Egyptian J. Anim. Prod. (1997) 34 (2): 89-101.

BODY WEIGHT GAIN AND SOME PHYSIOLOGICAL CHANGES IN FRIESIAN CALVES PROTECTED WITH WOOD OR REINFORCED CONCRETE SHEDS DURING HOT SUMMER SEASON OF EGYPT

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SUMMARY

Effect of direct solar radiation of hot summer season as compared to cool winter and to hot summer without solar radiation using roofed wood or reinforced concrete sheds was studied on 32 growing Friesian calves, aged six months. Animals exposed to summer solar radiation showed significant decrease in their daily gain, roughage feed intake and plasma concentrations of T_3 hormone, glucose, total protein and total lipids, but a significant increase in rectal temperature, respiration rate and plasma concentrations of cortisol hormone as compared to those exposed to solar radiation in winter season.

The use of wood roofed shed during summer season alleviated the heat load exerted on animals since the daily gain, royghage feed intake and blood T_3 content increased significantly whereas the the rectal temperature, compared with those under solar radiation.

Keeping the calves in reinforced concrete roofed shed did not alleviate the heat load on the animals as much as the case with wood roofed shed, since plasma T_3 level, daily gain and feed intake were significantly higher under such type of shading than under direct solar radiation, yet they were significantly lower than under wood shed.

It can be concluded that wood roofing is more comfortable than cement roofing for for rearing the Friesian calves under heat with solar radiation climate.

Keywords: Friesian calves, heat stress, hormones, shading types

INTRODUCTION

In Egypt, the sub-tropical arid climate is characterized by a long hot summer season (April to October) and a short mild winter (December to March). In such hot climate, the farm animals suffer from the direct and indirect solar radiation, especially, if unsheltered in the newly reclaimed desert lands. These conditions induce physiological and biochemical changes which impair the animal productivity, about 50% (Habeeb *et al.*, 1992). Protection of the animals from the direct solar radiation of the hot season by providing shade in order to modify the microclimatic conditions may help the animals to express their genetic potential under such conditions (Misra *et al.*, 1963; Ames and Ray, 1983; Bennet *et al.*, 1985 and Tony *et al.*, 1987).

Construction materials utilized for artificial shading of animals may determine to what extent the animals could be protected from environmental heat (Roman-Ponce *et al.*, 1977 and Abdel-Aziz *et al.*, 1979). In this regards, asbestos roofed shed was found to have a harmful effect on animals during hot summer (Kotby *et al.*, 1987 and Tharwat *et al.*, 1991).

In the present study, two types of shed roofs were used to study the shading efficiency for protection of growing Friesian calves from the heat stress condition of the hot season in Egypt.

MATERIALS AND METHODS

This study was carried out at Gemmiza Experimental Station, Gharbia Province, Animal Research Institute, Ministry of Agriculture, Egypt. The animals were 32 healthy Friesian male calves, 6 months of age and 130 Kg average body weight. Blood biochemical analysis and hormonal assay were conducted in the Tracer Bioclimatology Unit, Biological Applications Department, Atomic Energy Authority, Cairo, Egypt.

1. Experimental Design

The experiment included two seasonal studies. The first was carried out in winter season (January and February, 1994) on 8 calves with average body weight of 131.3±2.4 Kg. The second study was conducted during summer on another 24 calves divided randomly into 3 equal groups, each of 8 calves. The first group was raised for two months (June and July, 1994) in yards under natural solar radiation without protection. The second group was raised under wood roofed shed while the third group was kept under reinforced concrete roofed shed. The average body weight for these experimental groups were 128.3±2.1, 131.4±2.5 and 128.4±2.3 Kg, respectively. The dimension of either wood or reinforced concrete roofed sheds were 10 x 5 x 2.5 m for length x width x highth, respectively. The two types of sheds were in the middle of the yard.

2. Management and nutritional practice

Animals during both winter and summer studies were left loose and housed outdoors day and night in separate open yards (15x10m) with soil ground, surrounded with wall building (1.5 m high) made of bricks and cement. The calves were group fed on a ration of rice straw offered *ad libitum* and a concentrate mixture (Belkas factory, Dakahlya) provided once daily at morning (2.5 Kg) according to live body weight and gain (NRC, 1981). The components of the concentrate mixture as g/Kg ration are 360 undecorticated cotton seed cake, 200 yellow maize, 340 wheat bran, 40 rice bran, 30 molasses, 20 limestone and 10 raw sea salt. The chemical composition was determined by the Association of Official Analytical Chemist (1980) as g per 100 g dry matter being 17.14, 11.52, 4.31, 53.94 and 13.09 for crude protein, crude fiber, ether extract, nitrogen-free extract and ash, respectively The offered rice straw was weighed and any refusals were weighed at the morning of the second day, once each week. Drinking water was available to the animals all the time.

3. Micro-climatic conditions

The averages of ambient temperature and relative humidity were recorded at hourly intervals between 10:00 and 17:00 h daily during winter and summer natural conditions of the farm and under the two types of shed during summer. The averages are shown in Table 1. The microclimatic data were obtained by using digital Thermohygrometer hanged 1/2 m from the roof of the shed.

Table 1. Averages of ambient temperature and relative humidity during winter and summer natural conditions of the farm under the two types of shed during the experimental periods

Experimantal period (day)	Winter climate	Summer climate		
		Without shading	With shading	
			Wood	Reinforced concrete
		Ambient temperature (C°)		
From 1-7	14.8 ±0.9	36.6 ±0.5	32.5 ±0.6	34.8 ±0.7
8-30	15.3 ±0.7	36.9 ±0.8	32.6 ±0.9	34.9 ±0.9
31-60	15.2 ±0.8	37.1 ±1.0	31.0 ±0.5	33.6 ±0.8
1-60	15.1d±0.5	36.9a±0.5	32.0c±0.4	34.4b±0.6
		Relative humidity (%)		
From 1-7	64.5 ±2.5	48.8 ±2.1	47.5 ±2.5	47.9 ±2.2
8-30	65.0 ±2.8	47.3 ±2.9	45.9 ±2.8	46.5 ±2.9
31-60	65.0 ±2.2	47.8 ±2.5	46.8 ±2.1	45.9 ±2.1
1-60	64.8a±2.0	47.9b±1.8	46.7b±1.8	46.8b±1.8

No significant differences were found due to periods in each column neither in ambient temperature nor in relative humidity.

a,b,c,d: Means with different superscripts in the same row for the same parameter differ significantly ($P<0.05$).

4. Daily gain and physiological parameters

Live body weight was recorded in the morning before access to feed and water at the beginning of each experiment and at weekly intervals thereafter. Rectal temperature and respiration rate were measured daily at 13:00 h. Daily weight gain, daily roughage intake, rectal temperature and respiration rate were recorded at 3 periods; i.e. during the first week (1*st* to 7*th* days), from 8*th* to 30*th* days and 31*st* to 60*th* days, representing the acute, chronic and adaptability responses, respectively.

5. Biochemical analyses

Blood samples were collected in heparinized tubes by jugular vein puncture 3 times on days 7*th*, 30*th* and 60*th* after the beginning of each study. The collected samples were kept in ice box and the plasma was carefully separated by centrifugation (2500 x g) for 30 minutes and stored at -20°C. Plasma total protein, total lipids and glucose were determined using the biuret, sulfophosphovaneline and orthotoluidine methods, respectively. Plasma triiodothyronine (T_3) and cortisol were estimated by radioimmunoassay technique using solid-phase coated tubes and the

6. Statistical analysis

Data were statistically analyzed using the General Linear Models Procedure of the SAS (1991). The first model was used to study the effect of direct solar radiation of hot summer season as compared to winter season as follows:

$$Y_{ijk} = \mu + S_i + P_j + (SP)_{ij} + e_{ijk} \qquad \text{(Model 1)}$$

where, Y_{ijk} = an observation, μ= overall means, S_i= season effect (i=1,2), P_j= period effect (j=1,2,3), $(SP)_{ij}$= season x period interaction effect and e_{ijk}= random error.
The second model was used to study the effect of heat stress alleviation techniques using two types of sheds as compared to solar radiation without shading as follows:

$$Y_{ijk} = \mu + T_i + P_j + (TP)_{ij} + e_{ijk} \qquad \text{(Model 2)}$$

where, Y_{ijk} = an observation, μ= overall means, T_i= treatment effect (i=1,2), P_j= period effect (j=1,2,3), $(SP)_{ij}$= treatment x period interaction effect and e_{ijk}= random error.

Differences were subjected to Duncans's Multiple Range-Test (1955).

RESULTS AND DISCUSSION

1. Effect of direct solar radiation of hot summer season

Means of rectal temperature, respiration rate and concentration of cortisol hormone in Friesian calves exposed to direct solar radiation of the hot summer (summer group 1) were significantly ($P<0.01$) higher than those of calves exposed to winter season conditions (Tables 2&3). On the other hand, daily live body weight gain, daily roughage intake and plasma concentrations of triiodothyronine (T_3), total protein, total lipids and glucose concentrations were lower ($P<0.01$) in calves exposed to direct solar radiation compared to those in calves during winter seasons (Tables 2&3).

The overall mean of the two season showed that daily live body weight gain, respiration rate and concentrations of T_3 , conrtisol, total protein and glucose were significantly ($P<0.01$) affected by the experimental periods. The decreases due to summer solar radiation exposure in daily gain, total protein and glucose were more pronounced during the first week of the dummer exposure and than became nearly constant during the following experimental periods. Consequently there were significant interactions between seasons and periods. No significant difference due to periods were found in rectal temperature, daily roughage intake and plasma total lipids. It is interesting to observe that the lowest total lipids concentration was observed during the first period of exposure to summer solar radiation while their highest concentration was observed during the first period of winter season. Therefore, total lipids expressed a significant ($P<0.01$) interaction between seasons and periods. T_3 concentration progressively increased with the advancing in exposure period either in winter or in summer climatic conditions. Both, T_3 and cortisol hormones showed also a significant ($P<0.01$) interaction between season and periods of the experiment.

Table 2. Rectal temperature, respiration rate, daily body gain and roughage feed intake, T_3, cortisol and some blood constituents in Frisian calves under winter and summer natural conditions during the experimental periods

Experimental period (days)	Winter	Summer	Overall means for periods
	Rectal temperature (°C)		
from 1-7	38.4 ±0.11	39.8 ±0.29	39.1 ±0.23
8-30	38.3 ±0.12	39.5 ±0.25	38.9 ±0.23
31-60	38.2 ±0.18	39.2 ±0.24	38.7 ±0.20
1-60	38.3±0.08 [b]	39.5 ±0.15 [a]	
	Respiration rate (rpm)		
from 1-7	43 ±1.7	85 ±1.8	64 ±5.5 [A]
8-30	39 ±0.9	75 ±1.8	57 ±4.7 [B]
31-60	40 ±1.1	78 ±1.5	59 ±5.0 [B]
1-60	41 ±0.8 [b]	79 ±1.3 [a]	
	Daily body gain (g)		
from 1-7	857 ±15	571 ±11	714 ±11 [B]
8-30	896 ±10	609 ±10	753 ±10 [A]
31-60	910 ±11	600 ±10	755 ±10 [A]
1-60	888 ±19 [a]	593 ±12 [b]	
	Daily roughage intake (Kg/8 calves)		
from 1-7	10.9 ±0.0	5.6 ±0.0	8.3 ±0.0
8-30	10.9 ±0.12	5.6 ±0.3	8.3 ±0.7
31-60	11.0 ±0.12	5.6 ±0.3	8.3 ±0.7
1-60	11.0 ±0.06 [a]	5.6 ±0.2 [b]	
	T_3 hormone (ng/dl)		
At the 7*th* day	129 ±0.9	100 ±1.4	115 ±3.8 [C]
At the 30*th* day	150 ±1.3	125 ±1.3	138 ±3.4 [B]
At the 60*th* day	175 ±1.2	155 ±1.3	165 ±2.7 [A]
Overall mean	151 ±4.0 [a]	126 ±4.7 [b]	
	Cortisol hormone (ng/ml)		
At the 7*th* day	10 ±0.7	25 ±0.8	17 ±2.0 [B]
At the 30*th* day	11 ±0.4	40 ±1.3	25 ±3.8 [A]
At the 60*th* day	13 ±0.7	23 ±0.8	18 ±1.4 [B]
Overall mean	11 ±0.4 [b]	29 ±1.6 [a]	
	Total Protein (g/dl)		
At the 7*th* day	8.6 ±0.11	6.2 ±0.13	7.4 ±0.32 [B]
At the 30*th* day	8.7 ±0.06	7.3 ±0.14	8.0 ±0.19 [A]
At the 60*th* day	8.3 ±0.11	7.6 ±0.11	8.0 ±0.12 [A]
Overall mean	8.5 ±0.06 [a]	7.0 ±0.15 [b]	
	Total lipids (mg/dl)		
At the 7*th* day	400 ±7	310 ±7	350 ±11
At the 30*th* day	380 ±4	350 ±8	360 ±6
At the 60*th* day	390 ±4	350 ±7	370 ±6
Overall mean	390 ±3 [a]	340 ±5 [a]	
	Glucose (mg/dl)		
At the 7*th* day	86 ±1	62 ±1	74 ±3 [B]
At the 30*th* day	88 ±1	67 ±1	78 ±3 [A]
At the 60*th* day	86 ±1	68 ±1	77 ±2 [A]
Overall mean	87 ±1 [a]	66 ±1 [b]	

a,b,c: Means with the same letter in the same row for the same parameter are not significantly ($P<0.05$) different due to season.

A,B,C: Means with the same letter in the same column for the same parameter are not significantly ($P<0.05$) different due to periods.

During summer season of Egypt, the Friesian cattle suffer from the direct and indirect solar radiation which amounted about 4200 Kcal/h/m^2 of the animal body surface (Habeeb *et al.*, 1995). This heat load caused remarkable reduction in both feed intake and T_3 secretion which resulted in low protein biosynthesis and consequently decreased the daily gain and blood total protein, lipids and glucose. In addition, the increases in respiratory frequency consumed more energy and consequently the residual net energy for growth decreased resulting in the observed reduction in daily gain (Marai *et al.*, 1995). Moreover, the high level of cortisol which was observed in the heat stressed calves may be associated with the depression of daily body gain (Habeeb *et al.*,1992).

2. Effect of shading type

Using the wood for roofing sheds to protect the animals from direct solar radiation of the hot summer season decreased the ambient temperature under the shed by about 5°C as compared to unshaded conditions in the same season (Table 1). Therefore, calves maintained under wood roofed shed during summer (summer group 2) showed a significant (P<0.01) lower rectal temperature, respiration rate and concentration of plasma cortisol as comared to the calves exposed to summer direct solar radiation (summer group 1). At the same time, live body weight gain, roughage feed intake and concentrations of the plasma T_3 total protein, total lipids and glucose increased significantly (P<0.01) due to the respective treatment (Tables 4 and 5).

Using the reinforced concrete for roofing sheds decreased significantly the ambient temperature under the shed but by 2.5°C only as compared to unshaded summer condition. Live body weight gain, roughage feed intake and T_3 hormone level, in calves kept under such reinforced concrete roofed shed (summer group 3), increased significantly (P<0.05) as compared to the calves exposed to direct summer solar radiation (summer group 1). While the rectal temperature, respiration rate and plasma concentrations of; cortisol, total protein, total lipidis and gluocse were not significantly affectted due to such shading system (tables 4and 5)

The data in tables 3 and 4, further , show that the calves protected with wood shed during summer time had greater (P<0.05) weight gain , roughage feed intake and T3, total protein, total lipids and glucose concentration accompanied with lower (P<0.05) values in; rectal temperature, respiration rate and cortisol level than those of calves protected with reinforced concrete shed (summer group 3).

Concerning the effect of treatment periods, it is clear that rectal temperature, respiration rate and roughage feed intake did not significanly differ among the various periods (Table 5). meanwhile, live body weight gain and concentrations of total, protein total lipids, glucose, cortisol and T_3 hormone significantly (P<0.01) differed in this respect. The lowest values of daily gain, T3, total protain, total lipids and glucose, cortisol and T_3 hormone significantly (P<0.01) differed in this respect. the lowest values of daily gain, T_3 total protein, total lipids and glucose

Table 3. Test of significant for different parameters as affected by season, periods and their interaction

Source of variation	d.f	F - value								
		Rectal temperature	Respiration rate	Roughage intake	Daily gain	T_3	Cortisol	Total protein	Total lipids	Glucose
Season (s)	1	57**	991**	79**	684**	553**	662**	262**	81**	735**
Periods (P)	2	2	11**	761	0.04	7864**	52**	31**	2	9**
S x P	2	0.5	2	3.2*	0.04	6**	63**	29**	8**	5**
Error mean square	42	0.36	18	2.4	0.49	12.9	0.5	10	0.04	0.0007

* = P<0.05 and ** = P<0.01

Table 4. Effect of type of shading on adaptive response, daily body gain, feed intake, blood constituents and hormonal balance in Friesian calves

Experimental period (Days)	Without shading (First group)	With wood shading (Second group)	With reinforced concrete shading (Third group)	Overall mean for periods
		Rectal temperature (°C)		
From 1- 7	39.8 ±0.29	38.8 ±0.30	39.9 ±0.20	39.5±0.20
8- 30	39.5 ±0.25	38.5 ±0.30	39.7 ±0.20	39.2±0.20
31- 60	39.2 ±0.24	38.6 ±0.20	39.5 ±0.20	39.1±0.10
1- 60	39.5 ±0.15 [a]	38.6 ±0.10 [b]	39.7 ±0.10 [a]	
		Respiration rate (rpm)		
From 1- 7	85 ±1.80	58 ±2.90	78 ±1.30	74 ±3.10
8- 30	75 ±1.80	67 ±1.50	70 ±1.30	71 ±1.40
31- 60	78 ±1.50	69 ±1.20	73 ±1.20	73 ±1.40
1- 60	80 ±1.30 [a]	65 ±1.50 [b]	74 ±1.00 [b]	
		Daily body gain (g)		
From 1- 7	571 ±11	814 ±13	659 ±19	681 ±14 [B]
8- 30	609 ±10	826 ±10	717 ±10	717 ±10 [A]
31- 60	600 ±10	800 ± 9	733 ±11	711 ±10 [A]
1- 60	593 ±12 [c]	813 ±14 [a]	703 ±28 [b]	
		Daily roughage intake (Kg/8 calves)		
From 1- 7	5.6 ±0.0	8.8 ±0.0	6.5 ±0.0	7.0 ±0.0
8- 30	5.6 ±0.3	8.8 ±0.6	6.5 ±0.6	7.0 ±0.3
31- 60	5.7 ±0.3	8.8 ±0.6	6.5 ±0.6	7.0 ±0.2
1- 60	5.6 ±0.2 [c]	8.8 ±0.3 [a]	6.5 ±0.0 [b]	
		T3 hormone (ng/dl)		
At the *7th* day	100 ±1.4	115 ±0.9	103 ±0.9	106 ±1.5 [C]
At the 30*th* day	125 ±1.3	145 ±1.3	127 ±0.7	132 ±2.0 [B]
At the 60*th* day	155 ±1.3	170 ±1.5	158 ±1.8	161 ±1.6 [A]
Overall mean	126 ±4.7 [c]	143 ±4.8 [a]	129 ±4.8 [b]	
		Cortisol hormone (ng/ml)		
At the 7*th* day	25 ±0.8	25 ±0.9	26 ±1.2	25 ±0.5 [B]
At the 30*th* day	40 ±1.3	36 ±1.6	40 ±1.3	38 ±0.8 [A]
At the 60*th* day	23 ±0.8	10 ±0.7	20 ±0.8	18 ±1.2 [C]
Overall mean	29 ±1.6 [a]	23 ±2.3 [b]	29 ±1.7 [a]	
		Total protein (g/dl)		
At the 7*th* day	6.2 ±0.13	8.1 ±0.14	6.3 ±0.14	6.8 ±0.20 [B]
At the 30*th* day	7.3 ±0.14	8.3 ±0.13	7.1 ±0.13	7.6 ±0.13 [A]
At the 60*th* day	7.6 ±0.11	8.1 ±0.09	7.5 ±0.14	7.8 ±0.08 [A]
Overall mean	7.0 ±0.15 [b]	8.2 ±0.07 [a]	7.0 ±0.13 [b]	
		Total lipids (mg/dl)		
At the 7*th* day	310 ±7	360 ±4	340 ±7	330 ±5 [B]
At the 30*th* day	350 ±8	370 ±4	330 ±7	350 ±4 [A]
At the 60*th* day	350 ±7	370 ±4	340 ±6	350 ±4 [A]
Overall mean	340 ±5 [b]	360 ±3 [a]	340 ±4 [b]	
		Glucose (mg/dl)		
At the 7*th* day	62 ±1	74 ±1	64 ±1	67 ±1 [C]
At the 30*th* day	67 ±1	75 ±1	66 ±1	69 ±1 [B]
At the 60*th* day	68 ±1	84 ±1	68 ±1	73 ±1 [A]
Overall mean	66 ±1 [b]	78 ±1 [a]	66 ±1 [b]	

a,b,c Means with the same letter in the same row for each parameter are not significantly ($P<0.05$) different due to season.

A, B, C Means with the same letter in the same column for each parameter are not significantly ($P<0.05$) different due to Periods.

Table 5. Test of significant for different parameters as affected by type of shading, periods and their interaction

Source of variation	d.f	F - value								
		Rectal temperature	Respiration rate	Roughage intake	Daily gain	T_3	Cortisol	Total protein	Total lipids	Glucose
Temperature (T)	2	16**	106**	16**	27**	147**	25**	82**	15**	142**
Periods (P)	2	2	2.7	690**	0.01	1387**	256**	42**	6**	35**
T x P	4	0.02	2.6	1.6	0.01	2	9.4**	9**	1.8	5**
Error mean square	63	0.5	23	3.6	2.3	13	1.0	13	0.04	0.0008

* = P<0.05 and ** = P<0.01

were at the 7*th* day of the experiment representing the acute effect, while the lowest value of cortisol hormone was noticed at the 60 *th* day of the experiment (adaptability period). The concentration of T_3 and glucose increased progressively (P<0.05) with the advance in the experiment period, as the resopnse change from acute to adaptability. Daily body gain, total protien and total lipid values were quite similar during the chronic (at the 30*th* day) and adaptability (at the 60 *th* day) periods. Cortisol, total protien and glucose expressed a significant (P<0.01) interactions among treatment and the experimental periods.

Using wood roofed shed in the present experiment during summer season to protect calves from direct solar radiation decreased the ambient temperature from 36.9°C (unshaded to 32.0°C (with shaded). This decline in ambient temperature helped in alleviating the heat load on the calves as evident from their ability to maintain normal rectal temperature and respiration rate. Consequently, the feed intake and T_3 level increased and the level of cortisol decreased which led to the improvement of the daily gain under such shading system with wood as compared to unshaded calves under summer conditions. Keeping the calves under reinforced concrete roofed shed also decreased the ambient temperature by 2.5°C which did not completely alleviate the heat load on the animals since they had lower T_3 level and higher rectal temperature and respiration rate compared to calves shaded with wood.

The forgoing results lead to a general conclusion that Friesian calves at Gharbia Province develop hyperthermia during summer season, which may be ameliorated by shading. In this respect, wood roofing was more efficient than reinforced concrete roofing. Moreover, most of the physiological response of the animals occurred during the acute period, i.e. in the 1*st* week from the beginning of the animal treatment. After the first month, the adaptability response in those physiological changes may be reached. On the other hand, the hormonal response seemed to need more than one month for the adaptability to the new conditions as indicated from the lower T_3 and higher cortisol hormone obtained at the 30*th* day than that at the 60*th* day.

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تــأثير إســتعمال مظــلات خشــب أو خرســانة مســلحة علــى النمــو وبعــض التغــيرات الفسيولوجية للعجول الفريزيان تحت ظروف الجو الحار فى فصل الصيف

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تمت هذه التجربة على ٣٢ عجـل فريزيـان عمـر ٦ شـهور فـي محطـة بحـوث الإنتـاج الحيوانـى بالجميزة – غربية لدراسة تأثير أشعة الشمس المباشرة لفصل الصيف مُقارنـاً بفصـل الشـتاء المعتـدل وكذلك تأثير إستعمال مظلات من الخشب أو الخرسانة المسلحة للوقاية من هذه الإشـعة صيفا علـى النمو وبعض التغيرات الفسيولوجية والهرمونية .

شمل البحـث دراسـتين الأولـى كـانت فـي فصـل الشـتاء (١٥,١ م°) لعـام ١٩٩٤ (شـهرى ينـاير وفبراير) على ٨ عجول بينما كانت الثانية في فصل الصيف (٣٦,٩ م°) لعام ١٩٩٤ (شـهرى يونيـة ويوليو) على ٢٤ عجل مقسمة إلى ثلاث مجموعات متساوية الأولى كانت الحيوانات مُعرضــة لأشـعة الشمس المباشرة بـدون مظـلات والثانيـة وضعت الحيوانـات تحـت مظلـة مـن الخشـب بينمـا الثالثـة وضعت الحيوانات تحت مظلة من الخرسانة المسلحة .

وقد أظهرت النتائج أن تعرُض العجول لأشعة الشمس المباشرة صيفاً يقلل تركيز هرمـون التراى أيودو ثيرونين والجلكوز والبروتين الكلى والدهوّن الكلية في بلازما الدم وفى نفس الوقت يرفع تركيز الكورتيزول في بلازما الدم بالإضافة إلى إنخفاض كمية الأكل المتناولة من العليقة الخشنة وينتج عن ذلك نقص في العائد اليومى من النمو عند المقارنة بالحيوانات في فصل الشتاء.

إستعمال مظلات من الخشب تسبب في خفض درجـة حـرارة الجـو تحـت المظلـة حوالـى (٥م°) وأدى ذلك إلى زيادة معنوية في تركيز هرمـون التراى أيودوثيرونين إنخفـاض معنـوى فـي هرمـون الكورتيزول في بلازما الدم وتحسن في معدل تناول الأغذية الخشنة ونتج عن ذلك تحسن فـي الزيـادة اليومية في الوزن وإنخفاض معنوى لدرجة حرارة الجسم ومعدل التنفس بالمقارنة بدون إستعمال المظلات .

أما إستعمال مظلات من الخرسانة المسلحة لم يخفض تماماً كل العبء الحراري لأشعة الشمس المباشرة حيث أن تركيز هرمون الثراي أيودوثيرنين في بلازما الدم ظل منخفضاً وأن مُعدل التنفس ظل عالياً عند المُقارنة بدون إستعمال المظلات بالرغم من تحسن نوعاً ما في الزيادة النوعية في الوزن ومعدل تناول العليقة الخشنة .

وعلى ذلك نستنتج أن إستعمال مظلات خشبية أفضل من الخرسانة المسلحة لحماية الحيوانات النامية خلال شهور الصيف من أشعة الشمس المباشرة.