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Supplementation of Vitamin C for health promotion and combating heat stress in poultry

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Abstract: Heat stress is known to be one of the major problems facing broiler industry in the tropical and subtropical areas¹. This is because broilers can only attain the desired economic market weight in a stress-free environment. Heat stress may occur at 27°C and above; therefore, the birds start to use more energy to lose the accumulated body heat. The birds increase their respiration rate to increase their evaporative cooling, thus causing heat stress due to aspiration of more ambient humidity via panting. The present review discusses on the various promising effect of Vitamin C supplementation in diet in regulating the deleterious effect of heat stress in poultry birds.

Key words: Heat stress, Poultry, Vitamin C

Introduction

Gray *et al.*,² demonstrated that broilers subjected to high temperature exhibit many behavioral changes which allow them to reestablish heat balance with their surroundings. Fuquay³ had earlier reported that in hot environment, emphasis should be placed on diets to increase intake or alter the levels of proteins, amino acids or other nutrients to improve the conversion of feed to meat. Broiler chickens are more susceptible to changing environmental conditions compared to other domestic animals.⁴ The detrimental effects of high ambient temperature on feed intake, growth rate, and feed efficiency of broilers are well documented.⁵⁻⁷ It has been shown that feed intake of 4-8 week old broilers is significantly reduced when environmental temperature rise above the thermo neutral ambient temperature (18-21°C).⁸ The reduction in feed intake of heat-exposed broilers results in a decrease in daily intake of nutrients in order to reduce metabolic heat production and maintain homothermy. In particular, high ambient temperatures depressed feed intake, weight gain and increased mortality rates among broilers.⁹

Stress due to environmental factors

Birds do not have sweat glands, and use non-evaporative cooling (radiation, conduction, and convection) for heat dissipation. If

panting (open-mouth breathing) fails to prevent their body temperatures from rising, birds become listless, then comatose, and soon die due to respiratory, circulatory, or electrolyte imbalances. Pardue and Thaxton¹⁰ reported that particular environmental stressors could alter ascorbic acid utilization or synthesis in poultry.

Role of Vitamin C in poultry birds in combating against environmental stress

A possible approach to counteracting the negative effects of heat stress among chickens could be the supplementation of birds with the optimum level of Vitamin C. Vitamin C is a water-soluble vitamin required by the body to maintain normal metabolic activities, and is synthesized in the body to meet physiological requirements in poultry. Under stress conditions such as low or high environmental temperatures, humidity, high productive rate, and parasite infestation, ascorbic acid synthesis is inadequate¹¹⁻¹⁵. At temperatures above or below the thermally neutral zone (18-22°C), corticosteroid secretion increases as a response to stress.¹⁶ By decreasing synthesis and secretion of corticosteroids, vitamin C alleviates the adverse effects of stress in poultry performance.¹⁷ Therefore, mortality rate observed during heat stress with adequate ascorbic acid supply is generally lower.

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Vitamin C plays a major role in the biosynthesis of corticosterone¹⁸, a primary glucocorticoid hormone involved in gluconeogenesis to enhance energy supply during stress¹⁹. However, under critically high ambient temperatures, the production of Vitamin C in broilers is inadequate for optimum performance.²⁰ Blaha *et al.*,²¹ Raja and Qureshi²² and McCormack *et al.*,²³ reported the beneficial effect of anti-stress factor in ascorbic acid to maximize broiler production in the temperate region.

Under hot conditions, birds are not able to synthesize sufficient amounts of ascorbic acid and supplemental ascorbic acid could significantly reduce the body temperature. David and Brake²⁰ found that 1000 ppm ascorbic acid supplementation in broilers reduced mortality by 14.6 percentages. Several researchers have reported beneficial effects of Vitamin C supplements given either in diets and / in drinking water. The beneficial effect of ascorbic acid in facilitating calcium absorption for adequate bone formation and strength was also reported by McCormack *et al.*,²³ and Newman and Leeson²⁴. Supplements enhanced performance of broiler chickens with experimentally induced hypothyroidism^{25,26}, reduced stress related response¹⁰ and improved disease resistance of the birds²⁷. Nutritional modifications usually made are the optimization of diets for covering the altered needs of stressed birds for protein and energy and for providing some additional nutrients. Because it is expensive to cool poultry houses, methods are focused mainly on nutritional modifications. For this aim, vitamin C is used in the poultry diet because of their anti-stress effects and also because their synthesis are reduced during heat stress.

Earlier studies showed that dietary vitamin C can be effective in reducing mortality in laying hens^{28,29} and broilers³⁰ reared under environmental stress. Pardue & Thaxton¹⁰ concluded that, although vitamin C is not an essential nutrient for chickens maintained in optimal conditions, it may become an essential vitamin for birds under environmentally, pathologically or nutritionally stressful conditions.

Conclusion

The increase in body temperature due to exposure to ambient temperatures above the thermal comfort zone has a negative impact on bird performance by decreasing livability, feed intake, and body weight gain. In the market number of synthetic vitamin C (ascorbic acid) and herbal vitamin C preparations are available.

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