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Impact of different housing models on physiological responses of Saidi ewes under Upper Egyptian conditions

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ABSTRACT

A total of 40 Saidi ewes were used approximately 2 years of age and had an average initial body weight (BW) of 40 ± 2.46 kg. Ambient temperature (AT) and relative humidity (RH%) were recorded simultaneously while measuring the physiological responses at the level of the surface of the animal. All physiological measurements were recorded at early morning at 6:00 AM and afternoon 12 PM. The lowest rectal temperature (RT°C) was recorded in semi open models at AM but results recorded that there was no significant differences in RT among the different housing models at PM. The highest temperature humidity index (THI units) was recorded in open and semi open housing models. The highest skin temperature (ST) was recorded in single roof housing model at AM. The lowest plasma total protein (TP) was recorded in open housing model and the same trend was recorded in globulin (GL). Results also showed that there were insignificant differences in albumin (AL) among different housing models.

Key words: Saidi ewes, Housing models. Seasonal conditions, Physiological responses.

1. INTRODUCTION:

Housing had significant effect on the physiological responses and energy expenditure of sheep (Bhatta et al. 2005). While deciding housing for different breeds of sheep (crossbred and native) parameters like physiological responses, energy expenditure, health condition and economic aspects would be considered. Housing and various building materials affect the animal's surrounding environment in home and thus affect their productive and reproductive performance. Climate characterize in middle and upper Egypt with high temperature during summer that have a negative impact on production performance (Abozed 2014).

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Upper Egypt is a hot-dry subtropical region, extended from Giza north to Sudan border in the south (latitudes: 22^{o} south to 29^{o} north). It is characterized by intensive solar radiation, very hot summer, cold winter nights, and scarce rainfall (15 mm/annually). Ambient temperature varies widely between day and night; diurnal variation often exceeds 20^{o}C. The prevailed agro- ecological conditions in Upper Egypt are intensive agriculture of more than a crop/year, and mix crop-livestock production system. Animal productions depend on cut and carry of the cultivated green fodder (mainly Egyptian clover in winter), and grazing crop residues in summer. Saidi sheep and goat, are the indigenous Upper Egypt breeds. They are raised in small flocks; and are known for their tolerance to heat stress and the prevailed hot dry environment (Galal et al. 2005). Saidi sheep are considered the oldest Egyptian sheep breed in the country, they are characterized by high fertility, and high mortality rate of young animals (Elshazly and Youngs 2019). They are mostly dark in color, with open coarse fleece, some individuals are creamy or mixed colors. They have Roman noses, dewlap under the neck, length in tail and coarse wool cover (Ghanem 1980). (Fig. 1).

The present study was carried out to evaluate and assess the impact of different housing models on physiological and performance of Saidi ewes, under Upper Egypt hot and cold conditions. In addition, to decide which one of these models is the proper model for sheep housing.

Fig 1. Saidi Sheep

2. MATERIALS AND METHODS:

The present study was carried out during the period from November 2018 to Jan. 2019 (winter season) and from June 2019 to August 2019 (summer season) at Mallawi Animal Production Research Station; El Minia governorate that belongs to Animal Production Research Institute (APRI), Agricultural Research Center (ARC), Egypt.

Experimental animals:-

A total of 40 of Saidi mature ewes sheep were used during this experiment. Ewes had almost similar average body weight of 40 ± 2.46 kg.

Management and housing models:

Animals were randomly assigned to four groups raised under four housing models:

1- Semi open type house roofed (SOSR) with asbestos sheets 4.5 m.
2- A close type roofed with single asbestos roof at 3 m height (single low type) (CSR).
3- A close model roofed with double asbestos roofs at 3 and 3.5 m height for two roofs, respectively (CDR).
4- Open model house shaded hat rally with huge tree in the center (OM).

All animals were fed according to NRC (2001) wheat straw and concentrate mixture Table 1. Fresh water and mineral mixture blocks were freely available day and night. Animals were weighed in the morning before feeding at the beginning of the experiment then at biweekly intervals during the white experimental period (six months).

Table 1. Chemical composition of concentrated mixture and wheat straw.

Item	Concentrates	Wheat straw
Dry matter	93.70	87.3
Crude protein	13.75	1.51
Crude fiber	15.2	42.90
Ether extract	3.6	2.47
Ash	12	10.04
Nitrogen free extract	55.45	43.08
Organic matter	88	89.96

Environmental conditions:

All physiological measurements were recorded at 15 day interval for ewes at 6:00 AM and at 12:00 PM. Ambient temperature (AT) relative humidity (RH%) were recorded simultaneously while measuring the physiological responses. Temperature humidity index (THI) was calculated based on the equation of Mader et al. (2006) per each season.

Where THI = (0.8 × Tdb) + [(RH/100) × (Tdb − 14.4)] + 46.4,

where:

Tdb = dry bulb temperature (°C) and RH = relative humidity (%).RH= Relative humidity in %.

Physiological traits:

All physiological measurements were recorded at early morning for Saidi ewes at 6:00 AM and at 12:00 PM. Respiration rate (RR breaths/ min) was measured by counting the flank movements for one minute. Rectal temperature (RT, °C) was determined in centigrade units by using a clinical thermometer. Skin temperature (ST, °C), and wool temperatures (WT, °C) were measured by using infrared thermometer (Model 22-325 infrared thermometer, Radio Shack, USA.).

Blood sampling and analyses.

Blood samples were collected every month in each season (winter and summer). Samples were collected from jugular vein containing heparin; blood samples were centrifuged at 3000 rpm for 15 minutes, then plasma was separated, frozen and stored at -20° C until subsequent analysis. Plasma total protein (TP) and albumin (AL) were determined by spectrophotometer using kits supplied by Biodiagnostic Company (Egypt). Plasma globulin (GL) concentration was calculated by subtracting the concentration of AL from the TP concentration.

Direct radioimmunoassay (RIA) technique was performed for determination of plasma hormones. triiodothyronine: The total T3 Ria kit produced by Beckmak coulter was used for the determination of plasma triiodothyronine.

Statistical analysis:

The data were statistically analyzed using SPSS 21 (2012) for windows (SPSS Inc., Chicago, IL). Duncan's multiple range tests was used to compare the differences among means (Duncan's, 1955).

The model used was:

Yijk = μ +Ti + Pj + (TP)ij + eijk

Where,

Yijk = The studied trait.

μ = The overall mean.
Ti = The effect of housing system.
i = 1, -----4.
Pj = The period effect. Where:
J =1, -----2.
Sj = The season effect. Where:
J =1, -----2.
(TP) ij = The effect of interaction between housing system and period
(TS) ij = The effect of interaction between housing system and season.
eijk = the random error.

3. RESULTS AND DISCUSSION:

Influence of different housing models on ambient temperature (AT °C), relative humidity (RH %) and temperature humidity index (THI, units) during winter and summer seasons.

Results in Table (2) showed that there was significant different in AT among housing models, the highest AT was recorded at AM in double and single roof housing, but otherwise the highest AT was recorded PM in open housing models. On the contrary, results in RH (%) showed that the highest RH (%) was recorded AM in double roof housing models and in PM. The highest RH% were recorded in single and double roof. The same trend was recorded in THI at AM. The highest THI was recorded in single and double roof, but at PM the highest THI was recorded in open housing models.

Results in Table (3) illustrated that between the same row the lowest AT was recorded in double roof housing models at AM and the same trend was recorded at PM. While the higher RH was recorded in double roof housing models at AM and the higher RH was recorded in single roof housing models at PM it was 45.91±1.48. The different in THI values among housing models show that the higher THI was recorded in single roof housing models at AM, nevertheless THI was lower in single and double roof housing models at PM. These results agree with Schüller et al. (2013) who reported that temperature, RH% and THI were all consistently higher within the barn microclimate compared with official meteorological stations. Overall, the study by Schüller et al. (2013) noted a mean THI difference of 11.1 ± 6.5 throughout the 2 year of study. During the summer months, same results were recorded by Schüller et al. (2013), with mean differences of 3 to 4 THI units noted.

Table 2. Influence of different housing models on ambient temperature (AT, °C), relative humidity (RH, %) and temperature humidity index (THI, units) during winter (LSM ±SE).

parameters		Housing Models			
		Double roof	Single roof	Semi open	Open
AT	AM	10.69±0.38[a]	10.98±0.39[a]	10.32±0.44[ab]	9.13±0.49[b]
	PM	18.84±0.40[c]	19.18±0.35[c]	20.20±0.33[b]	21.56±0.34[a]
RH	AM	77.15±0.55[a]	75.64±0.58[b]	73.76±0.54[c]	73.81±0.44[c]
	PM	55.06±0.84[a]	54.15±.59[a]	46.88±0.43[b]	45.89±0.51[b]
THI	AM	54.10±0.42[a]	54.38±0.43[a]	53.62±0.48[ab]	52.36±0.55[b]
	PM	63.68±0.52[c]	64.08±0.46[c]	65.64±0.43[b]	67.57±0.45[a]

Means with different letters in the same row are significantly different, ($P<0.05$).

Table 3. Influence of different housing models on ambient temperature (AT, °C), relative humidity (RH, %) and temperature humidity index (THI, units) during summer (LSM ±SE).

parameters		Housing Models			
		Double roof	Single roof	Semi open	Open
AT	AM	22.14 ± 0.49^{b}	24.11 ± 0.61^{a}	23.87 ± 0.62^{ab}	23.13 ± 0.62^{ab}
	PM	31.85 ± 0.24^{c}	32.06 ± 0.42^{bc}	32.88 ± 0.34^{b}	33.88 ± 0.37^{a}
RH	AM	73.68 ± 0.67^{a}	67.83 ± 0.94^{b}	61.69 ± 1.13^{b}	67.64 ± 1.19^{b}
	PM	40.73 ± 0.82^{b}	45.91 ± 1.48^{a}	40.12 ± 0.98^{b}	37.88 ± 1.30^{b}
THI	AM	66.41 ± 0.57^{b}	69.36 ± 0.77^{a}	69.09 ± 0.76^{a}	67.92 ± 0.76^{ab}
	PM	82.21 ± 0.28^{c}	81.99 ± 0.62^{c}	84.13 ± 0.55^{b}	86.03 ± 0.59^{a}

Means with different letters in the same row are significantly different, (P<0.05).

Impact of different housing models on physiological responses of ewes during winter season:

Results in Table (4). illustrated the impact of housing models on thermo-respiratory response of ewes during winter season. The highest RR was recorded in semi open models at AM, on the other hand the highest RR was recorded in open models at PM. The lowest RT was recorded in semi open models at AM, but results recorded that there was no significant differences in RT between the different housing models at PM, results also showed that the ST in AM were highest in roof models than in open models but conversely in PM the highest ST was recorded in open models. Results also showed that the WT in AM were highest in roof models than in open models but conversely in PM the highest WT was recorded in open models. These results agree with Abozed et al (2021) who reported that the physiological responses of sheep housed under double-roofed closed type were better compared to semi-open type. This housing type provided a more comfortable climatic condition that alleviated external heat stress on the animal. Theurer et al. (2014) reported that RT was shown to increase with a high AT and decrease with high relative humidity and wind velocity. This should be taken into consideration when using it as a diagnostic tool. Sevi et al. (2001) found that shaded lactating ewes had significantly lower RT than non-shaded one. Also Naqvi et al. (2004) showed that no significant differences between morning and afternoon in RT of ewes under normal condition in shed. However, a significant increase in RT was recorded from morning to afternoon in ewes subjected to thermal stress (40°C) in hot chamber. Sleiman and Abi Saab (1995) found that RT of Awassi ewes were increased with increasing ambient temperatures and were lower in the morning hours than those in the afternoon in both breeds. Shalaby (1985), Marai et al (1997) and (2000) concluded that during the day, the RT was markedly lower at morning than at afternoon. Also Abozed (2009) showed that averages of RT of Farafra ewes and Farafra growing ram lambs at morning were significantly lower than that at afternoon. Mohamed and Abdelatif (2010) indicated that RT of desert rams was significantly lower (P<0.01) in the morning compared with that in the afternoon during summer and winter. Abdel Rahman and Nagpaul (2013) found that RT of goat during afternoon was higher than morning in concrete floor in semi covered barn with concrete roof and in barn of elevated slotted wooden floor with thatched roof during winter season.

Table 4. Impact of different housing models on physiological responses of ewes during winter season (LSM ±SE).

parameters		Housing Models			
		Double roof	Single roof	Semi open	Open
RR breaths/ min	AM	23.97±0.43^{b}	24.89±0.45^{ab}	25.87±0.55^{a}	24.49±0.51^{ab}
	PM	31.38±0.45^{b}	32.67±0.53^{ab}	32.83±0.53^{ab}	33.66±0.58^{a}
RT °C	AM	38.57±0.02^{a}	38.46±0.07^{a}	38.02±0.20^{b}	38.55±0.03^{a}
	PM	38.91±0.02^{NS}	38.92±0.032 ^{NS}	38.88±0.086 ^{NS}	38.83±0.09 ^{NS}
ST °C	AM	25.85±0.18^{a}	26.36±0.17^{a}	24.80±0.21^{b}	24.47±0.30^{b}
	PM	30.06±0.19^{b}	30.11±0.16^{b}	30.30±0.16^{b}	31.66±0.14^{a}
WT °C	AM	17.55±0.28^{a}	18.30±0.24^{a}	16.54±0.30^{b}	16.54±0.44^{b}
	PM	24.29±0.27^{c}	24.56±0.26^{c}	25.72±0.26^{b}	27.19±0.20^{a}

Means with different letters in the same row are significantly different, ($P<0.05$). NS = nosignificant. Respiration Rate (RR), Rectal Temperature (RT), Skin Temperature (ST) and Wool Temperature (WT).

Impact of different housing models on physiological responses of ewes during summer season:

Results in Table (5). Illustrated that the highest RR was recorded in single roof housing models at AM. Conversely the highest RR was recorded in open housing models at PM. Results also showed that there were insignificant differences in RT among all housing models during summer. Results also illustrated that the highest ST was recorded in single roof housing models at AM. Results also showed that the high-test ST in PM was recorded in open housing system. Results also showed that the high-test WT was recorded in single roof housing models at AM and at PM high-test WT was recorded in open hosing system. These results were agree with Sevi et al. (2001) who found that shaded lactating ewes had significantly lower RT than non-shaded one. Also, Naqvi et al. (2004) showed that no significant differences between AM and PM in RT of ewes under normal condition in shed. However, a significant increased in RT was recorded from morning to afternoon in ewes subjected to thermal stress (40°C) in hot chamber. Al-Samawi et al. (2014) showed that coat temperature was significantly higher in summer compared to winter season. Al-Tamimi (2007) found that hair coat temperature of Damascus male goat had significantly lower in a shaded housing compared with exposed to the natural sunlight (31.8 vs. 36.3°C, respectively).

Table 5. Impact of different housing models on physiological parameters of ewes during summer season (LSM ±SE).

Parameters		Housing Models			
		Double roof	Single roof	Semi open	Open
RR breaths/ min	AM	30.08±0.58^{ab}	31.80±0.56^{a}	29.69±0.55^{b}	30.24±0.62^{ab}
	PM	38.02±0.74^{c}	39.22±0.83^{bc}	40.34±0.76^{ab}	42.47±0.79^{a}
RT °C	AM	39.00±0.07^{NS}	38.99±0.02^{NS}	39.06±0.02^{NS}	39.05±0.03^{NS}
	PM	39.14±0.01^{NS}	39.20±0.02^{NS}	39.22±0.02^{NS}	39.22±0.04^{NS}
ST°C	AM	29.68±0.27^{ab}	30.48±0.24^{a}	28.87±0.43^{b}	29.33±0.28^{b}
	PM	33.52±0.12^{c}	34.01±0.15^{b}	34.18±0.18^{b}	35.13±0.14^{a}
WT°C	AM	24.76±0.52^{ab}	25.41±0.52^{a}	23.34±0.61^{bc}	22.96±0.65^{c}
	PM	31.69±0.18^{c}	31.71±0.20^{c}	32.63±0.16^{b}	33.77±0.15^{a}

Means with different letters in the same row are significantly different, ($P<0.05$). NS = nosignificant. Respiration rate (RR), Rectal temperature (RT), Skin temperature (ST) and Wool temperature (WT).

Effect of different housing models on some blood metabolites and T3 hormone during winter seasons:

Results in Table (6) showed that the lowest TP was recorded in open housing models and the same trend was recorded in GL. Furthermore there were insignificant differences in AL among different models of housing models. Results also showed that the highest T3 was recorded in double roof housing models. These results was agree with Sirohi and Michaelowa, (2007) who reported that small ruminants are homeotherms, which means, that they must regulate their body temperature within a relatively narrow range to remain healthy and productive. Kadzere et al. (2002) found that reducing feed intake is a method of adaptation to decrease the heat production in warm environment as the heat increment of feeding is an important source of heat production in ruminants. Animals go into a stage of negative energy balance, hence body weight decreased. Further, Abdel-Samee et al. (2008) reported that increase the desire for water intake may be attributed to increase the body water retention that helps to ameliorate the rise in body temperature. Salivation which observed in some cases may be considered as a method for decreasing the load of heat stress on the animal. While recumbence observed in severely affected animals due to the effect of heat stress on the muscular tone. Our results are in agreement with Sejian et al. (2013) who reported that concentrations of plasma total proteins and albumin have been used as indices for nutritional status. Plasma total proteins and albumin concentration decreased during thermal stress in goats. Present results are similarly to those of Sejian et al. (2010) who found that although there was no difference in globulin concentration of control and heat stressed group. The decrease in plasma protein could be due to decrease in protein synthesis as a result of the decrease in the anabolic hormone secretion.

Table 6. Effectiveness of different housing models on some blood metabolites during winter.

Parameters	Housing models			
	Double roof	Single roof	Semi open	Open
TP (g/dl)	8.18±0.29[a]	7.61±0.27[a]	7.63±0.33[a]	6.66±0.18[b]
AL (g/dl)	3.50±0.15[NS]	3.28±0.14 [NS]	3.28±0.16 [NS]	3.30±0.08 [NS]
GL (g/dl)	4.68±0.21[a]	4.33±0.17[a]	4.35±0.25[a]	3.36±0.24[b]
T3 (ng/ml)	2.65±0.32[a]	1.79±0.13[bc]	1.59±0.32[c]	2.47±0.26[ab]

Means with different letters in the same row are significantly different, ($P<0.05$). NS = nosignificant.
Total Protein (TP), Albumin (AL), Globulin (GL) and Triiodothyronine (T3).

Effect of different housing models on some blood metabolites and T3 Hormone during summer seasons:-

Results in Table (7) showed that the highest average of TP was recorded in semi open housing models and the highest average of AL was recorded in open housing models. Moreover there were non-significant different among all type of housing models in GL and T3. These results are in consistent with agreed with Thornton et al (2009) who reported that the ambient temperature below or above the thermoneutral range creates stress conditions in animals However, the thermal comfort zone is influenced by a range of factors, and is much higher in tropical breeds because of better adaptation to heat stress. Abdalla et al. (2009) also found that there was a decrease in plasma total protein in summer season than in winter 6.98 vs 7.04 g/dl respectively in Nubian goat these results are agree with Helal et al. (2010) who found that there was a decrease in plasma total protein - 10.39% in goat that exposed to heat stress during summer season. Although, a small decrease in TP was observed with high temperature, it was insignificant as reported by Marai et al. (2008) in ossimi × sullufk rams and Abdalla et al. (2009).

Table 7. Effectiveness of different housing models on some blood metabolites during season summer.

Parameters	Housing models			
	Double roof	Single roof	Semi open	Open
TP (g/dl)	7.91±0.49[ab]	7.03±0.14[b]	8.20±0.27[a]	7.58±0.41[ab]
AL (g/dl)	3.350±0.08[ab]	3.10±0.13[b]	3.55±0.09[ab]	3.78±0.27[a]
GL (g/dl)	4.56±0.44[NS]	3.93±0.14 [NS]	4.65±0.23 [NS]	3.80±0.39 [NS]
T3 (ng/ml)	2.68±0.14 [NS]	2.46±0.13 [NS]	2.27±0.10 [NS]	2.44±0.15 [NS]

Means with different letters in the same row are significantly different, (P<0.05). NS = nosignificant.
Total Protein (TP), Albumin (AL), Globulin (GL) and Triiodothyronine (T3).

CONCLUSION

Our results demonstrated that Double roof model is the best housing models that we can use to hosing sheep under Upper Egyptian conditions because the best physiological responses and performance of Saidi ewes was recorded under this model of housing.

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الملخص العربى

تأثير نماذج الايواء المختلفة على الاستجابة الفسيولوجية لنعاج الاغنام الصعيدى تحت الظروف البيئية

اجريت الدراسة باستخدام (٤٠) من نعاج الصعيدى خلال موسمى الصيف والشتاء. كان متوسط عمر النعاج حوالى عامين ومتوسط الوزن٤٠ ± ٢.٤٦ كم. تم تسجيل كل من درجة الحرارة ونسبة الرطوبة أثناء تسجيل القياسات الفسيولوجية. تم تسجيل القياسات الفسيولوجية عند الساعة ٥ صباحاً و١٢ ظهراً. كان اقل قياس لدرجة حرارة المستقيم فى نماذج الاسكان شبه المفتوح فى الصباح ولكن لم تكن هناك اختلافات معنوية فى قياسات درجة حرارة المستقيم بين نماذج الاسكان المختلفة. كان اعلى معدل لمقياس الحرارة والرطوبة مسجل فى نظام الاسكان المفتوح وشبه المفتوح. كان اعلى معدل مسجل لدرجة حرارة الجلد فى نموذج الاسكان ذو السقف المفرد فى الصباح. وكان اقل معدل مسجل لبروتينات البلازما والجلوبيولين فى نموذج الاسكان المفتوح. كما اظهرت النتائج ايضاً ان هناك اختلافات معنوية فى قياسات الالبيومين بين نماذج الاسكان المختلفة. سجل اعلى معدل لهرمون الثيروكسين فى الشتاء عند استخدام نموذج الاسقف المزدوجة فى الشتاء بينما لم يكن هناك فروق معنوية لهرمون الثيروكسين فى الصيف عند استخدام النماذج المختلفة للاسكان.

نستنتج من هذا البحث ان افضل نموذج يمكن استخدامه لاسكان الاغنام فى صعيد مصر هو نمودج الاسكان ذات الاسقف المزدوجة نظراً لان افضل القياسات الفسيولوجية والانتاجية تم تسجيلها عند استخدامه لاسكان الاغنام.

الكلمات الدالة:- نعاج الصعبدى، نماذج الاسكان المختلفة، الظروف الجوية خلال الشتاء والصيف.