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Effectiveness of positive pressure evaporative cooling on broilers production*

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ABSTRACT

The main concept of this research depends on the experimental work being performed on broiler houses, using positive pressure evaporative cooling systems. The experiments were conducted at the farms of the People's Development Company for Animal Production, Wad Medani, Sudan, during the period of May-July 1998. The objective was maintaining better environmental conditions during summer months, i.e., temperature and relative humidity, for housed birds, in order to obtain the maximum rate of birds growth, and reduce the rate of mortality, thus increasing economic returns. To evaluate the performance of broilers production, the parameters studied were temperature and relative humidity for bird's houses, live body weight, feed intake, water intake and mortality rate. The results of the experiments showed that evaporative cooling reduced the temperature by 18.9% and 16.6% in the houses with bird density of 10 birds/m2 and 13 birds/m2, respectively. The live body weight increased by 26.5% and 21.9% in the houses with bird density of 10 birds/m2 and 13 birds/m2, respect- tively. The mortality rate in the same houses was reduced by 79% and 75.7%, respectively. The results indicated that evaporative cooling effect was highly •siY1ificantly and positively correlated with most of the measured triats.

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INTRODUCTION

Poultry industry is highly regarded as a cheap source of good quality food and high nutritional value and also as an attractive quick- returns investment. Poultry production is an increasingly important agricultural industry in the world as poultry meat and eggs account for about 10% of the total weight of all meat, milk and eggs produced in the world each year (Rose, 1997).

The optimum poultry housing temperature for mature birds is generally accepted to vary between 12.80C as the minimum winter limit, and 29.40C as the maximum limit tor summer, Birds subjected to temperatures higher than this limit may suffer from heat stress and their productivity may decrease. Long time exposure to excessively higher temperature may result in high mortality rates (Dacon and Bozeman, 1566; Wilson, 1976

Under hot and arid climatic conditions, air temperatures exceed the maximum limit of the optimum range for poultry during most of the summer season. Evaporative cooling is often used to provide better thermal environment for birds under these condition (Esmay et ale, 1966; Welchert and Wiersma, 1972).

In broiler production, maximum feed efficiency was achieved at temperatures of 21 oc - 230C (Charles, 1980). Maximum growth rates were achieved at temperatures ranging between 150C and 200C (Deaton et ale, 1978). Heat stress decreases weight, feed intake and feed conversion efficiency (Kuitu and Forbes, 1993; Mckee and Harrison, 1995). Feed intake of broilers decreases linearly with increased temperature (Sakømura et al., 1993). Mortality resulting from heat prostration of broilers increases as temperatures approach 380C (Reece and Deaton, 1972 The thermal stress constitutes an obstacle which jeopardizes broilers production in the tropics because of the hot weather conditions, resulting in decreased food intake and body weight gain (Meltzer, 1983).

Efforts were made to minimize the effect of high temperatures on broilers through evaporative cooling with positive pressure fans. Evaporative cooling is a process that takes place when a stream of non-saturated ambient air is brought in contact with a free water surface. Due to the vapor pressure gradient between air mass and water surface, water evaporates at a certain rate absorbing the required heat of vaporization from the heat content of the stream of air, leading to reduction in temperature.

The objective of this research was to study the effectiveness of evaporative cooling in improving broiler production.

MATERIALS AND METHODS

The experiments were carried out at the poultry farm of the People's Development Company for Animal Production during the period May- July 1998. The farm is located north of Wad Medani city, Gezira state (latitude 140 24' N. and longitude 330 29' work was carried out in open-sides deep-litter houses (27m x 8m). The house was oriented east-west, with two high gable walls on the east- west direction.

The houses were divided into three equal parts (9 meters each) using angle bar and wire netting, and divided longitudinally into three parts, which were considered as replications. A similar poultry house was used as control, and it is typical to the houses used except for the cooling system. Additional rooms were constructed on the east side of the houses for installation of the cooling system, which consisted of pads (2.4m x I .8m and 0.1m thick) with water piping system. An axial flow fan (103m x 1.3m) was installed to push cooled air through two polyethylene tubes (each 27m) with many holes (each 0.79m) to distribute cooled air in the houses.

Commercial Lohmann broiler chicks, obtained from African Poultry Company (Khartoum), were used in the experimental work. Two houses containing 2106 chicks for each one (10 birds/m2) and 2738 chicks (13 birds/m2) were used in the experiments. Plastic containers were used as drinkers and traditional feeders were used for birds feed.

To evaluate the performance of the cooling system and its effect on production performance, a comparison was made in three identical houses each of a dimension of 27m x 8m without roof insulation. One of the houses was used as a control house (without cooling system and with bird density of 10 birds/m2), the other two houses were cooled and used at two bird density levels of 10 birds/m2 and 13 birds/m2. Experiments were arranged in a randomized complete block design. The parameters measured were temperature (^{o}c), relative humidity

(%), body weight (g), feed intake (g), water intake (ml) and mortality rate (0/0).

The data were subjected to the analysis of variance procedure. Simple linear correlation coefficient was calculated for the different measured parameters.

RESULTS AND DISCUSSION

The values of temperature, relative humidity, live body weight, feed intake, water intake and mortality rate in cooled and uncooled houses throughout the study are shown in Table 1. The analysis of variance mean squares revealed siY1ificant differences between the broilers in cooled and uncooled houses (Table 2). The results of using evaporative cooling system indicated that, the average mean temperature was reduced by 19.3% when compared with uncooled house. This result indicated that evaporative cooling was a good method for lowering temperature and hence protected birds from heat stress. These finding were in conformity with Welckert and Wiersma (1972). The results also indicated that the average value of relative humidity increased by 61.3%. The effect of relative humidity on growth rate and feed conversion in chickens appeared to be less than that of temperature (El Imam, 1991).

Table 1. Effect of evaporative cooling on temperature, relative humidity, body weight, feed intake, water intake and mortality rate of broilers.

Character	Temperature (oc)		Relative humidity (%)		Body we (g/bird	
Week no.	Cooled house	Uncooled house	Cooled house	Uncooled house	Cooled house	Uncooled house
Week 2	27.9	35.5	58.3	21.3	295	273
Week 3	29.0	35.0	59.2	19.8	512	448
Week 4	28.5	35.1	60.1	22.0	773	698
Week 5	28.2	34.7	60.7	23.5	1057	930
Week 6	28.4	35.5	60.9	24.3	1340	1130
Week 7	28.3	35.2	58.9	25.5	1627	1308
Week 8	28.1	35.1	61.2	25.8	1899	1455

Table 1. Continued.

Character	Feed intake (g/bird)		Water intake (ml/bird)		Mortality rate (%)	
Week no.	Cooled house	Uncooled house	Cooled house	Uncooled house	Cooled house	Uncooled house
Week 2	305	298	6053	1235	1.37	5.91
Week 3	673	656	1453	3654	2.00	8.78
Week 4	1176	1125	2475	6745	2.70	11.77
Week 5	1778	1653	3768	10252	2.87	14.82
Week 6	2431	2189	5382	13966	3.60	17.86
Week 7	3162	2726	7204	17976	4.28	20.89
Week 8	3827	3251	9246	19833	4.95	22.00

Table 2 shows that there were highly significant differences between the live body weights of birds in the cooled houses and the uncooled ones. The average live body weight was increased by 23.4% when compared with birds in uncooled houses. The results indicated that temperature had a direct effect on live body weight These results were in line with the findings of Kuitu and Forbes (1993) and Mckee and Harison (1995). The use of evaporative cooling increased the rates of broiler feed intake. The birds in the cooled houses consumed more feed than those in uncooled ones by 15.1% due to the reduction of temperature, which assisted the birds to dissipate a lot of metabolic heat, which led the birds to consume more feed.

Table 2. Analysis of variance mean squares for six parameters affecting broiler production.

Character	Mean squares	C.V. (%)
Temperature	441.70***	00.18
Relative humidity	10033.36 ***	00.45
Body weight	1770230.25***	10.14
Feed intake	2989441.00***	10.14
Water intake	1008845.82 ***	10.47
Mortality rate	223680.13 ***	09.82

*** Significant at the 0.001 probability level.

Moreover, the analysis of variance showed significant differences in water consumed by birds in cooled and uncooled houses. It was clear that birds in cooled houses consumed 53.3% less water as compared to those in uncooled houses due to reduction in water that was dissipated from birds by the respiratory system under evaporative cooling. The results also indicated that the mortality rate in the cooled houses was reduced by 77.5% when compared with the uncooled ones. The reason for this was mainly due to the reduction in temperature, which protected the birds from heat stress.

In addition, the analysis of variance mean squares showed significant differences between the different bird densities in cooled houses. The results indicated that the house with a bird density of 10 birds/m2 had lower values of temperature, water consumption, and mortality rates, and higher values of body weight, feed intake and relative humidity, when compared with the house with a bird density of 13 birds/m . The reason for this was mainly due to the additional sensible and latent heat dissipated from the birds, when the number of birds per square meter was increased.

The analysis of simple linear correlation coefficient, using the means of entries over the three houses, showed that the evaporative cooling system was highly significant and positively correlated with most of the measured "factors (Table 3). However, cooling was found to be strongly and positively correlated with body weight, feed intake and relative humidity, and negatively correlated with mortality rate water intake and temperature.

As it was mentioned earlier that high summer temperatures result in lower body weight and in some instances lead to higher mortality rate and consequently, farmers hesitate to produce broilers in summer. The method of evaporative cooling has resulted in minimizing the risks imposed by high temperature on production of broilers.

The evaporative cooling technology is now successfully operating at the farm of the People's Development Company for Animal Production (Wad Medani), and is on its way for application at Kenana Sugar Company poultry farm. The technology is simple and cheap and could be implemented by individual farmers.

Table 3. Simple linear correlation coefficients for six parameters affecting broiler production.

Character	1	2	3	4	5	6
I-Body weight	---	0.971 ***	-0.244*	-0.373*	-0.388*	0.398*
2- Feed intake	---	---	-0.055	-0.144	-0.159	0.167
3- Water intake	---	---	---	0.977***	0.973***	-0.988***
4- Mortality rate	---	---	---	---	0.942***	-0.983***
5- Temperature	---	---	---	---	---	-0.969***
6- Relative humidity	---		---	---	---	---

*,*** Significant at 0.05 and 0.001 probability levels, respectively.

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