

Effect of Seasonal Temperatures on Physiology and Behavior of Arabian Camels (*Camelus dromedarius*) in the Mid-Western Region of Saudi Arabia

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Abstract: The aims of this study were to compare the body temperature and behaviors of Arabian Camels (*Camelus dromedarius*) in two habitats (Up-land Taif and Low-land Makkah), during early morning and late afternoon for four seasons over one year. The results showed that there is a significant decrease in rectal temperature in early morning as compared with late afternoon in the same season at both habitats. Furthermore, the rectal temperature during winter and autumn in early morning were significantly lower than summer and spring in camels from the Up-land habitats. The behavioral results of three way analysis of variance showed highly significant difference between habitats in most behavioral aspects in social, non social, resting and feeding behaviors. The camels were more active during early morning than in afternoons.

Key words: Body Temperature • Physiology • Behavior • Arabian Camels • Season

INTRODUCTION

The dromedary or Arabian camel (*Camelus dromedarius*) is a large even-toed ungulate. Its native range is unclear, but it is probably indigenous to the Arabian Peninsula. The domesticated form occurs widely in North Africa and the Middle East. These camels live in a variety of habitats and feed on variety of plants [1-6]. Seasonal patterns in behavior and ecology have been studied in many species of mammals from different types of habitats. Within the Arabian Peninsula there are several different types of habitat used by camels. Camels are plain animals, adapted to life in open areas [7, 8]. Few studies have been conducted on their behavior and physiology in relationship to arid and hyper arid land regions such as Saudi Arabia [4]. Arid regions can satisfy the daily needs of camels, but hyper arid regions needs of camels can only be met temporarily [7].

The western region of Saudi Arabia is not a homogenous climatic entity. Rather, it constitutes a complex climatic system with characteristics varying according to region. There are two main climatic zones, the Up-land (Taif) and the Low-land (Jeddah), with the rainfall increasing toward the Up- land south. Whilest in the Low-land the hot Red Sea enhances the desert climate

making this area one of the most arid coastal regions in the world [5, 9]. In response to limiting climatic factors, the camel has developed a number of highly successful adaptive features involving different pattern of behavior [5, 9], body structures [10] and functions [11]. The most important of which is a unique mechanism of regulation of water and temperature regimes [4, 12, 13]. Camel have the ability to tolerate relatively large fluctuations in body temperature, the regulation of which is dependent on a variety of factors such as air temperature, solar radiation, period of the day, state of hydration, season and sex [4, 11, 14]. The main aim of the present study was to assess the impact of two different habitats (Up-land, Taif and Low-land, Makkah) on the behavior, ecology and physiology of camels living there.

MATERIALS AND METHODS

Animals: Camels studied in this investigation were similar in age (about 10 years old). They were kept under owner's control during the study period over four seasons being maintained in a semi-wild enclosure (100 m) surrounded by metal wire extending 1m above the ground level on all four sides. Food and water were supplied (twice) daily in two large and two small

containers kept above the ground level. Thus the camels were in a hydrated status. Twenty camels were randomly selected from two partly- guarded herds each totaling 40-50. The selected camels were divided into two groups:

Low-Land Animal: Ten female camels were randomly selected from partly guarded camels. These female camels were allowed to roam freely each day from 07:00-17:00 local time, at Almoghammas near Makkah during which time they ate their food from wild vegetation.

Up-Land Animals: Ten female camels were randomly selected from partly guarded camels. These female camels were allowed to roam freely each day from 07:00-17:00 local time, at alhawia (sail Road) near Taif during which time they ate their food from wild vegetation.

Habitats: Two different habitats were chosen, one in East North of Makkah Low-land (altitude 420 m) and the second habitat was in Up-land (altitude 1500 m) North of Taif in the Hijaz mountains. Air temperature for both habitats were recorded from the records of the Meteorological and Environmental Protection Administration (MEPA) in Jeddah.

Body Temperature Measurements: The body temperature of chosen camels was measured inside the enclosure during early morning (06:30-08:30) and late afternoon (17:30-19:30) over four seasons by inserting the probe of a digital thermometer (Geratherm color GT 131 Germany) into rectum. In addition observation was also made on the orientation of the chosen camels toward sun.

Behavioral Tests: Different patterns of behavior were studied in the chosen camels twice a day; in the morning (06:30-08:30) and in the afternoon (17:00-19:00) for four seasons. A direct observation is recorded for intervals of 10 min for each animal using a 7-channel recorder [8, 9]. The behavior of each camel was recorded in terms of time allocated to 9 broad categories of behavior outlined by AL-Hazmi [9] and AL-Hazmi and Brain [8] as:

Social Behavior Comprising: Agonistic gestures, approaching, following, genital sniffing, grooming, mutual grooming, naso-nasal investigation, sexual interaction and partner sniffing.

Non-Social Behavior Comprising: Exploration, sniffing the enclosure ground and tail-moving.

Attack Behavior Comprising: Bite, cross-neck biting, ear biting or pinching, front wrestling and knee bite.

Threatening Behavior Comprising: Chase, blowing inflatable (plot sac) from mouth, salivation and making sound by teeth grinding.

Defensive Behavior Comprising: Fleeing or running away, neck away defensive and raising tail up.

Resting Behavior Comprising: The time spent immobile by test camel during the observation time at the enclosure.

Feeding Behavior: The time allocated to feeding.

The Number of Feeds: i.e., the total number of times that the test camels returned to food sources, watering behavior.

Non-social investigation, attack, threat, defense, displacement, resting and feeding behavior and number of feeding efforts.

Statistical Analysis: Statistical evaluation of the mean, maximum, minimum, rectal temperature and the number of camels orienting lengthwise to the sun was carried out by using two-way analysis of variance and *t*-test [15], while collected data for behavior were analyzed using a three-way analysis of variance [15].

RESULTS

The mean \pm of the behavioral observations for female camels are given in Tables 1-2. Three way analysis of variance showed no significant differences between female camels from Up- and low-land habitats, for seasons, or period of the day in social, non-social investigation, attack, threat, defence, feeding behavior and feedings efforts, but there were significant differences on displacement behavior (habitat $P < 0.001$) and resting behavior in habitat as well as period of the day (habitat $P < 0.01$) and (day $P < 0.001$). Female camels spent more time in resting and displacement behavior in the morning during lower temperatures in Up-land, than did those living on Low-land (higher temperature). Whilst the three way interactions of habitat, season and period of the day were not significant with respect to all behavioral aspects tested, the only significant differences existed in the following interactions: habitat by season

Table 1: A Comparison of the Behavior (mean±SE) of female Camels in high land habitats (Taif) in early morning and late afternoon for four seasons

Season	Time of Observation	Behavior (mean±SE)									Number of feeding
		Social	Non-social	Attack	Threat	Defense	Displacement	Resting	Feeding		
Winter	Morning	22.20±1.77	456.80±7.200	0.00±0.00	0.00±0.00	0.00±0.00	251.00±5.750	104.20±5.040	110.20±4.61	1.50±0.22	
	Afternoon	7.0±2.810	142.90±8.490	0.00±0.00	0.00±0.00	0.00±0.00	156.20±7.130	544.60±10.35	362.50±9.08	3.40±0.27	
Spring	Morning	33.30±3.67	346.80±8.040	0.00±0.00	0.00±0.00	0.00±0.00	472.90±10.81	19.80±2.650	7.90±1.91	1.0±0.000	
	Afternoon	21.00±3.58	452.80±11.49	23.50±2.93	15.20±2.34	15.50±3.38	10.30±2.150	13.20±1.180	11.60±1.76	1.0±0.000	
Summer	Morning	24.30±3.68	458.60±11.58	18.60±2.61	21.10±2.75	23.0±2.230	359.20±12.61	0.00±0.000	0.00±0.00	0.00±0.00	
	Afternoon	0.00±0.00	375.60±13.90	0.00±0.00	0.00±0.00	0.00±0.00	225.30±9.180	482.60±11.09	355.90±9.70	3.30±0.30	
Autumn	Morning	112.70±8.68	447.30±10.85	3.80±0.71	2.80±0.83	1.70±0.52	0.00±0.000	0.00±0.000	0.00±0.00	0.00±0.00	
	Afternoon	14.90±1.40	417.70±11.75	0.00±0.00	0.00±0.00	0.00±0.00	239.20±8.820	0.00±0.000	0.00±0.00	0.00±0.00	

Table 2: A Comparison of the Behavior (mean±SE) of female Camels in low land habitats (Makkah) in early morning and late afternoon for four seasons

Season	Time of Observation	Behavior (mean±SE)									Number of feeding
		Social	Non-social	Attack	Threat	Defense	Displacement	Resting	Feeding		
Winter	Morning	39.70±6.91	472.40±13.24	03.10±0.90	24.10±2.88	2.0±0.7000	21.5±3.350	105.60±3.30	148.90±08.57	1.80±0.49	
	Afternoon	60.80±4.65	407.10±17.49	84.60±6.19	58.40±3.84	2.50±0.270	35.80±4.95	111.60±5.27	333.30±31.22	2.30±0.37	
Spring	Morning	2.40±0.48	750.30±34.16	10.50±1.91	1.80±0.33	0.80±0.200	22.20±1.83	146.70±5.59	128.40±5.650	2.70±0.34	
	Afternoon	21.00±1.41	595.20±20.05	36.20±2.06	8.50±0.79	0.10±0.100	29.30±3.55	133.80±6.10	49.80±7.550	1.50±0.22	
Summer	Morning	4.80±0.87	246.30±7.35	17.60±1.87	32.00±2.20	0.90±0.100	20.60±1.45	82.70±4.42	536.50±16.04	3.20±0.25	
	Afternoon	10.10±1.82	268.50±11.51	6.40±0.69	10.60±0.86	0.80±0.200	2.10±0.35	142.40±5.64	242.40±7.730	3.40±0.22	
Autumn	Morning	37.20±2.50	345.00±5.370	7.90±0.75	64.30±4.09	00.00±00.00	29.50±2.61	72.20±6.09	326.30±19.26	3.10±0.48	
	Afternoon	6.20±1.07	368.60±8.880	18.60±1.62	62.60±4.94	0.00±0.000	34.40±2.52	130.80±4.05	417.60±13.67	2.70±0.40	

Table 3: Mean body Temperature with Standard error (SE) of female Camels during early morning and late afternoon at four seasons in tow different habitats (High and Low Land)

Season	Makkah (Low Land)		Taif (High Land)	
	Morning	Afternoon	Morning	Afternoon
Winter	36.03±0.11	37.51±0.08	35.28±0.15	37.30±0.07
Spring	36.75±0.16	37.58±0.11	36.21±0.11	37.46±0.07
Summer	37.45±0.10	38.05±0.11	36.98±0.08	37.50±0.08
Autumn	36.35±0.10	37.70±0.07	35.60±0.14	37.62±0.09

for social behavior ($p < 0.05$) and season by period of the day in non-social behavior ($p < 0.05$) and for displacement behavior ($p < 0.05$). In addition, the interaction between habitats by season by period of the day showed significant variation in non-social ($p < 0.05$) and displacement behavior ($p < 0.05$).

Table 3 shows that effects of habitat, season and period of the day on body temperature of female camels. The two way analysis of variance revealed that in each season at both habitats, the rectal temperature, decreased to its lowest during early morning and reached its highest level late afternoon. The results of rectal temperature of female camels living at Low-land showed significant differences with period of the day ($p < 0.001$), season ($p < 0.01$) and their interaction ($p < 0.001$). In Up-land female camel rectal temperatures showed significant difference in period of the day ($p < 0.001$), season ($p < 0.01$) and their interaction ($p < 0.001$). The lowest rectal temperature of female Low-land camels was 35.7°C in early morning during winter and the highest

was 38.3°C in late afternoon during summer. In Up-land camels the lowest rectal temperature of female camels was 34.6°C in early morning during winter and the highest was 37.9°C in late afternoon during summer.

DISCUSSION

The present data revealed that time allocated to displacement, resting, feeding behaviors and number of feeding efforts varied significantly between habitat, but not between season or period of the day. However, there tended to be a decrease in time spent feeding in the winter, during the morning and an increase in spring and summer in Low-land camels and the opposite results has been reported in Up-land camels, with the converse being true for time engaged in resting. The findings to AL-Hazmi and AL-Gamdi [5] who reported that a higher percentage of time was allocated to feeding during winter and they also reported a higher percentage of time spent resting in summer supported the present result

study for camels in Low-land habitats. Observation of the camels in the Up-land, made Zari and AL-Hazmi [4] to conclude that, camels had spend more time during morning in social behavior and during the afternoon in feeding behavior. Similar conclusion were also made by Ghandour *et al.* [16] and AL-Hazmi [17] after observation on camels from Low-land habitats and Zari and AL-Hazmi [13] after observation on camels from Up-land habitats. A study on Up-land camels Zari and AL-Hazmi [13] suggested that, social behavior was high in autumn, spring and summer, but resting and feeding behaviors were higher in winter than in other seasons. The present study showed that camels spent more time during non-social and feeding behavior in Low-land habitats. Moreover, this work showed a contact threat in camels which was the most frequent class of agonistic behavior displayed. Chase and push were both infrequent even though chase appeared to represent a large percentage of this type of behavior in camels at both habitats. AL-Hazmi [17] observed camels from a Jeddah herd exhibited chase threatening more frequently than push threats in some circumstances during dry season in summer time.

Environment conditions may also influence behavior. In the present study ambient temperature in summer influenced the body temperature and seeking shade by camels, e.g. during period of high temperatures the subjects were frequently observed spending extended periods resting in the shade, but when shade was not available the camels oriented their bodies so that a minimal area was exposed to the sun. Sitting with the legs folded under the body and remaining seated on the same place so as to avoid contact with a fresh hot surface [4, 7, 13, 18] and this was more common during afternoon than morning in both habitats. Zari and AL-Hazmi [13] reported that, the orientation to the sun was probably adjusted daily and seasonally to reduce heat load in hot summers and to increase heat gain in cold winters. A similar result has been found in present study. As a desert mammal, the highest temperature during FE (feeding) grazing. In addition, the body temperature of fully hydrated camels, can vary by an increment of about 2°C [7] but when the camel is deprived of drinking water, this variation becomes much greater 7°C. Thus, dehydrated camels store considerable quantities of heat in the day, but at night they are able to radiate this heat load to the cold night sky, so considerably reducing the amount of water needed in thermoregulation, [11, 14]. In the present study, the camels are watered daily, nevertheless the variation over

the day in their body temperature was much greater previously reported for hydrated camels in the Sahara Desert by Schmidt-Nielsen *et al.* [14]. This discrepancy might be due to climatic difference and other ecological factors.

The selection of habitat with reference to vegetation has been reported earlier (in several ungulate species) by Ghobrial [19], Gauthier-Pilters and Dagg [7], Dunkan [2], Albiston and Brain [20], AL-Hazmi and Al-Ghamdi [5]. In this study the feeding behavior of camels varied between the two habitats which differ in the type and quantity of vegetation (grass) cover as a result of the level of rainfall and temperature, since rainfall was higher in Up-land than in Low-land habitats. On conclusion, habitats use is influenced by several factors, such as food availability, climatic conditions and individual physiology.

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