PRODUCTION PERFORMANCE OF CAGED LAYERS IN EVAPORATIVE COOLING AND MECHANICAL VENTILATED HOUSING

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Abstract

The study was designed to investigate effect of evaporative cooling and mechanical systems on the performance of caged layers for Konya province of Turkey. Two different treatments were analyzed- evaporative cooling, house - 1 and mechanical ventilation, house - 2 during the summer season of 2005. Inside temperature reduced effectively in house - 1 while higher inside temperatures in house - 2 created a stressful environment for caged layers. The average temperature in house - 1 was as 24.4ºC while it was 27.1ºC in house - 2. The average relative humidity was 52.7% and 40.1% in house - 1 and house - 2, respectively. Average egg production of layers was 1.03% higher in house - 1 than house - 2. The mortality rate in house - 1 and house - 2 was determined to be 0.18% and 0.23%, respectively. The average percentages of cracked eggs in houses - 1 and house - 2 were 1.41% and 0.89%, respectively. The average egg weights were 65.1g and 60.2g in houses 1 and 2, respectively. Daily feed intake of layers in houses - 1 and house - 2 was found as 116.5 g/hen and 103.4 g/hen, respectively.

Key words: evaporative cooling, mortality rate, cracked egg, egg weight

An adequate environment within poultry houses is a very important requirement for success in the poultry industry (Kocaman *et al.* 2006). High environmental temperature during summer season is stressful having harmful effects on productive performance of layers (Van Kampen, 1981). Temperature and relative humidity are two important factors affecting the production performance of laying hens. Temperature range for optimum production for laying hens is about 19ºC - 24ºC (Webster, 1994). Afolabi (2010) reported that heat stress not only causes suffering or death of birds, but results reduced or lost production and hence adversely affect the profit of the enterprises. In addition, high ambient temperature can have a major impact on performance of commercial poultry, and when they are coupled with high humidity, the combination can become critical. Charles (1994) reported that egg production and feed intake reduced under the ambient temperature exceeds 24ºC in poultry housing. In such research, those keeping layers in cooler section of the cage house increased egg production (Webster and Czarick, 2000). Talukder *et al*. (2010) reported that laying hens 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. Guo *et al*. (2012) researched effect of group size and stocking density on the welfare and performance of hens housed in furnished cage systems during summer. In such study, they were assigned a total of 924 Hy-Line Brown hens to three housing systems. They found that laying rate and egg weight were not significantly affected by housing systems. Hens continuously adjust their feed intake according to the environmental temperature. Uğurlu *et al*. (2002) stressed that feed intake decreased under high temperature and high ambient temperature had direct influence on the feed intake of caged layers (Ahmad *et al*., 2000). Kuney (1998) reported that feed intake directly influences egg size, shell thickness, body weight and rate of lay. Kocaman *et al*. (2006) found a negative correlation between daily feed consumption and temperature in poultry houses. As the temperature of poultry house increased, feed consumption reduced. Egg production improved by evaporative cooling under low pressure sprinkler system in cage house (Ikequcki and Xin, 1999). During the hot season of the some part of Turkey the temperature of ambient air inside the animal houses increases over 40°C. The evaporative cooling system has been accepted to be most effective, practical and economically feasible under hot and arid climatic conditions (Yagcıoglu *et al*. 2006).

In our study region, Central Anatolia, outside temperature is high and relative humidity is

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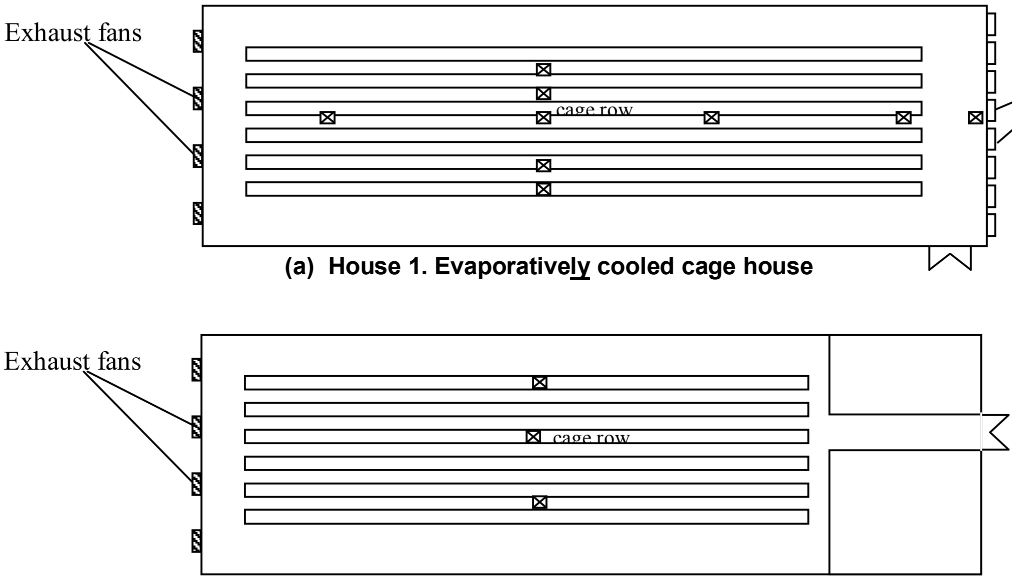
low in summers so evaporative cooling system appears to be one of the most efficient methods to solve the high temperature problems in cage houses (Uğurlu and Kara, 1999). This research was, therefore, performed to determine production performance of caged layers for two environmentally different poultry houses.

MATERIAL AND METHOD

This research was conducted in two different cage houses for Konya region of Turkey. Evaporative cooling was applied in one house and inside temperature was reduced effectively by this way. Eight cellulose evaporative cooling pads, 3.80m length x 1.40m width x 0.1m thickness, were mounted on the end wall. Eleven exhaust fans, each with a capacity of 39000 m^3/h, were mounted on end walls in evaporative cooling house - 1, while three exhaust fans, each with a capacity of 39000 m^3/h, were placed on the end wall in the mechanically ventilated house - 2 (*figure 1*). Lohmann Lsc-Classic breed laying hens were kept in both poultry houses during the experiment. Pullets were transferred from breeding house to experimental buildings at 18 weeks of age. The experiment was originally designated to determine the temperature variations of buildings and production performance of laying hens between June and September, where the outside temperature was very high. However, it was performed between 8 th July and 30 th September 2005 due to a delay in the installation of measurement equipments. There were 34 week age laying hens in house - 1 and 24 week age laying hens in house - 2 at the start of data recording. Initially, there were 47365 hens in house - 1 and 23204 hens in house - 2. There were six blocks in house - 1 and five blocks in house - 2. The number of tier-battery cage in houses - 1 and house - 2 were five and four, respectively. The structural properties of both research houses were the same except that the evaporative cooling system was installed in house – 1 (*table 1*). The cage size was 60x50cm and five or six birds were placed in each cage with a feeding space of 10 cm/bird as suggested by Charles *et al*. (1994). A group size of 4-5 hens/cage was optimum as suggested by Roush (1986). An optimal cage density for laying hens was 450cm^2/hen (Gerken, 1994; Okuroğlu, 1982) and was 450-455cm^2/hen in our experimental houses. The summer season ventilation rate in evaporative cooling house was 6.6 -7.5 m^3/h/hen (Uğurlu and Kara, 2002). During the experiment, inside and outside temperature and relative humidity data was recorded hourly by data logger. Outside temperature and relative humidity were recorded in an observation shelter near the each house. The number of measurement points was eleven in house - 1 and four in house - 2 (*figure 1*). In house - 1, three data logger were installed on fourth block in three different heights and other eight was mounted on 2, 3 and 4 cage tiers. In house - 2, two data logger were mounted on third block in two different heights and other two was on 2 or 3 cage tiers. Egg production, egg breakage % and mortality were recorded daily. The egg weights and feed intakes were recorded twice a week. A t-test was applied to determine the effects of evaporative cooling over mechanical ventilation on egg production, rates of mortality and cracked eggs of caged layers.

RESULTS AND DISCUSSIONS

The inside temperature and relative humidity for the each experimental houses as well as outside were presented in *table 2*. The mean daily maximum temperature in house - 1 was 26.9ºC while it was 33.3ºC for house - 2. The average temperatures were 24.4ºC for house - 1 and 27.1ºC for house - 2 during research period. The maximum temperature was in general over the 28ºC in the mechanically ventilated house, and stressful environment for layers was observed. The poultry movements in cages were observed higher in evaporative cooling house. The maximum temperature in the evaporatively cooled house was 6.4ºC lower than mechanical ventilation house, while the average temperature in the evaporatively cooled house was 2.7ºC lower than mechanically ventilated house. Hens were observed less stressed in evaporative cooling house since inside temperature was about optimum level. The poultry movements in cages were observed greater in evaporative cooled house. This is an agreement with the results obtained by Botcher *et al*. (1992). The relative humidity in house - 1 was higher than both house - 2 and outside. The possible causes either by the respiratory water loss of hens or the fact that the evaporative cooling system worked well and more moistened air entered to the building from pads. Relative humidity has the potential effect on pad cooling since, during the passing of air throughout the pads, evaporation increases. Under these conditions, inside temperature reduced while relative humidity increased. Our findings are in general concordance with Uğurlu *et al*. (2002).



(a) House 1. Evaporatively cooled cage house

House 2. Mechanically ventilated cage house

⊠ **Measurements points**

Figure **1 Plan view of both experimental houses**

Table 1

Structural properties of experimental cage houses

	House - 1	House - 2
House dimension , m	65x15m	80x18
Total floor area, m^2	840	1440
Average heat conductivity coefficient, U, kcal/m^{2o}Ch	0.62	0.62
Cage density, cm^2/ hen	450	455
Total number of birds	47365	23204
Natural light rate, %	5.4	4.2
Artificial light rate, w / m^2	1.4	1.4
Ventilation rate, m^3/h/hen	9.2	6.4

Maximum temperature in house - 2 was slightly above to the outside ranging from 30 to 33ºC. The average temperature in house - 2 varied between 24.1 to 29.0ºC. Furthermore, daily maximum and minimum temperature differences were more pronounced in mechanically ventilated house than in evaporative cooling house (*figure 2*). In house - 1, cooling pads did work rarely due to the cut off electricity in poultry houses.

Inside temperature distributions were obtained higher in house - 2 than house - 1.

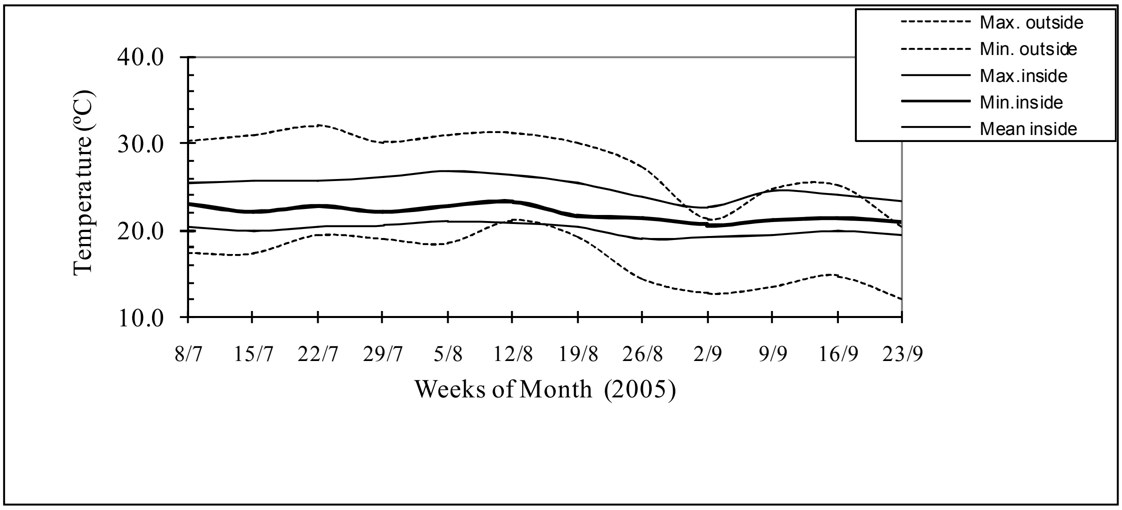
Table 2

Mean temperature and relative humidity of different cage houses and outside air

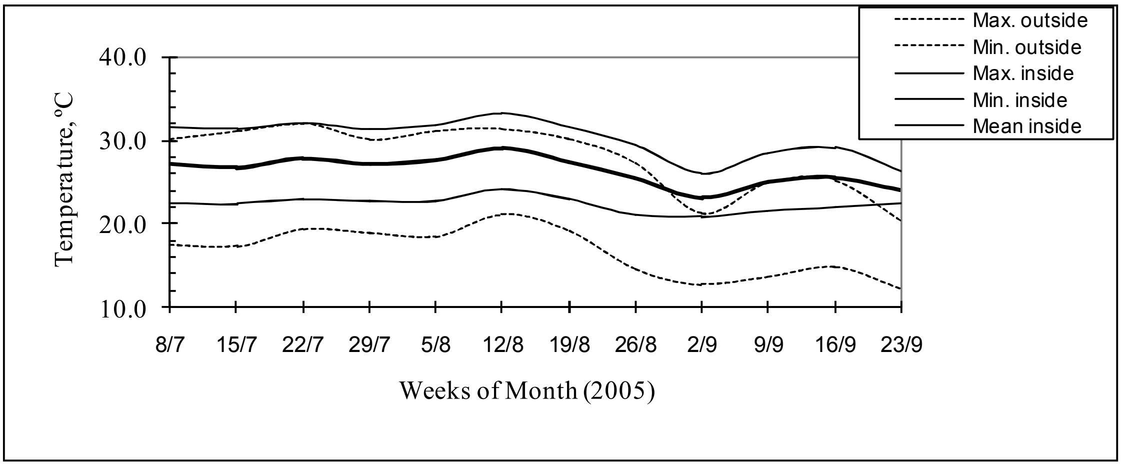
	Temperature (^oC)			Relative humidity (%)			Temperature differences (^oC)
	Outside	House - 1	House 2	Outside	House 1	House 2	(House 1- House 2)
Maximum	30.2	26.9	33.3	48.3	67.2	52.6	- 6.4
Minimum	12.1	19.0	20.9	26.2	44.9	38.5	- 1.9
Average	21.1	24.4	27.1	32.2	52.7	40.1	- 2.7
S.d.	12.7	7.7	8.7	11.4	11.2	7.7	1.0

S.d; Standard deviation

The daily maximum temperature varied from 32 to 36ºC in house - 2 while it varied from 23 to 26ºC in house - 1. The highest temperature was observed near to the roof. It may be inferred that house - 2 had a more stressful environment than house - 1, and the cooling pads reduced the internal temperature about optimum temperature requirement of the birds.



a) House 1. Evaporative cooled cage house



b) House 2. Mechanical ventilated cage house

Figure **2 Weekly maximum, minimum and average temperature changes in the experimental buildings according the outside**

Average egg productions in house - 1 and house - 2 were 89.05 and 88.02% during the experimental period, respectively (*table 3*).

Average mortality rate in house - 1 and house - 2 was determined as 0.18 and 0.23%, respectively. Evaporative cooling system significantly reduced mortality rate of birds in house - 1 (P<0.05). Our result is inline with Wolfenson *et al*. (2001) and Uğurlu and Kara (2003).

The average percentages of cracked eggs in house - 1 and house - 2 were 1.41 and 0.89%, respectively. It was significantly higher under evaporative cooling house than mechanically ventilated house (P<0.05). This could be resulted from movements of birds, since layers showed a higher activity in cooled house, and increased rolling speed of laid eggs causing more crushing of eggs to each other or cage partitions. Average egg weights were measured as 65.1 and 60.2g in house - 1 and house - 2, respectively. Increments in environmental temperature resulted reduction of egg weights.

Table 3

Effects of evaporative cooling system on egg production, rates of mortality and cracked eggs (20^{th} to 34^{th} week of age)

	Egg production (%)		Mortality (%)		Cracked eggs (%)	
	House 1	House 2	House 1	House 2	House 1	House 2
Average	89.05	88.02	0.18	0.23	1.41	
Maximum	93.70	92.10	0.22	0.28	1.62	0.89
Minimum	85.5	85.3	0.12	0.17	1.21	0.56
S.d.	0.8813	0.5898	0.0008	0.0102	0.0325	0.0882

Daily average feed intake of layers in house - 1 and house - 2 was 116.5 and 103.4g/hen, respectively. The study showed that increasing the environmental temperature led to low feed intake due to heat stress. Above 27ºC, bird's body temperature increases and a much dramatic reduction in feed intake can be anticipated (Bird *et al*. 1988). Similar results also were mentioned in the some investigations (Yahav *et al*. 2000; Kocaman *et al*. 2006).

CONCLUSIONS

Overall results of our study revealed that higher indoor temperatures were noted in the mechanically ventilated house by comparison to evaporative cooling house. The egg production, egg weights and feed intake were higher in evaporative cooling house. The mortality rate was lower in evaporative cooling house. It can be concluded that in areas having low relative humidity and high temperatures, evaporative cooling may be recommended as an efficient technique for reducing inside temperatures of poultry houses.

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