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SOME ASPECTS OF THERMO-REGULATION IN WATER DEPRIVED CAMELS UNDER THE SEMI-ARID CONDITIONS OF THE NORTH-WESTERN COASTAL DESERT IN EGYPT

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ABSTRACT

This study was conducted at Maryout Experimental Station near Alexandria, 32° latitude affiliated to the Desert Research Center in Cairo. In this study, the effect of heat stress resulting from the combined effect of water deprivation, the housing environment and season of the year on the changes of rectal (RT) and skin temperature (ST) and their amplitude (differences between morning and afternoon values), as well as gradients between core and surface temperatures and the ambient temperature were investigated in eight non-pregnant and non lactating female dromedary camels fed at the maintenance level. Half the animals were watered daily whereas the other half was intermittently watered, once every 7 days. Moreover, half the animals were kept outdoors and not sheltered whereas the other half was housed indoors. The experimental treatments were repeated three times between April and August to represent spring, early summer and late summer seasons. Climatic (ambient temperature (Ta), relative humidity (RH%) and temperature humidity index (THI) and animal data (RT and ST) were recorded twice daily at 7:00 am and 2:00 pm for seven consecutive days representing a complete water deprivation cycle.

It was evident that the housing environment in the morning was a significant source of variation affecting both RT and ST and their amplitude, as well as core, skin and ambient temperature gradients. Water deprivation also represented another significant source of variation that affected (RT), both in the morning and in the afternoon. However, (ST) was significantly affected by season only in the morning. All the above parameters were significantly affected by days of the water deprivation cycle.

It was noticeable that the RT of the water deprived camels kept outdoors was consistently lower than their control mates. Largest average RT amplitude was observed in the water deprived camels housed outdoors which was 4 folds of their water deprived mates housed indoors. On the other hand, ST behaved differently in such a way that in the water deprived camels it was frequently higher than in the daily watered controls. Evident was the capacity of camels to maintain constant, the overall rectal-air temperature gradient through varying rectal-skin and skin-air gradients, and invariably in opposite direction. This was aided by the fact that (Ta) were constantly lower than the (RT) and (ST). Hence, the temperature of the skin and its regulation determines to a large extent the core temperature of camels.

Keywords: Camels, dehydration, season, shelter, thermoregulation.

INTRODUCTION

Ruminants grazing arid and semi-arid rangelands are frequently exposed to different environmental stresses including, among other stress factors, the adverse climatic conditions and the shortage in quantity and quality of water and feed. Many studies Schmidt-Nielsen *et al.*, (1957); Ben Goumi *et al.*, (2003) Zine-Fillali and Show (2004) and Achaaban *et al.*,

(2000) were carried out to investigate adaptive responses under these conditions but stress factors were considered separately or in limited combinations, mainly the climate, water deprivation and water salinity (Farid, 1989), and without allowing for gradual and long-term adaptation characterising semi-arid and arid ecosystems (Farid, 1985). Different direct and indirect environmental stressors are known to interact and hence, adaptive responses might be modified.

A research project has been initiated to study physiological and nutritional adaptive responses in dromedary camels to heat stress, water deprivation and protein deficiency. The present study deals with observations on rectal and skin temperature changes in response to the stress of direct exposure to day and night climatic elements, intermittent water intake and protein deficiency imposed concomitantly on the camel during different seasons.

MATERIALS AND METHODS

Animals and management

This study was conducted at Maryout Experimental Station near Alexandria, 32° latitude affiliated to the Desert Research Center in Cairo. Eight female dromedary camels were used in this experiment. All were adults, non- pregnant and non- lactating. Their live body weight average was 502.2 kg. Half the animals were housed individually in floor pens inside a barn, whereas the other half was kept outside not sheltered from direct solar radiation, wind and other natural environmental elements.

In addition to housing effects, the animals were subjected to two watering treatments, daily vs. intermittent watering once every 7 days. The experiment was repeated on the same animals three times between April and August to represent spring, early summer and late summer seasons. Each period lasted six weeks, a 4-week preliminary period, one week for a digestion and nitrogen balance trial and one week for the studies of animal adaptation, blood chemistry and kidney function. Spring period (March 18-May 7), early summer period (May 08-June 26) and late summer period (June-August); records were taken during the last week of each period. However, only thermo-regulation and animal adaptation will be reported in the present work.

Animals were weighed periodically every two weeks before feeding and watering. Feeds were offered in the morning as per treatments detailed below. Refusals, if any, were collected in the following morning, and weighed and sampled, before the new feeds were offered. Water was made available free choice for one hour at feeding time, as per treatments, and intake was recorded.

Experimental treatments

Animals were subjected to two water treatments. Half the animals were watered daily whereas the other half was intermittently watered, once every 7 days. More severe water deprivation was not intended in fear of the combined effect of heat stress and the shortage of water on animal welfare especially those that were not sheltered.

Animals were fed at the maintenance level as per requirements determined locally, being 2.15g DCP and 26.8g TDN per kg 0.73 (Farid *et al.*, 1990 and Farid 1995). The ingredients used to formulate rations included a commercial concentrate mixture, corn grains and rice straw as the roughage. All animals received 100% of their estimated maintenance energy requirements.

Experimental procedures:

The following climatic elements were measured using standard equipment: 24- hour minimum (Tmin) and maximum (Tmax) temperatures; and dry-bulb ambient temperature (Ta) and relative humidity (RH%) at 7:00 AM and 2:00 PM Egypt standard time (EST= GMT+2). The temperature-humidity index (THI) was calculated according to the following equation of Mader *et al.* (2002):

$$THI = (0.8 \times Ta) + [(RH/100) \times (Ta-14.3)] + 46.3$$

where Ta is ambient temperature, °C, and RH is relative humidity, % .

THI categories (Mader *et al.* 2002) available at present were developed for high yielding dairy cattle. These are: no stress (up to 72), mild stress (73-79), stress (80-89), severe stress (90-99) and fatal (100 and above). These categories may not be directly applicable to other species, especially those adapted to desert conditions, such as dromedary camels.

The experiment was carried out at Maryout Experimental Station, affiliated to the Desert Research Center in Cairo, 32° latitude , a site 35 km south-west the city of Alexandria, about 20 km from the Mediterranean Sea shore. Table 1 summarizes the main climatic elements observed during the three experimental periods. They were typical of conditions prevailing in desert areas close to seashores. However, deep in the desert, The environmental conditions were characterized by extremely low temperatures before sunrise, much higher temperatures in the mid-afternoon and much lower relative humidity.

Rectal (RT) and skin temperatures (ST) were also measured at 7: 00 am and 2:00 pm. A thermocouple thermometer was used (Yellow Springs Instruments Co., Inc., Yellow Springs, Idaho, U.S.A.). Skin temperatures were measured from a shaved area in the mid-side region. Both climatic and animal data were recorded for a full water deprivation cycle (seven consecutive days).

Statistical procedures:

The analysis of variance was performed using the GLM model of SAS statistical software (SAS, 1998). F-test was carried out for the four main effects and two-way interactions. Higher interactions were pooled together to represent the error term. The main fixed effects were housing environment (H), watering treatment (W), season or periods (P) and days (D). The ambient temperature (Ta), relative humidity (RH%) , and temperature humidity index (THI) were included in the model as covariates, animals were included in the model as random effect. The morning and afternoon data were statistically analyzed separately.

RESULTS

Observed T-min and T-max were lower in spring than those in early and late summer (Table 1). Minimum temperature were practically similar indoors and outdoor, but the maximum were 4-5°C higher outdoors. The same applies to am and pm ambient temperatures, measured at 7:00 am and 2:00 pm, except that the am temperatures were greater than the minimum and the PM temperatures were less than the maximum. As anticipated, RH% was higher in the cool morning than that in the afternoon, and higher at indoors than outdoors. It was particularly low outdoors in early summer during pm times.

Table 1: Average climatic data during the three experimental periods and for measurements taken at 7:00 am and 2:00 pm .

Housing	Season	Tmin	Tmax	Ambient (Ta)		Humidity %		THI[2]	
		(°C)	(°C)	am	Pm	Am	pm	am	pm
Iindoors	Sp	16.79	24.21	19.79	23.21	72.03	58.57	66.56	69.89
	ES	23.29	31.43	25.57	30.64	69.21	45.84	74.23	78.36
	LS	24.14	31.34	25.36	30.71	78.17	59.83	74.84	80.16
Outdoors	Sp	16.64	28.00	20.57	23.93	70.90	53.72	67.40	70.41
	ES	24.43	35.02	25.57	33.71	69.35	36.21	74.24	81.32
	LS	24.07	36.47	26.07	34.36	75.15	43.94	75.51	83.01

1. **SP = spring period, (1-7 May), ES = early summer period (20-26 June) and LS = late summer period (4 –10 Aug).**
2. **THI = temperature-humidity index (Mader *et al.*, 2002).**

Considering the THI values in Table (1), it could be suggested that animals were not under thermal stress during the spring period. During the summer periods, on the other hand, animals may have been under mild stress in the morning, but were apparently stressed in the afternoon, and with no difference between those kept indoors (high humidity) or outdoors (high ambient temperature).

Rectal temperature (RT):

The climatic variables (AT,RH% and THI) were found to be non significant sources of variation that affected (RT) and (ST) as illustrated in (Table 2). However, (RT) and (ST) may have been affected by other climatic factors such as solar radiation. This was aided by the fact that (Ta) were constantly lower than the (RT) and (ST) throughout the experiment.

In general, morning RT was significantly ($P<0.05$) lower in the water deprived camels kept outdoors than indoors as compared to their control mates (Table 3). However, the effect of water deprivation was significantly ($P<0.05$) evident only in camels housed outdoors. The lowest observed average morning of RT was in the water deprived camels housed outdoors (Table 3). A similar trend was observed in the afternoon.

Table 2: Regression of ambient temperature (Ta), relative humidity (RH%) and temperature humidity index (THI) on rectal temperature (RT) and Skin temperature (ST) in the morning (am) and in afternoon (pm) during the water deprivation cycle (seven days)

Factor	Rectal temperature (RT)		Skin temperature (ST)	
	am	pm	am	pm
Ambient temperature (Ta)	0.001 ±0.023$^{N.S}$	0.10 ±0.142$^{N.S}$	0.05 ±0.031$^{N.S}$	0.30 ±0.185$^{N.S}$
Relative humidity (RH%)	-0.04 ±0.025$^{N.S}$	0.06 ±0.078$^{N.S}$	-0.05 ±0.033$^{N.S}$	0.02 ±0.101$^{N.S}$
Temperature humidity index (THI)	0.07 ±0.045$^{N.S}$	-0.01 ±0.011$^{N.S}$	0.06 ±0.058$^{N.S}$	-0.01 ±0.015$^{N.S}$

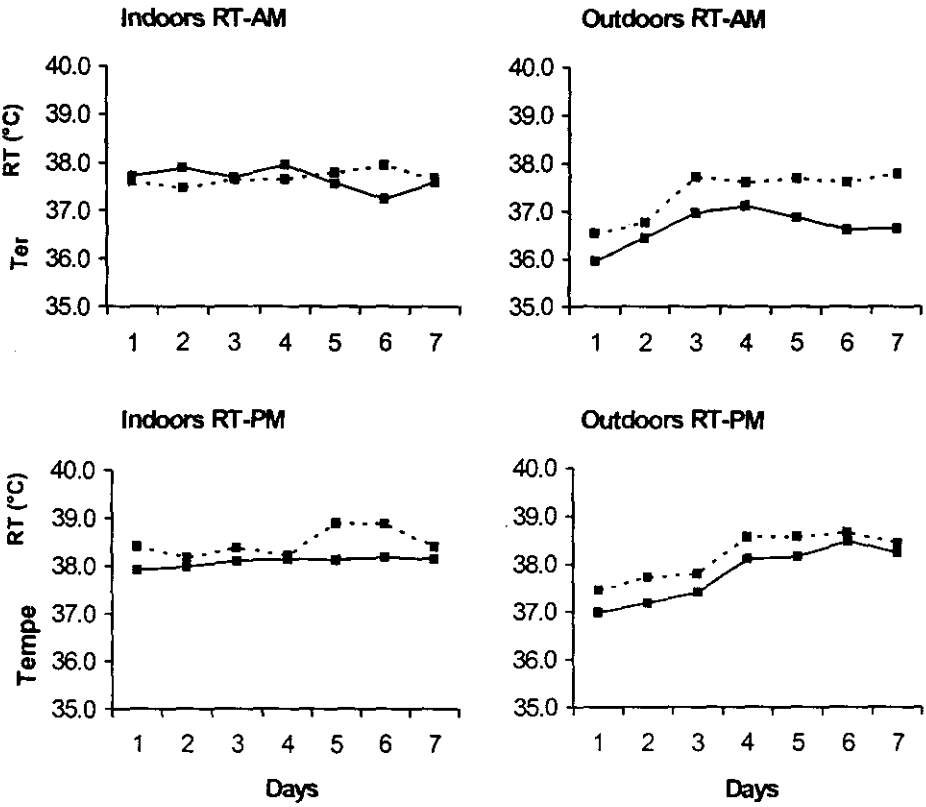
$^{N.S}$ **(P>0.05)**

Table 3: Rectal temperatures (RT, °C) in the morning (7:00 am) and in the afternoon (2:00 pm) and their amplitude (pm – am) values in daily watered (W) and water-deprived (W.D.) camels housed indoors or outdoors and during diferent seasons (L.S. Means + SEM)

Item	Water	Housing		Season			Overall means (water)
		Indoors	Outdoors	Spring	E-summer	L-summer	
Rectal T, am	W	37.7^{a} ±0.15	37.4^{a} ±0.16	37.4^{a} ±0.27	37.8^{a} ±0.21	37.4^{a} ±0.23	37.5^{a} ±0.08
	W.D.	37.7^{a} ±0.12	36.7^{b} ±0.15	37.8^{a} ±0.30	36.6^{b} ±0.19	37.1^{a} ±0.30	37.2^{b} ±0.09
	Overall Means	37.7^{a} ±0.08	37.0^{b} ±0.09	37.6^{a} ±0.26	37.2^{a} ±0.14	37.3^{a} ±0.22	
Rectal T, pm	W	38.5^{a} ±0.19	38.2^{a} ±0.20	39.00^{a} ±0.74	38.3^{a} ±0.35	37.7^{a} ±0.45	38.3^{a} ±0.07
	W.D.	38.1^{ab} ±0.17	37.8^{b} ±0.20	39.2^{a} ±0.73	37.5^{a} ±0.34	37.1^{a} ±0.47	37.9^{b} ±0.08
	Overall Means	38.3^{a} ±0.15	38.00^{a} ±0.16	39.1^{a} ±0.73	37.9^{a} ±0.32	37.4^{a} ±0.44	
Amplitude	W	0.7^{b} ±0.14	0.9^{ab} ±0.15	0.9^{a} ±0.16	0.7^{a} ±0.18	0.7^{a} ±0.14	0.78^{a} ±0.08
	W.D.	0.3^{b} ±0.12	1.2^{a} ±0.14	0.8^{a} ±0.18	1.0^{a} ±0.14	0.5^{a} ±0.21	0.77^{a} ±0.08
	Overall Means	0.5^{b} ±0.08	1.0^{a} ±0.09	0.88^{a} ±0.12	0.85^{a} ±0.10	0.58^{a} ±0.11	

Means with different superscripts in each subcell differ significantly at (P<0.05) level

The morning RT of daily watered and water deprived camels were lowest on the first two days of the 7-day cycle, but only in those housed outdoors (Fig. 1). The same trend was observed in the afternoon (Fig. 1).



During the water deprivation cycle (7 days).

Figure 1: Rectal temperature (RT) of watered (dashed line) and water deprived (solid line) camels indoors and outdoors, in the morning (AM) and afternoon (PM).

In spring, RT tended to increase as water deprivation progressed, and the controls had lower RT than their water deprived mates ($P>0.05$). In early and late summer, morning RT was practically constant or tended to decrease slightly (Table 3). It was also interesting to note that the water deprived camels had lower RT in summer than the controls. The afternoon RT, on the other hand, was less ($P>0.05$) in late than in early summer (Table 3).

The pattern of (RT) changes of the water deprived camels and controls through the seven days both am and pm, are presented in (Fig. 2). In general, the lowest (RT) was on the first day of the cycle (the watering day), and (RT) of the water deprived camels was lower than the controls (Fig. 2). It was higher on the seventh day than the first. After the third day of water deprivation the morning (RT) of water deprived animals showed an opposite trend to that observed in the afternoon as it decreased after the fourth day. It increased significantly on the fourth day, but was still lower than that of the controls; it then decreased till the end of the cycle. In the afternoon, it was still increasing till the end of the cycle

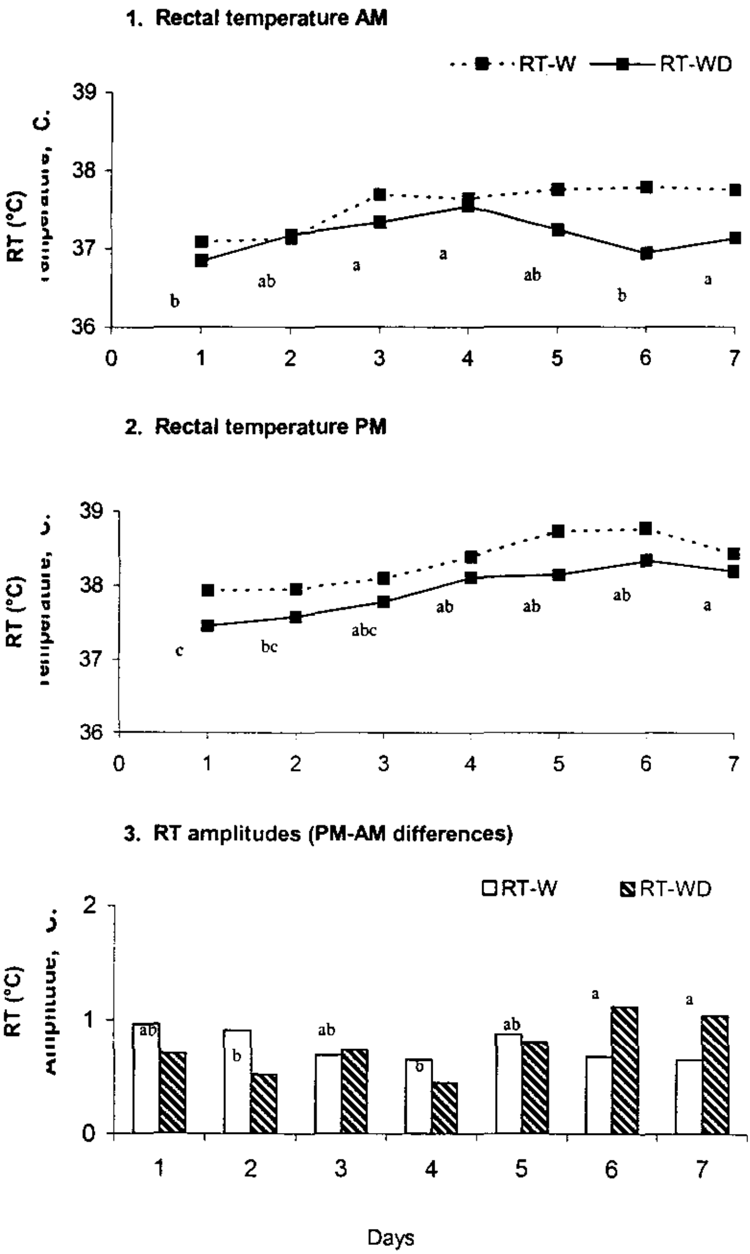


Figure 2: Rectal temperatures (RT) AM and PM, of daily watered (W) and water deprived (W.D) camels and their PM-AM amplitudes during the water deprivation cycle (7 days).
a, b, c different letters are significantly different at (P<0.05) level.

Rectal temperature amplitude (pm-am difference)

On average, morning and afternoon RT differences were similar in control and water deprived animals (0.78°C and 0.77°C, respectively, Table 3). However, it was greater at outdoors than that at indoors (P<0.05). Camels housed 0.5°C. Largest average RT difference was observed in water deprived camels housed outdoors, 1.2°C. (Table 3), which was 4 folds of the water deprived animals kept indoors. Therefore, the WxH interaction was significant (P<0.05). On the other hand, RT difference was similar in spring and early summer but lower in late summer (0.88°C and 0.85°C *vs*, 0.58°C) but these differences were not significant (P>0.05).

During the water deprivation cycle, difference decreased progressively in controls, whereas it increased in the water deprived animals (Fig. 2).

Skin temperature (ST)

The ST of camels was found to be significantly (P<0.05) affected by the housing environment and time of the year only in the morning (Table 4). In general, morning skin temp was higher indoors than outdoors, 34.8 *vs*. 33.8°C, respectively. However, the effect of water deprivation was significant (P<0.05) only in water deprived camels housed outdoors, and in the morning only (Table 4). The morning ST of water deprived camels outdoors was higher (about 0.8°C) than their control mates (Table 4, Fig. 3).

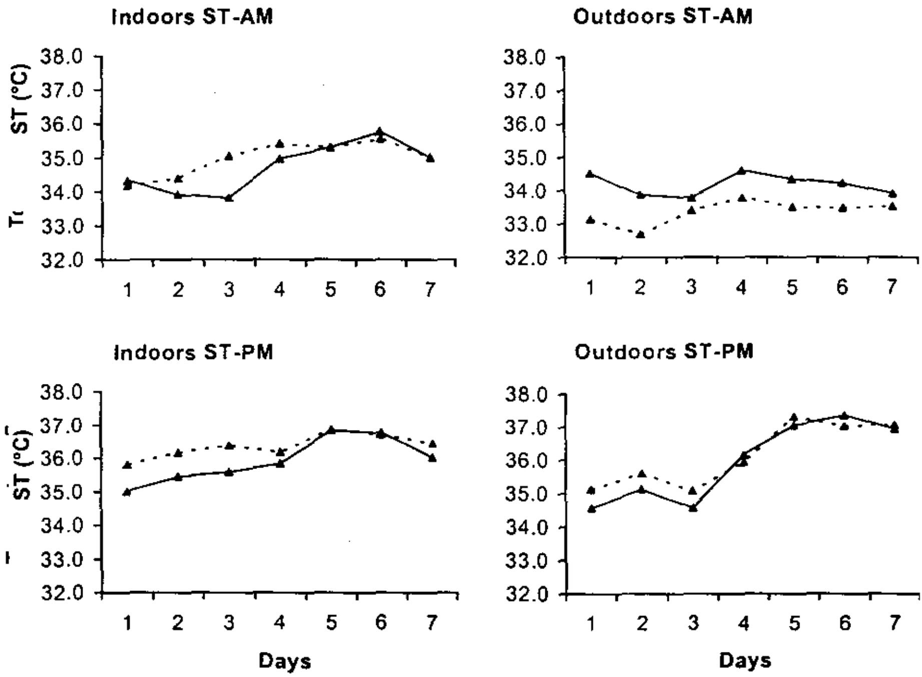


Figure 3: Skin temperatures (ST) AM and PM, of daily watered (dashed line) and water deprived (solid line) camels during the water deprivation cycle (7 days).

This was the opposite trend to that observed for morning RT in the controls. On the other hand, there was no significant difference between the ST of control and water deprived animals kept indoors. Thus, WxH interaction was significant (P<0.05) in the morning only (Table 4).

In the afternoon, these changes were not significant (P>0.05) as shown in Table 4. On the other hand, morning ST of camels was significantly (P<0.05) higher in early and late summer than in spring. The same trend was observed in the afternoon but differences were not significant (P>0.05).

In spring the water deprived camels had significantly (P<0.05) lower ST than the controls, while in early and late summer the opposite was observed. The ST of water deprived camels were significantly (P<0.05) higher only in the morning (Table 4).

Table 4: Skin temperatures (ST, °C) in the morning (7:00 am) and in the afternoon (2:00 pm) and their amplitude (pm – am) values in daily watered (W) and water-deprived (W.D.) camels housed indoors or outdoors and during different seasons (L.S. Means ± SEM)

Item	Water	Housing		Season			Overall means (Water)
		indoors	outdoors	spring	E-summer	L-summer	
Skin T, am	W	35.0^{a} ±0.20	33.4^{c} ±0.21	33.2^{c} ±0.36	34.3^{b} ±0.29	35.0^{b} ±0.31	34.2^{a} ±0.10
	W.D.	34.7^{a} ±0.16	34.2^{b} ±0.20	32.5^{d} ±0.39	35.0^{b} ±0.25	35.8^{a} ±0.39	34.5^{a} ±0.12
	Overall Means	34.8^{a} ±0.10	33.8^{b} ±0.12	32.8^{c} ±0.34	34.7^{b} ±0.19	35.4^{a} ±0.29	
Skin T, pm	W	36.4^{a} ±0.25	36.2^{a} ±0.26	35.9^{a} ±1.00	36.7^{a} ±0.46	36.2^{a} ±0.58	36.3^{a} ±0.10
	W.D.	35.9^{a} ±0.22	36.0^{a} ±0.25	35.5^{a} ±0.95	36.3^{a} ±0.44	36.1^{a} ±0.61	35.9^{a} ±0.11
	Overall Means	36.2^{a} ±0.20	36.05^{a} ±0.21	35.7^{a} ±0.94	36.5^{a} ±0.42	36.1^{a} ±0.57	
Amplitude	W	1.3^{bc} ±0.24	2.9^{a} ±0.26	1.7^{bc} ±0.27	2.7^{a} ±0.31	1.8^{bc} ±0.25	2.1^{a} ±0.13
	W.D.	1.0^{c} ±0.21	2.0^{b} ±0.25	1.9^{bc} ±0.31	1.7^{b} ±0.25	0.9^{c} ±0.36	1.5^{b} ±0.14
	Overall Means	1.1^{b} ±0.14	2.4^{a} ±0.16	1.8^{ab} ±0.21	2.2^{a} ±0.17	1.4^{b} ±0.19	

Means with different superscripts in each subcell differ significantly at (P<0.05) level

The pattern of change of ST of the water deprived camels throughout the 7-day water deprivation cycle is presented in Figs. 3 and 4. In the morning, ST of water deprived camels was higher than the controls on watering day, then it decreased (P>0.05) till the third day and thereafter increased (P<0.05) progressively afterwards till the end of the cycle. Again, th·· trend was the opposite of that observed in the RT.

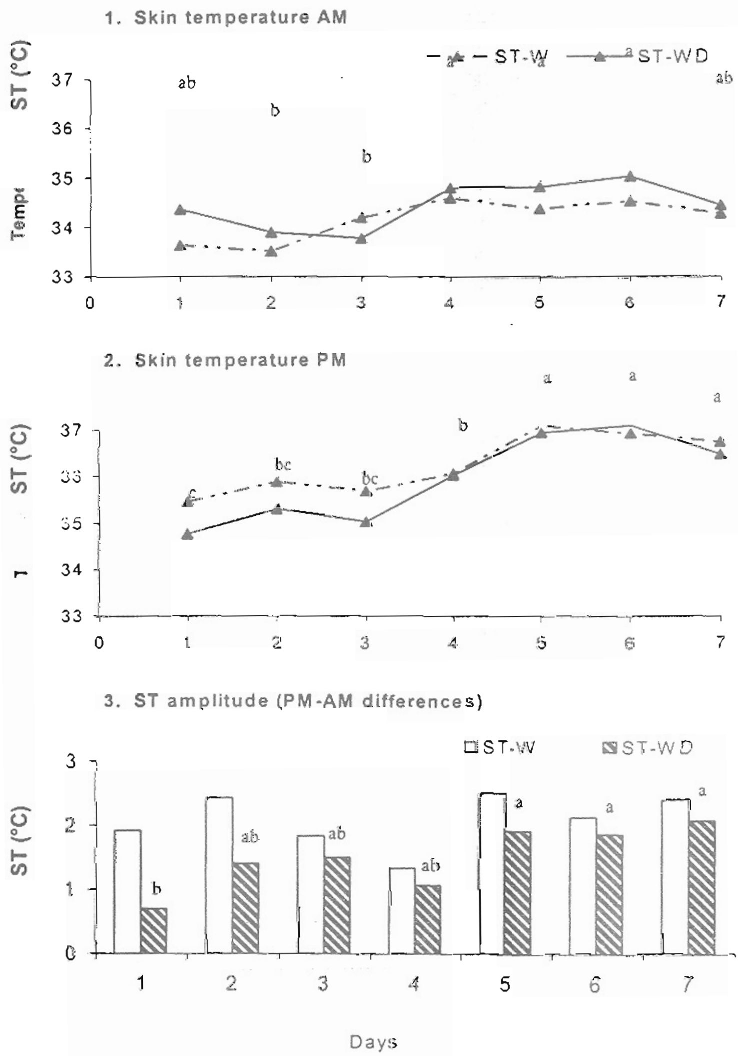


Figure 4: Skin temperatures (ST) AM and PM, of daily watered (W) and water deprived (W.D) camels and their PM-AM amplitudes during the water deprivation cycle (7 days).

a, b, c different letters are significantly different at (P<0.05) level.

In the afternoon the ST of water deprived camels was lower than the control on watering day, and up to day 3, then they were similar afterwards till the end of the cycle (Figs. 3 and 4). The magnitude of temperature increase was greater in the afternoon than that in the morning and in outdoors than that indoors (Figs. 3 and 4).

Skin temperature amplitude (pm-am difference)

Water deprivation significantly affected the ST difference ($P<0.05$). The ST differences of the water deprived animals were significantly lower than the control (1.5°C *vs.* 2.1°C, respectively, Table 4).

The housing environment was also found to be a significant ($P<0.05$) source of variation affecting ST differences (Table 4). The outdoor camels had twice the ST difference as their indoor mates. The highest ST difference was observed in the control animals outdoors (2.9°C, on average) and the lowest was that of the water deprived camels indoors (1.0°C) (Table 4).

The control animals had the greatest ST difference (2.7°C) in early summer than in spring and late summer (Table 4). However, their water deprived mates had the greatest difference in spring (1.9°C) and it decreased in early and late summer. During the 7-day deprivation cycle (Fig. 4), the ST difference in water deprived camels increased progressively. The highest values were those of the last three days of the cycle, but were still lower than those of the controls.

Temperature gradients

The skin might be considered a protective barrier between the core temperature and the surrounding environment, i.e. temperature, humidity, solar radiation, wind velocity ... etc. Therefore, the R/S and S/A gradients are of paramount importance to heat dissipation to the environment, as well as protection against heat gain from the environment, as the case might be. Those gradients were evaluated in the present experiment.

At the outset, it is noteworthy to mention that throughout the experiment the ambient temperature was always lower than both core and skin temperatures irrespective of the housing environment or the water treatment. That is there was no net direct heat gain from the environment except for some from solar radiation. However, as gradients varied between seasons, housing and water treatments effective heat dissipation may have been different.

Irrespective of treatments, all three gradients, R/S, S/A and R/A, were greater in the morning than in the afternoon (Tables 5,6 and 7; Figs. 5 and 6) because of the lower morning ambient temperature. Similarly, they were greater ($P<0.05$) in spring morning than in the morning of the two summer periods, also because of the lower spring ambient temperature. The seasonal effect was greater in magnitude on the S/A gradient as compared to R/S gradient. As a matter of fact, and in the afternoon as the R/S gradient decreased in summer, the S/A gradient increased, and the R/A gradient remained practically constant across seasons (Table 6 and Fig. 5and 6).

The effect of the housing environment was apparently and primarily related to the ambient temperature and the other climatic variables. Of particular importance were the afternoon gradients, and the morning to lesser extent. Evident was the capacity of the camels to maintain constant the overall R/A gradient through minimal variations in R/S and S/A gradients.

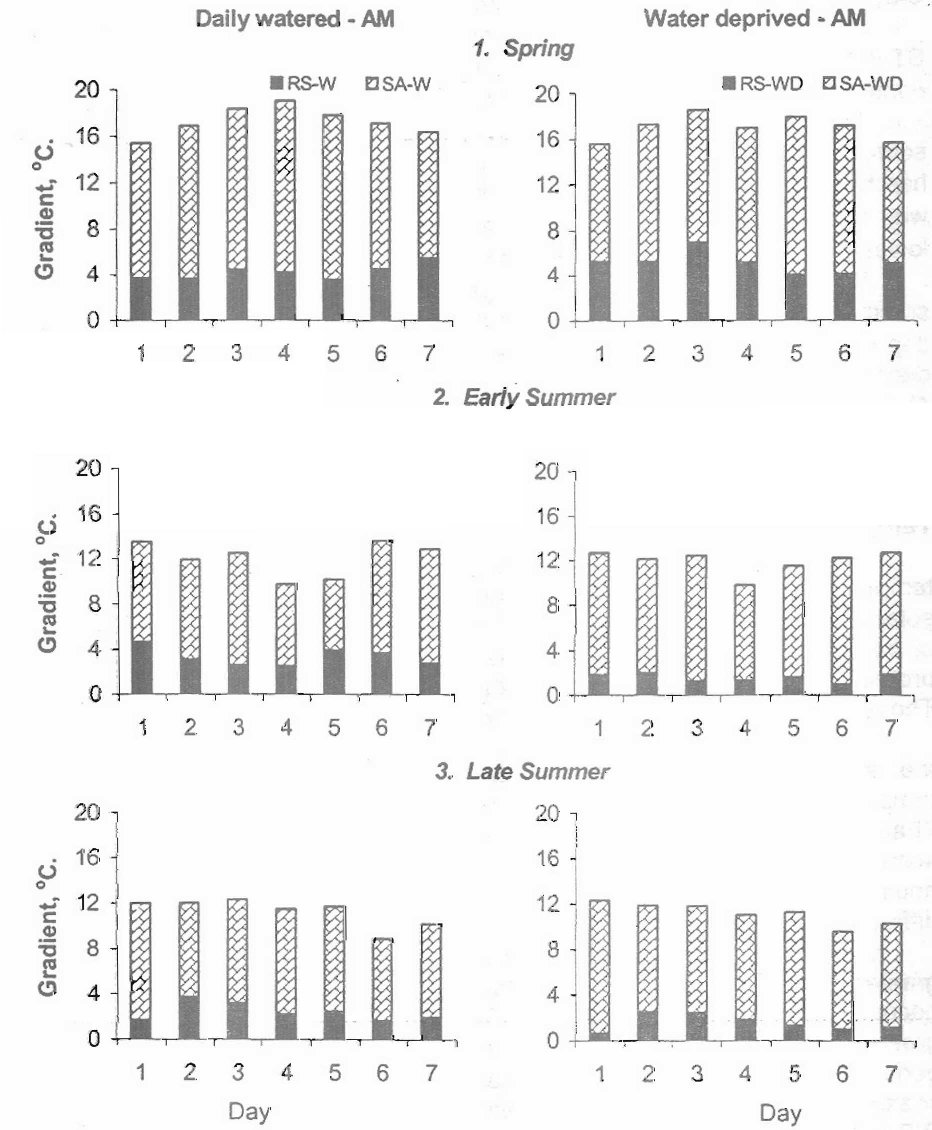


Figure 5: Morning (AM) Rectal-Skin (RS) and Skin-Air (SA) temperature gradients of daily watered (W) and water deprived (WD) camels during different seasons.
(note: RS+SA gradients= Total Core-Ambient temperature gradient).

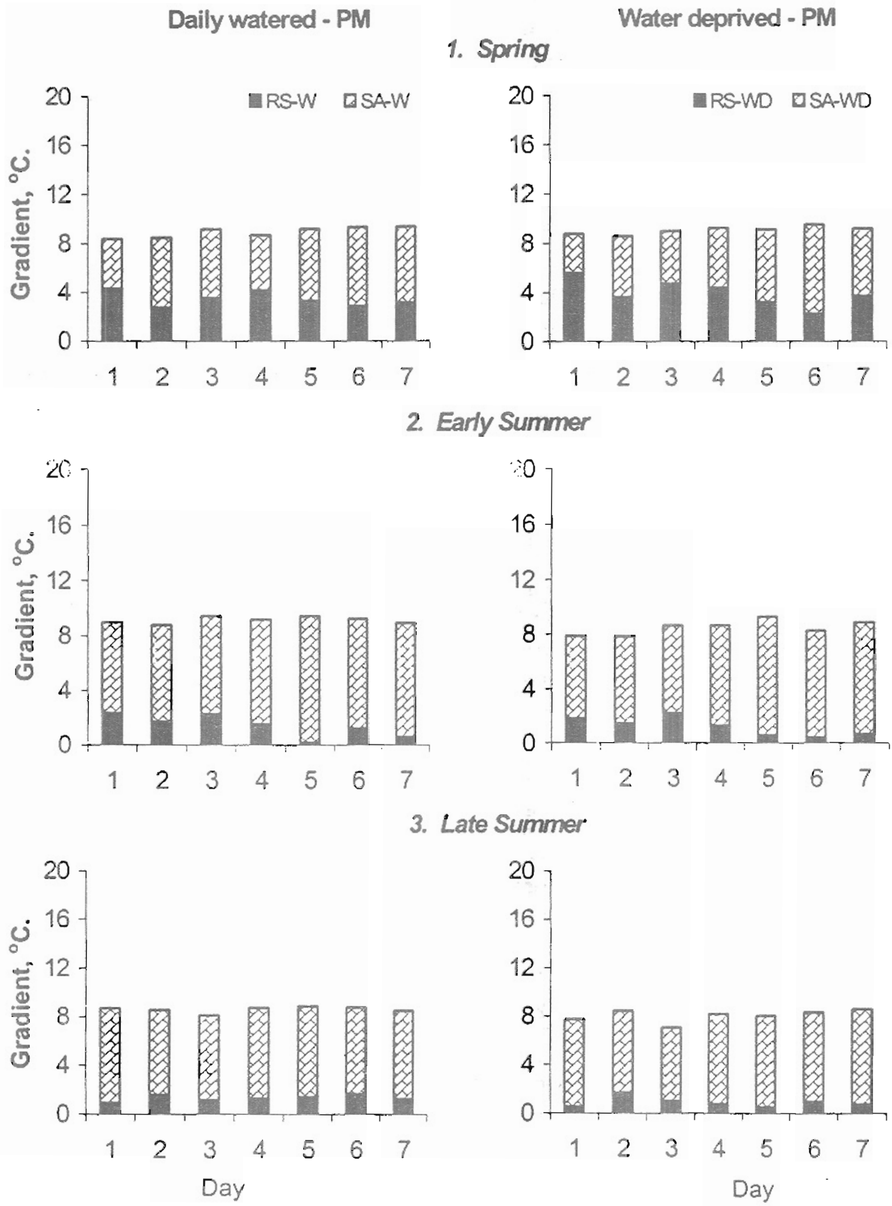


Fig. 6: Afternoon (PM) Rectal-Skin (RS) and Skin-Air (SA) temperature gradients of daily watered (W) and water deprived (WD) camels during different seasons.
(note: RS+SA gradients= Total Core-Ambient temperature gradient).

In the afternoon for example, R/S gradient was less outdoors than indoors (1.9°C *vs.* 2.1°C) whereas S/A gradient was greater outdoors than indoors (6.8° vs. 6.6°C) and R/A was, therefore, similar indoors and outdoors (8.8°C vs. 8.7°C) as illustrated in (Table 7 and Figs 5 and 6). Differences were not significant (P>0.05). In the cooler morning the opposite was observed.

Table 5: Rectal-Skin temperature gradients (RT - ST, °C) in daily watered (W) and water-deprived (W.D.) camels housed indoors or outdoors and during different seasons (L.S. means ± SEM)

Time of day	Water	Housing		Season			Overall means (Water)
		Indoors	Outdoors	Spring	E-Summer	L-Summer	
7:00 am	W	2.8^{b} ±0.24	3.9^{a} ±0.26	4.3^{b} ±0.44	3.3^{b} ±0.34	2.4^{b} ±0.37	3.3^{a} ±0.13
	W.D.	3.0^{b} ±0.97	2.5^{b} ±0.24	5.3^{a} ±0.48	1.5^{b} ±0.30	1.5^{b} ±0.48	2.8^{b} ±0.14
	Overall means	2.9^{a} ±0.12	3.2^{a} ±0.15	4.8^{a} ±0.41	2.4^{b} ±0.23	1.9^{b} ±0.35	
2:00 pm	W	2.2^{a} ±0.28	1.9^{a} ±0.29	3.3^{a} ±1.07	1.4^{a} ±0.51	1.4^{a} ±0.65	2.1^{a} ±0.11
	W.D.	2.2^{a} ±0.25	1.9^{a} ±0.28	3.8^{a} ±1.05	1.3^{a} ±0.49	1.0^{a} ±0.67	2.0^{a} ±0.12
	Overall means	2.2^{a} ±0.22	1.9^{a} ±0.23	3.5^{a} ±1.05	1.4^{a} ±0.46	1.2^{a} ±0.63	

Means with different superscripts in each subcell differ significantly at (P<0.05) level.

Table 6: Skin-air temperature gradients (ST - Ta, °C) in daily watered (W) and water-deprived (W.D.) camels housed indoors or outdoors and during different seasons (L.S. means ± SEM)

Time of day	Water	Housing		Season			Overall means (Water)
		indoors	outdoors	spring	E-summer	L-summer	
7:00 am	W	11.0^{a} ±0.32	9.4^{b} ±0.34	13.0^{a} ±0.58	8.7^{c} ±0.44	8.9^{c} ±0.49	10.2^{b} ±0.17
	W.D.	11.0^{a} ±0.25	10.3^{ab} ±0.32	11.8^{b} ±0.63	10.4^{b} ±0.40	9.7^{bc} ±0.63	10.6^{a} ±0.19
	Overall Means	11.0^{a} ±0.16	9.8^{b} ±0.20	12.4^{a} ±0.54	9.6^{b} ±0.30	9.3^{b} ±0.40	
2:00 pm	W	6.8^{a} ±0.27	6.9^{a} ±0.27	5.6^{a} ±1.04	7.7^{a} ±0.49	7.2^{a} ±0.63	6.8^{a} ±0.10
	W.D.	6.3^{a} ±0.24	6.7^{a} ±0.27	5.2^{a} ±1.02	7.3^{a} ±0.47	7.1^{a} ±0.65	6.5^{a} ±0.11
	Overall Means	6.6^{a} ±0.20	6.8^{a} ±0.22	5.4^{a} ±0.10	7.5^{a} ±0.45	7.2^{a} ±0.61	

Means with different superscripts in each subcell differ significantly at (P<0.05) level.