PERFORMANCE ANALYSIS OF THE BROILER CHICKS UNDER DIFFERENT COOLING DEVICES DURING HOT-DRY SUMMER

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ABSTRACT

The efficacy of two cooling systems with a low-cost Fan-Fogger (FF) and the conventional Fan-Pad (FP) system was tested to reduce the effect of heat stress in broiler chicks. Four hundred eighty, day-old sexed commercial broiler chicks were randomly divided into twelve groups each having forty birds with similar body weight range and equal sex ratio. All the chicks were reared under similar brooding conditions for two weeks. The FF and FP systems were used for four groups of chicks each from third to sixth week of age. All chicks were reared under deep litter system of housing with similar managemental conditions except the cooling systems. The average body weight of chicks at the start of experiment was 280g. The temperature in control, FF & FP during the experimental period of 4 weeks was 32.18 ± 0.11, 30.22 ± 0.85 and 29.40 ± 0.09 ºC with relative humidity of 39.21 ± 0.09, 44.65 ± 0.14 and 48.91± 0.10%, respectively. The body temperatures of birds in FF and FP were recorded to be 107.2 ± 0.18 and 106.9 ± 0.04ºF respectively, as compared to 108.2 ± 0.13ºF, in birds of control. The weight gain was 1101± 1.00, 1241± 1.50 and 1320 ± 1.49 g; the FCR was 2.23 ± 0.01, 2.08 ± 0.01 and 2.03 ± 0.02 while the PER was 2.37 ± 0.01, 2.55 ± 0.02 and 2.61 ± 0.01 in control, FF & FP, respectively. The survivability rate was 95.04 ± 0.56% in control, 96.78 ± 0.62% in FF and 98.23± 0.42% in FP, respectively. It was concluded that both the cooling systems had significant (p < 0.05) effect on the comfort and production efficiency of broiler chicks during hot-dry season. The fan-pad system was found to be more efficient than fan-fogger system.

Key words: Broiler, Cooling systems, Fan-Fogger, Fan-Pad, Heat stress

INTRODUCTION

High ambient temperatures have a major impact on performance of commercial poultry. Heat stress not only causes suffering and death in the birds, but also results in reduced or lost production that adversely affects the profit from the enterprise. The high metabolic heat production due to high growth rate in modern day broiler further aggravates the situation. The metabolic heat along with high ambient temperature decreases the feed intake and body weight by 15% and 23% respectively, in broiler birds (Yalcin et al, 1997). There is a decline of about 1.72% in feed intake for every degree celsius rise in ambient temperature from 18 to 32°C (Rama Rao et al, 2002). At high ambient temperature (31°C), body temperature of bird rises and respiratory rate (panting) increases to dissipate heat by evaporative cooling. This hyperventilation results in excessive carbon dioxide losses. Heat stress can enhance the formation of reactive oxygen species (ROS), which can cause oxidative injuries such as lipid peroxidation and oxidative damage to proteins and DNA (Halliwell and Anuma, 1991, Lord and Averill, 2002, Mujahid et al, 2007). Oxidative stress results from an imbalance between free radical generation and antioxidant defense systems (Ames et al 1993, Sandhu and Kaur, 2002). Antioxidant enzymes such as Malondialdehyde (MDA), Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione Peroxidase (GPx) are the first line of defense antioxidants. Various studies have been conducted to protect poultry birds from high ambient temperature through

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cooling of poultry houses using fans and air coolers. Further, use of these cooling systems becomes impractical during monsoon season, when both temperature and humidity remains high. Likewise, environmental controlled poultry houses are yet uncommon in India and such facilities may increase the cost of production, making poultry production uneconomical. Evaporative pads, fogger pads and fogger nozzles can also be used as a good alternate to control heat and its effects in broiler houses (Weaver, 2002). Therefore, the present study was planned to compare the effectiveness of Fan-Fogger and Fan-Pad cooling systems on micro environmental conditions, growth performance and oxidative stress parameters of broiler chicks during heat stress (Hot-dry) period.

MATERIALS AND METHODS

Experiments were conducted at the Poultry Research Farm of the Department of Livestock Production Management, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. 480 sexed day-old healthy ‘VENCOB’ broiler chicks were reared up to two weeks with ideal brooding condition. After that equal number of birds with average weight, were distributed in two treatments, provided with either Fan-Fogger system (FF) or Fan-Pad system (FP) which were tested and compared with control group without any cooling system. In the deep litter system, the size of the shed was 16 x 10 x 10 feet. One square foot floor space per bird was provided in the shed.

Air delivery systems: The broiler chick needs 7 cfm of air circulation for comfort; therefore, the air flow needed for comfort of 160 chicks is 1120 ft$^3$/min i.e 31.71 m$^3$/min. Hence a fan having air delivery 31.71 m$^3$/min. A blower fan of size 18 inches with air delivery 32 m$^3$/min i.e. 41.28 kg/min was selected. With the objective to increase of relative humidity from 40% to 60%, 0.0025 kg moisture/ kg dry air was required (standard from psychometric chart). The rate of moisture addition

\[ \text{Rate of moisture addition} = \frac{\text{Total amount of air delivered/min} \times \text{Total moisture/ kg dry air}}{\text{kg water/min or 6.19 kg/hr or 6 liters/hr.}} \]

Hence three numbers of foggers each of 0.2 mm diameter with a discharge of 2 l/hr at a pressure of 30 psi were fitted in front of fan in fan fogger cooling system.

Design of cooling Systems: Fan - Fogger system: The fan-fogger system consisted of a blower (18 inch) with the copper ring placed in front of it. Fine foggers (3 in number) were placed on the ring at the height of 3ft from ground. The fogger’s on/off-timing was controlled through a timer. This cycle for on and off time of 30 seconds and 60 seconds, respectively, was repeated throughout the day (fan remained in the running condition during off-time).

Fan-Pad system: The fan and evaporative pad system consisted of cellulose pads with a water distributor through a P.V.C header. The evaporative pads were placed at one end of the shed and exhaust fan of 24 inches dimension at the opposite end. The water was pumped to the pads through a pump and the pad was kept wet. The crossing air with the wind velocity of 0.5-0.7m/s through the system cooled the shelter.

Feed and water were made available ad libitum all the times. No cooling system was operated till second week of rearing as birds were provided with optimum temperature of brooding. The body weight of all the chicks was recorded individually at weekly intervals up to six weeks of age. The temperature and relative humidity (RH) in the house were recorded three times (9:00am, 12:00pm, and 3:00pm) in a day with data-logger (SIKA Electronics, MH 3350). Mortality, if any, was also recorded daily. Rectal temperature was noted once in a week by digital thermometer at around 2 o’clock in the afternoon. Temperature and Humidity index (THI) in each group was calculated by using the formula as mentioned by West (1994).

\[ \text{THI} = \frac{T_d - (0.55 - 0.55RH)(T_d - 58)}{\text{THI = Temperature and Humidity index (THI) in each group was calculated by using the formula as mentioned by West (1994).}} \]

The FCR was calculated as the amount of feed consumed per unit gain in body weight. The PER was calculated as grams of body weight gain per g protein consumed. The EER was calculated as Kcal of energy consumed per gram of body weight gain. At the end of experiment, blood sample were collected from 12 birds in each treatment groups to assay lipid peroxidation (Stocks and Dormandy, 1971), Superoxide Dismutase (Marklund and Marklund, 1974), Catalase (Aebi, 1983), Glutathione Peroxidase (Hafeman et al, 1974) and Glucose-6-phosphate dehydrogenase (Deutsch,
RESULTS AND DISCUSSION

Microclimatic conditions: The average ambient temperature of the shed in FF and FP groups was significantly (p < 0.05) lower than the control group by 1.96 and 2.78°C, respectively (Table 1). RH achieved with FP was significantly (p < 0.05) higher than with FF and the control group. THI varied from 77.31 to 79.25 in all the treatment groups throughout the experiment. The control group had significantly higher value than both the treatment groups. However, numerical difference in the THI value in both FF (77.71) and FP (77.31) was statistically similar. The rectal temperature was significantly (p < 0.05) higher in the control group than FF and FP groups. The chicks in FF and FP groups had statistically similar values for rectal temperature. It was indicated that FP (98.23%) group had significantly higher survivability rate than the control (95.04%) group. However, percent survivability in FF group was statistically similar to both FP and control group.

Growth performance: The average body weight during first and second week of brooding was 120g and 279.8g in all the treatment groups. The average body weight in 6th week of experiment showed clearly the (p < 0.05) highest body weight (1599g) in FP group followed closely by FF group (1521g), while control group lagged behind with the average body weight of 1381g (Table 2). The significant (p < 0.05) difference in average body weight of chicks in FP, FF and control groups revealed the adverse effect of the high temperature on growth rate of broiler chicks. The birds in the treatment groups performed better as compared to the control group that was exposed relatively to higher temperature and lower relative humidity conditions in the shed. Birds in the FP group achieved significantly (p < 0.05) highest weight gain of 1319.5g, while FF group by achieving 1240.9g weight gain had the second position and control group birds being the lowest achiever with 1101.4g, performed poorly among all the treatment groups. The significantly (p < 0.05) higher protein, energy and net feed consumption (Table 2) by the chicks of both the treatment groups associated with more weight gain indicated better efficiency for protein, energy and in turn feed conversion than those in the control group.

Antioxidant activity: The lipid peroxidation (LPO) in the form of malondialdehyde level differed significantly (p < 0.05) in all the treatment groups (Table 3). Control group had highest LPO in response to high shed temperature and lower relative humidity conditions than significantly (p < 0.05) lower values of LPO in FP and FF groups, respectively. The FP group had significantly (p < 0.05) lower level of Catalase and G6PD enzymes than the FF and the control group. However, FF group had statistically similar Catalase and significantly lower G6PD enzyme level compared to those in the control group. The lower level of SOD enzymes in the FP and FF groups and also the higher level of GPx enzyme in both the treatment groups than those in the control group were non-significant.

These results indicated the significant (p < 0.05) effect of cooling systems on the performance of broilers. The results are in agreement with the previous reports (Geraert et al., 1996, Cooper and Washburn, 1998). Depression in the growth rate, body weight gain in the control group at the mean temperature of 32.18°C in the shed might be due to many factors like decreased feed consumption, inefficient digestion, impaired metabolism and some of the feed energy used for muscle contraction associated with panting. The heat stressed birds in control group might have reduced their feed intake to reduce the metabolic heat production for

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shed Temperature (°C)</td>
</tr>
<tr>
<td>CONTROL</td>
<td>32.18 ± 0.11</td>
</tr>
<tr>
<td>FAN FOGGER(FF)</td>
<td>30.22 ± 0.85</td>
</tr>
<tr>
<td>FAN PAD(FP)</td>
<td>29.40 ± 0.09</td>
</tr>
</tbody>
</table>

Mean value bearing different superscripts in a columns differ significantly (p<0.05) from each other
TABLE 2: Effect of different treatments on growth performance of broiler chicks.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Parameters</th>
<th>Initial Body Weight, gm</th>
<th>Average Body Weight, gm (At 14 days of age)</th>
<th>Average Weight Gain, gm</th>
<th>Feed Intake, gm (At 42 days of age)</th>
<th>Protein Intake, gm (At 42 days of age)</th>
<th>Energy Intake, kcal/kg feed (At 42 days of age)</th>
<th>FCR</th>
<th>PER</th>
<th>EER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>279.8 ± 0.00</td>
<td>279.8 ± 0.00</td>
<td>1381.3 ± 5.36</td>
<td>1101.4 ± 1.00</td>
<td>2456.8 ± 2.13</td>
<td>464.4 ± 0.37</td>
<td>7266.2 ± 6.65</td>
<td>2.23</td>
<td>2.37</td>
<td>6.60</td>
</tr>
<tr>
<td>FAN FOGGER(FF)</td>
<td>279.8 ± 0.00</td>
<td>279.8 ± 0.00</td>
<td>1520.8 ± 3.49</td>
<td>1240.9 ± 1.50</td>
<td>2577.7 ± 4.78</td>
<td>487.0 ± 0.86</td>
<td>7624.5 ± 1.94</td>
<td>2.08</td>
<td>2.55</td>
<td>6.14</td>
</tr>
<tr>
<td>FAN PAD(FP)</td>
<td>279.8 ± 0.00</td>
<td>279.8 ± 0.00</td>
<td>1599.4 ± 5.38</td>
<td>1319.5 ± 1.49</td>
<td>2676.5 ± 6.51</td>
<td>504.8 ± 1.17</td>
<td>7918.6 ± 1.94</td>
<td>2.03</td>
<td>2.61</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Mean value bearing different superscripts in a column differ significantly (p< 0.05) from each other.

*maintaining the body temperature. The reduced energy intake by the chicks of control group was an unsuccessful attempt to regulate their heat production, thus reducing growth rate. The cooling systems especially Fan-Pad system was efficient enough to relieve the birds from the adverse effects of heat stress as it could maintained the shed temperature 3°C lower than that of control. Similar results were reported by Bayraktar et al (2004) and Dagtekin et al (2009). These studies also declared evaporative pad cooling to be effective to reduce the temperature thus to prevent negative effect of heat stress on efficiency of feed consumption and mortality in the broiler chicks. In addition to this, both the cooling systems in the present study were able to curb the mortality rate effectively. These findings confirmed the study of potential impact of climate variability and elevated temperature related morbidity and mortality. Andrew et al (1993) also reported high mortality among the control group than those under fan-fogger system of cooling. However, in contrast, present findings are not in accordance with studies conducted by Sharma and Gangwar (1985) as they revealed no trend of mortality rate in relation to high ambient temperature. The results obtained in this study with respect to lower weight gain and feed intake, and in turn poor FCR in control group are in agreement with temperature effect reported by Donkoh (1989), Geraert et al (1996), Altan et al (2000), Dozier et al (2005) and Andrew et al (1993) obtained similar results with respect to weight gain, feed intake and feed conversion ratio in the broiler chicks reared under high pressure fogging system. In the present study also, the birds under FF system of cooling performed significantly (p < 0.05) better than the control group. The data on biochemical analysis indicated that both the cooling treatments were able to provide necessary cooling and in turn comfort led to the maintenance of the enzyme level responsible for lipid peroxidation, which are the strong indicators of oxidative stress in the poultry birds. These results confirm the findings of the previous study by Altan et al (2000), in which higher MDA concentration was reported in the broiler chicks as a response to heat stress. Similar findings were reported by Azad et al (2010) with respect to MDA and GPx activity in the broiler chicks. Similarly, Lin et al (2010), and Tan et al (2010) also reported significantly higher production of antioxidative*
TABLE 3: Effect of different cooling systems on antioxidant enzymes of broiler chicks

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Enzymes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GPx, u/g Hb</td>
</tr>
<tr>
<td>CONTROL</td>
<td>0.90 ± 0.06</td>
</tr>
<tr>
<td>FAN FOGGER(FF)</td>
<td>0.96 ± 0.09</td>
</tr>
<tr>
<td>FAN PAD(FP)</td>
<td>0.91 ± 0.31</td>
</tr>
</tbody>
</table>

Mean value bearing different superscripts in a column differ significantly (p<0.05) from each other.

enzymes like SOD, catalase and GPx along with formation of MDA induced by acute heat stress.

**CONCLUSION**

Above study can concluded as cooling of broiler sheds had significant influence on micro environment condition of shed, on growth and on biochemical parameters of broiler chicks irrespective of the systems used. Both Fan-pad and Fan-fogger systems were effective to overcome the heat-stress during hot-dry period in which Fan-pad system could be the effective mean of providing comfortable micro-climatic conditions, thus improved production performance of the broiler chicks.

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