Effect of roofing material type on microclimate in the sheep buildings

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Abstract: A study was conducted on description of the sheep houses (materials, location, orientation etc) and its effect on microenvironment in two housing (concrete roofing material, Iron sheet roofing material) in Giza, Egypt.In order to select the appropriate type of housing that provides the best inside climate throughout making adjustment in housing.

During the experimental period, maximum temperature was recorded under Iron sheet and lowest temperature as in Concrete. The maximumprotection from high temperature was given in concrete than in Iron sheet. Adjustment of temperature and relative humidity through the day wassuccessful underconcrete than Iron sheet.

Keywords: sheep housing, roofing material, microclimate, building in hot climate, temperature – humidity index (THI)

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1 Introduction

Housing system is considered as an important factor affecting animal performance and behavior. It mitigates the climatic stress, saves labor, controls disease vectors, and harvests the products. It increases the efficiency of breeding and milk production. In addition, allows better control of feed intake and its quality (Wagner et al., 2003).

Housing and management practices can be a source of stress for sheep and domestic animals. Climatic conditions have direct and indirect effects on production and reproduction of livestock. The high environmental temperature and lack of feed may restrict sexual activity months of the year in the tropics, Hafez (2000) and El-Sayed (2003).

The number of Sheep in Egypt was estimated in 2011 to be 55.9 million head (FAO, 2012).There are three breeds in Egypt: Rahmani, Osseimi and Barki. Rahmani is the largest breed and then followed by Osseimi and Barki.Recently, Marai et al. (2006) reported that the common sheep-breeding season in Egypt is at May–June, during which the climate is hot with rapid and sudden fluctuations. During this breeding season, temperature rises, this difficult weather effect on reducing the productive and reproductive performance of sheep. This condition let us to care of searching about the proper housing system. Selecting a building for the livestock farm should include all the personal needs of the breeder in addition to the livestock needs. This should be done at a minimal cost to the farm enterprise. Selecting an appropriate site for a new animal facility is one of the most important steps in the animal design process, Martin (1998).Animal production is based on the inter play of animal and environment. The farmer can manipulate both factors in order to reach an optimal result. In any micro climate, individual cattle should ideally be able to select for themselves the microclimate that they find affords

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the thermal comfort or least comfort. Microclimate refers to the natural physical environmental factors affecting livestock are: air temperature, relative humidity, radiant heat, precipitation, atmospheric pressure, ultraviolet light, wind velocity and dust (Hahn, 1981).

In animal housing the roof plays a primary role in the determination of the thermal exchanges of the animals (Liberati and Zappavigna, 2004). In particular, in the hot climate, a high thermal resistancein daily hours can be helpful in order to reduce the effect of the solar radiation. But by increasing the thermal resistance the possibility to the animals of discharging heat through the roof in the night hours is to reduce the diurnal negative effect of the radioactive heat load onto the animals the use of insulation materials is often recommended. But this is an expensive solution, the usefulness of which is not ascertained, depending on various factors: climate, latitude, building geometry and orientation, constructive solutions, animal physical and spatial parameters (Zappavigna and Liberati, 2007).The main objective of this research is studying the microclimate for common Egyptian sheep housing under two different roof materials in order to recommend the optimal roof material suitable for Egyptian conditions.

2 Materials and method

The present study was conducted at the sheep farm, Agricultural Research Station, Giza, Egypt. Thirty Sheep (3 months to 2years of age) were housed under each treatment. Different roofing materials were used for covered area under each treatment in following manner. A: Concrete shading roof: Layer of concrete of 20 cm thickness, B: Iron sheet shading roof: Layer of Iron sheet of 0.2 cm thickness fixed to Iron Frame. The study was undertaken both in summer and winter seasons.

2.1 Sheep rearing facilities:

As shown in Figure 1 House (A) is roofed by concrete material with 20cm thickness and it is flat. The walls height was 1.20 m and was made of 12cm common brick and 2cm plaster inside and outside of the wall. The houses have no windows, but there are openings for ventilation (2.3 m high) at all sides. The house has one iron door made of 1.23 cm thickness.(1.2 m high x 1.5 m width).The dimensions of the house are 4.30 m, 7.0 m, 3.5m, width, length and height, respectively. House (B) is roofed by flat Iron Sheet 0.2 cm thickness. The dimensions of walls, windows and door are similar to that of house A, and the floor is normal soil. The experiment houses were north south oriented.

House (A)

House (B)

Figure1Sheep rearing facilities in Giza, Egypt

2.2 Experimental procedures

Meteorological data were measuredeach2 intervals using Tri-sense device and hygrometer on the 1.5m height from the floor of buildings at 8:00,10:00,12:00,14:00,16:00 O’clock, each three consecutive days every week for each experiment. Daily air temperature (dry and wet bulb) and relative humidity of inside and outside the two buildings were recorded at8:00, 10:00, 12:00, 14:00,16:00 O’clock, by using thermometer, tri-sense and hygrometer.

The instrument was hangedat equal heights by thread in covered area under each treatment roof and at equal height in the outside (open area) for outside conditions records.

Appropriate equations of heat transfer were applied to calculate rates of heat gain and loss from buildings every day during experimental period.

2.3 Statistical analysis

A randomize complete design with two factors was used for analysis all data with five replications. The treatment means were compared by least significant difference (L.S.D.) test as given by Snedecor and Cochran (1976)by using ASSISTATprogram.

3 Results and discussion

Studying the effect of roof material type on the air temperature (AT, ℃) and relative humidity (RH%) inside sheep buildings has been done in both winter and summer seasons.

3.1 Air temperature distribution during summer season within sheep houses

In summer season, the experiment has been conduct from July to September. Maximum and minimum air temperatures during the experimental period were 41.3 ℃ and 30 ℃ for house A and 44.5 ℃ and 32 ℃ for house B respectively. The maximum and minimum relative humidity values were 64.4% and 47.25% for house A and 67.5% and 53.7% for house B respectively. The lowest air temperature has been observed in the house roofed by concrete in September. While the highest air temperature was in August within the sheep house roofed by steel sheet, Figure 2. Increasing of ambient air temperature within the house roofed by steel sheet is over the outside air temperature. Where the steel sheet has high ability to absorb the solar radiation and accumulate the heat in the rearing zone for period. With concrete roof, gaining and loosing heat is performing slowly in comparison to steel roof. It may returns to their thermal conductivity.

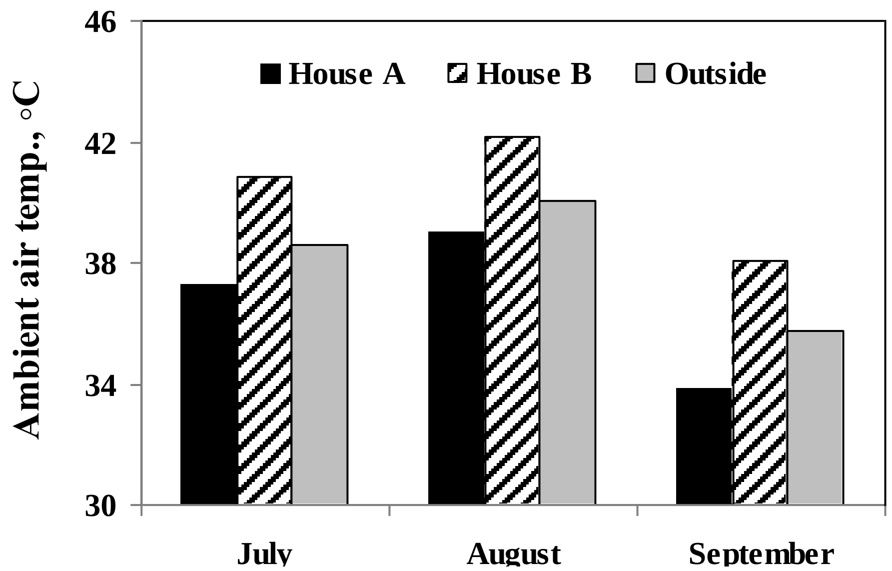


Figure 2 Average air temperature during summer season within different sheep houses in comparison with outside air temperature

By considering the calculated temperature – humidity index (THI) (Esmay 1969), heat stress was severe in the months of July and August whereas moderate in September for house B. In case of house A, THI was below 75 units. It means, there was safe and almost no stress on the animal.

3.2Air temperature distribution during winter season within sheep houses

In winter season, the variety of inside air temperature is very low for both houses in comparison to outside temperature. The lowest temperature occurs in December, Figure 3. The ambient air temperature inside house A is quite higher than house B. This is due to the concrete material ability for keeping the heat for a while before losing it as mentioned previously. In winter season, there is no heat stress has been observed according to THI.

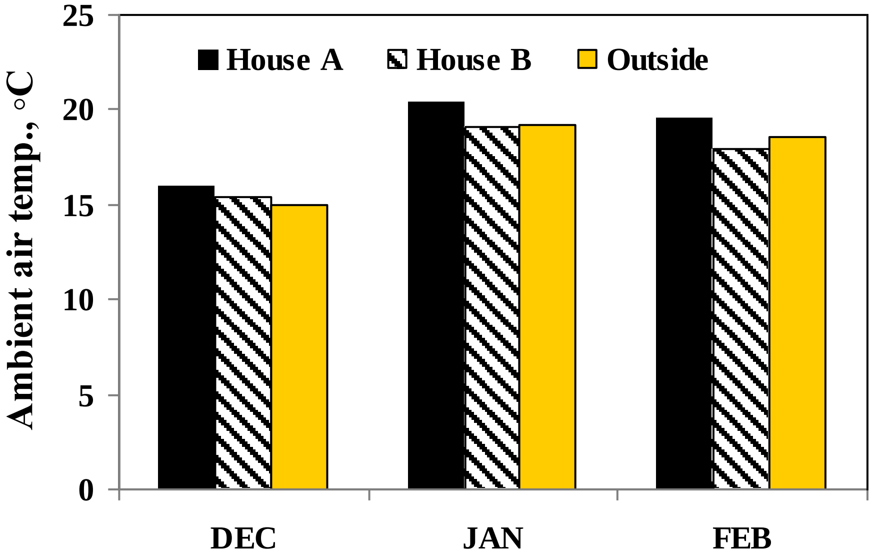


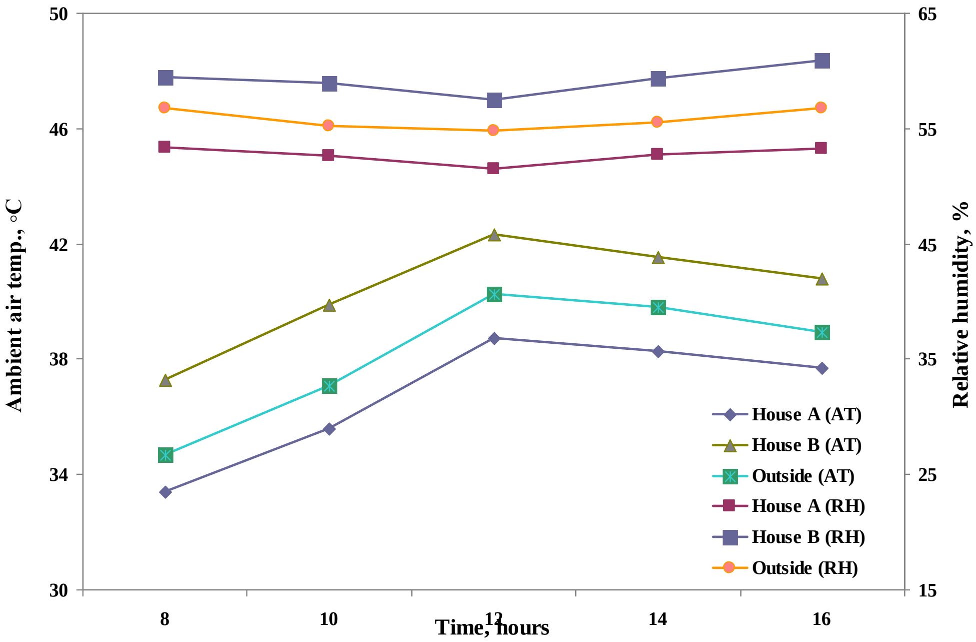
Figure3 Average air temperature during winter season within different sheep houses in comparison with outside air temperature

3.3 Relative humidity and air temperature distribution within different sheep houses

Air temperature and humidity are important property of the climate that has implications in areas related to animal comfort. They are essential components of a comfortable environment. From the study it has been statistically proved that the moisture holding capacity of air depends on the air's temperature. It increases with increase in temperature. As the moisture holding capacity increases the relative humidity decreases.

In winter season, non-significant difference in relative humidity has been observed where the variance in air temperature in minimized. See Figure 4 please.

For Summer Session:



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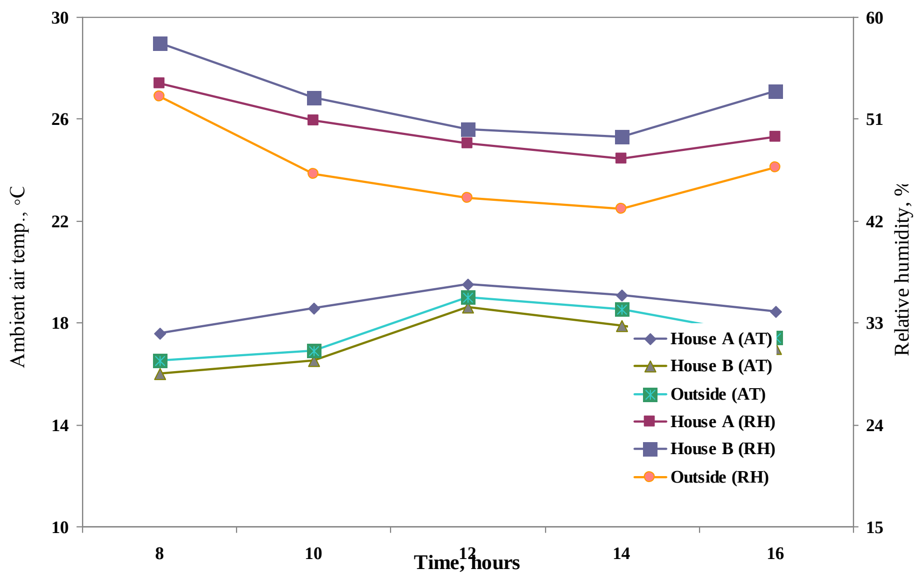

Figure 4 Average of inside-outside air temperature and relative humidity for the two types of Sheep houses on the experimental during measured period

4 Conclusions

The high thermal conductivity of Iron sheet does not enable the roof to reduce both temperature and relative humidity during the day compared to concrete material which significantly reduced the negative effect of environmental variables and can prove to be effective in warding off the hot and humid environmental condition than Iron sheet.

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