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PHYSIOLOGICAL REACTIONS OF WEANED FRIESIAN CALVES IN DIFFERENT HOUSING TYPES

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SUMMARY

Twenty-two weanling Friesian calves were used to study the physiological responses under two different housing types, concrete roofed (C) stable (semi-open) and asbestos roofed (A) stable (semi-close). This work comprised two seasonal studies, two months for each season. Ten weanlings averaged 22 weeks of age and 125 Kg body weight were used in winter. Twelve weanlings averaged 26 weeks of age and 153 Kg body weight were used in summer. The studied parameters were, environmental conditions indoors and outdoors, physical properties of buildings, thermal responses of animals, respiratory response, hematological responses, leukocyte types and thyroid activity. Concrete roof induced greater rise in the stable internal air temperature over the outdoors temperature than that caused by the asbestos roof. The (C) stable had a limited diurnal change in its temperatures in comparison with a wider change in (A) stable. This observation suggests that the colder walls and roof at night and early morning in (A) stable act as heat sinks. Generally the calves in (C) stable showed, higher values in; rectal temperature, respiration rate, hemoglobin concentration, hematocrit value, neutrophils and eosinophils percentages and T_3 concentration, except at winter morning, while they had lower values of lymphocytes and monocytes percentages, also, T_4 level and T_4/T_3 ratio, than those in (A) stable. However, the differences between (C) and (A) stables, in most parameters, were statistically not significant. There were highly significant correlation coefficients between all the physiological responses with each others.

The concept of heat sinks needs to be elucidated by further experimentation and consideration of the thermal properties. The economic feasibility of the housing establishment has to be considered, taking in consideration the technical feasibility.

Keywords: Friesian calves, housing, physiological reactions, seasonal and diurnal variations

INTRODUCTION

Animals have complex physiological mechanisms which enable them to interact with their environment in various ways to fulfill the most successful maintenance and activities. The most stressful environmental conditions are those of the physical properties of the housing structures of the stables. Animals' buildings have changed over the years as different requirements have been imposed and new methods and materials have been developed. Housing and management technologies are available through which climatic hazards on livestock can be reduced, but the rational use of such technologies is crucial to the survival and profitability of the livestock enterprise (Hahn, 1985).

The thermal environment influence animal performance primarily through the net effect of energy exchanges between that animal and its surroundings. In hot environments, as in Egypt, energy exchanges by radiation are dominant. Providing a shade or housing to protect the animal from direct solar radiation can reduce the total heat load, though, the shed, stable, yarn...etc provide another source of infrared radiation. Garrett *et al.* (1967) indicated that, for a shaded standing steer in a hot environment, the thermal radiation received by the animal was; from hot unshaded ground (26%), from the horizon (21%), from the sky (14%), from the shaded ground beneath the shade (18%) and from the shed itself (21%). Physiological responses of animals under different climatic conditions are good indicators for the effect of the environment. There were contradictory results, as found by many workers, in the relationship between the climatic conditions and animals' responses, most probably due to the negligence of the stress imposed by the housing systems in most of these studies.

Despite the availability of several research and review articles on the effects of climatic conditions on livestock production there are, still, a real problem in applying this information to the selection of appropriate housing and management for adverse weather.

This study was carried out to assess and compare the effect of two different housing types under diurnal and seasonal climatic variations on the physiological responses of Friesian calves in the Nile Delta, Egypt. Also, to decide whether these types are satisfactory in their current conditions or whether they should be remodeled.

MATERIALS AND METHODS

Experimental animals

Twenty-two healthy weanling Friesian calves belonging to Sakha Experimental Station, Located in the northern part of the Nile Delta, Animal Production Research Institute, Egypt, were used in this study. This work comprised two seasonal studies, two months for each season. During the coldest months of winter season (January and February) the study was carried out on ten weanlings averaged 22 weeks of age and 125 kg body weight. During the hottest months of summer season (July and August) another twelve weanlings averaged 26 weeks of age and 153 Kg body weight were used.

Housing types and management

Two housing types, already established, semi-open and semi-close stables differing mainly in the roofing materials and height, as shown in Figures (1 and 2), were used in this study. The semi-open shed was made of brick walls, 2 m in height and 25 cm in thickness, with reinforced concrete roof (10 cm thickness) at the height of 3.25 m and earthen floor. The semi-close stable was made of similar brick walls roofed by asbestos sheets at the height of 5 m and earthen floor. Ventilation in both types is acquired by 1 m horizontal openings throughout the walls at 2.25 to 3.25 m above the ground. The calves were divided into two groups, each one was housed in one model in both seasons. Concentrate rations were offered twice a day at 08:00h and 16:00h according to the farm routine management. Feeding in summer and winter was the same except that green berseem in winter was replaced by berseem hay in summer. Clean drinking water was always available.

Investigations and procedures

The following parameters were investigated under the two housing types by the same techniques and procedures. Indoors and outdoors air temperatures and relative humidity were recorded simultaneously with testing the animals physiological responses at 08:00 and 14:00 hs in two consecutive days at weekly intervals. Meanwhile, thermal characteristics of each housing type, internal and external walls and roofs temperatures and floor temperature were measured four times on one of that days at 06:00, 12:00, 15:00 and 22:00 hs by using infrared thermometer. Thermal responses of the animals; rectal, black and white skin and hair temperatures (°C) were recorded by using clinical and digital thermometers. Respiration rate was determined by counting the flank's movements/min. Blood samples were taken at 08:00 h and 14:00 h within that day at weekly intervals. Fresh blood samples were used to determine the hematological responses. Hemoglobin concentration (g/ dl) was determined by kits of Egyptian American Company. Hematocrit value (%) was determined by a microhematocrit centrifuge 12000 r.p.m for 3 min. Differential leukocyte counts were determined using blood films stained by Leishman's stain. Plasma T_3 and T_4 concentrations were determined by using RIA techniques of Diagnostic Product Corporation (DPC, USA).

Fig. 1. Semi-close stable

Fig. 2. Semi-open stable

Data were statistically analyzed by using SAS package (1990). Correlation coefficients among the variables were estimated according to Sendecor (1982). Also, Duncan test (1955) was done to determine the degree of significance of differences between the means.

RESULTS AND DISCUSSIONS

1- Climatic conditions

There were seasonal and diurnal differences in the climatic conditions (Table 1). Winter morning showed the lowest air temperature (AT), while summer afternoon showed the highest AT and the lowest relative humidity (RH) in both indoors and outdoors. At 08:00 h, the average of indoors ambient temperature (IAT) and relative humidity (IRH) were higher than those of the outdoors conditions (OAT and ORH). At 14:00h, the averages of IAT in both stables in summer were higher than that of OAT, meanwhile, in winter the opposite trend was observed. On the other side the averages of IRH were higher than ORH in winter and summer in the two types of housing. In all cases the differences between IAT and OAT were not significantly, this was true for RH except in few cases.

Table 1. Outdoors and indoors ambient air temperature, °C (OAT and IAT) and outdoors and indoors relative humidity, % (ORH and IRH) during winter and summer at morning (08:00 h) and afternoon (14:00 h) for the two housing types with asbestos (A) and concrete (C) roofs

Item	Times (h)	Winter		Summer	
		A	C	A	C
OAT	08:00	12.1^{d}	12.1^{d}	24.0^{b}	24.0^{b}
	14:00	20.8^{c}	20.8^{c}	33.9^{a}	33.9^{a}
IAT	08:00	12.9^{d}	13.6^{d}	25.0^{b}	26.1^{b}
	14:00	19.6^{c}	20.7^{c}	34.9^{a}	35.4^{a}
ORH	08:00	81.5^{ab}	81.5^{ab}	88.1^{a}	88.1^{a}
	14:00	61.0^{c}	61.0^{c}	52.6^{d}	52.6^{d}
IRH	08:00	82.3^{b}	82.8^{b}	90.9^{a}	89.5^{ab}
	14:00	65.2^{c}	65.7^{c}	57.3^{d}	62.9^{cd}

Mean values with the same superscript letter are not significantly different.

The rise of IAT over the OAT was greater in concrete roofed stable (C) than in asbestos roofed stable (A) during summer at 08:00 h and 14:00 h and in winter at 08:00 h. Even in winter afternoon (14:00 h) the (A) stable had lower temperature difference of IAT from the OAT than the (C) stable (Table 1).

2- Thermal characteristics of housing components

The diurnal rhythms in the temperatures of the physical components of the buildings (Walls, roofs and floors) are presented in Table (2). The winter data revealed that the lowest values of internal temperatures of walls, roof, floor and IAT were at 06:00h followed by great increase at 12:00 h, 15:00 h with abrupt drop at 22:00 h. This trend was more obvious in roof temperature, less in IAT and the least in floor and walls temperatures. Summer data showed the same trend, but the difference between the temperature degrees at the four day times were lower as percentage change than in the case of winter. Southern wall had the highest values of both external and internal temperatures especially at 12:00h and 15:00h, while the northern wall had the lowest values.

Table 2. Seasonal and diurnal temperatures (°C) of internal (Int.) and external (Ext.) wall and roof surfaces and floors and indoors air temp. (IAT) at successive day times in winter and summer

Season	Stables' roof type	Times (h)	Walls*		Roofs**		Floors	IAT
			Int.	Ext.	Int.	Ext.		
Winter	Asbestos (A)	06:00	6.5	6.0	5	3	10	10
		12:00	12.0	13.5	22	25	14	22
		15.00	14.8	16.0	20	22	16	22
		22:00	10.5	8.8	6	4	10	11
	Concrete (C)	06:00	9.8	7.5	7	5	11	11
		12.00	11.8	16.8	14	23	13	16
		15:00	12.8	17.3	20	27	13	21
		22:00	11.3	5.8	6	5	10	13
Summer	Asbestos (A)	06:00	21.3	19.3	17	13	21	19
		12.00	24.3	29.5	47	50	26	32
		15:00	29.3	33.3	40	45	27	31
		22:00	25.0	24.0	17	14	25	23
	Concrete (C)	06.00	23.8	20.0	21	14	22	22
		12:00	22.8	30.8	28	52	24	30
		15:00	24.5	32.0	25	44	24	31
		22.00	25.3	22.5	24	21	24	25

* Average of the four wall sides at the height of 2m above the ground.

** At the roof center.

The concrete roof conserved more heat than the asbestos roof. The difference between external and internal temperatures at 12:00h and 15:00h of asbestos roof was 2 to 3°C in winter and 3 to 5°C in summer. The corresponding values of the concrete roof were 7 to 9°C in winter and 19 to 24°C in summer. The internal temperature of the concrete roof in summer was decreased by only 4°C, from 28°C at 12:00h to 24°C at 22:00 h, while the corresponding value of asbestos roof was 30°C, from 47°C at 12:00 h to 17°C at 22:00 h (Table 2). These results indicate that asbestos roof was cooled or warmed more rapidly than that of concrete roof. Thus, concrete roof is apt to increase heat stress during summer

3- Thermal responses of animals

There were no significant differences in rectal temperature (RT) of the calves between the two types of housing (Table 3). In both summer and winter RT was significantly higher at 14:00 h compared with that at 08:00 h in the two stables. Shafie and El-Sheikh Aly (1970) reported that the steady increase in the body reaction in Friesian cattle from the morning to the afternoon could be attributed to the gradual rise in atmospheric temperature and the increase in the body activities of the animals. Similar results were obtained by Badreldin *et al.* (1951) and Kobeisy (1983). The seasonal variation was pronounced under asbestos roof than under concrete roof, being 0.4 vs. 0.3 °C at 08:00 h and 0.5 vs. 0.4 °C at 14:00 h, respectively.

Table 3. Means ±SE of rectal temperature (RT), white and black skin (WST, BST) and hair (WHT, BHT) temperatures (C°) and respiration rate (RR, breath/min) of weanling calves kept in asbestos (A) and concrete (C) roofed stables at 08:00 h and 14:00 h during winter and summer

Item	Times (h)	Winter A	Winter C	Summer A	Summer C
RT	08:00	$38.7^{e}\pm0.1$	$38.9^{de}\pm0.1$	$39.1^{bcd}\pm0.1$	$39.2^{bcd}\pm0.1$
	14:00	$39.2^{bcd}\pm0.1$	$39.3^{bc}\pm0.1$	$39.7^{a}\pm0.1$	$39.7^{a}\pm0.1$
WST	08:00	$33.4^{d}\pm0.1$	$33.7^{d}\pm0.1$	$35.3^{b}\pm0.1$	$35.4^{b}\pm0.1$
	14:00	$34.7^{c}\pm0.2$	$34.6^{c}\pm0.1$	$36.6^{a}\pm0.1$	$36.6^{a}\pm0.1$
BST	08:00	$34.2^{f}\pm0.1$	$34.3^{f}\pm0.1$	$35.6^{bc}\pm0.1$	$35.6^{bc}\pm0.1$
	14:00	$35.2^{cd}\pm0.1$	$35.1^{de}\pm0.1$	$36.9^{a}\pm0.1$	$36.9^{a}\pm0.1$
WHT	08:00	$31.3^{d}\pm0.1$	$31.3^{d}\pm0.1$	$33.1^{b}\pm0.1$	$33.3^{b}\pm0.1$
	14:00	$32.1^{c}\pm0.1$	$32.2^{c}\pm0.1$	$35.1^{a}\pm0.1$	$35.0^{a}\pm0.1$
BHT	08:00	$31.3^{e}\pm0.1$	$31.5^{e}\pm0.1$	$33.3^{b}\pm0.1$	$33.7^{b}\pm0.1$
	14:00	$32.2^{cd}\pm0.1$	$32.5^{c}\pm0.1$	$35.4^{a}\pm0.1$	$35.1^{a}\pm0.1$
RR	08:00	$27.2^{i}\pm0.6$	$28.7^{hi}\pm0.8$	$60.9^{d}\pm2.3$	$67.4^{c}\pm2.1$
	14:00	$36.1^{gh}\pm0.6$	$42.3^{f}\pm1.4$	$80.8^{b}\pm2.5$	$90.0^{a}\pm2.3$

Mean values with the same superscript letter are not significantly different.

There were highly significant ($P < 0.01$) diurnal and seasonal differences in white and black skin regions (WST and BST) and hair (WHT and BHT) temperatures. The lowest values were obtained at the lowest temperature, morning and winter measurements versus afternoon and summer values. These results are in agreement with those of Shafie and El-Sheikh Aly (1970), Amakiri and Funsho (1979), Chikamune (1986) and Thiagarajan and Thomas (1992). In both stables, BST and BHT were significantly higher ($P<0.01$) than

WST and WHT, respectively. Meanwhile, there were no significant diurnal variations between the values in the two stables. The seasonal changes in temperatures of WHT and BHT was higher under asbestos roof at 14:00 h, while it was higher under concrete roof at 08:00 h, anyhow the differences were not statistically significant (Table 3).

Temperature gradient between RT to AT decreased linearly with the increase in AT from winter to summer (Table 4). This result is in agreement with Zenhom and Daghash (1994). The gradients RT to ST and HT to AT decreased gradually, they were greater in calves kept in (A) stable. However, the gradient between ST to HT temperature was greater in (C) stable. There was an evident difference between asbestos and concrete roofs, where in the morning (06:00 h), during winter and summer, the asbestos roof was cooler than the concrete roof. On the other hand, at noon and afternoon (12.00 h + 15.00 h/2) the asbestos roof was hotter than the other one, this result is due to the thermal capacity which is great in concrete roof than asbestos roof. Hahn (1985) reported that with sufficient thermal capacity, the inside temperature will not only be moderated and relatively constant, but will reach its minimum during midday.

Table 4. Temperature gradients (°C) of weanling calves at 08:00h and 14:00h in asbestos (A) and concrete (C) roofed stables during winter and summer

Item	Times	Winter		Summer	
	(h)	A	C	A	C
RT-ST	08:00	5.1	4.8	3.8	3.6
	14:00	4.4	4.4	3.0	3.0
ST-HT	08:00	2.5	2.7	2.3	2.0
	14:00	2.8	2.5	1.5	1.7
HT-AT	08:00	18.4	17.8	8.2	7.4
	14:00	12.6	11.7	0.4	0.4
RT-AT	08:00	26.0	25.2	14.2	13.0
	14:00	19.7	18.5	4.8	4.8
HT-roof T	08:00	26.3	24.4	16.2	12.5
	14:00	11.2	15.4	0.8	8.6
HT-wall T	08:00	24.8	21.8	11.9	9.7
	14:00	18.8	20.1	6.2	11.4

4- Respiratory response

In the two stables, there were significant diurnal and seasonal variations in respiration rate (RR) as shown in Table (3). This was due to the increased heat load on the calves collectively from the hot housing elements and internal hot air in summer than in winter. These results are in good accordance with those of Shafie and El-Sheikh Aly (1970) and Kobiesy (1983). Also, there were highly significant differences between RR of calves under asbestos and concrete roofs in both day times and seasons, except only at winter morning when the difference was not significant. The difference between summer and winter values of RR at 08:00 h was greater under concrete roof than that under asbestos roof being 38.7 vs. 33.7 breath/min. At 14:00 h, the corresponding values were 47.9 vs. 44.7 breath / min. This indicates that the thermal stress within the (C) stable was more sever than in the (A) stable as evidenced by the extremely increased RR in the first stable particularly in summer. In case of winter season, especially at 08:00 h, the IAT is in the range of the thermo-neutral zone imposing no heat stress on the animals. However, the RR in the present study was faster than that recorded by El-Barody (1987) and Thiagarajan and Thomas (1992). This suggests that additional thermal stress by radiation from the building elements (walls and roofs) is imposed on the animals. The RR was the most sensitive physiological response to heat load.

The correlation coefficients of all physiological responses (RR, RT, WST, BST, WHT and BHT) were positive and significant with AT (P>0.01) and negative and significant with RH (P>0.01). Also, there were positive and highly significant (P> 0.01) correlation between all the physiological responses with each other (Table 5).

5. Hematological responses

5.1. Hemoglobin and hematocrit values

Higher hemoglobin content (Hb) and hematocrit values (Ht) were observed during winter than summer (Table 6). This result is in agreement with Kotby *et al.* (1987), Ashour (1993) and Ashour and Shafie (1993). There were no significant differences in these traits between the two housing types, either diurnally or seasonally.

5. 2. Leukocyte percentages:

Observable changes occurred in the percentages of leukocyte types in response to AT under the two types of housing (Table 6). Lymphocytes (LYM) percentage was higher in winter, while neutrophils (NEU), eosinophils (EOS) and monocytes (MON) percentages were higher in summer. This negative relationship between LYM and NEU percentages is in agreement with Greatorex (1957) and El-Banna (1990). Few basophils were observed in both stables. Greatorex (1954) reported zero percentage for basophils in calves from birth to one year old. Asbestos roofed stable had higher percentages of LYM and MON at all cases, except only at winter morning. On the other hand, concrete roofed stable had always higher percentage of NEU and EOS at all cases, although, the differences between the two housing types were not significant.

Table 5. Correlation coefficients of climatic conditions with physiological performance of weanling Friesian calves kept in asbestos and concrete roofed stables

Stables	Items	AT	RH	RR	RT	WST	BST	WHT
	RH	-0.50**						
	RR	0.86**	-0.34**					
Asbestos	RT	0.66**	-0.47**	0.74**				
(A)	WST	0.88**	-0.49**	0.74**	0.60**			
	BST	0.87**	-0.52**	0.73**	0.60**	0.97**		
	WHT	0.91**	-0.47**	0.79**	0.64**	0.86**	0.87**	
	BHT	0.92**	-0.47**	0.79**	0.63**	0.86**	0.87**	0.98**
	RH	-0.41**						
	RR	0.89**	-0.28**					
Concrete	RT	0.39**	-0.28**	0.39**				
(C)	WST	0.92**	-0.36**	0.82**	0.34**			
	BST	0.89**	-0.41**	0.79**	0.34**	0.96**		
	WHT	0.88**	-0.35**	0.75**	0.34**	0.89**	0.90**	
	BHT	0.85**	-0.31**	0.73**	0.32**	0.88**	0.87**	0.93**

** P < 0.01

Table 6. Means ±SE of hemoglobinn (Hb) concentration, hematocrit (Ht) value and leukocyte types in calves kept in asbestos (A) and concrete (C) roofed stables

Item	Times	Winter		Summer	
	(h)	A	C	A	C
Hb (g/100 dl)	08:00	$12.4^{a}\pm0.3$	$12.9^{a}\pm0.3$	$10.1^{b}\pm0.3$	$10.4^{b}\pm0.7$
	14:00	$11.9^{a}\pm0.3$	$12.7^{a}\pm0.2$	$10.0^{b}\pm0.5$	$10.3^{b}\pm0.3$
Ht (%)	08:00	$31.8^{bc}\pm0.6$	$35.9^{a}\pm0.7$	$27.3^{d}\pm0.8$	$29.7^{c}\pm0.6$
	14:00	$30.1^{c}\pm0.6$	$33.6^{ab}\pm0.7$	$26.0^{d}\pm0.7$	$26.9^{d}\pm0.5$
LYM%	08:00	$74.9^{ab}\pm2.1$	$73.3^{ab}\pm2.5$	$61.4^{ef}\pm1.5$	$58.7^{f}\pm1.5$
	14:00	$75.5^{a}\pm1.6$	$74.1^{ab}\pm2.1$	$64.1^{de}\pm1.1$	$60.2^{ef}\pm1.7$
NEU%	08:00	$20.6^{f}\pm2.0$	$22.0^{ef}\pm2.5$	$30.7^{abc}\pm1.3$.	$32.9^{a}\pm1.4$
	14:00	$19.4^{f}\pm1.3$	$21.0^{f}\pm2.0$	$28.3^{bcd}\pm0.9$	$32.6^{ab}\pm1.6$
EOS%	08:00	$2.1^{ef}\pm0.3$	$2.3^{ef}\pm0.4$	$3.9^{abc}\pm0.4$	$4.9^{a}\pm0.4$
	14:00	$1.5^{f}\pm0.3$	$2.4^{ef}\pm0.3$.	$3.7^{bcd}\pm0.4$	$3.9^{abc}\pm0.4$
BAS%	08:00	$0.3^{a}\pm0.1$	$0.1^{ab}\pm0.1$	$0.0^{b}\pm0.0$	$0.1^{ab}\pm0.1$
	14:00	$0.1^{ab}\pm0.1$	$0.2^{ab}\pm0.1$	$0.0^{b}\pm0.0$	$0.0^{b}\pm0.0$
MON%	08:00	$2.1^{f}\pm0.2$	$2.3^{ef}\pm0.3$	$4.2^{b}\pm0.3$	$3.6^{abcd}\pm0.3$
	14:00	$3.1^{bcd}e\pm0.3$	$2.5^{def}\pm0.2$	$3.8^{abc}\pm0.4$	$3.4^{abcd}\pm0.4$

Mean values with the same superscript letter are not significantly different.

6. Thyroid hormones concentration

Considerable seasonal and diurnal differences were observed in both T_4 and T_3 levels. Concentration of T_4 was higher in summer than that in winter and at 14:00 h than at 08:00 h (Table 7). This result is in agreement with those of Collier *et al.* (1982) and Mohamed (1984) who found that T_4

concentration increased under heat stress. Youssef (1990) found in Friesian calves that T_4 level was 9.3 and 7.1 μg/dl in winter and summer, respectively. The seasonal difference in T_4 level was higher in the (A) than in (C) stables at 08:00 h, 1.5 μg/dl vs. 1.2 μg/dl, meanwhile, the opposite trend was observed at 14:00 h, 1.5 vs. 1.3 μg/dl, respectively, however the differences were not statistically significant.

Table 7. Means ±SE of thyroxin (T_4), triiodothyronine (T_3) and T_4/T_3 ratio in calves kept in asbestos (A) and concrete (C) roofed stables

Item	Times (h)	Winter A	Winter C	Summer A	Summer C
T_4 (μ/dl)	08:00	4.2^{cd}±0.4	4.1^{cd}±0.4	5.7^{ab}±0.4	5.3^{abc}±0.3
	14:00	4.7^{bcd}±0.4	4.3^{cd}±0.3	6.0^{a}±0.5	5.8^{ab} ±0.3
T_3 (ng/dl)	08:00	116.5^{a}±9.8	101.0^{a}±13.1	94.4^{a}±10.5	122.2^{a}±7.8
	14:00	122.5^{a}±17.0	130.9^{a}±11.0	95.8^{a}±11.6	122.5^{a}±11.0
T_4/T_3 ratio	08:00	36.1	40.6	60.4	43.4
	14:00	38.4	32.8	62.6	47.3

Mean values with the same superscript letter are not significantly different.

Regarding T_3 concentration, in the two stables there were considerable higher values in winter than in summer, except at winter morning in the (C) stable. This seasonal trend was opposite to that of T_4, but both hormones showed the same diurnal trend being higher at 14:00 h. This result is in agreement with Ahmed (1990) who found in Friesian cattle that T_3 levels were 106.9 and 68.7 ng/dl in winter and summer, respectively. At all cases the calves in (A) stable had higher values of T_4, while those in (C) stable had higher values of T_3 except only at winter morning.

Thyroid index (T_4/ T_3 ratio) was higher in summer than in winter, due to the greater level of T_4 (Table 7). This seems to be due to the reduced conversion of T_4 to T_3, the most active hormone, in summer to check the metabolic rate, thus less production of metabolic heat. T_3 is some 3-5 times more active than T_4 (Paxton, 1986). About 90% of thyroid hormone is T_4, about 30% of daily T_4 production is diverted to produce 80% of the daily T_3 hormone (Reece, 1991). The present thyroid index is greater than that obtained by Ashour *et al.* (1998) in cattle (24.1) who suggested that this lower ratio was due to faster conversion of T_4 to T_3 to meet metabolic needs of meat production.

GENERAL DISCUSSION AND CONCLUSION

Summing up the points of comparison between the two housing types, for the weanling calves, under study, the physical properties of the building materials and design of the building and their effect on the physiological response of the calves could be discussed in accordance with the obtained data from this study.

It is clear in Table (1) that the concrete roofing induced greater rise in IAT over the OAT than that in case of asbestos roof. However, the difference in the internal temperature among the two types was slight.

It is evident in Table (2) that the (A) stable had, clearly, greater differences between the temperatures of the components between the highest level at 12:00 h and 15:00 h and either at 06:00 h or 22:00 h in comparison with a limited diurnal changes in their values in the (C) stable. This housing type difference in the extent of rhythmical diurnal temperature was reflected on the floor and indoors air temperatures. It could be suggested that the colder walls and roof at night (22:00 h) and early morning (06:00 h) in the (A) stable act as heat sinks, comparable to the experimentally studied sinks by Esmay (1976). On the contrary the slight fluctuations in the (C) stable seems to be less effective as heat sinks. Such heat sinks facilitate heat dissipation periodically, at night, through radiative heat transportation from the animal body, thus relieving the animal from the excess of stored body heat during the midday time. This concept of heat sinks needs to be elucidated by further experimentation and consideration of the thermal properties (capacity, transference, emissivity etc.) of the building materials for walls and roof. The ventilation means of the stables has to be considered in relation with connective heat loss from the animals.

Considering the reflection of these physical conditions in the two stables, it was evident that the animals had better comfort condition in the (A) stable (the type of roof was the only difference between the stables). Therefore, the animals in this stable showed lower body temperature (Table 3) although slight. The RR was significantly higher in the (C) stable (Table 3) which is a sign of distress. This rise of RR is a mean of achieving more heat dissipation through excess water vaporization in case of low radiative heat dissipation. The excess of RR coincidentally increases water loss which affects the water compartments in the body with probable reduction in blood plasma volume. This response seems to has occurred in this study as evidenced by the observed greater hematocrit value and hemoglobin concentration in animals kept in the (C) stable (Table 6).

The economic perception (cost and benefit) of the two types is not included in this study. Anyhow it is expected that the concrete roof is expensive than the asbestos one, however, with long duration. The economic feasibility has to be considered, but in condition that the technical feasibility is to the optimum level.

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الإستجابة الفسيولوجية لعجول الفريزيان المفطومة تحت اشكال نظم الايواء المختلفة

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استخدم ٢٢ من العجول الفريزيان المفطومة لدراسة إستجابتها الفسيولوجية في نوعين مختلفين من نماذج الإيواء هما نموذج ذو سقف خرساني (نصف مفتوح) ونموذج ذو سقف أسبستوس (نصف مغلق) وإشتملت الدراسة على إثنتين من التجارب الموسمية ، شهرين لكل منهما. تراوحت أعمار العجول من ٢٢ إلى ٢٦ أسبوع وتراوح الوزن من ١٢٥ إلى ١٥٣ كجم. وقد تم تسجيل عدة مقاييس هى الظروف الجوية داخل وخارج النماذج والخصائص الطبيعية الحرارية لمكونات المباني(الحوائط ، السقف) مع كل من الإستجابة الفسيولوجية الحرارية والتنفسية للحيوانات وإستجابة بعض مكونات الدم وأنواع كريات الدم البيضاء وكذلك نشاط الغدة الدرقية .

أدى النموذج ذو السقف الخرساني إلى زيادة الإجهاد الحرارى حيث أدى إلى زيادة كبيرة فى درجة الحرارة داخل هذا المسكن عن تلك الموجودة داخل النموذج ذو السقف الأسبستوس وأعلى من درجة الحرارة خارج المباني . وكانت التغيرات اليومية فى درجات الحرارة محدودة فى النموذج ذو السقف الخرساني مقارنة بالتغيرات الواسعة فى النموذج ذو السقف الأسبستوس. وهذه الملاحظة أدت الى إقتراح أن الحوائط والأسقف الباردة أثناء الليل وفى الصباح الباكر فى النموذج ذو السقف الأسبستوس تعمل كماصات للحرارة . وأظهرت الحيوانات داخل النموذج ذو السقف الخرساني قيم عالية فى كل من درجة حرارة المستقيم - مع انها طفيفة- ومعدلات التنفس ومحتوى الهيموجلوبين وقيم الهيماتوكريت ونسب كل من كريات الدم المتعادلة والحامضية ومستوى تركيز هرمون التراى ايودوثيرونين. بينما أظهرت هذه الحيوانات قيم منخفضة فى كل من نسب كريات الدم الليمفاوية والأحادية ومستوى هرمون الثيروكسين ونسبة الثيروكسين إلى التراىأيودوثيرونين عن تلك القيم داخل النموذج ذو السقف الأسبستوس. وبالرغم من أن الإختلافات بين كلا النموذجين- فى معظم القياسات- كانت إحصائياً غير معنوية. وكانت معاملات الإرتباط بين كل من الإستجابات الفسيولوجية وبعضها البعض معنوية جداً وكذلك تمت مناقشة العلاقة بين هذه الإستجابة الفسيولوجية للعجول مع الظروف المناخية.

وأوضحت هذه الدراسة أن فكرة ماصات الحرارة تحتاج الى زيادة إيضاح وتأكيد بواسطة العديد من التجارب مع الأخذ فى الإعتبار الخصائص الحرارية للمبانى . ويجب أن تؤخذ فى الإعتبار أيضاً الجدوى الإقتصادية مع التأكد من المستوى المناسب للنواحى التكنولوجية.