EFFECT OF ROOFING MATERIAL TYPE ON MICROCLIMATE IN THEBUILDINGS OF SHEEP

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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 sheetand lowest temperaturewas in Concrete.The maximumprotection from high temperature was given in concrete than in Iron sheet. Adjustmentof temperature and relative humidity through the day was suucceful under concrete than Iron sheet .

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 during some months of the year in the tropics, Hafez (2000) and El-Sayed (2003).

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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, as these months are at the end of spring and the beginning of the summer season. During breeding season in Upper Egypt 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).

Chaplin etal.,(2000) reported that Cows have longer lying times on rubber mats than on concrete (Guard,2000).Caw health may be improved by increased amounts of bedding and by using of rubber mats instead of concrete .Weary and Taszkun (2000) found a significant negative relationship between sawdust as bedding on the cow stall and severity of lesions. Tucker and Weary(2004)indicated that more sawdust bedding improves cow comfort in stalls with geotextile mattresses.(Bøe, 1990 and Manninen et al., 2002) stated that the goats' preference shifted towards flooring materials with a lower thermal conductivity in the cold period. Mattress and solid wood were most preferred in the cold period, but no difference between mattress and expanded metal.

1.2Animal housing orientation

Hatem (1994) statedthat the north south orientation, in Egypt, for the shed will provide better animals' environment (good protection from mud and direct sun radiation).

The shading efficiency should not be lower than 85% and the shade structure should be oriented east-west where the largest area of the structure should face the prevailing summer winds to allow better aeration. The distance between two cowsheds should never be shorter than 15 m to avoid carrying the contaminated air from one cowshed and spreading it into another one (Hatem et al., 2006; Samer et al., 2008b; Samer et al., 2008d).

1.3. Building materials

The building materials can be divided in two categories according to their function. The first category involves materials, which are mainly necessary for the structural stability of the building such as bricks, concrete, asbestos cement,metals,and wood. The second category is mainly intended for insulation such as cork, peat, glass wool, rock wool, expanded plastics, and cement wood fiberboard.

There are different types of materials used to provide shade to the animals and these range- from solid basic concept of housing materials like iron and asbestos sheets to shade cloths, normally buffer the extremes of climatic condition to reduce effect of solar radiation on the sheltered animal by different proportions and protect the animals from hot or inclement weather (Kamal etal., 2013).Animal housing with solid walls, made from mud bricks, wattle and daub or concrete, with attach or flat roof, made of solid materials (white walls being effective reflectors).

Abdel Rahman et al.(2013)found attached roof with elevated slotted wooden floor had created better microenvironment, which in turn could lead to improve milk production, feed intake, feed conversion efficiency and physiological comfort of the lactating crossbred goats during summer conditions.

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 resistance in 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 radiative 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).

2. Environmental control in animal housing

Animal production is based on the interplay of animal and environment. The farmer can manipulate both factors in order to reach an optimal result. In any microclimate, individual cattle should ideally be able to select for themselves the microclimate that they find affords the thermal comfort or least comfort. Microclimate refers to the climate which the animal is exposed to it directly at any given time or place. The main natural physical environmental factors affecting livestock are: air temperature, relative humidity, radiant heat, precipitation, atmospheric pressure, ultraviolet light, wind velocity and dust (Hahn,2000).

2.1 Air Temperature and relative humidity

Mclean and Calvert (2007) stated that increasing the air humidity at 35°C ambient air temperature caused an increase in respiratory activity and caused insignificant change in heat production. They reported that at ambient air temperature above the normal accepted range, and high humidity will progressively reduce the animal's ability to keep cool by evaporation until, if the air is saturated and as warm as the animal, it will lose the ability altogether. Very dry air, blow 30 % RH, may dehydrate the mucous membranes of the respiratory tract and create discomfort (Sainsbury, 1988).Moreover, Reece (1991) reported that cattle and sheep appear to be most able to withstand extremes of heat. Open mouth panting and sweating occur as the temperature rises and they can withstand temperature as high as 43°C with the humidity above 65 %.

Dixon et al. (2010) found that sheep increasedrectaltemperatureand decreased feed intake when reaches a mean maximum ambient air temperature to 30℃ during summer season in Western Australia.

2. MATERIALS AND METHODS

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 IronFrame. Thestudy was undertaken both in summer and winter seasons. But as in Egypt the temperature and relative humidity at the summer season remain high resulting in high of temperatures which is the main concern of the paper and research, so only the data pertaining to the summer season are provided hare . Data were recorded from 16th July to30th September, 2012.

2.1 Sheep rearing facilities

House A, is roofed by concrete material with 20cm thickness and it is flat. The walls height was 1.20m and were made of 12cm common brick and 2cm plaster inside and outside of the wall. The floor was made of concrete. 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.

Fig.1 Sheep rearing facilities in Giza, Egypt

2.2Experimental procedures

Meteorological data were measuredeach2 hintervals 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. Values of the measured meteorological data at different points inside and outside buildings are showing in table (1).

Table 1- Meteorological Data	Unit
Dry bulb temperature (DBT)	°C
Relative Humidity (RH)	%
Air Velocity (V)	m /s
Wet bulb temperature (WBT)	°C
Maximum temperature	°C
Minimum temperature	°C

Daily temperature (maximum and minimum) , dry bulb and wet bulb temperature and relative humidity of inside and outside the two buildings were recorded at8:00, 10:00, 12:00, 14:00,16:00o'clock . by using thermometer, tri-sens and hygrometer. The instrument were 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 .

Surface temperature of roof materials and walls temperature were measured by infrared digital thermometerat equal distance (0.5cm).Appropriate equations of heat transfer were applied to calculate rates of heat gain and loss from buildings every day during summer season.

Table 2- Maximum and minimum temperature under different roof materials inside and outside houses during summer season

Month	Concrete roof		Iron sheet roof		outside	
	Max. (°C)	Min. (°C)	Max. (°C)	Min. (°C)	Max. (°C)	Min. (°C)
July	32.40±0.93	26.44±0.32	34.51±0.95	28.34±0.45	40.72±0.23	30.75±0.66
August	32.55±0.39	24.87±0.25	34.10±0.55	26.53±0.28	37.88±0.53	28.47±0.38
September	32.10±0.36	25.93±0.33	34.76±0.58	26.81±0.18	37.32±0.49	28.23±0.22
Mean	32.35±0.93	25.75± 0.33	34.46±0.50	27.23±0.15	38.64±0.55	29.15±0.60

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 used ASSISTATprogram.

3-RESULTS AND DISCUSSION

Effect of roof material type on the air temperature (AT, °C) and relative humidity (RH%) inside the buildings of sheep during summer season

Figure(3-1) and table (3-1) shows that the maximum air temperatures were recorded at 12:00 o'clock for the three different conditions. The data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house , along the daytime from 8:00 to 16:00 o'clock . This is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-2) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

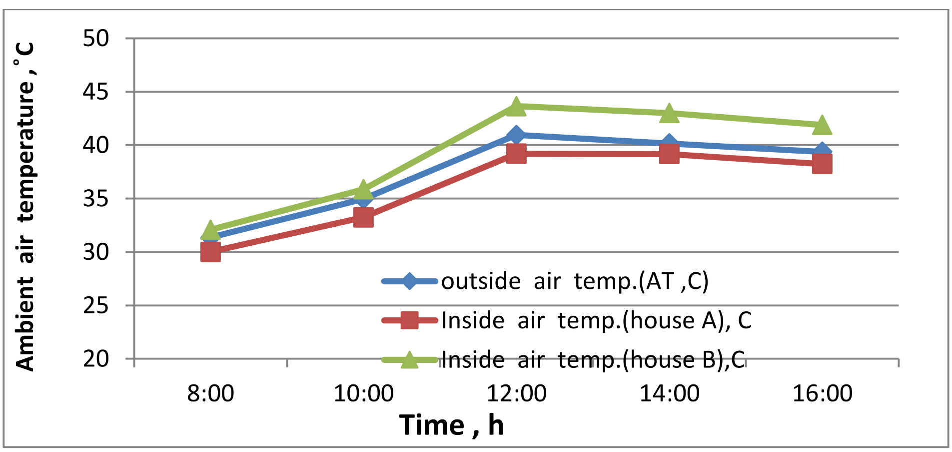

Fig.(3-1)Average inside–outside air temperature for the two types of Sheep's housesduring period (16-18, July.2012).

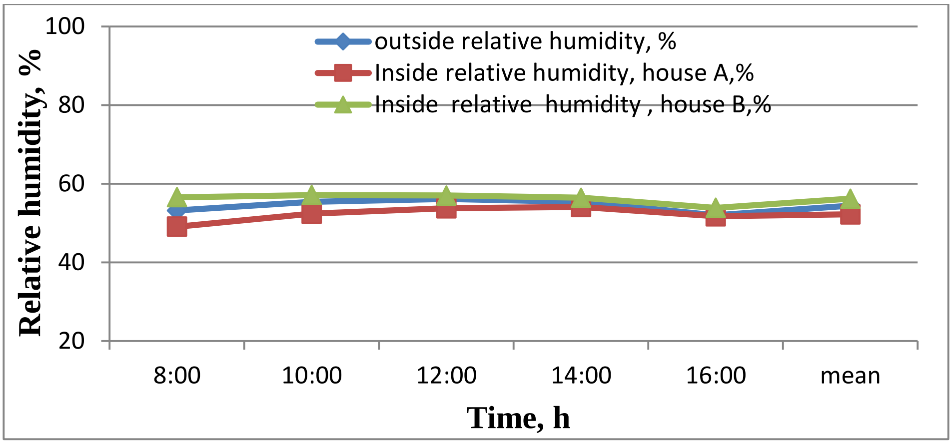

Fig.(3-2).Average inside–outside relative humidity (RH %) for the two types of Sheep's houses duringperiod (16-18, July.2012).

Table (3-1).Average of inside-outside air temperatures and relative humidity for the two types of Sheephousesonthe experimental during period (July 16-18, 2012).

Time ,hr	Experiment					
	House A		House B		Outside	
	AT, °C	RH,%	AT, °C	RH,%	AT , °C	RH,%
8	30.00	49.11	32.08	56.58	31.35	53.21
10	33.25	52.38	35.87	57.14	34.95	55.45
12	39.20	54.08	43.65	57.03	40.95	56.13
14	39.17	53.75	43.00	56.44	40.15	55.43
16	38.23	51.75	41.89	53.87	39.37	52.00
Mean	$35.97^{a}\pm$ 1.85	$52.21^{b}\pm$ 0.89	$39.30^{a}\pm$ 2.27	$56.21^{a}\pm$ 0.60	$37.35^{a}\pm$ 1.83	$54.44^{ab}\pm$ 0.78

There is no significant difference between three treatments (House A, House B, outside) in ambient air temperature (AT, °C). there is significant difference between two treatment (House A, House B) in Relative humidity (RH,%) and there is no significant difference with outside Relative humidity .

Figure (3-3) and table (3-2) show that the maximum air temperatures (AT) were recorded at 12:00 o'clock for the three different conditions.

the data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock ,this is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-2) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

Table (3-2).Average of inside-outside air temperature and relativehumidity for the two types of Sheep houses on the experimental duringperiod (July 24-26, 2012).

Time, hr	Experiment					
	House A		House B		Outside	
	AT , °C	RH ,%	AT , °C	RH, %	AT , °C	RH , %
8	35.15	55.00	40.27	62.78	37.00	58.12
10	38.10	55.87	43.71	63.23	40.00	58.80
12	41.28	57.95	43.83	64.50	41.65	61.73
14	39.53	57.00	42.07	64.19	40.77	61.57
16	39.13	55.14	41.95	60.87	40.00	59.91
mean	$38.64^{b}\pm$ 1.01	$54.59^{b}\pm$ 1.21	$42.37^{a}\pm$ 0.66	$62.36^{a}\pm$ 1.08	$39.88^{ab}\pm$ 0.78	$57.82^{b}\pm$ 1.81

There is significant difference between two treatments (House A, House B) in ambient air temperature (AT, °C), and there is no significant difference with treatment (outside) in ambient air temperature. There is no significant difference between two treatments (House A, outside) in relative humidity (RH, %). but there is significant difference between two treatments (House A, outside) relative humidity (RH, %) with relative humidity at house B.

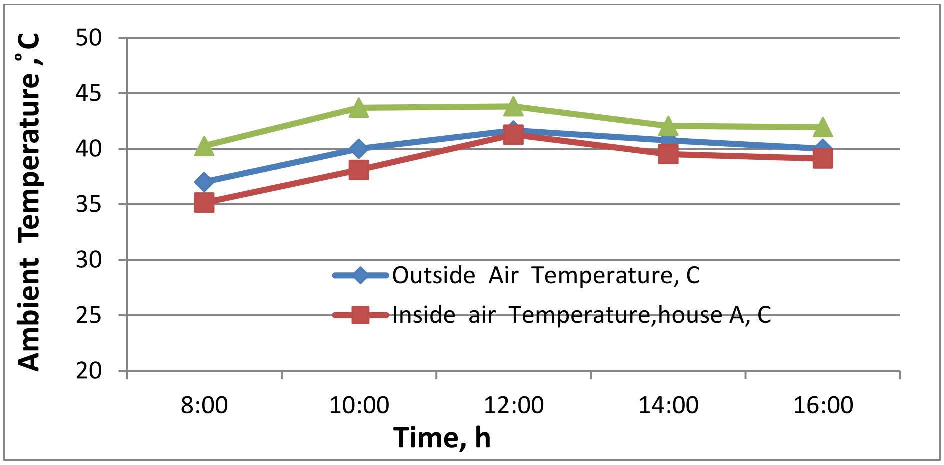

Fig.(3-3).Average inside–outside air temperature forthe two types of Sheep's houses during period (24-26/, July, 2012).

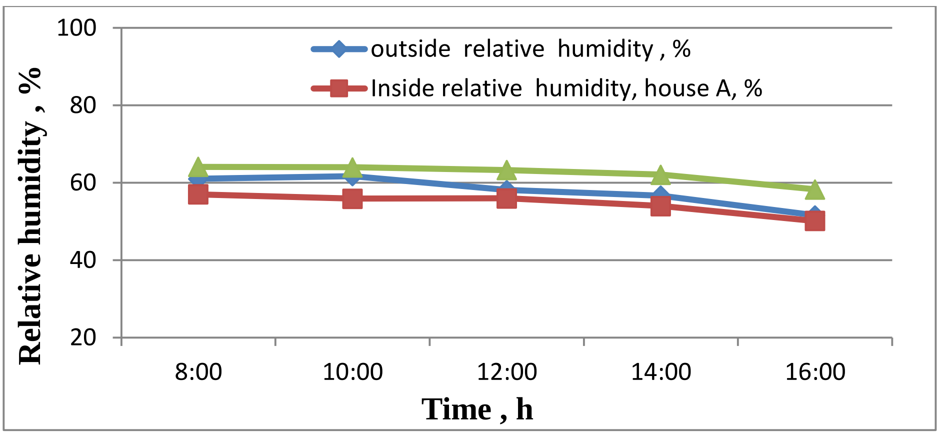

Fig.(3-4) Average inside–outside relative humidityforthe two typesof Sheep's houses during period (24-26, July, 2012).

Figure (3-5)and table (3-3) show that the maximum air temperatures (AT) were recorded at 12:00 o'clock for the three different conditions. the data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock . This is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-6) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

Table (3-3).Average of inside-outside air temperatures and relative humidity for the two types of Sheep houses on the experimental during period(Aug.6-8, 2012).

Time, h	Experiment					
	House A		House B		Outside	
	AT , °C	RH, %	AT , °C	RH , %	AT , °C	RH , %
8	35.00	63.35	40.10	65.34	36.18	65.16
10	37.78	63.46	42.38	65.57	39.25	65.87
12	41.80	64.45	45.00	67.56	42.70	67.00
14	41.00	62.90	44.56	67.30	42.63	66.24
16	40.57	62 .67	43.29	66.65	41.60	66.00
mean	39.23^{b} ±1.26	63.366^{b} ± 0.27	43.33^{a} ± 0.87	66.484^{a} ± 0.58	40.79^{ab} ± 1.21	66.054^{a} ± 0.54

There is significant difference between two treatments (House A, House B) in ambient air temperature. And also there is significant difference between (House A)with (House B, outside) in relative humidity (RH %).

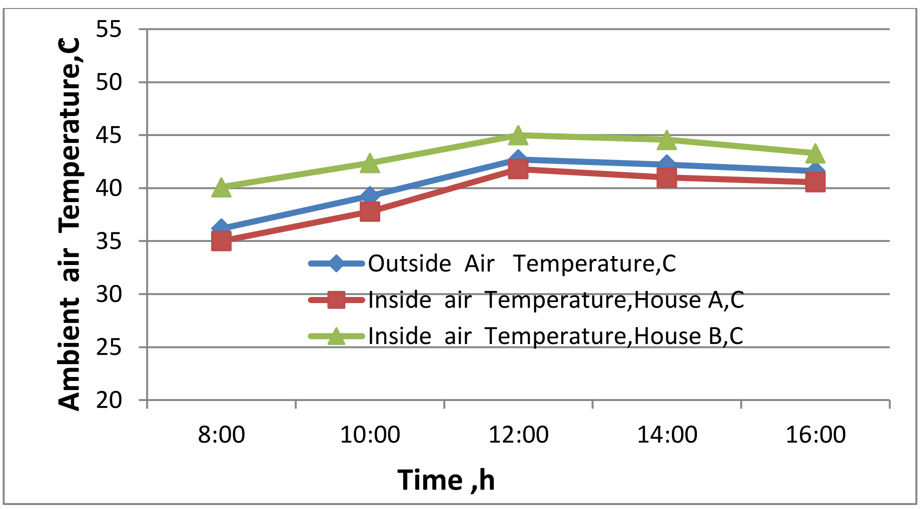

Fig.(3-5). Average inside-outside air temperature for the twotypes of Sheep's houses during period (6-8/8/2012, Aug.).

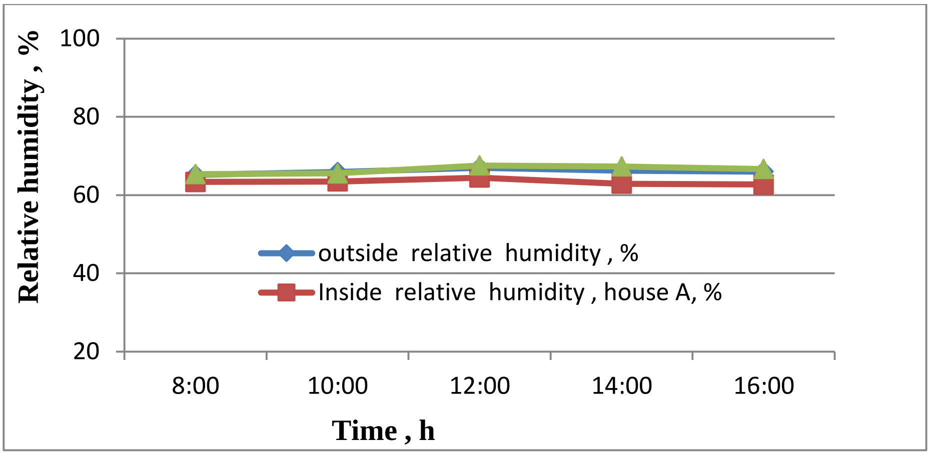

Fig.(3-6). Average inside-outside relative Humidity for the twotypes of Sheep's houses during period (6-8/8/2012, Aug.).

Figure (3-7) and table (3-4) show that the maximum air temperatures (AT) were recorded at 12:00 o'clock for the three different conditions. the data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock . This is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-8) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

Table (3-4).Average of inside-outside air temperatures and relative humidity for the two types of Sheep houses on the experimental during Period (Aug. 27-29, 2012).

Time, h	Experiment					
	House A		House B		Outside	
	AT , °C	RH, %	AT , °C	RH, %	AT , °C	RH , %
8	36.14	54.15	39.44	61.25	36.73	57.00
10	37.83	55.46	40.78	63.75	38.29	59.17
12	40.55	57.50	42.85	63.34	41.56	59.45
14	39.76	57.36	42.18	61.67	41.18	58.24
16	39.68	56.05	41.26	60.85	40.06	57.30
mean	$38.79^{b}_{\pm0.80}$	$56.10^{c}_{\pm0.62}$	$41.30^{a}_{\pm0.59}$	$62.17^{a}_{\pm0.58}$	$39.56^{ab}_{\pm0.91}$	$58.23^{b}_{\pm0.49}$

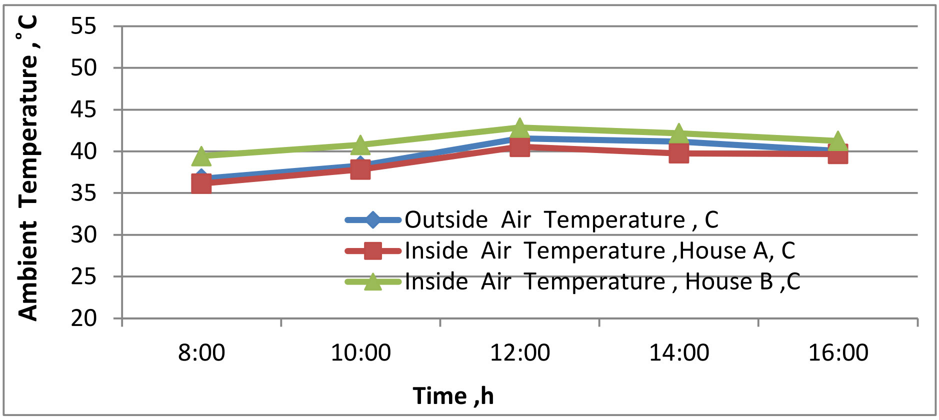

Fig.(3-7).Average inside – outside ambient temperature (AT, ℃)for the two types of Sheep's houses during period (27-29/8, Aug.2012).

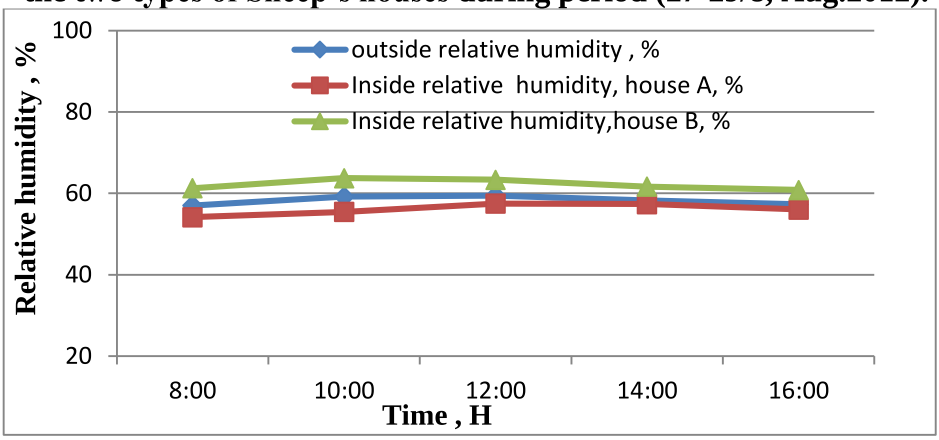

Fig.(3-8).Average inside – outside relative humidity (RH %) for the two types of Sheep's houses during period (27-29/8, Aug., 2012).

There is significant difference between two treatments (House A, House B) in ambient air temperature and there is no significant difference with outside ambient temperature. There is significant difference between three treatments in relative humidity.

Fig.(3-9) and table (3-5) show that the maximum air temperatures (AT) were recorded at 12:00 o'clock for the three different conditions. the data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-10) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Ironsheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

Table (3-5). Average of inside-outside air temperatures and relative humidity for the two types of Sheep houses on the experimental during Period (Sep., 3-5, 2012).

Time ,h	Experiment					
	House A		House B		Outside	
	AT, °C	RH , %	AT , °C	RH , %	AT , °C	RH, %
8	33.70	50.65	37.93	53.71	35.06	51.83
10	35.48	53.40	40.55	57.23	37.14	55.26
12	37.05	54.74	41.87	59.67	40.03	56.64
14	37.00	53.23	41.38	60.03	39.75	56.43
16	36.17	51.53	40.65	59.45	38.86	54.80
mean	35.88b ±0.62	52.71^{b} ±0.72	40.48^{a} ±0.68	58.02^{a} ±1.18	38.17^{ab} ±0.93	54.99^{b} ±0.86

There is significant difference between two treatments (House A, House B) in ambient air temperature. But there is no significant difference at two treatments (Houses A, House B) with outside air temperature. There is no significant difference between (House A, outside) in relative humidity but there is significant difference between (House A, outside) with House B in relative humidity.

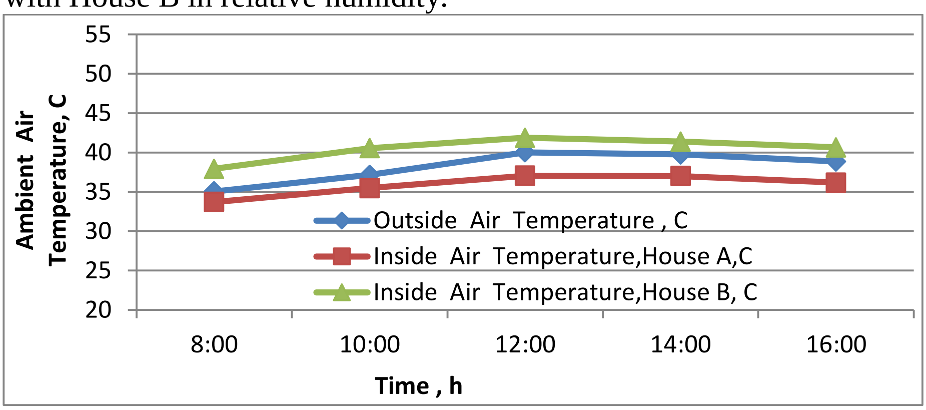

Fig.(3-9).Average inside-outside ambient temperature (AT,°C)for the two types of Sheep's house during period (3-5, Sep.2012).

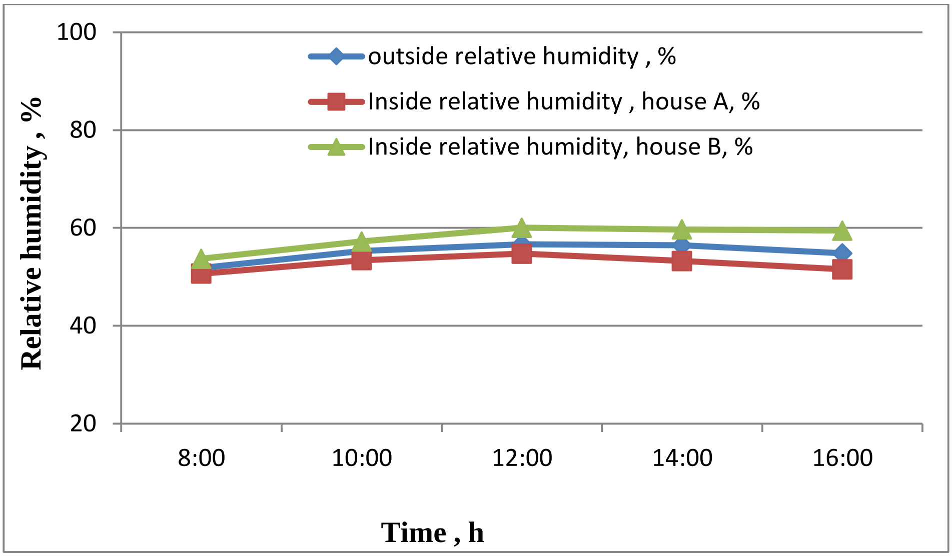

Fig (3-10).Average inside-outside relative humidity (RH %) for the twotypes of Sheep's houses during period (3-5, Sep.2012).

Figure (3-11) and table (3-6) show that the maximum air temperatures (AT) were recorded at 12:00 o'clock for the three different conditions. the data revealed that the concrete roofed house caused a higher reduction of air temperature than the Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock . This is due to that coefficient of heat transfer of the concrete roof is lower than that of the Iron sheet roof.

Figure (3-12) shows that the maximum relative humidity (RH %) were recorded at 12:00 o'clock for three different conditions. The data revealed that the concrete roofed house caused a higher reduction of relative humidity than Iron sheet roofed house, along the daytime from 8:00 to 16:00 o'clock. This is due to the interaction between the two air character, temperature and relative humidity.

There is significant difference between three treatments (House A, House B, outside) in ambient air temperature (AT, °c) and also in the relative humidity.

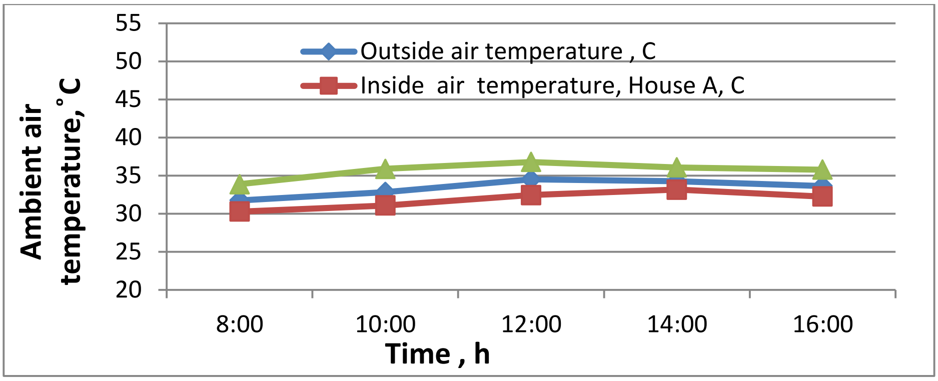

Fig.(3-11) Average inside-outside ambient temperature (AT, C) for the two types of Sheep's houses during period (24-26, Sep., 2012).

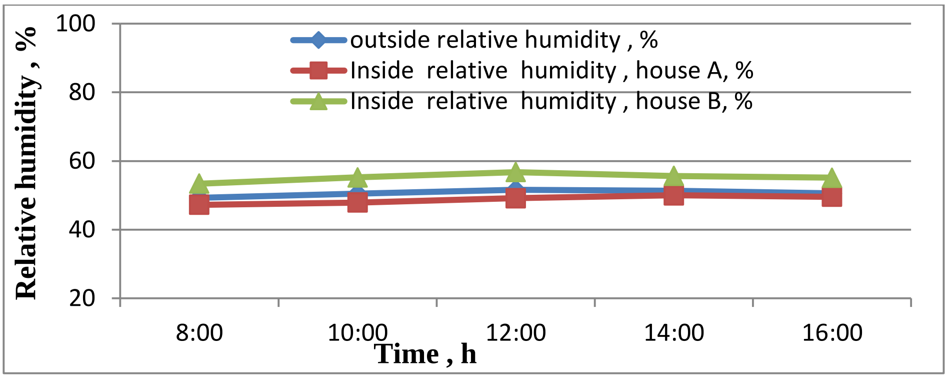

Fig.(3-12)Average inside-outside relative humidity (RH%) for the two types of Sheep's houses during period (24-26, Sep.,2012).

Table (3-6).Average of inside-outside air temperatures and relative humidity for the two types of Sheep houses on the Experimental during period (Sep.24-26, 2013).

Time ,h	Experiment					
	House A		House B		Outside	
	AT, °C	RH , %	AT , °C	RH , %	AT, °C	RH, %
8	30.27	47.25	33.86	53.40	31.75	49.23
10	31.08	47.87	35.88	55.23	32.84	50.45
12	32.45	50.00	36.78	56.75	34.50	51.57
14	33.15	49.55	36.07	55.63	34.27	51.35
16	32.25	49.17	35.79	55.12	33.63	50.54
mean	31.84^{c} ±0.51	48.77^{c} ±0.52	35.68^{a} ±0.49	55.23^{a} ±0.54	33.40^{b} ±0.50	50.63^{b} ±0.41

Table (3-7)mean of Ambient air temperature and relative humidity inside and outside buildings during summer season

month	Concrete		Iron sheet		Outside	
	AT	RH%	AT	RH%	AT	RH%
July	**38.62^{b}± 0.91**	**49.87^{b}± 1.32**	**42.11^{a} ± 0.81**	**60.78^{a}± 1.11**	**40.94^{a}± 0.97**	**56.06^{a}± 2.19**
August	**39.54^{b}± 0.93**	**66.05^{a}± 2.10**	**42.80^{a} ± 0.85**	**70.53^{a}± 0.79**	**41.00^{a}± 1.05**	**68.04^{a}± 1.60**
September	**36.65^{b}± 0.94**	**49.62^{b}± 0.17**	**40.25^{a} ± 0.98**	**56.13^{a}± 1.64**	**38.34^{a}± 0.94**	**51.88^{b}± 0.93**
mean	**38.74^{b}± 0.93**	**55.18^{ab}± 1.2**	**41.72^{a}± 0.88**	**62.48^{a}± 1.18**	**40.093^{a} ±0.99**	**58.66^{a}± 1.57**

CONCLUSION

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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الملخص العربي

تأثير نوع مادة سقف المبنى على درجة الحرارة والرطوبة داخل مباني الأغنام

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أجريت هذه الدراسة لوصف مساكن الأغنام من حيث (مواد البناء المستخدمة, توجيه المبنى, الموقع ...الخ) وتأثيراتها على البيئة الداخلية ,فالبيئة الداخلية للمبنى تتأثر بالعوامل المناخية للبيئة الخارجية المحيطة , نوع مواد البناء , الادارة,... الخ, وبالتالي تؤثرعلى أداء الحيوانات الفسيولوجي والانتاجي. حيثأجريت الدراسة على نوعين من مباني الأغنام ذات نظام شبه مفتوح:

المعاملة الاولى: مبنى ذو سقف خرساني (A)
المعاملةالثانية: مبنى ذو سقف من الصاج (B)
المعاملة الثالثة : الظروف البيئية الخارجية
لدراسة تأثير نوع مادة السقف على المناخ الداخلي لمباني ايواء الأغنام, حيث تم قياس العوامل التالية داخل كل مبنى:١-درجة الحرارة ,درجة الحرارة العظمى والصغرى
٢-الرطوبة النسبية
٣-سرعة الهواء
٤-درجة حرارة الحوائط والأسقف والأرضية
هذه القياسات سجلت داخل المباني عند عدة نقاط ثابتة وعلى ارتفاع ثابت عند مستوى الحيوانات كل ساعتين لمدة ثلاث أيام متواصلة من كل أسبوع وذلك خلال موسم الصيف والشتاء.
٥-القياسات الفسيولوجية والانتاجية الخاصة بالحيوانات التي من خلالها نفهم أي نوع من المساكن أفضل أواجراء تعديلات على المبنى
وهنا في هذا البحث عرضنا جزء من النتائج التي حصلنا عليها من هذه الدراسة (النتائج الموجودة في هذا البحث خلال فصل الصيف)وهي كما يلي :
١-سجلتقيم درجة الحرارة العظمى تحت سقف الصاج خلال فصل الصيف مقارنة بالسقف الخرساني .
٢-سجلت أعلى درجة حرارة عند الساعة 12:00pm تحت المعاملات الثلاث وكانت أعلى درجة حرارة مسجلة تحت السقف الصاج مقارنة بالسقف الخرساني على مدار اليوم وذلك بسبب معامل الانتقال الحراري العالي لمادة الصاج.
٣-سجلت أعلى قيمة للرطوبة النسبية تحت السقف الصاج عند الساعة 12:00pmوكانت نسب الرطوبة عالية خلال فصل الصيف في المبنيين خصوصا المبنى الصاج مقارنة بالمبنى الخرساني .
ومن هذه النتائج نستنتج أن قيم درجة الحرارة والرطوبة كانت أفضل داخل المبنى ذو السقف الخرساني مقارنة بالمبنى ذو السقف الصاج الذي يحتاج الى اجراء عزل للسقف لخفض التوصيل الحراري الكبير لمادة الصاج.

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