MANAGEMENT OF HEAT STRESS IN POULTRY FLOCKS DURING SUMMER SEASON

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ABSTRACT

Poultry birds fulfill the dietary requirements of animal proteins for humans. Raising of poultry birds is the challenging task for poultry growers especially during the harsh weather. The extreme summer season and heat stress check productive performance of poultry flocks. Heat stress affect feed intake, water intake, feed conversion ratio, growth, reproductive performance, immune response, egg quality, meat quality, the egg fertility, birds' welfare, the hormonal response and other functions. Efficient role of farm management can play its role in combating the heat stress through management of feeding, watering, litter and stocking density. The nutritional supplements of vitamins, amino acids and minerals play role in averting heat stress in poultry flocks. The present paper overviews the effects of heat stress on health of poultry birds and measures for averting heat stress in poultry flocks. This study is expected to provide significant information about management of heat stress and the poultry flocks during the summer season.

INTRODUCTION

The poultry farming is very profitable business if done on modern and scientific basis by maintaining health and production of poultry birds and by protecting the poultry flocks against extreme hot summer season in Pakistan. Birds are warm blooded living creatures and maintain body temperature throughout the year. Heat is produced inside the body of bird as result of metabolic processes. Excess heat is dissipated to nearby environment to maintain body temperature and avoid overheating. When the heat produced by the bird is not dissipated to surrounding environment or when the heat produced is more than dissipated, the body temperature of bird increases resulting heat stress in poultry flocks. Similarly, birds are heat stressed if they feel difficulty in achieving a balance between body heat production and heat lost. When equilibrium is disturbed in the body between heat production and heat loss, less heat loss and more produced within the body of bird results the heat stress.

The summer weather and high environmental temperatures are the factors responsible for heat stress in the poultry flocks. The mortality due to heat stress is cause of the high economic losses to producers (Pereira, Vale, Zevoli & Salgado, 2010). Sankhyan, Katoch, Thakur, Patial and Bhardwaj (2013) recorded mortality in young flocks and adult flocks during summer season are as 16.8% and 17.2 %, respectively. Season contributes towards growth performance and health in poultry flocks. Climate variation is posing threat to poultry enterprise (Alade & Ademola, 2013). The chickens die during hot-wet and hot-dry seasons (Kusina, Kusina & Mhlanga, 2001; Maphosa, Kusina, Makuza & Sibanda, 2004; Muchadeyi, Sibanda, Kusina & Makuza, 2005). High deaths in risky hot weathers are due to bird inability to cope environmental changes. Adult chicken body temperature varies amid 105–107°F (40.6–41.7°C) and body temperature of newly hatched chick is about 103.5°F (39.7°C).

For maximum production performance of poultry flock, the body temperature of a bird must remain within narrow limits of 106°F (41°C). Certain physiological conditions also cause variations in body temperatures among birds. Like, the male birds have high body temperature than females because of higher metabolic rate and more muscular activity. Stress is responsible for activating the hypothalamic-pituitary-adrenal axis, which results in production and release of corticosterone and catecholamines (Calefi, Filho, Ferreira & Neto, 2017). The exposure to heat stress results in change of the respiration rate, cloacal temperature, abdominal fat, meat lipid and pH of the broilers (Attia, Harthi & Elnagar, 2018). Heat loss from the body occurs through radiation, conduction, convection and panting in birds. The radiation is the process through which the heat loss occurs from the body of bird to environment through the variation in temperature of the body and environment, the more the temperature difference more will be heat lost from surface of the body.

Temperature loss through convection occurs through movement of air inside the poultry houses, and when the temperature of surrounding air is higher than the temperature of the body, heat loss reduces very much and may fail completely through the process of convection. The conduction is direct touch of the body of bird to the cool objects inside poultry house. Physiological activity and increased mobility increases body temperature in both males and female birds. Panting is the process through which heat is lost through vapors during respiration by exhaling the moist air. The birds have no sweat glands and most of the heat loss occurs through respiratory route. The respiratory tract of birds is moist and during respiration the vapors come out and evaporate along with excessive heat resulting in the lowering of the body temperature (Pereira at al., 2010). The water vapors may not evaporate form the respiratory tract due to high level of humidity in the atmosphere.

If the humidity is more the heat loss will not occur and the internal body temperature will increase. Some degree of the body heat is also lost through the fecal excretion. Heat stress can be acute or chronic. Short and sudden periods of extremely high temperature and humidity result in acute heat stress. Extended period of elevated temperature along with increased humidity results in chronic heat stress. The birds exposed to heat stress have shown decreased antibody titer and increased heterophil count in relation to raised under thermoneutral conditions (Olfati, Mojtahedin, Sadeghi, Akbari & Martinez-Pastor, 2018). The understanding of the cellular and molecular mechaniss involved in poultry production including physiological and immunological aspects of the poultry birds under heat stress can help in development of the poultry breeds through the different positive enormities (Pawar, Basavaraj, Dhansing, Pandurang, Kusina, Sahebrao, Vitthal, Pandit & Kumar, 2016).

LITERATURE REVIEW

When environmental temperature increases in poultry shed, main indicator is prolonged panting. Slow panting is normal activity during summer in birds but prolong panting is the result of heat stress. Rasping, dullness, increased heart rate, congestion of mucous membranes, dehydration, raise heat, staggering, trembling, convulsions, slowness and lethargy, cannibalism and dyspnoea. Heat stress significantly affected the daily behavior of broilers, including drinking, laying, feeding, standing and walking (Li, Wu & Chen, 2015). Body weight gain, feed conversion rate, egg production, growth rate, egg size, egg quality and fertility will be decreased in layer and breeder flocks. Heat stress negatively affects productive routine, meat yield, egg yield, egg quality, reproductive performance, intestinal functions and immune response (Fouad, Chen, Ruan, Wang, Xia & Zheng, 2016). Although the rural poultry is adopted to harsh environmental stresses (Faranisi, 1995), but season has affected animal husbandry (Osaguona, Fajobi, Meduna, Irokanulo & Ogunjobi, 2009).

In case of exposure to excessive heat the birds will stretch their feathers outwards to give maximum exposure to surface of skin for dissipation of heat to the external environment. The panting requires muscle activity in the birds will result in excessive heat production inside body of bird. Respiration rate can increase up to 10 times. Increased respiration rate causes more loss of Carbon-dioxide (CO_2) from body resulting in rise in plasma pH, and will result in respiratory alkalosis. The concentrations of Sodium (Na^+) and Chloride (Cl^-) ions in the blood will increase and Potassium (K^+) and Phosphates (PO_4^{++}) will be reduced. The birds will try to find the 'comfort zones' inside house and will stick to cooler objects inside the sheds, take shelter under feeders, attach drinking water troughs and containers, attach the walls of the sheds, sit on litter, stretch their necks high and will try to take bath in litter. There will be restricted movement or birds may show no movement with depression symptoms. Diarrhea results in loss of electrolytes, legs become dry and blood thicker.

The electrolyte intake in feed is also reduced because no intake of feed. Some degree of mortality can also be seen inside poultry shed with the following post mortem changes like, dry and sticky muscles with the cooked appearance, blood thick in the consistency, shriveled and dry legs. The petechial hemorrhages are found on the mucous membrane, abdominal fat, liver, heart and skin. Hyperemia and congestion of respiratory tract along with congestion of lungs, blood vessels and brain can be seen. Glue like contents can be seen in intestine with empty crop and gizzard. Dilatation of right side of the heart is also observed. Rigor mortis sets and goes early. Putrefaction is also rapid in dead birds. Liver weights, spleen, thyroid gland, ovary and the oviduct weights are reduced and oviduct lengths are lowest in the hens reared under the chronic heat stress conditions in different situations (Attia, El-Hamid, Abedalla, Berika, Al-Harthi, Kucuk, Sahin & Abou-Shehema, El-Hamid, Abedalla, Berika, Harthi, Berika, Sahin & Shehema, 2016; Abidin, Berika, & Khatoon, 2013).

Effect of Heat Stress on Health and Production

Above temperature of 20°C with 1°C increase in temperature 1.5 % feed intake decreases but water intake remains normal. Water requirement increases above the temperature of 30°C and lead to the diarrhea because of reduced feed intake. With 1°C increase of body temperature, 20-30% of metabolic rate increases thus heat production increases and the normal temperature of bird increases form 42°C to 44°C. At this stage water intake and metabolic rate of body increase very much, but reduced feed intake leads to wet dropping and diarrhea. Naturally birds decrease intake of feed during hot environment to reduce heat production from metabolism. When respiration increase, the panting increases, CO_2 level increases and effects on central nervous system ensuing convulsions and death. With long periods of high environmental temperature, the fertility and hatchability of eggs is reduced.

Tables 1 Effect of Increasing Temperature on Health and Production of Poultry Birds

Temperature	Effect on Health and Production of Birds
65 – 80 °F	The birds enjoy temperature less than 75°F but also feel comfortable and function normally up to 80°F.
81 – 85 °F	Feed consumption drops, water intake increases. Feed conversion ratio and weight gain decreases. Egg production drops in layer and breeder flocks.
86 – 95 °F	Egg production, egg shell quality and fertility rate in breeder / layer flocks decrease. Feed consumption and FCR are reduced in broiler and layers.
96 – 100 °F	Some degree of the mortality, marked depression, nervous signs along with symptoms of trembling, staggering and convulsions be seen in birds.
101°F & Above	The temperature above 101°F is referred to as "Lethal Temperature". Severe stress results shock and death in birds at this temperature.

Management of Heat Stress

The primary objective of heat stress management is to ensure maximum heat loss from the house in order to lower the temperature of the house. Further management practices require maintenance of the production from layer flocks, maintenance of weight gain in broler flocks, maximum fertility and hatchability from breeder flocks and maintenance of levels of titers against prevalent diseases. Efficient role of farm management can play its role in combating the heat stress through management of the feeding, watering, litter and stocking density. Decreased feed intake leads to the production of thin shelled, cracked and poor quality eggs. The temperature of drinking water should not be more than 20°C. The birds during production stage are under the stress and become susceptible to heat stress in most of cases/situations (Attia, Al-harthi, El-Shafey, Rehab & Kim, 2017). For this determination, following points/sockets might be kept in mind during running the poultry flock.

Feeding Management

The suboptimal management according to weather conditions result in limited growth of rural poultry flocks (Sankhyan et al., 2013). Water supply to the poultry flock should be clean and cool during summer season. During the summer season water consumption is increased and helps in reducing body temperature of bird. The number of drinkers and space should be increased and supply of maximum water should be ensured to prevent dehydration in birds. On an average for each 1gm of feed intake birds consume 2–3mL of drinking water during winter to and 4–5mL of drinking water during summer. Specific indicators of the adaptation to heat, water consumption, or body temperature, should be added for rapid growth to improve broiler performance in hot climates (Deeb & Cahaner, 2002). In open house poultry systems, feeding to poultry birds done during cool hours of the day i.e. during the early hours in the morning and during late hours in the evening. Feeding during hot part of day should be avoided. Although, the feed conversion, egg production, weight gain, metabolic and growth rates are reduced due to depriving feed to birds, but this method is beneficial in reducing mortality in the birds due to heat stress in summer season.

Use of Vitamins/Mineral/Feed Supplements

Use of vitamins, minerals, amino acid and feed supplements play a key role in combating the heat stress. The heat stress results in imbalance of electrolytes in the body of birds. Electrolyte therapy should be done to balance salts. Vitamins and minerals can be added in the feed. Vitamin C should be given in the feed or in water for the regulation of body temperature of birds. Protein metabolism produces more heat production than fats and carbohydrates. The protein to energy ratio may be readjusted during summer season. The supplementation of diet with mineral, amino acids, vitamins, etc in a single form or in combination with other elements overcomes heat stress in birds. The supplementation of chromium in organic form reduced heat stress depression in immune-competence of broiler chicks (Ghazi, Habibian, Moeini & Abdolmohammadi, 2012). Heat stress severely reduced growth performance and immune response of birds, but immune response of birds be improved by dietary vitamin E supplementation under heat stress (Niu, Liu, Yan & Li, 2009).

The productive and physiological decreases of slow growing chicks in chronic heat stress can be mitigated by adding the amino acids (250mg AA/kg diet) in the feed or increasing metabolizable energy (ME) by addition of 3% vegetable oil (Attia, Hassan, Tag El-Din & Abou-Shehema, 2011). The supplementation of anino acids and α-lipoic acid decreased the adverse effects of heat stress in birds exposed to the heat stress (Imik, Ozlu, Gumus, Atasever, Urgar & Atasever, 2012). Supplementation of diet with antioxidants, especially vitamins and chromium be necessary to overcome bad effects of heat stress in broilers (Tawfeed, Hassanin & Youssef, 2014). The productivity of poultry birds is improved and

stress factors minimized by using 100 to 200 mg of vitamin C per kg of feed (Ahmadu, Mohammed, Buhari & Auwal, 2016). Supplementation of vitamin E and C, probiotics and different combinations reduced effects of chronic heat stress (Attia, harthi, Shafey, Rehab & Kim, 2017).

It is reported that use of vitamin C at dosage of 12 gm / liter of the drinking water has not been found much beneficial but only reduced the oxidative stress especially in short term chronic the heat stressed birds (Mosleh, Shomali, Nematollahi, Ahrari & Namazi, 2018). Vitamin E supplementation at 65 IU/kg diet enhanced the production from laying hens (Puthpongsiriporn, Scheideler, Sell & Beck, 2001). Supplementation of feed with vitamin C showed greatest production traits in laying hens exposed to chronic heat stress (Attia et al., 2016). The serum profile of birds supplemented with the vitamin C and Zinc had shown that these birds had higher IgM and IgG titers as compared to non-supplemented birds maintained in groups under heat stressed conditions (Al-Masad, 2012). Under high stocking densities in broilers the supplementation of the vitamin E at 70 gm / ton of feed also decreased the negative effects of the stress due to the high stocking density and the improved broiler performance (Selvam, Saravanaumar, Suresh, Surreshbabu, Sasiumar & Prashanth, 2017).

The use of probiotics decreased the detrimental effects of the heat stress in poultry and improved the intestinal microbial ecology and resultant performance of the birds reared under heat stress conditions (Sugiharto, Yadiarti, Isroli, Widiastuti & Kusumanti, 2017). The supplementation of the feed with turmeric rhizome also decreased the activity of the dehydrogenase enzyme and improved antioxidant status without affecting performance and immunity in heat stressed broilers (Hosseini-Vashan, Golian, Yaghobfar, Zarban, Afzali & Esmaeilinasab, 2012). The hens reared under the chronic heat stress and the supplemented with vitamin C at 200gm/kg diet and Betaine at 1000mg/kg enhanced the laying performance in chronic heat stress conditions (Attia et al., 2016). Heat stressed birds supplemented with vitamin C and Zinc had greater body weight, higher daily gain, better feed conversion ratio and less mortality as compared to non-supplemented birds (Al-Masad, 2012).

Use of Immune Boosters

Different studies have documented the role of the minerals, vitamins, amino acids and the minerals as the immune boosters for the poultry flocks under stress conditions. The supplementation of betaine in diets improved broiler feed intake, FCR, weight gain, and immunity under the heat stress conditions (Chand, Naz, Maris, Khan, Khan & Qureshi, 2017). The use vitamin E supplementation improved the meat quality and the immune response in broiler chickens (Pompeu, Cavalcanti & Toral, 2018). The immune response of broilers is also influenced under heat stress conditions by combination of different levels of vitamin C and zinc in diet (Al-Masad, 2012).

Litter Management

Management of litter plays a key role during summer season. Litter should be dry and not be much wet. The dry litter indicates the excessive heat and decreased humidity, the wet litter during summer is indicative of increased humidity inside the poultry house. The wet litter forms cakes and stick to the floor. Bad smell and ammonia is produced inside the house from wet litter and hamper the growth rate, attract flies, affect eyes and increase the stress upon birds. Regular stirring of litter during summer season should be done. The wet litter should be discarded out to the poultry house and should be replaced with the new and dry litter. The depth of litter should be set according to the season. The thick layer of layer provides insulation to birds and is not suitable during the summer season. The thin layer of the litter with depth of 2-3 inches of the litter is more suitable during summer.

Breeder Flock Management

The fertility and hatchability from breeder flock is decreased during summer season. The breeder flocks require the special care and attention during summer season. In order to achieve maximum hatchability during summer special considerations should be given for maintaining the maximum fertility from the flocks. The excessive heat stress causes decreased mating frequency. The mating ratio should be re-adjusted. The ratio of the number of females to males should be decreased. The old males may be replaced with young, energetic and active males during summer season. The use of anti-stress vitamins like vitamin C (Ascorbic acid) in diet of breeder poultry flocks can ameliorate the heat stress related problems including reduced weight gain, the decreased feed intake, poor immunity, oxidative stress, rectal and body temperature, decreased fertility, decreased carcass weight, decreased semen quality and increased mortality in the flocks (Abidin & Khatoon, 2013).

DISCUSSION

The direction of building of the poultry sheds should be from East to West in length and North to South in width in the plain and warm areas under Pakistani climatic conditions. It is recommended to provide flow of wind from the North and South sides and to avoid poultry birds from maximum exposure of hot sunlight during the day from the sides. Evaporative cooling system can be used inside the shed through cooling pads and from using the sprinklers at those farms where environmental temperatures are high while humidity level is low. The excessive heat is lost during evaporation of water and cool air is produced inside shed, resultant humidity produced should be monitored efficiently. There is about 4.5% RH increase for every 1°C decrease of temperature over evaporative cooling. Vegetation should not be done along the sides of poultry house. The trees, crops and vegetables along poultry house decrease flow of wind across shed and increase stress on the birds.

The vegetating lands often remain irrigated during summer and increase the humidity level in the surrounding environment, thus making the situation more adverse. About 60% of the heat inside the poultry shed comes from the roof. The roof of the poultry shed can be made steeper and high. Water sprinkling in the high temperature can be done to make roof cool. Furthermore, an insulated house is necessary for maintaining internal temperature of the poultry house. During the summer season the efforts should be made that the temperature of the poultry house should be decreased enough so that birds feel comfortable in losing their body heat to the external environment in different situations. Poultry farmers should be conscious and vigilant about maintaining the environmental temperature according to the requirement of the birds to avoid the heat stress in certain circumstances. Temperature requirement of broiler birds based on age of birds should be monitored.

The day old chicks and early aged growing broiler chicks require different temperature for their survival growth as compared to the adult ones. The environmental temperature should be adjusted with increasing age of birds. The special care should be taken during loading and transporting of birds. Transportation of birds should be done during cooler parts of the days especially during morning, evening or in the night. The transportation of birds during hot weather should only be done in case of unavoidable circumstances after ensuring that the birds are off feed for 2-3 hours and consumed maximum water after feeding ration. The overall general health conditions of the poultry birds should be maintained. In this regard timely diagnosis of diseases and prompt treatment of diseased birds should be ensured. The layer and breeder flocks should be regularly screened for *Mycoplasmosis, Salmonellosis Avian Influenza* and Newcastle Disease over serological examinations.

Any decrease in titer of antibodies should be monitored regularly and re-vaccination or immune boosters should be administered accordingly. Stagnant air inside the shed can be circulated to the maximize heat loss by convection. Internal re-circulation fans can be used for even distribution of air inside the house. Exhaust fans can also be used for expulsion of hot air from the poultry house. The distance between the sheds should be adjusted in this way that the flow of wind across the sheds is not interrupted and fresh air is available to flocks. The stocking density should be decreased during summer. High stocking density will result in ventilation failure. Increased metabolic rate of birds during summer increases heat production inside poultry house. Decreased loss of heat during hot and humid weather will increase ambient temperature inside the poultry house. The stocking densities should be adjusted according to temperature and humidity conditions in relevant area.

CONCLUSION

The efficient heat stress management during summer season in the poultry flocks can increase profitability of poultry business. The extreme summer season and heat stress check productive performance of poultry flocks. The increased egg and poultry meat production during summer season can be helpful in fulfilling the protein requirement of the public. Efficient role of the farm management can play its role in combating the heat stress through management of feeding, watering, litter and the stocking density. Getting increased production of the eggs and meat during summer season has always been the challenge for the poultry farmers, however through adopting the guidelines regarding management of heat stress the losses in the form of decreased egg production, decreased weight gain, decreased fertility, decreased hatchability and increased mortality can be minimized in summer season.

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