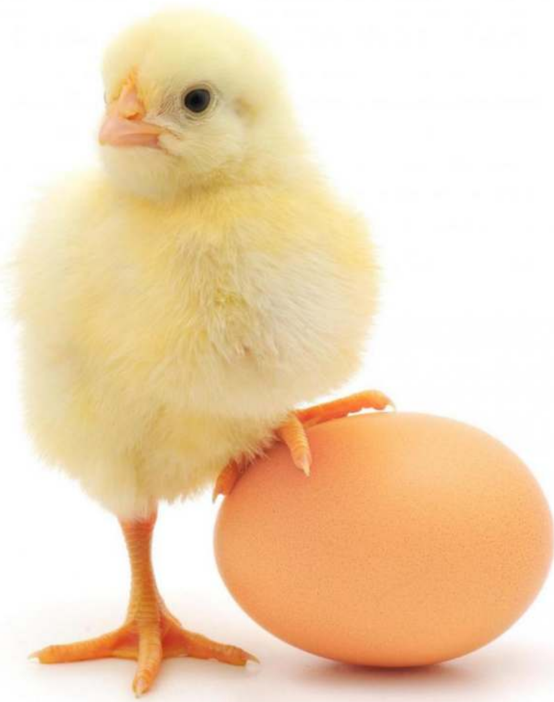

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Feeding Management of Poultry in High Environmental Temperatures

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Abstract: Poultry can only regulate their body temperature within a narrow range of environmental temperatures (between 16-26°C). In the tropics, environmental temperatures are usually above this zone during most part of the year. High ambient temperatures adversely affect the performance of poultry with meat-type birds being more susceptible than egg-type birds. The poor performance of poultry under high ambient temperatures is mainly as a result of decreased feed intake which consequently reduces growth and meat quality, egg production and egg quality and efficiency of feed utilization. Several feeding practices have been used to alleviate the adverse effects of high temperatures on poultry performance. Although most studies on nutritional management of heat stress have been carried out in broilers there are also few reports on nutritional management in laying hens under heat stress condition. Feed form (particle size, moisture content), nutrient manipulation (especially energy and protein), electrolyte and vitamin supplementation, feeding time/feed restriction, choice feeding and drinking water management have all proven to be beneficial to heat-stressed poultry. The present paper reviews some common feeding management practices used to alleviate the effect of high ambient temperatures on poultry performance as well as their limitations.

Key words: High temperatures, poultry performance, feeding management

INTRODUCTION

The environmental temperature range within which poultry are able to keep a constant body temperature with minimum effort ('thermo neutral zone' or 'comfort zone') is ranges from 16-26°C. In the tropics, environmental temperatures are above this range during most part of the year. As temperature rises above the "comfort zone" (common in the tropics), poultry are susceptible to heat stress because they can no longer keep a balance between body heat production and heat loss.

The effects of heat stress in poultry are varied and range from decreased feed intake (NRC, 1994; Yahav, 2000; Sohail *et al*., 2012), reduced weight gain and meat quality in broilers (Imik *et al*., 2012; Zhang *et al*., 2012), reduced rate of lay and egg qualities (Star *et al*., 2008; Deng *et al*., 2012), increased feed conversion ratio (Niu *et al*., 2009; Imik *et al*., 2012) and high mortality rate (Shane, 1988; Yahav, 2000).

Birds of all classes and ages suffer from heat stress, but meat birds are more susceptible than egg-type birds and this is probably, the reason why the management of broilers under high temperatures has received more attention. The effects are also more pronounced in older birds as the increase in size and insulation reduces their ability to dissipate heat compared to young birds.

Several management practices have proven to be beneficial in alleviating the adverse effects of high ambient temperatures on poultry. This paper reviews the some feeding practices that may alleviate the adverse effects of heat stress in poultry.

FEEDING MANAGEMENT DURING HEAT STRESS

Feed form: The form in which the feed is fed affects its intake by poultry at high ambient temperatures. Poultry, especially broilers, have been reported to prefer feed with larger particle size in hot climate (Syafwan *et al*., 2011) as an attempt to reduce feeding time and body heat production. Feeding pellets have been shown to ameliorate the effect of HS in chickens by reducing feeding time and saving energy (Gous and Morris, 2005; Syafwan *et al*., 2011). Almirall *et al*. (1997) also reported increase egg production; feed efficiency and water intake of laying hens fed pellets under high temperatures compared to mash feeding.

Improved feed intake and efficiency of utilisation have been observed in heat-stressed broilers fed wet mash compared to dry mash fed birds (Kutlu, 2001; Moritz *et al*., 2001; Khoa, 2007; Awojobi *et al*., 2009). Mixing the diet of broiler chickens with water in the ratio of 1.5:1 resulted in significant increases in body weight gain, dry matter (DM) intake and carcass weight (Kutlu, 2001). Similarly, moistening the feed of laying hens at the ratio of 1:1 (feed: water) at high environmental temperature improved laying performance compared to dry feeding (Tadtiyanant *et al*., 1991). The increased DM intake on

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wet feed which increases micronutrients intake is probably the main factor responsible for the improved performance of poultry in high environmental temperatures.

Dietary energy concentration: Dietary energy concentration is an important factor governing feed intake as poultry consume feed to meet energy requirement. Poultry kept under HS, have the desire to control their body temperature by reducing energy intake. Feeding low metabolizable energy (ME) and high protein diets has been reported to be advantageous under moderate HS condition (De Andrade *et al*., 1977; Balnave and Murtisari Abdoellah, 1990). As the environmental temperature increases however, there is increased need for dissipating body heat through panting which increases the need for ME. Under such conditions, fats have been shown to be the ideal source of dietary ME due to their lower heat increment compared to carbohydrates and proteins. Mateos *et al.* (1982) also observed that addition of fat to the diet decreased the rate of feed passage in the GIT and increased nutrient utilisation. Improved heat tolerance of broilers with dietary fat addition has also been reported by Daghir (1995), Zulkifli *et al.* (2007) and Ghazalah *et al.* (2008). If energy density is to be increased however, the level of all other nutrients must be adjusted in order to keep their intake at optimum levels.

Protein and amino acids levels: Protein nutrition of poultry in high temperatures is well documented. Decreased synthesis and increased breakdown of proteins have been reported under HS (Lin *et al*., 2006) but increasing dietary protein was not found to restore the rate of synthesis (Temin *et al*., 2000; Lin *et al*., 2006) probably due to the high heat increment of proteins. The growth rate and meat of fast growing broiler chickens were reported to be suppressed on high protein diets at high ambient temperatures (Cahaner *et al*., 1995). In another study, Alleman and Leclercq (1997) observed that decreasing dietary protein level results in poor feed efficiency (FE) and body weight gain (BWG) as chickens on low protein diets tend to eat more to meet requirement. The increased body heat production as a result of the increased feed consumption may be the primary reason for the poor performance. Gonzalez-Esquerra and Leeson (2005) found that the response of birds to dietary protein level is affected by the length of exposure to HS and that reducing the crude protein level as a means of combating HS was not justified.
Supplementation of low poor protein diets with essential amino acid (EAA) in heat stressed chickens has also been studied with varying responses. While some authors (Brake *et al*., 1998; Corzo *et al*., 2003) reported positive response of poultry to dietary EAA supplementation, others (Mendes *et al*., 1997; Rose and Uddin, 1997; Veldkamp *et al*., 2000) observed that the supplementation was unable to attenuate the adverse effects of HS in broiler chickens. Heat intensity and duration, breed and age of birds, level of EAA supplementation and diet composition may all be factors of variation in the response of heat-stressed poultry to low protein diets.

Electrolytes and vitamins supplementations: During panting, there is an increase loss of CO_2 and a decreased hydrogen ion concentration resulting in increased pH (alkalosis) according to the reaction below:

$$HCO^{-} + H^{+} \rightarrow H_2CO_3 \rightarrow CO_2 + H_2O$$

The change in acid-base balance and the decreased feed intake have been reported to be the main factors responsible for poor performance of heat stressed chickens (Teeter *et al*., 1985). The loss of CO_2 also reduces blood bicarbonate concentration and this is probably a major factor affecting the rate of lay and egg shell quality of heat-stressed laying hens.
Sodium (Na), potassium (K) and chlorine (Cl) are key mineral elements involved in the maintenance of the acid-base balance of body fluids (Borges *et al*., 2007). The beneficial effects of supplementing the feed or drinking water of heat stressed poultry with compounds of these minerals such as ammonium chloride (NH_4Cl), sodium bicarbonate ($NaHCO_3$), sodium chloride (NaCl), potassium chloride (KCl) and potassium sulphate (K_2SO_4) are well documented (Teeter *et al*., 1985; Smith and teeter, 1988; Ubosi *et al*., 2003; Ahmad *et al*., 2005). Teeter *et al.* (1985) supplemented diets of broiler chickens under HS condition with NH_4Cl at 3 and 10 g/kg feed and reported 9.5 and 25% improvement in weight gain respectively and a decrease in blood pH. The same authors reported an increased body weight gain of 9% when the diet was supplemented with 5 g $NaHCO_3$/kg feed They recommended the use of NH_4Cl and $NaHCO_3$ in combination as excessive use of NH_4Cl will increase the risk of acidosis.
The alleviation of the adverse effects of HS by supplementing the drinking water with Na^+, K^+ and K^+ and Cl^- salts were attributed to increased water consumption which facilitates heat dissipation and cools down the body (Smith and Teeter, 1988) and normalization of blood electrolyte balance (Ahmad *et al*., 2005). Ubosi *et al.* (2003) reported significant improvements in egg production and egg qualities of HS laying hens supplemented with 0.5% HCl in the drinking water. The increased water consumption as a result of high levels of Na^+ and K^+ has however, been found to increase excreta and litter moisture (Ahmad and Sarwar, 2006). There is therefore the need for further research into optimum supplementation with Na and K

compounds that will alleviate the adverse effects of HS and keep the litter at an acceptable moisture level.

The beneficial effect of vitamins on the performance of poultry under heat stress is well documented. Supplementation of the drinking water with vitamins A, D, E and B complexes has been found to improve performance and immune function of broilers under HS (Ferket and Qureshi, 1992). The use of vitamin C (VC) as anti-HS has received much research attention. The beneficial effects of VC supplementation are varied and range from reduction in respiratory quotient in heat-stressed birds (Kutlu and Forbes, 1993; Mckee *et al*., 1997; Kadim *et al*., 2008), decreased body temperature (Orban *et al*., 1993), improved performance through increased feed intake (Kutlu and Forbes, 1993) and nutrient utilisation (Fry, 1998). Ascorbic acid supplementation has also been reported to increase carcass weight and carcass protein content while reducing its fat content in broilers under HS (Kutlu, 2001). Daghir (2009) recommended VC at 1 g/L of drinking water throughout heat periods.

Feeding time and space: As fasted animals produce less heat compared to fed animals, withdrawal of feed during the hottest periods of the day and feeding during cooler periods (early morning or evening) have been shown to have ameliorating effects (Francis *et al*., 1991; Yalcin *et al*., 2001; Daghir, 2009). Ozkan *et al*. (2003) observed that feed withdrawal for 6 h/day (10:00-16:00h) during the 7 days before market age was not found to affect slaughter weight of broilers. Feeding laying hens during the evening period has been found to improve rate of lay and egg shell quality through increased calcium intake. Samara *et al*. (1996) reported favourable effects of feeding once a day (18:00) on the performance of laying hens during HS. Birds fed during the cooler periods of the day will increase their consumption to compensate for the loss of nutrients during fasting.

Because isolation is an important behavioural mechanism to cope with HS, increasing feeding space allowance by the provision of extra feeders may have beneficial effects under high temperatures. There is therefore the need to increase research into optimum feeder: bird ratios at high environmental temperatures.

Choice feeding: Choice fed birds have been reported to select from various feed ingredients to meet their nutrient requirements (Hughes, 1984; Yo *et al*., 1998). Birds that have access to choice feeding seem to select feed ingredients with less heat increment to reduce the heat load during the hottest periods of the day thus, improve their heat tolerance. Sinurat and Balnave (1986) observed that at high temperatures, choice fed broilers consumed less protein and more energy compared to those fed a complete diet probably in an attempt to reduce body heat production from the high heat increment of proteins. Similar observations were made with heat-stressed Japanese quail (McLeod and Dabutha, 1997).

Water supply: At high temperatures, which are characteristics of the tropical environment, chickens consume more water than feed. The reduced water intake is primarily behind the loss of production. According to NRC (1994), water intake of chickens increases by about 7% for each 1°C increase above 21°C.

Water temperature (Daghir, 2009), drinker type (May *et al*., 1997; Daghir, 2009), height (May *et al*., 1997) and shape (Daghir, 2009) have all been found to affect birds performance under HS. May *et al*. (1997) observed significant decrease in water intake from nipple drinkers at high ambient temperature compared to bell drinkers. These authors also reported an increased water intake from high nipple drinkers compared to low nipple drinkers probably due to heat produced during muscular efforts of stretching the neck to reach water from high nipples. As increased water consumption is an important factor limiting feed intake, the reduced consumption observed from these drinkers will increase feed intake and thus improve performance under HS. Daghir (2009) recommended the use of wider and deeper drinkers during HS as they will permit immersion of not only the beak but the whole face and help dissipate more heat.

Conclusion: High ambient temperatures adversely affect the performance of commercial poultry through reduced feed intake and high mortalities. Feeding management practices such as alteration of energy: protein ratio, wet feeding, electrolyte supplementation, feeding time, drinker type and height have been found to improve performance under heat-stress. However, the effectiveness of these practices will vary with several factors including the duration and intensity of heat, relative humidity, air velocity, class and age of birds.

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