PSM Veterinary Research ISSN(Online): 2518-2714

Mini-Review 2020 | Volume 5 | Issue 1 | 16-21

Article Info

Open Access

Citation: Ali, Q., Mafeng, L., Anchun, C., 2020. Role of Electrolytes, Vitamins and Minerals during Transportation Stress and Heat Stress in Broilers. PSM Vet. Res., 5(1): 16-21.

Received: January 4, 2020

Accepted: March 12, 2020

Published: March 31, 2020

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Role of Electrolytes, Vitamins and Minerals during Transportation Stress and Heat Stress in Broilers

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Abstract:
The higher growth rate and feed conversion efficiency of broiler birds make them more prone to transportation stress and heat stress than ever before. As from hatchery to farm and from farm to processing units the broiler chickens went through many stressors that affect their well-being as well as the production performance. The negative aspects of heat stress and transportation stress on poultry welfare have recently increased the awareness and concerns among the poultry industry. Much information has been published about the use of electrolytes, vitamins, and minerals against the negative effects of transportation stress and heat stress on the productivity and immune response in poultry. However, yet, the efficacy of most of the involvements has been variable or incompatible. This review highlights the scientific facts available on the importance and impact of transportation stress and heat stress in poultry production, with emphasis on broilers.

Keywords: Poultry broiler birds, transportation stress, heat stress, welfare, electrolyte, vitamin, mineral.

INTRODUCTION

Poultry is the 2nd largest industry in Pakistan. Being a source of proteins, the demand for poultry is increasing tremendously (Ali *et al.,* 2019a; Butt *et al.,* 2016; Hadyait *et al.,* 2018; Khanam *et al.,* 2016). Poultry fat can be used for biodiesel production (Ashraf *et al.,* 2017). The production of poultry and its utilization demonstrates the global trend towards an overall increase despite the temporary effects of the current slump. In 2018, the production of poultry meat for Pakistan was 1.4 million tonnes. Production of poultry meat in Pakistan increased from 13,994 tonnes in 1969 to 1.4 million tonnes in 2018 growing at an average annual rate of 10.40% (World Data Atlas, 2020). Certain limitations do not permit to attain the maximum potential. All poultry species engaged in the main intensive production systems are transported at least twice during their lifetimes over distances that may range from a few kilometers to journeys with durations of many hours. Most of the transportation of birds is by road e.g. form hatchery to production site (farm) or from farm to processing plant but some birds may also be transported by air or sea (Mitchell *et al.,* 2000; Mitchell and Kettlewell, 2008). All the procedures and practices concerned in the micro-environments of vehicles and the transportation of broilers may enforce the varying degrees of stress (heat stress and transportation stress) upon them which results in the compromise of the welfare status of the birds' health and productive efficiency.

Stressors

During transportation, the birds are exposed to a variety of possible stressors including the thermal demands of the transport micro-environment, acceleration, vibration, motion, impacts, fasting, withdrawal of water, social disruption, and noise (Carlisle *et al.,* 1998; Abeyesinghe *et al.,* 2001). Either each of these factors or their various combinations may impose stress upon the birds, but the heat stress produced during transportation stress is the major threat to poultry well-being and productivity (Weeks and Nicol 2000; Nilipour 2002). The transportation of poultry is a convoluted multifactorial stressful and distressing event and stress must be well defined to understand its impact on the broiler birds. Stress is difficult to define and understand because of its nebulous observation; however, stress is a response to unfavorable stimuli. According to Selye (1996), stress is the nonspecific response of the body to any demand. Whereas the agent that causes stress at any time is called stressor.

Heat stress is because of the negative balance between the net amount of energy flowing from the animal's body to its surrounding environment and the amount of heat energy produced by the animal. This negative balance of energy may be caused by variation of various environmental factors such as sunlight, thermal irradiation, air temperature, thermal demands of the transport micro-environment, and characteristics of the animal (e.g., species, metabolism rate, and thermoregulatory mechanisms). Particularly due to public awareness and concerns environmental stressors, such as heat stress and transportation stress has quickly become a great point of interest in animal agriculture (Renaudeau *et al.,* 2012). A recent study shows that birds subjected to the heat stress conditions spend less time feeding, more time drinking, and panting. The blood is diverted from internal organs to the skin, that darkens the skin color. Under severe heat stress, their production efficiency drops, and mortality risk rises (Mack *et al.,* 2013) and that more drinking of water is beneficial for broiler birds in the response of decreasing heat stress (Bahrami *et al.,* 2012; Mack *et al.,* 2013). It is very imperative to use glucose against heat stress that is advantageous in the response to the changing environment (Ali *et al.,* 2019b).

Nutritional supplements

There are different nutritional manipulations which are an easy and cheap way to reduce stress (transportation and heat stress).

The most widely used nutritional supplements in recent days to prevent stress during the transport of slaughtered birds are those which are based on amino acids, vitamins, electrolytes, and minerals (Jayaprakash *et al.,* 2016). Transportation induced changes in blood composition as well as increase heart rate, imbalances the electrolyte concentration, hormone levels, metabolites enzymes, decrease the live weight, and deteriorate the meat quality. Different internal and external factors influence the acid-base balance of the broiler birds. These factors are the diet, environmental conditions (low temperature and high temperature), and metabolism. The pattern of change in acid-base balance depends upon the effects of stressors (i.e. either by heat stress or by transportation stress) on the condition and rate of metabolism, respiration, and the mechanism of H^+ equivalent ion exchange (Olanrewaju *et al.,* 2007).

Management of stress

Several management procedures including nutritional managemental strategies are being performed to alleviate the deleterious effects of stress; among these managemental strategies is the dietary electrolyte balance (Borges *et al.,* 2003). Supplementation of salts in the feed or water can beneficially affect the acid-base equilibrium of broiler birds (Borges *et al.,* 2004a). For these effects of heat stress and transportation stress different common salts were used in poultry broiler diets to adjust the dietary electrolyte balance (DEB) such as Sodium carbonate, Potassium chloride, Sodium chloride, Ammonium chloride, and Potassium Sulphate. Among them, there are the two most common salts i.e. sodium bicarbonate and potassium chloride (Ioannis, 2016).

The supplementation of electrolytes is beneficial in prevailing transportation stress and heat stress. An electrolyte is a chemical that breaks down into its ionic components (Borges *et al.,* 2004b). Under this concept, the Na^+, K^+, and Cl^- are the ionic components of electrolytes. The main anion found into the extracellular tissue is the chloride and its association with Na^+ and K^+ plays an important role in maintaining the body's acid-base balance and osmotic regulation (Mcdonald *et al.,* 2011). The levels of chloride for broilers diets are at 0.2% for the starter phase (1 to 3 weeks) and 0.15% for the finisher phase (4 to 6 weeks) (NRC, 1994).

Oba et al. (2009) observed that the body weight in broilers was decreased during a long-time transport period as compared to the short transport period. But this is compromised by the supplementation of Na, K, and Cl in poultry feed or water as these salts enhanced the bird's body weight gain and feed conversion. When the electrolyte ratio was increased only by the supplementation of Na, the electrolyte balance (EB) showed a quadratic effect on weight gain and feed conversion ratio in the broilers (Borges *et al.,* 2004a). The high production rate and more efficiency of feed conversion ratio of poultry broilers make them more susceptible to diseases (Rasool *et al.,* 2018).

Karaman (2009) also observed that during transportation from hatchery to farm and from farm to the slaughtering unit the bodyweight of broiler chicken was decreased. But the pre-starter diet within Na and DEB has a positive effect on the performance of life of broiler chicks (Bidar *et al.,* 2007), and that the DEB (dietary electrolyte balance) and CP (crude protein) content has also influenced the broiler chick performance in the starter period and growing period. It is suggested that a good diet and biosecurity measures in chickens and proper vaccination program can benefit the farmers (Baksi *et al.,* 2017; Baksi *et al.,* 2018).

CONCLUSION

The most important environmental stressors are heat stress and transportation stress challenging poultry production worldwide. The negative effects of transportation stress and heat stress on broilers range from reduced growth production to decreased poultry and safety. However, a major concern should be the

negative impact of transportation stress and heat stress on poultry welfare. So, the nutritional strategies intended to minimize the disadvantage of transportation stress and heat stress are by supplementing the electrolytes, vitamins, and minerals in the poultry feed or water. However, these potential opportunities, although optimistic (particularly, for poultry production during transportation stress and heat stress), still require further research and development.

ACKNOWLEDGMENT

The authors would like to thank the Institute of Preventive Veterinary Medicine, Sichuan Agricultural University, Chengdu, Sichuan, People's Republic of China for the support to perform this study.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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