

## Effect of High Temperature on Body Weight Gain, Egg Production and Egg Shell Formation Process in Laying Hen: A Review

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**Abstract:** This review article mainly focuses on the effect of high temperature on body weight gain, egg production and egg shell formation process in laying hen. Heat stress has detrimental effects on egg production, egg quality of laying hen and reduced growth rate in broiler production. Heat stress has adverse effects on behavior, welfare and immunity of poultry and decreases the egg production resulting in massive economic losses of farmer. Higher environmental temperature contributing to reproductive failure (fewer eggs), poor egg quality (soft shells or shell-less eggs) and impaired skeletal integrity of the hen. Poultry can only regulate their body temperature within a narrow range of environmental temperatures. Egg weight, eggshell thickness, eggshell percentage and eggshell density were negatively affected by high ambient temperature. Controlling the environmental variation is a critical to successful poultry production and welfare. Laying birds should be kept in a good environment conditions with a good care. In poultry house if environmental temperature is allowed to exceed normal ranges, then egg production, egg size and growth will be negatively affected. These factors along with others affect the birds' metabolism which in turn is responsible for the output of eggs, meat and body heat to maintain normal physiological processes and functions.

**Key words:** Temperature • Eggshell • Egg Quality • Egg Production • Production • Metabolism

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### INTRODUCTION

The total chicken population in Ethiopia is estimated to be 60.5 million with regard to breed 94.33% indigenous, 3.21% hybrid and 2.47% exotic breeds [1]. Poultry production, like any other enterprise is not immune to day-to-day constraints. Notable amongst these, especially in developing nations located in hot tropical environments, are managerial ability, feed availability and competition with foreign poultry products, harsh climates, disease and poor government policies - among others. However, high ambient temperature (HAT) has been identified as one of the major stressors in poultry production in the tropical environment [2] and most especially in under-developed countries where poultry farmers cannot afford expensive modern artificial control of ambient temperature in poultry houses [3].

High environmental temperature is one of the most serious factors affecting the production performance of laying hens in both tropical and temperate countries. The 3 major factors contributing to these losses are reproductive failure (fewer eggs), poor egg quality (soft shells or shell-less eggs) and impaired skeletal integrity of the hen [4]. Egg production is affected by both genetic and environmental factors and many interactions between these have been detected. Mean rate of lay in a flock of hens at a particular age is determined by the individual patterns of sequential laying at that time [5].

Hens lay eggs in sequences, the length of which varies over the age of the hen both within and between the various types of chicken [5]. Poultry plays an important role in human nutrition, employment and income generation. In poultry housing environment may affect

the performance of birds as well as its wellbeing. Heat stress results from a negative balance between the net amount of energy flowing from the animal to its surrounding environment and the amount of heat produced by the animal [6]. Egg shell quality is an important economic factor for producers, being affected by time of oviposition [7], age of hen [8], genotype [9] and environmental temperature [10, 11].

Therefore, this paper is involved with the topic under review to discuss some of the underlying characteristic in performance of layer in egg production, body weight gain and eggshell quality via high temperature condition.

The objective of this paper is to review:

- To access the effect of high temperature on body weight gain of laying hen.
- To access the effect of high temperature on egg production.
- To access the effect of high temperature on eggshell formation.

**Effect of Temperature on Egg Production:** Poultry production as an integral part of livestock production system plays an important socioeconomic role in developing countries [12, 13]. As an important non-genetic and bio-climatic factor, environmental temperature influences optimum physiological functioning of egg-type poultry. Therefore, a suitable rearing environment is fundamental to the optimum metabolic, physiological and endocrinological activities connected with the entire egg production process [14].

Mashaly, *et al.* [15] explained that the eggs from hens housed in a hot chamber were significantly fewer than the number of eggs produced in controlled chambers meaning that egg production was inversely related to level environmental temperature. This was confirmed by the fact that in an experiment conducted by Star, *et al.* [16] the hens that were exposed to a high temperature had a laying percentage that ranged from 83.6 to 83.8 as compared to the birds in the control group which had a laying production of 93 to 93.2%. The attendant hypo-function of ovaries and low egg production in response to HATs might be mediated through inhibitory activity of heat stress on the hypothalamo-pituitarygonadal axis. Interference with normal ovarian function will consequently obstruct or depress secretion and circulation of ovarian steroids (progesterone, estradiol) and gonadotropins (luteinizing hormone, follicle stimulating hormone) thereby impairing regulation of

physiological mechanisms fundamental to steroid genesis, follicular recruitment and growth and ovulation thus resulting in poor egg production [17]. From the above we understand that optimum temperature is better for laying more egg. Poultry meat and eggs are estimated to contribute 20 to 30% of the total animal protein supply in low income food deficient developing countries [18].

**Effect of Temperature on Egg Quality and Weight:**

A decline in egg weight is mainly due to the impact of heat stress rather than reduced feed intake. High temperatures also contribute significantly to the weight loss in egg yolk and egg albumen [19]. The findings of Ugurlu, *et al.* [20] as well as Rozenboim, *et al.* [17] support these results as they suggested the reduced egg weights were one of the consequences of exposing chickens to heat. The same report explained that ambient temperature has the potential of altering the other components of the egg such as egg albumen and egg yolk. High temperatures are capable of greatly reducing the weights of the egg yolk, egg albumen and shell weight but their relative weights to the egg weight were not affected by the temperature. The chickens that commenced their laying in summer produced lighter eggs compared to the chickens that started their laying cycle in winter [21]. The findings of Mashaly *et al.* [15] revealed that in addition to the weights of the egg yolk, egg albumen and the shell weight high temperature could significantly lower the shell thickness and specific gravity.

**Effect of Temperature on Egg Shell Quality:** According to study of Dhawale [22] eggshell formation is a complex process and is affected by heredity, nutrition, hormone, environment, pathology and management. Producing good quality eggshell is workable only when hens are raised in ideal conditions and all necessary factors are present and functioning in concord. Shell calcium content was higher in eggs from hens kept at the higher temperature, this result corroborating with that of Cusack, *et al.* [23] who explained this by demonstrating that calcium carbonate precipitation is more rapid at higher temperatures and also It is possible that the higher calcium deposition rate at the high temperature caused larger crystals to form resulting in poorer egg shell strength.

Ahmed, *et al.* [24] stated that material with smaller crystal size is more solid and is therefore consistent with stronger shells. Shell strength is one of the most important external quality parameters of an egg, usually

dependent on egg shell proportion and thickness. Differences in egg shell physical parameters are dependent, among other factors, on the rate and extent of mineral deposition in the egg shell.

The characteristic poor eggshell quality of fowls subjected to thermal stress can be partially accounted for by low feed intake. Reports from various studies indicate that egg shell qualities are compromised during high ambient temperature as a result of a decrease in feed intake. Elijah and Adedapo [25] attributed small egg size, low egg production and incidence of cracks to the inability of hens to take adequate feed necessary to manufacture egg shell at high ambient temperature.

According to the study, of Mujahid, *et al.* [26], lower plasma concentrations of potassium (after 6 and 12 hours exposure to heat stress) and sodium (after 6 hours

exposure to heat stress) but marginal decrease in plasma calcium level after 6, 12 and 18 hours of subjecting broilers to heat stress (34°C).

**Effect of Heat Stress on Reproduction:** High temperature with high relative humidity has more detrimental effect on reproduction of animal. Exposure of White Leghorn hens to high environmental temperature to causes decline in reproductive activity leads to reproductive failure and poor egg quality [27]. Ambient temperatures may influence reproductive ability by altering feed intake of chickens. Ayo, *et al.* [28] obtained 20% reduction in feed intake in heat-stressed layer chickens during the hot-dry season, associated with high ambient temperature and high relative humidity which resulted in a significant decrease in hen-day production.



Fig. 1: Effect of heat stress on productive performance of birds



Fig. 2: Effect of heat stress on reproductive organs of birds

**Sign of Heat Stress in Poultry:** The signs of heat stress in poultry are panting with open mouth, elevated their wings and squatting near to the ground, droopy acting, slowness and lethargic closed eyes, lying down, increased water intake, decreased appetite, drop in egg production, reduced egg size, poor egg shell quality, reduced body weight and increased cannibalism [29, 30]. Birds are trying to lose heat by gasping and changing the position of their feathers, losing water in their breath and cooling by evaporation through the surface of the lungs. Birds are facing to heat stress conditions, they spend less feeding time during feeding, more time drinking and panting, less time moving or walking and more time resting [31].



Fig. 3: Sign of heat stress

**Management Approaches to Reduce Heat Stress in Poultry:** To reduce the heat stress in poultry is the multidisciplinary approach. Modification of surrounding environment, ventilation system, bird density and nutritional management to reduces the heat stress in poultry [30].

**Modification of Surrounding Environment:** Environmental temperature and relative humidity of the surrounding environment affects the evaporative cooling mechanism in birds. Evaporative heat loss increases in high temperature with wind speed but decreases with increasing humidity [32, 33]. Air movement inside the house is important for efficient ventilation. Use of sprinkler and fogger with fan reduces the temperature inside the house on hot climatic condition [34].

**Ventilation System:** Good ventilation system is essential for heat stress management. Removes the moisture Loaded air from the poultry house and enter equal amount of fresh air from outside. Ventilation system should be maximized as the air movement assist removal of ammonia, moisture and carbon dioxide from the poultry house and enter fresh oxygen from outside [35]. Evaporative cooling

pads works on the same cooling principle as foggers, air is cooled inside the house when it passes through the cooling pads. Circulation fans are recommended for proper ventilation in a good ventilated house for maximizes air movement over the birds to increase convective cooling. The installation of circulation fans at 1-1.5 meters above the floor and tilted downward about 5° angles for producing maximum air over the birds [36].

**Nutritional Management:** Reduce the heat stress in poultry by nutritional management approaches. Decrease in feed intake and increase water intake of poultry under hot climate to control the body temperature [10, 38]. Vitamins and minerals supplementation has been determine to decrease mortality and improve growth performance of poultry birds during heat stress as because heat stress increases excretion of mineral from body and decreases the serum and liver concentrations of vitamins and minerals [10]. According to Elnagar *et al.* [39] panting is accompanied by an increase in water loss so more water has to be consumed by birds during hot, dry weather in order to prevent dehydration. Drinking water cooler than body temperature will absorb body heat, which will help with cooling the bird. Adding an electrolyte to the drinking water will replenish vital nutrients that will help balance blood pH levels.

## CONCLUSION

Total control of heat stress problem is difficult and the costs involved are not affordable by poultry farmers in warm and hot climates which are mostly affected. Laying birds should be kept in a good environment conditions with a good care. In poultry house if environmental temperature is allowed to exceed normal ranges, then egg production, egg size and growth will be negatively affected. These factors along with others affect the birds' metabolism which in turn is responsible for the output of eggs, meat and body heat to maintain normal physiological processes and functions. Environmental stressors such as hot temperatures, high air humidity and other, may affect the bird in an additive manner if these stressors are imposed concurrently. These stressors can negatively affect bird's growth performance, feed intake and efficiency and physiological status.

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