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The impact of high temperatures on the productive performance (behavioral, physiological, and immunological) of poultry

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Abstract: The poultry sector produces chicken meat and eggs, which are the most significant protein sources among livestock foods. The industry is dealing with the effects of climate change, which is creating heat stress and negatively influencing poultry performance and well-being. Heat stress has been the most significant climatic stress confronting the worldwide poultry business, with birds having just a small temperature range when stressed. The purpose of this paper is to determine the effect of heat stress on the performance and well-being of hens. The study examined the research articles of numerous researchers and discovered that high temperature influences poultry performance, nutrition, and health. High temperature decreases feed efficiency, body weight, feed intake, and egg production while increasing the proportion of mortality and the incidence of pathological injuries in poultry fields, which generate major material losses.

Keywords: high temperatures, productive performance, poultry, heat stress.

Introduction

Heat is one of the most important environmental factors that affect the life of poultry and its productive performance during the breeding period, as poultry are warm-blooded animals with a constant temperature; that is, They possess the capability to keep their internal body temperature within a consistent range physiologically constant through thermal equilibrium (Nagy, 2004), where chickens produce heat, moisture, and carbon dioxide as products of natural activities. In addition, because it has a special temperature-regulating device called the Thermo Regulation System, which controls its effectiveness and regulates the functioning of the hypothalamus (Donald and William, 2002), this device is responsible for regulating body temperature. Thus, the bird is able to maintain her body temperature at a constant level. This equilibrium is based on the heat exchange between the bird's body and the surrounding medium. To regulate the body temperature and keep it constant, the bird's body performs some physical or chemical processes in order to adapt to the external atmosphere. The physical activities include heat loss through radiation if the ambient temperature rises, and they may resort to carrying out device operations where heat is lost through the loss of water vapor through the breathing process. The chemical temperature of the body in chickens is between 40 and 42.8. The body can experience heat loss for multiple reasons, such as a decrease in ambient air temperature, increased wind flow around the body, a lower temperature in the environment, and higher humidity levels. Heat loss also decreases when the ambient temperature rises, air movement is slow, or the bird's body was covered with feathers. The quantities of enzymes, nutrients, and hormones, as well as physical activity, breathing rate and weather conditions, all these factors can influence the level of heat that was generated within chickens. (Alagawany et al., 2017; El Kholy et al., 2018). In order to regulate body temperature and avoid overheating, the body releases excess heat into the environment through natural processes.

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High temperature the straining in the chicken.

The rise in temperatures in Iraq is one of the seasonal problems that affect poultry production, on which many breeders depend. This negatively affects the supply of poultry meat and eggs in the summer, which leads to a rise in the prices of those products. In addition to the losses inflicted on breeders as a result of the cessation of their fields for production, the rise in temperatures of more than 30 degrees Celsius leads to a phenomenon called "thermal stress," and the occurrence of this phenomenon leads to behavioral changes for the bird, such as a decrease in feed consumption, increased drinking of water, increased breathing rate, and daytime sleepiness. In addition to physiological changes such as a decrease in heat production, the rise in temperatures of more than 30 degrees Celsius leads to a phenomenon called "thermal stress," and the occurrence of this phenomenon leads to behavioral changes for the bird, such as a decrease in feed consumption, increased drinking of water, increased breathing rate, and daytime, in addition to physiological changes such as a decrease in heat production from inside the body and allowing the temperature to rise In severe cases, when the temperature of the taifune rises to 47 degrees Celsius, death occurs due to heart failure, as the normal temperature of the bird ranges from 41 to 42 degrees Celsius . Ambient temperatures between (13-24) degrees Celsius do not require changes in metabolism to generate or eliminate heat. This is defined as the "thermally neutral zone" (Van Kampen et al., 1979; Scanes, 2015), and the optimum ambient temperature between 18 and 24 degrees Celsius is defined as the "comfort zone." In summer, when the ambient temperature rises above the comfort zone of the birds, the birds must keep their bodies cool by evaporation, radiation, conduction, and convection. During heat stress, we will see some birds staying put, others standing next to the walls, and the majority of birds spreading their wings in an attempt to escape the heat through a variety of mechanisms: **Steaming:** the skin of birds does not have any sweat glands at all, so the breathing process has a big role in thermoregulation in chickens (Donald and William, 2002), where the bird performs a process let's call it the process of steaming water—where the bird can increase the normal respiratory rate by more than 10 times (Gupta, 2011).Zhong et al. (2012) discovered that when broilers were exposed to high temperatures, their drinking rose considerably but their feed consumption decreased.

The act of flapping releases moisture that induces evaporation in the avian nasal cavity, leading to a fall in the bird's thermoregulation. Extra energy produced by flapping is transported away by moisture when it evaporates from the nose and throat. This occurrence has been recorded in research journals (Scanes, 2015).The primary mode of temperature dissipation at elevated temperatures is through anterior flapping, as reported by Ahmad and Sarwar (2006) and Abbas et al. (2008). Avian organisms experience a substantial reduction in efficiency, as they expend five hundred and fourteen kcal of energy for each milliliter of water evaporation, leading to a marked decline in productivity (Holik, 2010).On the other hand, increased humidity in the environment reduces the efficiency of latent heat loss (Donald and William, 2002), raising internal body temperature (Speakman, 2004). **Radiation:** the transfer of body heat to the surrounding environment decreases with increasing temperatures (Scanes, 2015; Donald and William, 2002) at an ambient temperature of 40 degrees Celsius, the body almost does not lose heat. **Conduction:** It is often done by conduction and deltoids, where very little heat is transferred because the contact surface is small (Holik, 2010).

Convection: The bird raises its wings and feathers to increase air movement on its skin and thus convection (Donald and William, 2002).).Another way to temper the body temperature of birds is during the excretion of feces outside the body or during the spawning process, and this is indicated (Donald and William, 2002; Skanes, 2015). Where the heat supplied must be the same as the heat produced; this is known as the temperature distribution. **Stress define** condition that occurs when poultry are exposed to high temperatures and humidity levels that exceed their ability to regulate body temperature. Poultry are particularly susceptible to heat stress because they cannot sweat, and their only means of heat dissipation is through panting and evaporative cooling from their respiratory tract. As per Selye (1976), "tension or stress is the generalized reaction of the organism to any demand," whereas a stressor may be described as "an agent that creates stress at any moment." As a result, anxiety is the living organism's reply (i.e., a biological response) to stimuli that disrupt its normal physiological balance or harmony. **Thermal overheating** in chicken flocks is well recognized because of an increase in maintenance energy costs (Abbas et al., 2017; Abdelnour et al., 2018). High temperature in poultry field has a negative impact on chicken productivity, reproduction rate, financial attributes, and health (Oguntunji and Alabi, 2010; Yousaf et al., 2019). An increase in avian oxygen consumption of 10–20 times generates greater CO2 leakage through the airways.

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Symptoms of overheating in poultry

Chicks and mature hens, like dogs, panting to stay cool—the first indicator that they under high temperature climate, and fly freely, spreading their wings and stooping close to the surface. (Nardone et al., 2010). They are attempting to minify temperature by altering the location of their feathers. Shrieking with panting • Stretching wings • Sleepy and floppy acting • Closing eyes • stretch on ground• decrease production of hens • reduce weight, and shell quality • Increased thirst • lessen appetite • diminish body weight • Increased aggressive behavior. Thermal fatigue can occur in laying chickens. An egg's major component is water. Producing eggs requires a lot of fluid, so keeping your hens nourished and happy is essential. (Boissy et al., 2007). To prevent thin eggshells, egg layers require a substantial amount of calcium. When the place become so wormed, your chickens did not eat enough food, resulting in Decreased diet content of calcium salt. Add a few drops of An acidic substance such as vinegar to their drink twice or more times each week. This aids in maintaining their Acidity measurement coefficient, which facilitates calcium absorption.

Effects of high temperatures on the behavioral and physiological qualities of poultry: When temperatures rise inside the poultry field, most birds resort to reducing their body temperature through a variety of behaviors and physical movements in order to achieve thermal balance. According to recent research by Mack et al. (2013), birds exposed to heat stress spend less time eating, more time getting drunk and breathing, more time with their wing up, less time moving or walking, and more time resting. When exposed to high external temperatures, animals use a variety of methods to maintain thermogenesis and equilibrium, including enhanced radiative, convective, and evaporative heat loss via vasodilatation and sweat Mustaf et al. (2009).

Li and others explained in 2015 that exposure of chickens to high temperatures (> 40 °C) led to a change in feeding behavior, walking, drinking, and stretching, as the cycle of stretching and drinking water increased while feeding behavior and standing decreased significantly. Heat exhaustion caused prostration, convulsions, and even death in the seriously afflicted birds (Liu et al., 2007). In many other researches, domestic geese revealed thermally induced asthma, stopped (interrupted) asthma, and wing drooping that lasted after the heat stress phase. The enhanced water-sticking plumage of domestic geese is a prominent behavioral reaction to high-temperature stimuli (Zhong et al., 2012). These findings show that high temperatures have a substantial impact on the everyday behavior of poultry and that studying the impacts of heat stress on the behaviors of maturing and growing young chicks is critical. Under extreme heat, some chicks demonstrated a variety of clinical indicators, including trouble breathing, open-mouth breathing, severe feed intake decrease, decreased appetite, agitation, functional decline, and lying face-down at the bottom of the cage (Zhou et al., 2004).

Chicken behavior may have a considerable impact on their growth rate and hence on production costs (Neves et al., 2010, 2014). Young chicks have a high metabolic rate. While they develop quickly, their capacity to adjust to changes in environmental circumstances is limited.

Birds employ air sacs as another way to improve heat substitution between their bodies and the milieu. Lungs in birds are highly effective throughout panting because they stimulate heat circulation on their skin surface, because of increased gaseous interactions with the environment and, as a result, increased evaporation and thermal resistance (Fedde, 1998). However, increased panting under hot climate conditions causes increased CO_2 levels and higher blood acidity (i.e., alkalosis), which impede Which allow the egg shell to form inside the oviduct, as well as a decrease in free calcium levels in the blood. Because it affects eggshell quality, this process is critical for breeders and laying chickens (Marder and Arad, 1989). Despite the fact that many studies have attempted to characterize the physiological mechanisms associated with the reduction in egg production in high temperature-tensed birds, there is no conclusive knowledge, and several possible pathways, including variations in reproductive hormone levels and small intestine calcium uptake, are still being investigated (Elnagar et al.,2010 , Ebeid et al., 2012). High temperatures can have a variety of effects on the reproductive function of chickens. High temperatures in poultry farms have a significant impact on Functional capabilities of chickens (Mashaly et al., 2004; Ayo et al., 2010). When Sustainability potential expenditures rise, stress occurs (Abbas et al., 2012); for example, gular flapping in birds necessitates muscular activity, resulting in excessive heat generation inside the body. Gular fluttering induces greater CO_2 escape from the body and elevates the pH of blood plasma, leading to respiratory alkalosis (Borges et al., 2007; Abbas et al., 2012). Increased gular fluttering increases bicarbonate (HCO_3) loss as well as urine production, thus increasing

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electrolyte loss (Borges et al., 2003, 2004). Furthermore, because there is no feed intake, the electrolyte intake from feed was decreased (Scanes, 2015). Additionally, tension hormones were released into the bloodstream, and heat shock proteins are activated (Kamboh et al., 2013). Gene function may be altered, leading birds susceptible to many illnesses (Scanes, 2015). Figure 1 depicts the reactions of hens to climate variability and change. Overheating causes an increase in NACL levels. (Na+) and chlorine (Cl) ions in the blood (Abbas et al., 2012), while potash (K+) and phosphorus (PO4++) fractions are dwindling (Yosi et al., 2017). Yosi and colleagues (2017) Blood cortisol extent rise (Abbas et al., 2017), but serological of important growth hormones, triiodothyronine, and thyroxine decline (Sahin et al., 2001; Abbas et al., 2017).

The Influence of High Temperatures on Immunological Response

A number of research have been carried out to establish the effects on immune system response in chicks. (CNS) of the brain modulates protective immunity through a connection net that facilitates communication between nervous, glands, and immune mission. This networks immediately, meaning it transmits information from the CNS to the endocrine and immune systems, and vice versa.. major channels via which the immune response may be changed are the (HPA) and (SAM) axes. Several neuroendocrine products of the HPA and SAM axes, such as corticosterone and catecholamines, have been shown to have immune cells in lymphocytes, monocytes or macrophages, and granulocytes that could affect cellular trafficking, proliferation, cytokine secretion, immune regulation, and cytolytic activity. In recent years, various studies on the impact of heat stress on the immunological response in chicken have been conducted. All investigations, despite employing various methods, reveal that heat stress has an immunosuppressive impact on broilers and laying hens. Lower relative weights of the thymus and spleen, for example, have been identified in heat-stressed chickens and turkeys Ghazi et al. (2012) It was found that the survival of laying hens under hot climatic conditions caused a decrease in the weight of internal organs such as the liver (Quinteiro-Filho et al. (2010), Niu et al. (2009), and Felver-Gant et al. (2012) They had the same results when exposing chickens to long periods of heat, which reduced the weights of the same internal organs mentioned earlier. Bartlett and Smith (2003) discovered that extreme heat reduced total immunoglobulin as reactions in birds. In addition, they discovered a drastically diminished thymus.

During hot weather, laying hens with access to cooling perches fared better. The heterophil to lymphocyte ratio was greater in the control chickens after four hours of chronic thermal stress. Cooled perches have been suggested such a way to reduce the impact of high temperatures on immunity of Birds. Strong, (2014) Heat-stressed Chickens perished at a greater rate after being administered an Escherichia coli inoculation than chicks under controlled ambient conditions (Compean et al., 2011). High environmental temperatures have been shown to impact the immune reaction in hens (Naseem et al., 2005) as affecting particular immunologic indicators like, a higher Heterophil-lymphocyte ratio (Felver Gant et al., 2012). Studies have revealed that heat stress can impair the immune system of hens and broilers by diminishing their ability to produce antibodies, which ultimately leads to a reduction in their immunocompetence (Mashaly et al., 2004).

Habibian et al., (2013) Broilers exposed to heat stress exhibited decreased levels of total immunoglobulin (Bartlett and Smith, 2003). High environmental temperatures have been shown to impact on the body's ability to protect itself against many ailments that may harm it. (Naseem et al., 2005) by affecting particular immunological indicators like a higher Heterophil-lymphocyte ratio (Felver Gant et al., 2012). The high temperatures to that which chicken is subjected have been shown to decrease resistance by reducing immunoglobulin in bird blood.

The effect of high temperatures on the performance of poultry:

Tropical regions include high temperatures and humidity, which can be detrimental to poultry birds if not properly controlled. In severe circumstances, high temperatures and humidity can cause fatigue and even mortality (Olawumi and Ogunlade, 2010). Heat stress has been shown to reduce feed intake, feed efficiency, egg quality and quantity, and flock activities, with a resultant rise in cardiac and respiratory rates, water intake, and mortality (Olawumi, 2011). As a result, if not handled correctly, high temperatures may increase the issue of limited and insufficient supplies of eggs and chicken meat to fulfill the dietary protein demands of the residents of these locations. Furthermore, while it is obvious that the demand for eggs and poultry meat is increasing in tropical regions, their supply can be hampered by a variety of constraints, including the breed of poultry birds, harsh environmental factors, building area, insufficient financial resources, and producers' lack

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of scientific understanding (Bhadauria et al., 2014).Habibian et al. (2013) likewise showed a substantial drop in body weight and the extent of utilization of the available feed at high temperature in meat chicken's ; however, low utilization rate of available feed at these high temperature conditions. Naseem et al. (2005) discovered an increase in feed conversion in broiler chicks subjected to temperature. Extreme heat (acute or chronic) reduces poultry development performance (Attia et al., 2011; Ghazi et al., 2012; Imik et al., 2012). Heat stress reduced body weight, nutrient digestibility, egg output, and egg quality in laying chickens, just as it did in broiler chicks (Deng et al., 2012). Lin et al. (2004) discovered that exposing laying hens to high heat inside the breeding sheds led to a deterioration in the qualities of the eggs produced, such as weight, size, shell thickness, susceptibility, or breaking strength.

High temperature during broiler growth has been linked to undesirable meat traits in addition, quality loss (Lu et al., 2007; Zhang et al., 2012 b) Furthermore, transporting livestock and poultry from fields to industrial facilities under high temperatures has been shown to result in meat quality losses (Debut et al., 2005). High temperature in poultry house were proven it was reduce products quality in laying chickens (Bozkurt et al. 2012). Feed digestion generates metabolic heat in the bird. To lessen its heat burden, the bird will limit its meal intake. The most common effect of heat stress is a decrease in eggshell quality, which makes the eggs more sensitive to shattering or degradation. The majority of shell quality issues caused by heat stress are not due to a lack of calcium in the diet. Instead, they are the product of incredibly intricate physiological activities within the hen. Excess carbon dioxide is released when the bird pants to stay cool. This causes the blood to become more alkaline, limiting its capacity to retain and transport calcium for shell production. A bad scenario cannot be altered by raising calcium intake. (Ward and Creighton 2020).

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