Available online at www.agrifarming.org

DOI: http://dx.doi.org/10.18782/2582-7146.179

ISSN: 2582 – 7146

Curr. Rese. Agri. Far. (2022) *3*(6), 9-18

Review Article

Current Research in Agriculture and Farming

Peer-Reviewed, Refereed, Open Access Journal

Effect of Heat Stress in Poultry and Its Mitigation

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Received: 15.10.2021 | Revised: 17.12.2022 | Accepted: 24.12.2022

ABSTRACT

The major problem for huge economic loss in the poultry industry was stress and from different types of stressors; heat stress was a major one. In this developing era, poultry played an important role in almost economic gain of every country. But with changing climatic conditions it had become hard to maintain the temperature in poultry production system. Heat stress effects the overall performance of both layers and broiler in terms of meat quality, growth, egg quality and egg production. If these types of parameters start showing in poultry farms timely taken steps will save farm from huge economic loss. Scientists are using different methods and techniques to alleviate the devastating effects of heat stress in both economically important poultry sectors, layer and broiler. Providing birds with suitable environmental conditions like proper ventilation and stocking density helps minimize HS. Supplementation of feed additives also helps in reducing damaging effects of HS by improving performance and gut health. Scientists worldwide are trying to develop birds with high heat tolerating ability so that birds will perform well during high-temperature phase. Conditioning of birds with high temperature at early age also helps the birds to perform better in later phases of life. This article highlights major issues regarding to chicken health under HS condition and some techniques to perform well under stressed conditions.

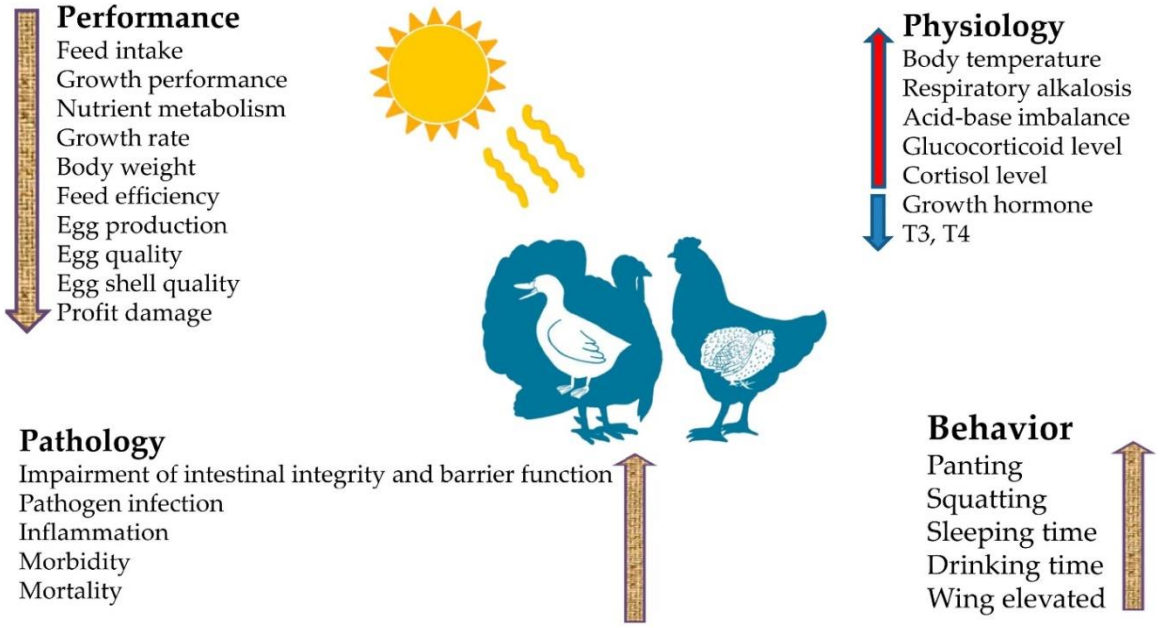
Keywords: *Heat Stress, Poultry, Thermoregulation, Meat Quality, Gut Health, Mitigation.*

INTRODUCTION

There is a limit of the temperature at which every organism performs well, but when you try to exceed that limit, the problem will happen more often that is why when the environmental temperature gets higher the decrease in livestock production is seen worldwide. In this era poultry is a big source of protein for human beings that is c also a cheap source.

Cite this article: Safi, A., Imtiaz, M., Ahsan, H. M. T., Riaz, A., Ali, S., Uzair, M. D. (2022). Effect of Heat Stress in Poultry and Its Mitigation, *Curr. Rese. Agri. Far.* *3*(6), 9-18. doi: http://dx.doi.org/10.18782/2582-7146.179

High temperature is a devastating stressor of the poultry production system and causes a major loss in the economy of every country. When there is an imbalance between the energy released and energy produced, heat stress (HS) will arise. There are two types of heat stress according to its duration, long term also known as chronic heat stress and short term also known as acute heat stress. The effect of heat stress can by intensified when there is relatively higher humidity. There must be a balance between temperature and humidity for proper growth of birds. Egg production and quality, overall growth, feed intake are the factors that are seriously affected by heat stress, there is also an increase in mortality and morbidity (Barrett et al., 2019). These effects show a cumulative effect of the processes taking place in the body. Whenever the temperature of a bird rises due to respiratory alkalosis (it is causes by panting or over breathing due to lack of fresh air) it is a confirmed marker of stress in poultry (Franco-Jimenez et al., 2007). The integrity of bird is affected when the bird is under stressed and it will make the pathogens to enter into the epithelial lining of gut, because gut it the foremost organ that is connected to external material that is feed (Liu et al., 2016). There are also immunosuppressing effects of heat on broilers and layers for example whenever a bird suffers from heat, it will have swollen or overweight (abnormal) thymus and spleen (Ghazi et al., 2012). there is an increased level of reactive species of oxygen (ROS), as a result the body of bird will go in an oxidative state and starts producing heat shock proteins to overcome the effects of ROS (Dröge, 2002). Different effects of HS on Poultry production system (Ahmad et al., 2022).

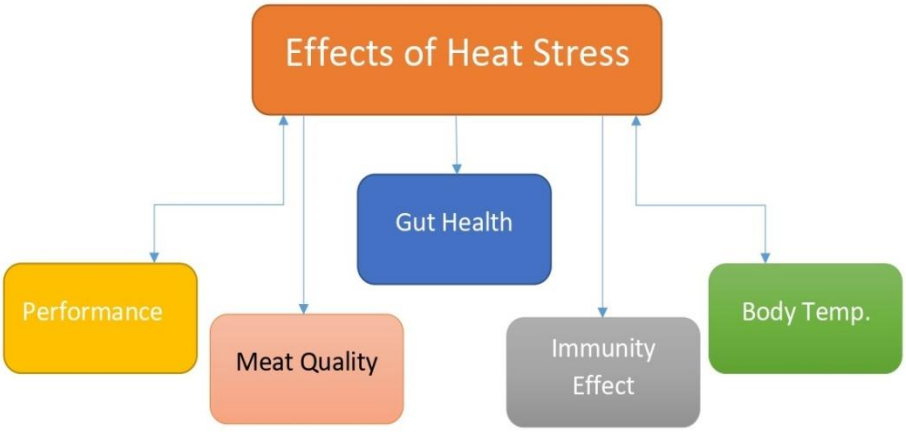


Researchers have suggested many strategies to overcome the highly destructive effects of stress, such as the use of minerals, herbal products and vitamins is constantly being used to control the effect of heat stress (Tang et al., 2018). Birds of high performance with high tolerance of heat can be bred together to produce best progeny (Radwan, 2020). Studies also showed that when birds are early conditioned with eat, they will perform well in later stages of life (Oke et al., 2020). As the population of the world is increasing day by day and, ultimately temperature of the world is increasing, so effects of HS are crucial on poultry health.

Detrimental effects of HS on poultry

There are different types of stressors in poultry systems, but one major is heat. Basic indication of heat stress in poultry is reduction in feed intake making birds weaker by

reducing their weight-gaining ability and also a decrease in egg production in layers, this all happens by abnormal metabolic activities (Barrett et al., 2019). As belonging to class ave, birds like poultry lack sweat glands it means that they lack the ability to release heat from body, and thus they are dependent on a technique or behaviour is known as panting to release heat from the body by breathing rapidly from the mouth.



Performance

Poultry is an excellent source of protein for human beings and are mostly kept for meat production and egg production, birds that are reared for meat are called as broilers whereas that are reared for egg production are called as layers. Birds belonging to Cornish breed have good breast meat production that is why the broilers are developed from Cornish breed by crossing and crossing again, now in most countries the broiler strains that are being used are Ross 308, Cobb 508, Ross 708, which are performing very well under different environmental conditions, similarly layers are developed from white leghorn strains. At start broilers reached its maximum weight in 60 days, but with good genetic selection and better nutritional status, it reaches its maximum weight in only 35 days and a layer produces more than 200 eggs per year, but birds suffering from HS show adverse reduction in overall performance, Potency of the effect is equal to both broilers and layers. Birds with increased temperature or suffering from heat stress will eat less, drink more and do panting all the time with resting rather than walking or moving (Mack et al., 2013). Researchers conducted research on broilers, and the effect of HS was tested the results were 8-9% reduction in feed intake reducing body weight and increasing of feed conversion ratio for almost 10% when the birds were exposed to 34º C for almost 6 hours daily from later grower to finisher stage of 22 days to 35 days (Awad et al., 2020). Water intake is also increased during HS situation, almost 10% of high water intake is noted in the birds suffering from HS after increased temperature to 32ºC from 17th to 42nd day. Barrett et al. (2019) stated that shell weight of eggs was decreased, body weight gain, feed intake and increased of feed conversion ratio when the birds were reared at high temperature more than 33ºC from 24-28 weeks. Whenever temperature rises you will see visible effects on poultry body and therefor good practices must be applied at that time.

Body Temperature

There is an increase in temperature when the birds suffer from heat stress. Due to the absence of sweat glands in poultry, birds will reduce the temperature by increasing respiration rates by reducing blood carbon dioxide concentration (El Hadi & Sykes,

1982). When birds suffer from HS it will have a higher respiration rate, Respiratory alkalosis is a disease caused by a higher respiration rate when the pH of blood goes beyond normal range and there will be a change in bicarbonate to carbon dioxide ratio (Franco-Jimenez et al., 2007). Higher body temperature is a major indicator of HS and is used for evaluating high possessions of heat stress that can be devastating because of alkalosis problems in the bird.

Gut Health

The most important part of the digestive tract is gut or intestine which plays an important role in the digestion and absorption of most of the nutrients. Gut health is severely affected by heat stress as it tempers the morphology of gut and also it effects the height of villi with increased crypt depth misbalancing the ration between the two of them (Song et al., 2013). When the temperature increases beyong the normal limits the permeability of intestine will get affected causing leaky gut syndrome (a condition in which bacteria and toxins can cross the intestinal lining and mix directly in bloodstream).

Immunity Effect

For surviving well in an environment full of pathogens and other microorganism birds must have strong immune systems for performing well in under every condition but this system is compromised by heat stress (Mashaly et al., 2004). Organs that play an important role in immune response are spleen, thymus and bursa of fabricus, all of these three organs are studied to be effected by heat stress by decreasing their size. The permeability of the membranes increases during heat stress allowing pathogens to get into the gastrointestinal tract, as by increasing the pathogens like salmonella and clostridium in the gut the overall health of birds is effected very greatly. Lymphoid organ alterations will happen when harmful bacteria start colonizing in the gut and intestine (Quinteiro-Filho et al., 2017). In broilers the birds challenged with heat stress show decreased bursa weight with reduced number of lymphocytes in cortex and medulla region of bursa (Aengwanich, 2008)

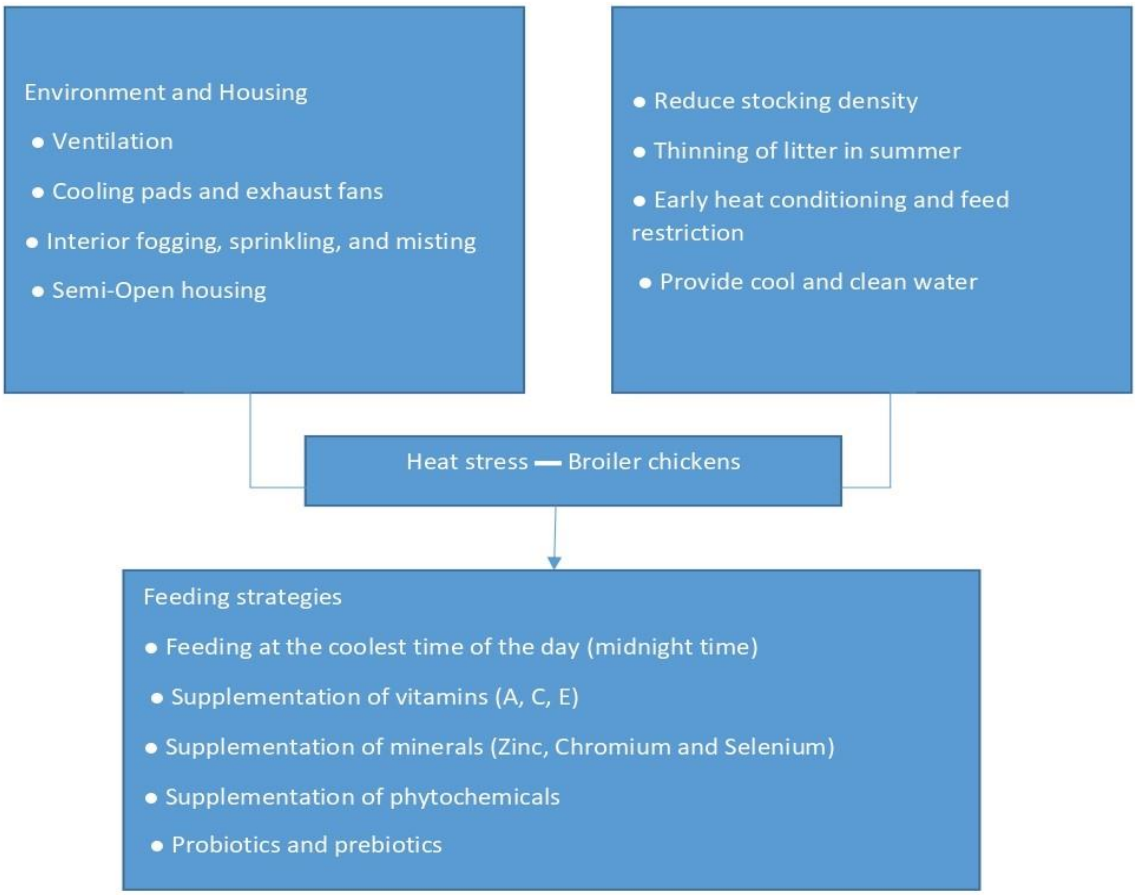
Meat Quality

Different types of stressors affect differently, for consumer acceptance quality of meat like tenderness is very important. Because of the selection of meat on its appearance, produces work hard on broilers to get their meat in good appearance as final product otherwise they will get negative impact on their price (Fletcher, 2002). Any change in pH will severely affect the meat quality, for good and bad quality meat pH is widely used as indicator for sensory qualities (El Rammouz et al., 2004).

Management or strategies to alleviate Heat stress

As the temperature of the world is rising so scientists are working hard to develop strategies to overcome temperature stress on poultry system because poultry production system is effected greatly.

Environmental Management:

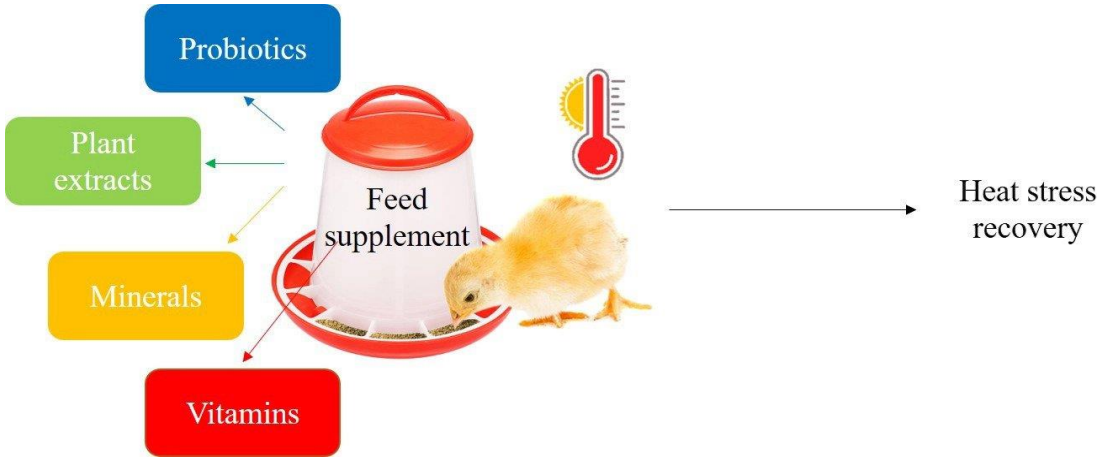


There are different types of system for broilers and layers according to their production profits, most commonly used systems are litter rearing system (LRS) and cage rearing system (CRS) but mostly LRS system is used worldwide because the installation cost of CRS is high and birds especially performs well in it because of their good immune response and fewer chances of disease (Abo Ghanima et al., 2020).

Teeter and Belay (1996) stated that for avoiding economic losses from heat stress different types of methods have been tried like reducing stocking density good ventilation and better cooling system which aided reducing HS. But with less stocking density the profit gain from the end product is minimum and with good ventilation and better cooling systems the expense cost is high. Poultry industries is so much competitive you have to manage each and every thing like consumer satisfaction, good profit and less loss.

Nutritional Management

One of the major and basic step in minimizing heat stress in birds is provision of cold water and birds easily adapt this change during HS phase. Teeter and Belay (1996) stated that the provision of cool and fresh water during HS phase can reduce the effects of HS. Water-containing electrolytes solutions (Sodium, Chloride and Sodium Hydroxide) provides some electrolytes and acid base balance. Moreover, water containing electrolytes show increased uptake during heat stress phase, enhancing heat tolerating capacity in birds (Balnave & Mueereza, 1997). The addition of feed additives such as plant extracts (essential oils), minerals and vitamins in post-hatch programs have effectively mitigated heat stress during later stages of life (El-Gawad et al., 2008). The diagram is based on articles (Kucuk et al., 2003; & Sohail et al., 2011).



Sahin and Kucuk (2003a, 2003b) described that adding dietary supplementation like vitamins A, C, and E helped increase egg production and fertility with reduced mortality and morbidity in laying hens or layers. Chung et al. (2005) described that broiler and quail suffering from HS performed well when they are supplemented with Vitamin C and E. Broilers and Quails suffering from HS showed good feed intake, egg production in laying phase, egg quality, shell thickness and fatty acid composition (Vakili & Rashidi, 2011). Oxidation stress is a stress in free radicals are formed that react with any other chemical easily and their rate is increased under high-temperature conditions but with use of salts from mineral origin posing antioxidant properties reduced the process of free radical formation.

When vitamin E is used in correlation with zinc in the diet of poultry, the input resulted in increased FCR, body weight and carcass quality (Sahin et al., 2006). While when Zinc and Vitamin C are supplemented together, they reduced blood glucose and cholesterol levels in birds under heat stress (Sahin et al., 2009). Sohail et al. (2011) resulted that devastating effect of HS were reduced with use of prebiotics like mannan-oligosacchrides. Abo Ghanima et al. (2019) demonstrated that use of boldo leaf extract in the drinking water of broiler chicken improved growth performance and antioxidant enzymes. One of the best dietary feed supplements that helped reduce the dangerous effects of heat stress is probiotics that improved overall gut health by making colonies of advantageous or gut-friendly bacteria and diminishing the growth of enemy bacteria. Recent studies demonstrated that lactobacillus culture (Probiotics) increases the feed intake of broiler chicken to 36℃ ± 1℃ from 21 to 42 days with 3 hours daily (Zulkifli et al., 2000). Birds suffering from heat stress (Hyperthermia) show decreased feed intake that results in less egg production, so if birds increase feed intake, that might be linked to the recovery of overall performance and egg production in layers. Dietary supplementation addition in feed mitigates the devastating effect of heat stress in poultry and must be used according to environmental temperature when the temperature goes up from the thermo-neutral zone.

Breeding Stock Selection

Genetic selection is a process in which good quality lines are crossed to produce better birds that are superior in quality or have good genetic makeup, selection is based on growth and immunity status. By selecting good traits and genetic makeup scientists have developed broilers with best qualities and early maturity. But broilers' main problem is that they are highly affected under HS because of their less heat tolerance ability (Deeb & Cahaner, 2002). The main aim for rearing layer hen is that it is reared for good egg production but when they are challenged under HS they show decreased production and poor quality egg (Barrett et al., 2019), however genetically modified birds are

selected that reduce decline in egg production and egg quality. Selecting birds from the heat tolerant lines and producing their progeny will help reduce HS and birds will perform better in stress.

Early Age Thermal Conditioning

The main of broiler industry is to grow birds that gain maximum weight in a minimum period of time, but the problem is that when broiler grow fast they will have metabolic rate, higher metabolic rate will increase body temperature and that is why broilers are easiest to be under HS (Deeb & Cahaner, 1999). In an environment where temperature varies, birds cannot maintain their body temperature even with mechanisms like panting etc. (Nichelmann & Tzschentke, 2002).

Recent studies showed that when the birds of 5-day old are kept under thermal conditioning at 40^0C, broilers decreased temperature (Basilio et al., 2003). Birds show different types of responses for different temperature. Oke et al. (2020) stated that when the birds are kept at 35^0C for first stage of life up to 4 days it had a better overall growth like good rectal temperature and good glucose level better than the birds with same temperature for 2 days. Conditions during early stages of life will help develop a better thermoregulatory mechanism that plays an important role in later stages of life under heat stress.

CONCLUSION

With increased environmental temperature, it is necessary to identify severe effects of HS on poultry. With faster growth rate of broiler reaching peak in 5 weeks, if overall weight of birds is decreased due to heat stress there will be huge loss in economy, so different techniques like early age thermal conditioning, breeding stock selection with good environmental and nutritional management skills are being applied to minimize the devastating effect of heat stress.

Acknowledgement:

This creative scientific literature, an acknowledgement, is an expression of gratitude for assistance in creating original work.

Funding: No Funding for this paper

Conflict of Interest: There is no conflict of interest between authors.

Author's Contribution: All authors are contributed equally, and equal response is observed from all authors.

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