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# The Effectiveness Of Cooling Broiler House Floors To Reduce Heat Stress

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## ABSTRACT

**OBJECTIVE:**

This study aimed to evaluate the effectiveness of a floor cooling system in reducing heat stress in broiler chickens by assessing behavioral responses, heat transfer dynamics, and changes in rectal temperature.

**METHODS:**

Ten broiler chickens were randomly selected and placed in a climate-controlled glass house. The temperature inside was raised to 36°C before cooling the flooring. Body surface temperature, rectal temperature, floor temperature, and ambient temperature were recorded. Measurements were taken before and after cooling, and behavioral changes, particularly time spent lying down, were observed. Heat transfer from the chickens to the floor was also quantified.

**RESULTS:**

Chickens housed on cooled floors exhibited a significant increase ($p < 0.05$) in lying behavior, indicating an active thermoregulatory response. Heat transfer from the chickens' bodies to the floor was significantly higher ($p < 0.05$) in the cooled flooring group compared to the non-cooled group. Additionally, rectal temperature showed a significant reduction ($p < 0.05$) in chickens with floor cooling.

**CONCLUSION:**

Floor cooling effectively reduces body temperature and enhances thermal comfort in heat-stressed broilers. These findings highlight the potential of integrating cooling floors into poultry housing as a practical and cost-effective strategy to mitigate heat stress and improve bird welfare and productivity.

**Keywords**: Broiler, Behavior, Heat-Stress, Floor-Cooling.

## INTRODUCTION

Heat stress continues to be a significant challenge in poultry production across many regions worldwide, particularly during the summer months. It leads to substantial economic losses and adversely affects bird health, productivity, and overall industry efficiency (Nawab *et al.* 2018). Broilers are more vulnerable to changing environmental conditions than other domesticated animals, especially during the growth-tomarket phase. This can be ascribed to their quick production cycle, high feed efficiency, growth rate, quick metabolism, high body temperature, and lack of a sweat gland (Liu & Peng 2001; Taha *et al.* 2013). Despite their rapid growth, broiler chickens have a limited capacity to adapt to environmental changes. (Zhong *et al.* 2012). The body surface temperature of broiler chickens serves as a reliable indicator for assessing their exposure to heat stress.

According to Yahav et al. (2004), accurately estimating the sensible heat exchange between broilers and their environment requires assessing heat loss across multiple body regions. The primary determinant of sensible heat loss is the temperature gradient between the bird's surface and the surrounding environment. Under heat stress conditions, blood flow increases in various body areas to facilitate heat dissipation (Nascimento et al., 2011; Cangar et al., 2008). As a result, birds regulate their skin temperature, which typically remains within 5°C of ambient temperature, depending on the affected body region, even when environmental temperatures exceed the thermal comfort range (Zhou & Yamamoto, 1997). Heat stress is a major challenge in poultry production, significantly affecting the behavior, welfare, and overall performance of broiler chickens. Understanding how young chicks respond to heat stress is essential, as their behavioral adaptations may provide early indicators of thermal discomfort. However, limited research has systematically characterized these behavioral responses or evaluated practical solutions to mitigate heat stress in commercial broiler housing. Observing these responses could help establish predictable patterns of thermal stress adaptation and guide the development of effective environmental control strategies. The present study aimed to evaluate the effectiveness of a floor cooling system in optimizing the thermal environment within broiler housing. Specifically, the study assessed how the cooling system influences broiler behavior, thermal comfort, and overall heat stress mitigation, providing insights into its potential application as a practical intervention in poultry farming.

## MATERIALS AND METHODS

### Study Design and Experimental Setup

This study was designed as an experimental controlled study to assess heat transfer dynamics in broiler chickens under controlled environmental conditions. The experiment was conducted in the science laboratories of the College of Basic Education at Misan University. Three glass house measuring 160 cm in length and 80 cm in width was used to observe the behavior of 35-day-old broiler chickens.

### Experimental Procedures

Temperature measurements were recorded to evaluate heat transfer between the floor surface and the birds. The experiment followed these steps:

**Temperature Monitoring:** An infrared thermometer was used to remotely measure body surface temperature and ground temperature every 10 minutes. As well, a manual rectal thermometer was used to record core body temperature every 30 minutes.

**Repetition and Cooling Phase:** The experiment was repeated after one hour under the same conditions. Before each trial, the floor was cooled, and temperature measurements of the ambient greenhouse atmosphere, floor surface, and birds were taken every 15 minutes to ensure consistency and stability.

## HEAT TRANSFER CALCULATIONS

The amount of heat transferred was calculated using the heat flow equation, which accounts for conduction through a body over time:

$$Q = kA\Delta T \times t / L$$

Where: Q = Heat transferred (Joules); k = Thermal conductivity of the material (W/m·K); A = Surface area in contact ($m^2$); ΔT (Delta T) = Temperature difference (°C); t = Time (seconds); L = Thickness of the material (m).

Body temperature and floor temperature were measured, and the surface area of contact was calculated to determine the heat exchange rate.

## STATISTICAL ANALYSIS

Data were analyzed using SPSS software to evaluate differences in heat transfer rates before and after heat stress exposure. Descriptive statistics and appropriate statistical tests were applied to determine the significance of temperature variations over time. Data were analyzed using SPSS software. Paired sample t-tests were conducted to compare temperatures and heat transfer rates before and after cooling. Significance was set at $p < 0.05$.

## ETHICAL CONSIDERATIONS

This study was conducted in compliance with the Ethical Guidelines for Research at Misan University. The ethical approval for this study was issued the ethical code for grant number from the Committee on Research Ethics of based on the Ethical Guidelines of Research from Misan University.

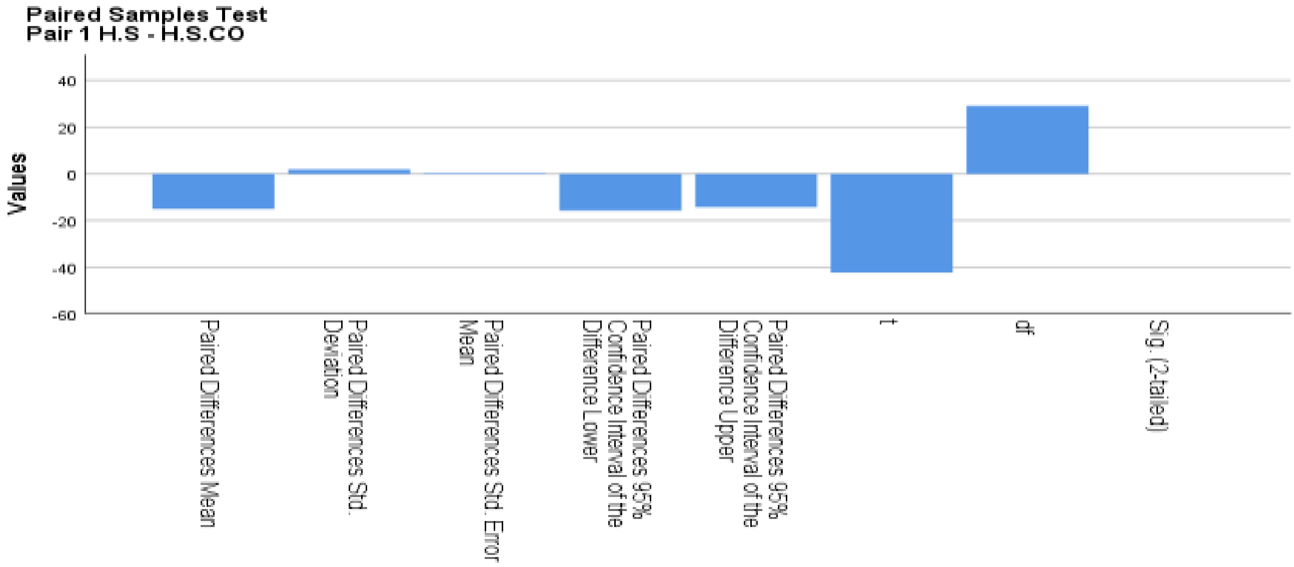
## RESULT AND DISCUSSION

**Table 1** presents the effect of cooled floors on chickens exposed to heat stress at 36°C, specifically analyzing the duration of time spent perching. The results indicate that chickens subjected to heat stress with access to cooled floors perched for an average time of 19.43 minutes, whereas those on non-cooled floors exhibited a statistically significant shorter perching duration (5.22 minutes,$p < 0.005$). This finding highlights the potential benefit of floor cooling in improving thermal comfort and behavioral adaptation under heat stress conditions.

**Table 1:** The mean time (minute) of broiler lying down on the cooling and uncooling floor

**PAIRED SAMPLES TEST**

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | t | df | Sig. (2-tailed) |
| Pair 1 | H.S - H.S.CO | -15.05000 | 1.94276 | .35470 | -15.77544 | -14.32456 | -42.431 | 29 | .000 |




This study assessed cooled flooring's impact on heat-stressed broilers, showing increased perching duration, highlighting its role in mitigating heat stress and improving welfare. Li et al. (2015) reported that heat stress significantly alters broiler behavior, increasing the time spent lying down while reducing activities such as standing and walking. This aligns with our findings, as birds in the non-cooled condition likely exhibited increased lying behavior due to thermal discomfort. Similarly, studies by Mazzuco and Hester (2005) and Branco et al. (2021) describe lying down and lateral lying as thermoregulatory strategies employed by broilers under heat stress to facilitate conductive heat dissipation. The findings of Branco et al. (2021) further emphasize that specific behavioral sequences emerge under heat stress, with birds predominantly engaging in lying behaviors rather than perching. While previous literature primarily associates lying behaviors with heat stress, our results indicate that perching on cooled floors may serve as an alternative thermoregulatory strategy.

**Table 2** presents the amount of heat transferred from the body of broiler chickens to the floor under different thermal conditions. The results indicate a significant increase ($p < 0.05$) in heat transfer in chickens placed on cooled floors (24°C) compared to those on non-cooled floors. The heat transfer values for chickens on cooled floors ranged between 0.99 and 1.3 watts, whereas for those on non-cooled floors, it was significantly lower, ranging from 0.10 to 0.14 watts. These findings align with the observations of Cangar et al. (2008) regarding the role of conductive heat dissipation in thermoregulation. They reported that the efficiency of heat dissipation depends on the extent of body-surface contact with cooler surfaces. Likewise, in our study, the increased lying behavior on cooled floors likely contributed to the higher heat flow observed. Efficient heat dissipation is crucial for broilers under heat stress, as their ability to regulate body temperature directly affects welfare, productivity, and survival. Our study confirms that broilers placed on cooled floors exhibited significantly greater heat transfer, highlighting the role of conductive cooling in mitigating thermal stress. These findings are consistent with Yahav et al. (2004), who emphasized the importance of quantifying heat loss from different body regions to estimate sensible heat exchange in broilers. Specifically, the inner thighs and abdominal regions, which are poorly feathered, play a major role in facilitating heat dissipation through direct contact with cooler surfaces. This explains why chickens lying on cooled floors exhibited greater conductive heat loss, as these regions allowed for maximum heat transfer to the floor.

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**Table 2:** The value (t) of the rate of variation between the temperatures transferred from the chicken body to the floors by unit area before and after floor cooling

| | Mean | Std. Deviation | Std. Error Mean | 95% CI of the Difference Lower | Upper | T | Df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| H.S - H.S CO | -0.88 | 0.02 | 0.01 | -0.90 | -0.87 | -129.45 | 9.0 | 0.0001 |

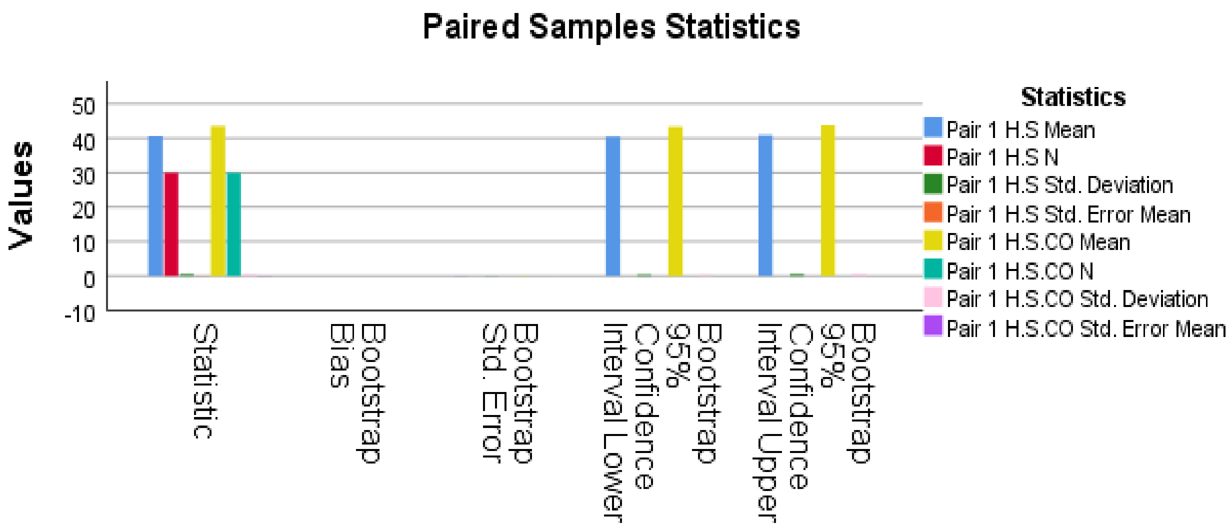
The most important factors that lead to the transfer of heat from the chicken's body to the cooled floors are the surface area of the chicken's body that contact the cooled floors of the chicken house, the thermal difference between the chicken body and the cooled floors, the amount of heat in the parts of the body connected with the cooled floors of the houses, as well as the existing insulators and the specific heat of the floor, all these factors determine the amount of heat transmitted (Zhao et al. 2013; Nääs et al. 2010).

**Table 3** presents the effect of floor cooling on rectal temperature in heat-stressed broilers (36°C). The results indicate a significant reduction in rectal temperature ($p < 0.05$) in chickens with access to cooled floors (41.40°C) compared to those on non-cooled floors (43.58°C). This suggests that floor cooling effectively enhances thermoregulation, providing a practical intervention to mitigate heat stress in broilers. In fact, conductive heat loss through direct contact with cooled surfaces plays a crucial role in maintaining thermal balance in broilers. Our findings align with Hu et al. (2021), who also reported that floor-cooled chickens exhibited lower rectal temperatures, reinforcing the effectiveness of this cooling strategy. The movement and flow of blood, which transports body heat, influence rectal temperature regulation. As body temperature decreases, rectal temperature drops accordingly, highlighting the role of peripheral blood flow in thermoregulation. The feet and shanks, being unfeathered, highly vascularized, and with minimal muscle tissue, facilitate heat dissipation and contribute to approximately 25% of total body heat loss (Li & Yamamoto, 1991). This supports our hypothesis that conductive heat loss from the feet complements panting, further improving thermal comfort in hot environments. Moreover, Rado (2004) emphasized that regions such as the abdomen, thighs, and legs—which have minimal feather insulation—serve as additional areas for heat dissipation. Thermal regulation is also influenced by blood flow distribution, with heat being transferred from the core to the surface and eventually dissipated through contact with cooled floors (Cangar et al., 2008; Shinder et al., 2007). Birds instinctively adjust their posture, increasing contact with cooler surfaces, to enhance heat exchange efficiency. The abdominal region, which houses vital organs involved in digestion and metabolism, has high blood flow, making it an effective site for heat transfer when in direct contact with a cooled floor (Weurding, 2002; Shakeri & Le, 2022).

**Table 4:** The value (t) indicates the rate of variation between the rectum temperatures of chickens exposed to floor cooling and chickens not exposed to floor cooling.

**PAIRED SAMPLES CORRELATIONS**

| | | N | Correlation | Sig. | Bootstrap for Correlation[a] Bias | Std. Error | 95% Confidence Interval Lower | Upper |
|---|---|---|---|---|---|---|---|---|
| Pair 1 | H.S & H.S.CO | 30 | .042 | .827 | .012 | .199 | -.362 | .440 |




To ensure optimal thermal conditions in broiler housing, our findings confirm that floor cooling is an effective strategy for regulating bedding temperature and enhancing heat dissipation. The observed increase in lying and perching duration on cooled floors suggests that chickens actively seek these surfaces for heat loss, particularly through conductive transfer from poorly feathered regions such as the abdomen, thighs, and legs. This highlights the need for cost-effective, energy-efficient, and environmentally sustainable cooling technologies to improve poultry welfare and productivity. As Leeson & Walsh (2004) noted, the limited feather distribution in these regions facilitates greater heat transfer, supporting our findings that floor cooling enhances thermal regulation in heat-stressed broilers.

The implementation of floor cooling systems in broiler housing proves to be a cost-effective and efficient strategy for mitigating heat stress, improving bird welfare, and enhancing productivity. Our findings highlight the importance of conductive heat loss in thermal regulation, emphasizing the role of poorly feathered body regions in heat dissipation. Future research should focus on optimizing cooling temperatures, durations, and physiological responses to refine this approach further. Integrating such systems into poultry housing designs will not only support industry sustainability but also provide practical solutions for minimizing heat stress-related losses in broiler production.

## CONCLUSION

This study provides compelling evidence that floor cooling systems are an effective solution for mitigating heat stress in broiler chickens. The significant reductions in rectal temperatures and increased heat transfer rates demonstrate the physiological benefits of floor cooling, while the behavioral observations highlight its role in improving thermal comfort. The findings of this study confirm that broilers actively modify their behavior in response to thermal stress, with a significant increase in perching duration on cooled floors. This suggests that floor cooling plays a crucial role in thermoregulation, allowing birds to efficiently transfer body heat to the cooler surface. The economic implications of floor cooling, including reduced mortality rates, improved feed efficiency, and enhanced meat quality, make it a viable investment for poultry producers in hot climates. Future research should explore the scalability and cost-effectiveness of floor cooling systems in large-scale commercial operations.

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**Conflicts of interest:** There is no conflict of interest

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