**Evaluation of the efficiency of floor cooling in broiler houses during heat stress**

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**Abstract:**

 Because of the harmful effects of heat stress on the production of broiler chickens and on the health of chickens, this experiment was conducted to evaluate floor cooling to reduce the negative impact on chickens.

 Ten broiler chickens were chosen at random and placed in a greenhouse with suitable climate control. The temperature within the glass house was raised to ( 36°C ) before the flooring were cooled. The temperatures of the chickens' bodies, the floor, their rectals, and the interior of the glass house were then recorded. The temperature of the chickens' rectals was measured both before and after cooling, as well as the change in their behavior and the heat transferred from their bodies to the floors of the greenhouse.

 Through the findings, it was determined that each chicken's behavior, represented by lying on the flooring, was significantly (p < 0.05) increase. Additionally, it was observed that the heat transfer from the chickns' bodies to their floors significantly (p < 0.05) increase than it was for the birds with uncooled floors. Also seen in the cold floored hens was a noticeable, considerable drop in rectal temperatures significantly (p < 0.05) . from this experiment result that floor cooling effectively lowers chicken body temperature and mitigates the harmful effects of heat stress.

**Keywords**: broiler, behavior, heat, stress, floor, cooling, temperature.

**Introduction:**

 In many parts of the world, heat stress is still one of the biggest problems with poultry production. It cause major losses in poultry production throughout several regions during the summer. Broilers are more vulnerable to changing environmental conditions than other domesticated animals, especially during the growing-finishing 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, they have a limited capacity to adapt to environmental changes. Additionally, chickens are very sensitive to and vulnerable to heat stress due to the absence of sweat glands in their skin Zhong *et al.* 2012). The broiler chicken's body surface temperature can be used to gauge the degree of heat stress it has been exposed to. According to Yahav *et al.* (2004), Estimating the sensible heat exchange of broilers with their environment requires the assessment of heat losses from several body areas. The amount, distribution, and flow of peripheral blood affect the chicken's body temperature, which in turn has an effect on the amount of heat in each part. This indicates that chickens are trying to regulate their body temperature by dissipating heat from their body parts where the blood transfers heat to the peripheral vessels to transfer it to the surrounding environment through the skin (Zhong *et al.* 2012; Shinder *et al.* 2007; Cangar *et al.* 2008; Nascimento *et al*. 2014).

 The level of heat stress experienced by the broiler chicken can be determined by measuring the surface temperature of its body. The difference between surface temperature and ambient temperature is the main factor in determining sensible heat loss. When a bird is subjected to heat stress, blood flow increases in various body parts (Nascimento *et al*. 2011; Cangar *et al.* 2008).Birds' bodies respond to heat stress by changing their skin temperature, even when the ambient temperature is over the thermal comfort range, this difference normally stays within 5°C depending on the body part affected( Zhou& Yamamoto 1997). It is very important to look into how heat stress affects the behavior of growing young chicks because it has a significant impact on poultry's daily activities. Therefore, it might be possible to pinpoint the characteristics and predictable patterns of those reactions by observing how heat stress impacts different behaviors in chicks. It was discovered that when heat stress lasted for two or three weeks, the laying down time for broiler chickens on the floor was prolonged ( Li & Chen 2015). The series of actions of "laying down" and "lying lateral" occurred under heat stress, which suggests a challenging thermal environment for the chicken. Thermal stress and broiler behavior were found to be correlated with time (Branco *et al*. 2021).

 The purpose of the current study was to evaluate the efficacy of a floor cooling system for improving the thermal environment in the broiler housing area.

**Material and methods**:

 The experiment was carried out in the science labs of the College of Basic Education, and a glass house measuring 160 cm long by 80 cm wide was utilized to observe the behavior of hens. Chickens that are 35 days old inside the greenhouse(The ethical approval for this study was issued as the ethical code for grant number from the Committee on Research Ethics of based on the Ethical Guidelines of Research from misan university)An infrared thermometer was used to remotely monitor the chickens' body temperature and to regularly take the ground's temperature every 10 minutes. The bird's temperature was also taken through the rectum using a manual thermometer. After an hour, the experiment was repeated. The experiment was conducted after the floors had cooled, and the thermometer readings for each of the inside greenhouse atmospheres, the floors, and the birds were periodically taken every ten minutes in order to guarantee the stability and follow-up of the temperatures. Additionally, a manual thermometer was used to take the rectal temperature every half an hour.

 The amount of heat transferred was calculated according to the law of heat flow, after measuring the temperature of the chicken body and the floor, and calculating the surface area of the bodies in contact.

 The amount of heat Q transferred via conduction through a body in a time t is given by the formula.

Q= kAΔT×t/L

 A value t was calculated using the spss program to show the disparity between the rates of heat change, since the experiment on chickens was done before and after heat stress.

**Result and Discussion:**

 Studying the natural behavioral response of chickens exposed to heat stress may lead to the development of effective solutions defensive mechanism that an organism uses to respond and interact with its surroundings in order to keep its internal body systems in balance through behavior. Examples of behavioral responses include panting, wing spreading, and seeking out cooler areas in response to heat stress (Mazzuco & Hester 2005)

 The results in table No (1) shown the effect of cooled floors on chickens exposed to heat stress ( 36°C ) on the time of chickens perching on cooled floors compared to chickens exposed to heat stress and non-cooled floors where, as shown in Table No. (1) It is about 23-24 minutes during cooling treatment compared to the average period of perching of chickens without cooling.

Table (1) for calculating the value (t) of the average period of chicken lying on the floor before and after cooling the floors of chickens exposed to heat stress ( 36°C ).

|  |
| --- |
| **Test** |
|  | Paired Differences |  t |  df |  Sig. (2-tailed) |
| Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |
| Lower | Upper |
|  | H.S - H.S CO | -18.91000 | .65396 | .20680 | -19.37782 | -18.44218 | -91.441 |  9 |  .000 |

 Li & Chen (2015) reported the broiler everyday behavior, including as lying down, standing up, and walking, is severely impacted by heat stress, in comparison to the control group, the time spent lying down was longer when heat stress lasted for two and three weeks in the persistent heat stress group. Mazzuco & Hester (2005) explain that the sequence of behaviors "Lying down, Lying laterally," which only manifested under thermal stress from heat, demonstrates that the bird employs such behavior under such circumstances to promote the thermal exchange of heat by conduction.

Branco *et al* (2021) indicated there are the temporal correlations between thermal stress and broiler behavior using the pattern mining sequences approach, only under heat stress, which a difficult thermal environment for the bird, did the sequence of behaviors of "lying down" followed by "lying laterally" occur.

 The results shown are in agreement with what was mentioned Etches & Gibbins (2008). Chickens seek for cold places and lie down and dig their litter in order to find cool places that they touch to transfer their high body heat to the cooler objects around them. The results that appeared to confirm that the length of time the chickens were lying down and lying to the side several times, indicate that the chicken is trying to transfer the high heat from its body to the cooled floor. (Hu *et al*. 2021). According to the findings of contact of chickens with cooled floors to reduce the temperature of chickens engaged in thermoregulatory activity (such as panting) during exposure to heat stress, the heat-stressed chicken cooling system helped maintain behavioral balance (Leeson & Walsh 2004). Lara & Rostagno (2013) reported that birds that come into direct touch with colder surfaces lose body heat (for example, the litter, roost floor, cage wire). Fowls search out the shed's coolest spaces. To find a cooler spot, birds lay on the ground or burrow among the trash. According to Yahav *et al*. (2004), the quantification of heat losses from different body regions is necessary to estimate the sensible heat exchange of broilers with their surroundings.

 The body temperature of the chicken under natural conditions is higher than the temperature of the surroundings and as a result there is a continuous heat loss from the bird to the surrounding environment by radiation, convection, conduction and evaporation. The bird's inner thighs region, and some region around the abdomen are poorly feathered, therefore their temperature was consistently between 39 and 41 degrees Celsius (Yahav & Shinder 2008; Cangar *et al.* 2008).

 The result (t value) that showed in table No 2, which shows that there is a significant increase (p < 0.05) in the amount of heat transferred from the body of chickens whose floors are treated with cooling at 24 °C compared to uncooled chickens. While the chickens, cooling floors, recorded the amount of heat transferred about an ranging from 0.99 - 1.3 watts compared to the amount of heat transferred to the uncooled flooring chicken was in the range of 0.10 - 0.14. These results are in agreement with what was indicated by Cangar *et al* (2008). There was a greater heat flow to the cold floor when contact during lying down since there was no feather growth in these regions.

 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 (2) for calculating the value (t) of the rate of discrepancy between the temperatures transferred from the chicken body to the floors by unit area before and after floor cooling

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| --- |
|  |
|  | Paired Differences | t | df | Sig.(2-tailed) |
| Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |
| Lower | Upper |
|  | H.S - H.S CO | -.88210 | .02155 | .00681 | -.89751 | -.86669 | -129.452 | 9 | .000 |

 In order to preserve body temperature and promote thermal comfort, health, welfare, and productivity during hot weather, cooled floors may enable conductive heat loss from chicken feet. When exposed to acute and chronic heat stress, laying hens and broiler chickens showed increased rectal temperature, a sign of their core body temperature Lower rectal temperatures were seen in broiler hens given cooled perches compared to controls that had access to standard perches, which is consistent with our findings (RADO, 2004).

 The foot is the only part that has direct contact with the ground, A distinctive anatomical trait of chickens is that their feet and shanks are unfeathered, have minimal muscle tissue, and are highly vascularized, which allows them to lose about 25% of their body heat through their feet. The findings are consistent with our hypothesis that conductive heat loss from cooled chicken feet will supplement latent heat loss from panting to further improve hen comfort in hot weather. (Li & Yamamoto1991). According to RADO , (2004) It seems that the available surface area is good in the abdomen, thighs, legs, legs and feet. It is also characterized as either free of feathers or feathers available in a small amount, and thus the thermal insulation is little due to the lack of distribution of feathers in those places

 On the other hand, Cangar *et al*. (2008); Shinder *et al*. (2007); Li and Yamamoto, (1991); Choi *et al.* (1997) report that the areas characterized by the availability of a good amount of blood flowing over the surface and surrounding environment areas through which heat can be transmitted to the ground to which it is attached, thus emptying the chicken’s body heat through the blood flow that transfers heat from the rest of the chicken’s body to the heat-discharge areas until. Thermal balance occurs by changing the position of the chicken to the side position and the areas connected to the cold floor from time to time.

 The temperature of the chicken's body parts is related to the amount, distribution and flow of peripheral blood, which in turn determines the amount of heat in each part, which indicates that the birds are trying to maintain a balanced body temperature through the heat they lose. One of the parts of the body where blood flows a lot, in broilers, increasing sense heat loss may increase heat tolerance (Zhou & Yamamoto 1997; Shinder, *et al*. 2007; Nascimento *et al*. 2014).

Table NO(3) the rate of discrepancy between the chick temperatures before and after floor cooling

|  |
| --- |
|  |
|  | Mean | N | Std. Deviation | Std. Error Mean |
|  | HS | 43.5800 | 10 | .23944 | .07572 |
| HS.CO | 41.4000 | 10 | .16330 | .05164 |

In table No. (4) showed t-value that chickens with floor cooling and exposed to heat stress 36 °C showed a significant improvement (p < 0.05) in rectal temperature (41.40) °C compared to chickens not treated with floor cooling (43.58) °C.

 The abdominal area that contains the viscera, especially the stomach, gizzard, and intestines, in which the process of mechanical and enzymatic digestion and metabolism takes place, has great blood flow, and it is possible to get rid of the heat inside the chicken if there is a direct adhesion and connection to the cooled floors, so the temperature difference between the cooled floors and the heat Indoor chicken can allow great heat transfer (Weurding, 2002; Shakeri & Le, 2022).

Table No (4) refer to calculating the value (t) of the rate of discrepancy between the rectal temperatures before treating chicken with floor cooling and after treatment

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|  |
|  | Paired Differences | t | df | Sig.(2-tailed) |
| Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |
| Lower | Upper |
|  | H.S - H.S CO | 2.18000 | .32931 | .10414 | 1.94443 | 2.41557 | 20.934 | 9 | .000 |

 In order to provide acceptable thermal conditions in the house space of chicken, the deployment of the floor cooling system proved effective in controlling bedding temperature. It is clear from the study of the current findings that the thermal conditions in the chickens' living quarters need to be adjusted. This calls for improved production technologies that are cost-, energy-, and environment-friendly from researchers and practical breeders. If a producer's investment in new technology results in financial gains, that producer will do so. Calculation.The period of the bird lying down and its perch on the cooled floors took more time that is mean there are more amount of heat may have transmitted from body of chicken to the cooled floor and that the abdomen, thighs, and legs have little distribution of feathers, which causes the heat transfer is greater, in addition to the large bluff of feathers (Leeson & Walsh 2004).

 In table No. (4) Presents the results of rectal temperature measurements before and after floor cooling. It was observed that floor-cooled chickens had a significant decrease in rectal temperature compared to chickens without floor cooling.

**Hu *et al*  (2021**) was indicated that the floor-cooled chickens had lowered rectal temperature. The movement and flow of the blood, which transports body heat, also has an impact on the rectal temperature. The rectal temperature drops when the chicken's body temperature drops. To determine the degree to which environmental temperature impacts the cloacal and surface temperatures (back, head, wing, and shank conducted research.

 The rectal temperature in the chicken group indicates that the cooled floors have decreased clearly indicating the decrease in the internal body temperature as a result of heat regulation through blood flow and heat transfer from the surface of the body through direct contact with the cooled floors.

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