



Role of Dietary Minerals in Heat-Stressed Poultry

Sneh D. Patel^{1*}, Bharat A. Pata² and Lokendra³

¹Dept. of Animal Nutrition, ²Dept. of Livestock Production Management, ³Dept. of Veterinary and Animal Husbandry Extension, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh, Gujarat (362 001), India



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Corresponding Author

Sneh D. Patel

✉ patelsneh0702@gmail.com

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Abstract

One of the main issues the poultry business in tropical regions is dealing with is heat stress. Several approaches have been recommended for minimizing the negative effects of heat stress and to reduce loss of production during this time. Nutritional management is one of the most effective methods and is used all over the world. Fulfilling the mineral requirement during heat stress is necessary in nutritional management for the effective performance of the poultry. Due to the limited feed intake during heat stress conditions, it is essential to supplement with minerals such as calcium, phosphorus, zinc, copper, iron, sodium, potassium, magnesium, selenium, chromium, manganese and iodine. These minerals support animal reproduction, increase nutrient uptake and at the same time efficiently reduce oxidative stress and improve the weakened immune systems of heat-stressed poultry.

Keywords: Heat stress, Immunity, Mineral, Poultry

Introduction

One of the biggest problems the poultry business is currently facing is heat stress. It lowers bird efficiency, which has a direct impact on income. When the net heat loss from the body is less than the net heat production, poultry are said to be under heat stress because they struggle to maintain an equilibrium between the two. Heat stress can impact birds of all species and ages. Compared to layer chickens, broiler birds are typically more sensitive to heat stress. The thermo-neutral zone in birds refers to the range of ambient temperatures, where the poultry's internal temperature stays more or less constant. Birds control their core body temperature (41 °C/ 106 °F) within a narrow temperature range of 16-26 °C. If the upper critical temperature is exceeded, bird resorts to panting which is a normal physiological response to the heat stress. Birds use a variety of tactics to reduce heat production from the body, one of which is reducing feed intake. Reduced feed intake causes decreased growth rates, poor meat quality, decreased egg production, poor egg quality and decreased feed utilization efficiency. The nutritional management of broilers is more commonly studied than that of laying chickens. Particle size, moisture content of feed, feed restriction, manipulation of energy and protein needs, choice feeding, supplementation

of herbs, electrolytes, minerals and vitamins and drinking water management are all helpful in alleviating heat stress in poultry. Minerals are essential for efficient development, egg production and reproduction. Heat stress has a detrimental impact on mineral metabolism. Heat stress causes an excess loss of minerals from the body, which not only diminishes the ability of poultry to adapt but may also result in disease conditions in chronic cases.

Calcium (Ca)

The production of eggs by the layers depends on calcium. Egg production is closely correlated with calcium intake levels. Chickens under heat stress frequently consume less calcium per day than 3.5 g. Stress decreases the intestinal expression of calbindin, a protein that binds calcium and is essential for calcium intake. Due to decreased calcium intake and inadequate absorption under heat stress, there is less calcium available for the formation of the egg shell, which leads to decreased egg production, smaller eggs or eggs with thin shells (Allahverdi *et al.*, 2013). In order to supplement calcium during heat stress, larger calcium source particles (such as limestone or oyster shell) are typically used because they are retained in the gizzard for a longer period of time and released slowly into the duodenum for ultimate absorption into the circulation.

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Phosphorus (P)

As the second-most prominent mineral in the body, phosphorus is crucial in poultry diets for proper development and growth. Because of the decreased growth, chronic heat stress has a lower requirement for the phosphorus that is easily available. When poultry are under heat duress, their nutrient intake is compromised, which lowers their intake of phosphorus. Furthermore, heat-stressed poultry have also been found to have lower plasma phosphorus content (Usayran *et al.*, 2001). Heat-stressed poultry should ingest 400 mg of the available phosphorus because extremely low levels can be fatal. Poor shell quality will result from an excessive phosphorus intake, but due to limited feed intake during heat stress circumstances, this is uncommon.

Zinc (Zn)

The most important element, zinc, is necessary for animals to grow and develop properly. It is a component of more than 300 enzymes connected to various processes in the body. Zinc is a crucial component of the enzyme carbonic anhydrase, which turns carbon dioxide into bicarbonates and then carbonate to form egg shells. Dietary zinc supplementation has a positive effect on the growth and FCR in heat stressed poultry. Zn (30 ppm) and Pyridoxine increased feed conversion and egg production in layers raised at high temperatures. Zinc supplementation as ZnSO₄ (30 ppm) combined with Vitamin A increased weight gain and feed efficiency in heat-stressed broilers. Zinc is essential for keeping an effective immune system during heat stress. During heat stress, zinc supplementation tends to raise antibody titer (IgM and IgG) and improve cell-mediated immunity in poultry (Sunder *et al.*, 2008).

Copper (Cu)

Copper is a component of a broad range of enzyme systems involved in various body processes such as anti-oxidant activity and bird immunity. Heat stress reduces copper intake due to decreased feed ingestion and increased excretion, which can contribute to marginal copper deficiency. Copper being the part of many antioxidant systems (SOD) may reduce the antioxidant activity in heat stress birds. Copper supplementation during heat stress may help birds deal more effectively. The copper requirement in birds ranges from 5 to 8 ppm of diet. Copper is present in significant amounts in egg shells (8.73 ppm). Any copper deficiency under heat stress may directly affect the quality of egg shell.

Iodine (I)

Heat stress typically lowers the levels of thyroid hormones in the blood, which may or may not be connected to the drop in feed intake. The serum T3, T4, and TSH concentrations decreased in the heat-stressed layers, and ACTH concentrations were increased. Metabolic and thermogenic functions are largely regulated by the hormones of thyroid glands in birds. Iodine deficiency in poultry causes many metabolic disorders and lowers the laying rates because they are very prone to it. The recommended iodine level for layer diets is 0.48 mg kg⁻¹ of feed.

Chromium (Cr)

Through its effect on insulin, chromium participates in the metabolism of carbohydrates, proteins, lipids and

nucleic acids. Cr supplementation would be beneficial because glucose is heavily utilized when under heat stress. Furthermore, serum Cr concentrations in heat stressed birds are lower than in thermoneutral birds, exposing the birds to additional stress circumstances. It reduces oxidative stress, lipid peroxidation and regulates the expression of hepatic nuclear protein and heat shock proteins in heat stressed layers. Organic chromium has more bioavailability and lower toxicity than the inorganic forms. Cr supplementation increases feed intake, egg production, weight, and strength of the egg shells as well as the Haugh unit. Supplemented Cr increases insulin, glucose, and cholesterol levels in heat stressed birds.

Sodium (Na), Potassium (K) and Chlorine (Cl)

The monovalent elements sodium, potassium, and chloride provide important functions in maintaining acid-base balance, osmolarity and electric potential across membranes (Borges *et al.*, 2007). Heat stress alters the acid-base balance of poultry due to excess excretion of carbon dioxide and leads to respiratory alkalosis. Mineral compounds like Ammonium chloride (NH₄Cl), Sodium bicarbonate (NaHCO₃), Sodium chloride (NaCl), Potassium chloride (KCl) and Potassium sulphate (K₂SO₄) can be supplemented to heat stressed poultry for maintenance of electrolyte balance.

Conclusion

The birds are under a lot of pressure due to heat stress. Some of the negative effects of heat stress can be successfully treated with trace minerals. The supplementation of trace minerals is absolutely essential for the birds to completely recover and perform effectively during heat stress, even though there are other ways to reduce the losses during heat stress.

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