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IMPACT OF DIFFERENT HOUSING SYSTEMS WHILE FEEDING THREE TIMES DAILY ON PRODUCTIVE AND PHYSIOLOGICAL PERFORMANCE OF FARAFRA MALE LAMBS UNDER HOT CLIMATE CONDITION

M. A. Boraei[1]; M.A.I. El-Sysy[1]; Y. H. Hafez[2] and O. A. M. El-kheshen[2]
1. Al-Azhar University, Faculty of Agric., Anim. Prod. Department, Nasr City, Cairo, Egypt.
2. Animal Production Research Institute, Agriculture Research Center, Dokki, Giza, Egypt.

SUMMARY

Twenty Farafra male lambs aged 3-4 months and weighed 15.59 ±1.99kg randomly distributed into two groups (10 animals each). First group kept in semi-open shaded yard and the second in open yard with double asbestos roof pen. The experiment lasted 140 days (23 May to 10 October 2015). Feed of animals in the two groups consisted of 75% concentrate feed mixture and 25% corn silage. All animals offered feed three times per day (at 8 am,1 and 6 pm). The results showed significant increase (P <0.05) in total body weight gain of the first group than the second group (21.67 vs.19.38 kg) and average daily gain (0.154 vs. 0.138 kg). Dry matter intake was slightly higher in first group than the second one (1.071 vs.1.035 kg/h/d) and the same with feed conversion efficiency (6.95vs.7.50). At the morning there were no significant differences between the first and second groups in relative humidity (70.2 vs. 67.8), temperature humidity index (71.1 vs. 72.3), respiration rate (34.97 vs. 41.99), while rectal temperature was significantly (P<0.05) lower in the first group than the second (39.35 vs. 39.5). At afternoon the relative humidity was significantly (P<0.001) lower in the first group than the second (32 vs. 47.3). Temperature humidity index was significantly (P<0.01) higher in the first group than the second (90.6 vs. 84). Respiration rate was significantly (P<0.05) higher in the first group than the second (59.95vs.51.35) and rectal temperature was higher in the first than the second group (39.70 vs.39.63).

The results indicate that rearing Farafra lambs in semi-open shaded yard is better than in open yards with double asbestos roof pen in productive and physiological performance.

Keywords: *Farafra, lambs, housing, system, relative, humidity, temperature, index, respiration and rectal temperature.*

INTRODUCTION

The open housing system with varying designs for protection from heat stress is a good choice under hot climate condition. ***Bhatta et al., (2005)*** concluded that housing had significant effect on the physiological responses and energy expenditure of sheep. 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).** Expose to high temperature for a long time with high relative humidity affect feed intake, production of animal, reproductive efficiency, which reflected on the profitability. This heat stress needs to decrease temperature through improving housing system **(Das *et al.*, 2016**).

Karabacak *et al.*, (2015) found that total feed intake and daily live weight gain of Merino lambs were not differ significantly (P>0.05) between indoor and outdoor under temperature (20.41 *vs.* 20.46 °C) and humidity (47 vs. 40 %), respectively. **Zali and Ganjkhanlou (2007)** found that increase of feeding frequency did not affect final body weight of lambs. As well as, **Afify (2000)** revealed that body weight not significantly affected by feeding frequency.

Rana *et al.*, (2014) found, on sheep, that hemoglobin% **(**Hb) and packed cell volume % (PCV) were significantly higher ($p<0.05$) with exposure to heat stress for 8 hours than non-exposure, being 9.80±0.23 and 31.67±1.45%, respectively, but there was no significant difference between either non-exposure and 4 hour exposure or between 4 hour and 8 hour exposure. **Alfredo *et al.*, (2008)** reported no significant difference in hematocrit values among thermo neutral and stressful conditions.

This work aimed to evaluate the impact of two housing systems, while feeding three times per day, on productive and physiological performance of Farafra lambs kept under hot climate condition.

MATERIALS AND METHODS

The experimental work carried out at Malawi Experimental Station (Minya Governorate), belonging to Animal Production Research Institute (APRI), Agricultural Research Center, Egypt, The work done cooperating with Animal Production Department, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt,.

Experimental animals and treatments:

Twenty Farafra male lambs aged 3-4 months and averaged 15.59±1.99kg live body weight was used. The experiment lasted 140 days (23 May to 10 October 2015). Lambs were randomly distributed into two groups (10 animals each), the first kept in semi-open shaded yard and the second in close pen had double asbestos roof. The two groups fed 75% concentrate feed mixture (CFM) and 25% corn silage (CS) according to **NRC** allowances **(2007)**. Feed offered three times per day (at 8 am, 1 and 6 pm). The amounts of concentrate feed mixture and corn silage adjusted according to body weight gain, every week. Composite feedstuffs samples collected and stored for laboratory proximate analysis, according to **A.O.A.C (1995)**. Proximate analysis of concentrate feed mixture (CFM) and corn silage illustrated in Table (1). Fresh water was freely available throughout the day. The consumption of water and feed intake were estimated every two weeks.

Table (1): Analysis of experimental diet (% on DM basis).

Item	Corn silage	CFM*
DM	23.75	92.35
OM	90.9	89.17
CP	9.63	14.89
CF	38.34	15.46
EE	4.90	3.50
NFE	38.03	55.32
Ash	9.10	10.83

* Concentrate feed mixture (CFM) was consisted of: 40% wheat bran, 30% ground yellow corn, 24% un-decorticated cottonseed meal, 3% cane molasses, 2% lime stone and 1% common salt.

Animals weighed in the morning before feeding at the beginning of the experiment, then every two weeks until the end of experiment. Body weight changes (BW), average daily gain (ADG) and feed conversion efficiency (FC) were estimated.

Experimental Parameters:

Ambient temperature (AT) and relative humidity (RH %) were recorded periodically while measuring the physiological responses. The temperature humidity index (THI) was calculated from the ambient temperature (AT) and relative humidity (RH) according to **Hahn *et al.*, (2003):**

THI = [(1.8xTdb) +32] – [0.55 (RH/100)] x [((1.8Tdb) +32) -58].
Where:
Tdb = Dry bulb temperature in °C.
RH = Relative humidity in %.

Physiological measurements were recorded every two weeks for lambs at times 6:00 to 8:00 and 12:00 to 14:00.

Respiration rate (RR) measured by visual counting flank movement for one minute. The rectal temperature (RT) recorded using a clinical thermometer inserted directly into the rectum. Skin temperature (ST) and wool temperature (WT) measured by infrared thermometer (model 22-325, Radio Shack, USA.).

Blood samples collected monthly from five lambs of each group, from the jugular vein, then transferred to three vials, one contained EDTA (Ethylenediaminetetra acetic acid) for determination of packed cell volume (PCV) and hemoglobin concentration (Hb), while the second vial contained sodium fluoride for glucose estimation after separation and the third one was centrifuged at 3000 rpm for 15 minutes, then serum was separated, frozen and stored at -20°C until subsequent analysis of total protein, albumin, urea, AST, ALT and free thyroxin hormone. Hemoglobin (Hb, g/dl) concentration determined by spectrophotometer using kits provided by Biodiagnostic CO. (Egypt). The packed cell volume (PCV ٪) determined by Hawskey microhematocrit method (**Schalm et al., 1975**).

Serum total protein was determined according to **Armstrong and Carr (1964)**; albumin according to **Doumas et al., (1981)**; AST and ALT according to **Reitman and Frankel, (1957)**; urea according to **Fawcett and Soctt (1960)**; serum glucose according to **Trinder, (1969)** and free thyroxin hormone according to **Britton et al., (1975)**.

Statistical analysis:

Statistical analysis was carried out using SPSS program **(SPSS, 2008)**. Descriptive statistics was calculated using Descriptive Statistics of SPSS. One-way analysis of variance was used to test the effect of housing system on different measurements. To test the effect of interaction student t test was used (SPSS, analyze and compare means of independent-samples) to test the effect of housing type within each feeding group as well as feeding frequency groups within each housing type on different measurements.

RESULTS AND DISCUSSION

Growth performance:

Results presented in (Table 2) showed that semi-open system had significantly ($p<0.05$) higher total body weight gain (21.67 vs.19.38 kg), and average daily gain (0.154 kg vs.0.138 kg) compared with double roof. This might be explained by the recorded increase in feed intake and low humidity accompanied the better air circulation under open yard compared to the close yard though having double roof. Concerning housing systems, **Serafettin Kaya (2011)** found less daily gain with indoor cafeteria group and higher daily gain with outdoor cafeteria group for Awassi lambs.

Feed intake, feed conversion and water consumption:

Results in Table (2) show that total dry matter intake (DMI) was slightly higher under semi-open housing system than double roof (1.071 vs. 1.035 kg/h/d). So, feed conversion efficiency slightly improved with semi-open system compared with double roof (6.95 vs.7.50). This light improve in feed conversion, due to increase in average daily gain (12.75%) of semi open system, was accompanied with increase of feed intake (1.07 vs. 1.03 kg/d). Concerning housing systems, Serafettin Kaya (2011) found that outdoor cafeteria group had better feed conversion ratios either than raising in indoor with single feeding, outdoor with single feeding or indoor with cafeteria feeding for Awassi lambs. On the contrary, AliKarabacak et al., (2015) found that feed conversion ratio for Merino lambs was not significantly differ between indoor and outdoor sheepfolds. Water consumption recorded nearly similar consumption under semi-open compared to double roof (3.373 vs. 3.330 kg/d).

Table (2): Impact of housing system on growth performance, feed intake, water consumption and feed conversion.

Item	Semi-open	Double roofed	Sig.
Live body weight, kg			
Initial live body weight	**15.52±0.72**	**15.65±0.56**	**NS**
Final live body weight	**37.19±0.97**	**35.03±0.75**	**NS**
Total body weight gain	**21.67±0.68**	**19.38±0.69**	*****
Average daily gain	**0.154±0.01**	**0.138±0.01**	*****
Intake, kg/h/d.			
Concentrate	**0.849**	**0.817**	
Roughage	**0.222**	**0.218**	
Total DMI	**1.071**	**1.035**	
Water	**3.373**	**3.33**	
Feed conversion, kg feed/kg gain	**6.95**	**7.50**	

NS= non-Significant* Significant (P<0.05).

Impact of housing system on relative humidity and temperature humidity index.

Results obtained in Table (3) showed non-significant difference in relative humidity between semi-open and double roof at morning, but at afternoon, relative humidity was significantly (P<0.001) lower in semi-open compared with double roof.

Results presented in Table (3) showed non-significant difference in temperature humidity index (THI) between semi-open and double roof at morning, but at afternoon, temperature humidity index was significantly higher (P<0.01) under semi-open compared with double roof.

Table (3) Indoors ambient temperature (AT, °C) and relative humidity (RH, %) as effected by housing types while feeding three times daily.

Item	Semi-open		Double roofed		Sig.	
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
AT (°C)	**26.3 ±1.00**	**36.4 ±0.81**	**28 ±0.83**	**34 ± 0.92**	**NS**	**NS**
RH (%)	**70.2 ±0.89**	**32 ±1.35**	**67.8 ±1.11**	**47.3 ±2.95**	**NS**	***
THI	**71.1 ±1.14**	**90.6 ±1.23**	**72.3 ±0.96**	**84 ±1.16**	**NS**	**

NS= non-Significant ** Significant (P<0.01). *** Significant (P<0.001).
AT =Air temperature. RH=Relative humidity. THI=Temperature humidity index.

Impact of housing system on Physiological parameters

Respiration rate

The results showed that RR at morning under double roof was higher than under semi-open but without significance. Contrarily, at afternoon RR was significantly lower (P<0.05) with double roof than semi-open (Table 4**)**. **Al-Samawi *et al.*, (2014)** reported that respiration rate was significantly higher (P<0.001) during summer than winter, **Dangi *et al.*, (2015)** indicated that RR was increased when goats exposed to heat stress. **Panda *et al.*, (2016) and patel *et al.* (2016)** found that RR increased with increasing air temperature.

Rectal temperature

Results obtained in Table (4) showed that lambs at morning significantly had lower (P<0.05) rectal temperature under semi-open housing system than under double roof. This may due to rise of THI in semi-open than double roof. While the results showed insignificant lower rectal temperature at afternoon for lambs kept under double roof compared with semi-open housing system**.** The same trend was found by **Serafettin Kaya (2011)** who reported that RT of Awassi lambs under hot climate was markedly lower at 08:00h than at 12:00h and 16:00h. **Panda *et al.*, (2016)** showed insignificant increase in RT of goats exposed to heat, when the average temperature over the 30 days was 43.60 ºC and relative humidity was 88%.

Skin temperature

Skin temperature (ST) of Farafra lambs at morning showed significant (P<0.001) higher temperature under double roof than semi-open housing system, while at afternoon it was significantly (P<0.01) higher under semi-open compared to double roof (Table 4). This may due to difference in THI. Similar results obtained by **AL-Haidary (2004**) who found that skin temperature of Naimey sheep significantly increased when exposed to heat stress. **Al-Samawi *et al.*, (2014)** showed that skin temperature was significantly higher in summer compared to winter season.

Wool temperature

Results obtained in Table (4) showed significant (P<0.001) lower wool temperature (WT) at morning when animals kept under semi-open compared to double roof housing system, while WT at afternoon was significantly (P<0.001) higher under semi-open compared to double roof housing system. This may due to difference in THI and solar radiation. **Al-Samawi *et al.*, (2014)** showed that coat temperature was significantly higher in summer compared to winter season.

Table (4): Physiological parameters as affected by housing types with feeding three times daily during diurnal periods.

Item	Semi-open		Double roofed		Sig.	
	Morning	After noon	Morning	After noon	Morning	After noon
RR	34.97±3.24	59.95±3.39	41.99±1.67	51.35±1.88	NS	*
RT	39.35±0.03	39.70±0.03	39.50±0.05	39.63±0.05	*	NS
ST	32.01±0.08	35.83±0.09	33.56±0.03	35.49±0.04	***	**
WT	26.83±0.07	35.37±0.12	28.60±0.15	33.33±0.05	***	***

NS non-Significant.* Significant (P<0.05).**Significant (P<0.01). *** Significant (P<0.001).
RR= Respiration rate.
RT=Rectal temperature
ST=Skin temperature.
WT=Wool temperature.

Impact of housing system on blood parameters

Results in (Table 5) show that blood packed cell volume, hemoglobin, total protein, albumin, globulin, glucose, urea, ALT, AST and free thyroxin hormone were not significantly differ between semi-open and double roof housing system. Similar results obtained by **Alfredo *et al.*, (2008)** who found non-significant differences in hematocrit values among thermo neutral and stressful conditions. **Verma *et al.*, (2012)** indicated that different housing systems not significantly affected T_4 hormone levels for ewes. **Wojtas *et al.*, (2014)** showed that hemoglobin and AST not significantly affected when air temperature increased from 20°C to 30°C. **Abd El-Khalek (2007)** showed, on Ossimi rams, that no significant differences

Table (5) Impact of housing system with feeding three times daily on some blood constituents

Item	semi-open	double roofed	sig
PCV%	26.2±1.249	26.06±1.112	NS
HB(g/dl)	11.68±0.58	12.42±1.33	NS
TP(g/dl)	5.8±0.1	5.73±0.144	NS
Alb(g/dl)	3.78±0.08	3.87±0.118	NS
Glob(g/dl)	2.023±0.048	1.857±0.229	NS
Glucose(mg/dl)	59.66±1.911	64.1±1.59	NS
Urea (mg/dl)	41.42±2.49	38.83±1.94	NS
ALT (u/l)	21.72±2.82	19.24±3.23	NS
AST (u/l)	43.8±3.117	40.46±3.092	NS
F T4(pmol/l)	15.78±1.15	17.64±0.91	NS

GL= Globulin.
ALT=Alanine aminotransferase
AST=Aspartate aminotransferase
FT4= Free thyroxin hormone.
NS= non-Significant.
PCV = Packed cell volume.
Hb= Hemoglobin.
TP = Total protein.
ALB= Albumin.

noticed in hematocrit value, total protein, albumin and globulin between thermo neutral zone and moderate heat stress.

CONCLUSION

In general, it could be concluded that semi-open house is a better choice under hot climate condition compared with closed double roof house when concern with coast of housing, weight gain, feed conversion and physiological parameters. These results tested on Farafra lambs.

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تأثير نظم الإسكان المختلفة مع تقديم الغذاء ثلاث مرات يوميا على الاداء الإنتاجي والفسيولوجي لحملان الفرافرة تحت الظروف الحارة

محمد عبد المجيد برعي[1]، محمود عبد الفتاح السيسي[1]، يوسف حسين حافظ [2]، أسامه أحمد محمد الخشن[2]

1 قسم الإنتاج الحيواني - كلية الزراعة– جامعة الأزهر–مدينة نصر، القاهرة
2 معهد بحوث الانتاج الحيواني - مركز البحوث الزراعية- الدقي – الجيزة – مصر.

استخدم في هذه الدراسة عدد عشرون ذكر من حملان الفرافرة عمر 3-4 شهور بعد الفطام وبمتوسط وزن 15.59± 1.99 كجم، واستمرت التجربة 140 يوما (23مايو– 10 أكتوبر2015م)، تم توزيع الحملان على مجموعتين عشوائيا حسب الوزن والعمر كالاتي:
المجموعة الأولى (G1): الحملان داخل مسكن شبة مفتوح (نصف مظلل) مع تقديم الغذاء ثلاث مرات يوميا (8 صباحا ، 1 ظهرا و 6 مساء).
المجموعة الثانية (G2): الحملان داخل مسكن ذو سقف مزدوج مصنوع من الأسبستوس مع تقديم الغذاء ثلاث مرات يوميا (8 صباحا ، 1 ظهرا و 6 مساء).
تم تغذية الحملان في كلا المجموعتين على عليقة مكونة من 75% مخلوط علف مركز و 25% سيلاج أذرة.
أظهرت النتائج تحسن حملان المجموعة الأولى مقابل حملان المجموعة الثانية عند مستوى (0,05) في وزن الجسم المكتسب (21.67 مقابل 19.38كجم) ومتوسط الزيادة الوزنية اليومية (0.154 مقابل 0.138 كجم) وزيادة طفيفة في كمية المادة الجافة المستهلكة يوميا (1.071 مقابل 1.035 كجم/رأس/يوم). وتحسن في معامل الكفاءة التحويلية للغذاء (6.95 مقابل 7.50) .
في فترة الصباح أظهرت النتائج عدم وجود اختلافات معنويه بين المجموعة الاولى والثانية في قياس الرطوبة النسبية (70.2 مقابل 67.8) ودليل الحرارة والرطوبة (71.1مقابل 72.3) ومعدل التنفس (34.97 مقابل 41.99)، كما حدث انخفاض معنوي (0,05%) لدرجة حرارة المستقيم للمجموعة الاولى مقارنة بالثانية (39.35 مقابل 39.5).
في فترة ما بعد الظهر كانت الرطوبة النسبية منخفضة معنويا لنظام المسكن شبه المفتوح مقارنة بنظام المسكن ذو السقف المزدوج (32 مقابل 47.3)، بينما كان هناك ارتفاع معنوي (0,05) للمجموعة الاولى عن المجموعة الثانية في دليل الحرارة والرطوبة (90.6 مقابل 84) ومعدل التنفس (59.95 مقابل 51.35) كما حدث ارتفاع غير معنوي في درجة حرارة المستقيم لحملان المجموعة الاولى مقارنة بالثانية (39.7 مقابل 39.63).
نستخلص من النتائج المتحصل عليها وجود تحسن فى الاداء الانتاجي والفسيولوجي للحملان المرباة في نظام المسكن شبه المفتوح (نصف مظلل) عن المقفول ذو سقف مزدوج في المناخ الحار، وقد طبقت الدراسة على اغنام الفرافره.