Emir. J. Agric. Sci. 2005. 17 (2): 01-13
http://www.cfa.uaeu.ac.ae/Research/EJAS.htm

Effect of different management conditions on rutting behavior of Indian dromedary camel

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Abstract :Ten adult male camels of 8-10 year aged were divided into two comparable groups. Group I was given regular exposure to adult female camel for 20 to 30 minutes daily in the morning hours, whereas group II was denied such kind of exposure. Environmental variables, rutting behavioral frequency and intensity parameters, important physical parameters, cardinal physiological responses and plasma hormone levels were studied in non-rutting (Nov- Dec) and rutting (December-February) seasons. The statistically analyzed experimental observation revealed that peak winter season started after 4th and 5th weeks and RH during morning hours was significantly higher than evening, whereas THI was significantly higher during evening hrs than during morning. Rutting behavioral frequency of extrusion of soft palate, flapping of tail and frequency of micturition and spreading urine on it's back were significantly increased in group I as compared to group II after 3rd week. Behavioral intensity of frothing of salivary secretion, making metallic and gurgling sound, back leg separate apart, flow of poll secretion and marking territory were very low during first two weeks, however, during 9th, 10th weeks the intensities were very prominent. In fact the significant variation between groups was found during 3rd and 4th week onwards. In both the groups, frequency and intensity parameters were significantly higher during morning hrs as compared to evening hrs. The cardinal physiological responses like, respiration rate and pulse rate were significantly increased during evening hrs as compared to morning hrs in both the groups. The plasma testosterone and cortisol levels greatly varied among studs in both, the exposed and the unexposed groups. During first two weeks, variations in plasma testosterone and cortisol levels between the two groups were non-significant. But testosterone and cortisol level significantly increased in group I as compared to group II from 4th week onwards and continued till 10th week. Third week onwards DMI (fodder) and body weight got significantly reduced in group I as compared to group II. In both the groups, all rutting behavioral frequency and intensity parameters were negatively correlated with DMI (fodder), water intake, body weight and environmental variables. It is concluded that early rut in adult mature male camel can be aroused by giving regular exposure for 20-30 min to adult female camels, at least for two weeks during the onset of winter season.

Key words: Camel, Management, Rut, Behavior, Testosterone, Cortisol.

تأثير الظروف الإدارية على مظاهر الرغبة الجنسية في البعير الهندية ذات السنم الواحد

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الملخص: قسمت عشرة بعير عمر 8 – 10 أعوام إلى مجموعتين. تم تعريض المجموعة الأولى إلى ناقات ناضجة لمدة 20–30 دقيقة يومياً بينما لم تعرض المجموعة الثانية لأي أنثى. درست العوامل البيئية من حيث تكرار وشدة الرغبة الجنسية والعوامل الفسيولوجية الهامة ومستويات الهرمونات في بلازما الدم في المجموعتين من البعير خلال الموسم وذلك من ديسمبر إلى فبراير. كانت النتائج التي تم تحليها إحصائياً قد أوضحت أن قمة الموسم خلال الشتاء قد بدء بعد الأسبوع الرابع والخامس وأن الـ RH كان عالياً خلال فترة الصباح عنه في المساء بمستوى معنوية وكان معدل تكرار ظاهرة الرغبة الجنسية المتمثلة في تحريك المنطقة ما بين البلعوم والحنجرة وأيضاً تحريك الذيل وخروج البول

ونثره على ظهره كان زائداً في المجموعة الأولى عنه في المجموعة الثانية. كثافة إفراز المخاط بمظهر لامع مع صوت متقطع وتباعد في الأرجل الخلفية وتيار من الإفرازات وعمل مناطق نفوذ كانت قليلة جداً في الأسبوعين الأولين بينما عند الأسبوع التاسع والعاشر كانت بكثافة وإستمرارية عالية. في الواقع كانت الاختلافات معنوية ابتداء من الأسبوع الثالث والرابع. ولوحظ أن كثافة وتكرارية العوامل المختلفة مرتفعة صباحاً عنها خلال المساء في كل من المجموعتين، وكانت مستويات التستتيرون والكورتيزول في البلازما متباين داخل كل من المجموعتين خلال الأسبوعين الأوليين بينما التباين بين المجموعتين كان غير معنوي وعند الأسبوع الرابع وحتى العاشر زاد مستوى التستيسزون والكورتزون بسرعة في المجموعة الأولى بالمقارنة بالثانية. عند الأسبوع الثالث وجد أن DMI ووزن الجسم قد قل بدرجة معنوية في المجموعة الأولى بالمقارنة بالثانية. وقد وجدت علاقة عكسية بين تكرار وكثافة مظاهر الرغبة الجنسية من جهة والـ DMI وإستهلاك المياه ووزن الجسم والعوامل البيئية. يستنتج من ذلك أنه يمكن تحفيز الرغبة الجنسية للبعير بتعريض الإناث لها لمدة 20–30 دقيقة عند بداية أول أسبوعين من الشتاء.

كلمات مفتاحية: البعير – الإدارة – الرغبة الجنسية – السلوك التستيسرون – الكورتيزون.

Introduction

In a desert ecosystem, camel keeping is regarded as an important resource for sustenance. Camels are able to with stand and sustain up to 20 to 22% of body weight loss during severe famine conditions, whereas other livestock, like cattle and buffalo can not sustain beyond 10 to 12% loss in body weight. (Sahani and Mehta, 2004). Due to short pay back period and higher benefit cost ratio, from carting and farming, the use of camel is profitable and advantageous in Thar desert ecosystem (Bhakat and Sahani, 2005). Camel population in the world is 19.32 million and out of that India possesses 1.03 million camels (FAO, 2002). Indian camel population is however mainly confined to north- western states (Rajasthan, Gujrat, Haryana and Punjab), with highest density in Rajasthan (Khanna et al. 1990).

Camels are considered to be stoic which means that they repress emotions and are indifferent to pleasure and pains. They are seasonal breeders. The breeding season in the northern hemisphere, at a distance from the equator, is roughly the later half of the cold weather, generally from December to March. Doerges et al. (1992) reported that during Australian winter, breeding camel groups are composed of one adult male with several females and calving occurs only in breeding season. The great problem of camel rearing enterprise is that they are slow breeders, having late puberty and breeding take place only in a few months, which causes low calving rate. To make maximum use of breeding stud within a few months, it is very necessary to initiate rut as early as possible. The ideal management procedure which are of least cost can be used as a tool to arouse early rut. Thus, an adult mature camel can be used effectively in the best possible way during their short breeding period. As socio-economic developments are taking place in the rural areas of dry and cultivable land, the camel management systems are also changing. It is, therefore, necessary to investigate different management conditions to introduce early rut appropriate to ecosystems and tradition for economic up keep of camels.

Materials and Methods

Ten adult male camels (*Camelus dromedarius*) of 8-9 years of age (Bikaneri breed) belonging to National Research Centre on Camel, Bikaner, were used in the experiment. Animals were divided into two comparable groups by maintaining uniformity in all aspects, having almost similar average body weight. Group I was given exposure in front of five adult female camels for 20 to 30 minutes everyday during morning hrs, whereas group II was not provided such an exposure. Camels were kept under asbestos roofed shelter and fed same kind of dry fodder and concentrate (1 kg molasses + 1 kg mustard oil).

Environmental variables

Daily observations of the microclimatic components were taken during non-rutting season (Nov - Dec) and rutting season (December - February). Micro-environmental parameters under the asbestos roofed shelter such as maximum temperature, minimum temperature, dry bulb and wet bulb temperature were recorded. The dry and wet bulb temperatures were recorded at 8 AM and 4 PM daily. The relative humidity (morning and evening) and temperature humidity index (morning and evening) were calculated (McDowell, 1982).

Biological samples

Blood samples were collected from each camel at fortnightly interval. The plasma testosterone and cortisol levels were assessed by RIA method. The Gamma Coat [^{125}I] cortisol radio immuno assay (Diasorin S.p.a, Italy) kit was used for estimation of camel blood plasma cortisol. The intra and inter assay coefficient of variation were ranged from 6.6 to 7.7 and 8.8 to 9.8 percent respectively. The minimal detection limit of assay was 0.21ug / dl. The Gamma Coat [^{125}I] testosterone radio immuno assay (Diasorin S.p.a, Italy) kit was used for determination of camel blood plasma testosterone. The intra and inter assay variation coefficient were ranged from 3.5 to 8.6 and 6.2 to 7.6 percent respectively. The minimal detection limit of assay was 0.02 ng / ml at 95 % confidence limit.

Rutting behavioral frequency and intensity parameters

Rutting behavioral frequency and intensity parameters were recorded by scientific coding method. For this purpose a suitable score card was developed containing all related parameters, which were graduated time wise (morning and evening) and also animal wise. All these observations were recorded for six days in a week for ten-weeks, covering rutting and non-rutting seasons. Rutting behavioral frequency parameters such as extrusion of soft palate (per min), flapping of tail (per min), micturition frequency (per hr), urine spreading on it's back (per hr) were recorded. Rutting behavioral intensity parameters such as frothing of salivary secretion, making metallic sound and gurgling sound, back leg separate apart, flow of poll secretion and marking territory were observed on a five point scale which refers to the degree of the behavioral intensity i.e. 1 – very low, 2 – fair (noticeable degree), 3 – medium, 4 – prominent and 5 – very prominent according to Fraser (1988).

Cardinal physiological responses

Cardinal physiological responses such as pulse rate (per minute) and respiration rate (per minute) were recorded daily around 10 AM (morning) and 4 PM (evening). The pulse rate was recorded by placing the finger tips in middle coccygial artery of ventral aspect of tail and respiration rate was measured by stethoscope.

Physical parameters

Some important physical parameters such as fodder intake and water intake and body weight changes were recorded. One type fodder namely *Phaseolus aconitifolius* (Moth chara) was provided to both groups during whole experimental periods. Fodder and water intake recorded twice in a week and body weight recorded once in a week. Dry matter content of fodder samples were estimated at weekly interval.

The experimental data were subjected to statistical analysis. The paired t-test was applied between the groups and within a group between morning - evening observations (Snedecor and Cochran, 1989). The paired sample correlations were also calculated between groups and within groups (Steel and Torrie, 1981).

Results and Discussions

Environmental variables

The observations were recorded for ten weeks starting from last week of November with the onset of winter season. Mean ± SE of micro climatic components in different periods is presented in Table 1. From 4th and 5th (3rd week of December) weeks onward, the peak winter season started. R.H (morning and evening) gradually reduced over the weeks, as the severity of cold weather increased. RH during morning hrs was significantly ($P<0.01$) higher than evening, whereas THI during evening was significantly ($P<0.01$) higher than morning values. Similar trend of observations has been reported by Bhakat (1997).

Table 1. Mean ± SE of micro climatic components in different periods.

Period (Weeks) n=70	Maximum Temperature (°C)	Minimum Temperature (°C)	RH morning %	RH evening %	THI morning	THI evening
			**		**	
1st	31.54 ± 0.40	14.66 ± 0.16	88.86 ± 0.46	53.86 ± 0.51	67.50 ± 0.15	70.72 ± 0.07
2nd	29.73 ± 0.19	13.56 ± 0.13	85.43 ± 0.53	49.28 ± 0.56	68.20 ± 0.42	71.68 ± 0.11
3rd	28.47 ± 0.15	12.30 ± 0.18	81.86 ± 0.51	45.14 ± 0.40	68.43 ± 0.25	72.24 ± 0.04
4th	27.17 ± 0.23	10.73 ± 0.16	78.28 ± 0.56	43.43 ± 0.57	68.90 ± 0.24	72.24 ± 0.04
5th	25.07 ± 0.13	9.36 ± 0.14	74.43 ± 0.65	39.86 ± 0.34	69.01 ± 0.08	72.59 ± 0.05
6th	23.81 ± 0.15	8.07 ± 0.16	71.00 ± 0.82	36.14 ± 0.74	69.58 ± 0.19	73.18 ± 0.13
7th	22.61 ± 0.17	7.00 ± 0.14	63.57 ± 1.00	32.57 ± 0.57	69.93 ± 0.18	73.82 ± 0.10
8th	21.08 ± 0.19	5.94 ± 0.11	57.43 ± 0.78	30.57 ± 0.30	70.94 ± 0.19	74.19 ± 0.06
9th	20.81 ± 0.23	4.94 ± 0.12	54.71 ± 0.42	29.14 ± 0.34	71.38 ± 0.09	73.04 ± 0.73
10th	19.60 ± 0.16	4.10 ± 0.08	51.71 ± 0.42	28.71 ± 0.42	71.09 ± 0.09	73.64 ± 0.69

** Significant at 1 % level. THI = Temperature Humidity Index, RH = Relative Humidity.

Rutting Behavioral Frequency

Table 2 represents weekly mean ± SE of rutting behavioral frequency before and during the breeding season in camel. Rutting behavioral frequency like extrusion of soft palate, flapping of tail and frequency of micturition were almost similar in both groups during 1st and 2nd weeks. These first two weeks were actually the onset of winter season, and the differences between the two groups were non-significant with respect to these rutting attributes. From third week onwards, the frequency of all these parameters significantly (P<0.01) increased in exposed group, as compared to unexposed group. Exposure of male camel in front of female camels rather provoked the animals and increased all the rutting behavioral frequency, just during onset of winter season. In both the groups the frequency of these parameters were significantly (P<0.01) higher during morning hrs as compared to evening hrs. Since during morning hrs exposure to adult female was given, all rutting behavioral frequencies were higher as compared to evening time.

Table 2. Weekly mean ± SE of rutting behavioral frequency before and during breeding season.

	weeks	Exposed Group (n=300)						Unexposed Group (n=300)					
		Extrusion of Soft Palate /min		Flapping of Tail /min		Micturition frequency /hr		Extrusion of Soft Palate /min		Flapping of Tail /min		Micturition frequency /hr	
		M	E	M	E	M	E	M	E	M	E	M	E
Early rut	1st	0.28 ± 0.18	0.28 ± 0.18	2.87 ± 0.51	2.43 ± 0.43	1.00 ± 0.10	1.00 ± 0.11	0.28 ± 0.18	0.27 ± 0.19	2.43 ± 0.48	1.71 ± 0.28	1.00 ± 0.11	1.00 ± 0.12
	2nd	1.28 ± 0.18	1.14 ± 0.14	5.28 ± 0.28	4.28 ± 0.27	1.28 ± 0.18	1.00 ± 0.10	1.14 ± 0.14	1.12 ± 0.13	4.86 ± 0.40	4.00 ± 0.31	1.00 ± 0.10	1.00 ± 0.11
		**		**		**		**		**		**	
	3rd	1.50 ± 0.20	1.00 ± 0.10	7.28 ± 0.42	6.28 ± 0.43	1.86 ± 0.26	1.14 ± 0.14	1.28 ± 0.18	1.00 ± 0.10	6.57 ± 0.30	5.57 ± 0.31	1.14 ± 0.14	1.00 ± 0.12
Mid rut	4th	2.43 ± 0.20	1.42 ± 0.20	9.28 ± 0.29	8.28 ± 0.28	2.71 ± 0.18	1.71 ± 0.18	1.57 ± 0.20	1.00 ± 0.10	8.28 ± 0.28	7.28 ± 0.27	1.71 ± 0.18	1.00 ± 0.10
	5th	3.14 ± 0.26	2.14 ± 0.26	11.28 ± 0.68	9.43 ± 0.61	3.28 ± 0.18	2.28 ± 0.19	2.14 ± 0.26	1.28 ± 0.18	9.57 ± 0.37	8.28 ± 0.36	2.28 ± 0.18	1.28 ± 0.17
		**		**		**		**		**		**	
	6th	3.71 ± 0.18	2.86 ± 0.26	21.71 ± 1.49	19.71 ± 1.60	3.87 ± 0.14	2.86 ± 0.14	2.71 ± 0.18	1.71 ± 0.18	18.57 ± 1.74	16.28 ± 1.61	2.86 ± 0.14	1.86 ± 0.15
	7th	4.28 ± 0.18	3.43 ± 0.20	33.14 ± 1.26	31.14 ± 1.26	3.87 ± 0.15	2.86 ± 0.14	3.28 ± 0.18	2.57 ± 0.43	30.43 ± 1.49	28.57 ± 1.62	2.86 ± 0.12	1.86 ± 0.14
Peak rut	8th	4.52 ± 0.10	4.00 ± 0.12	43.00 ± 1.17	40.14 ± 0.91	4.28 ± 0.18	3.28 ± 0.17	4.00 ± 0.10	3.00 ± 0.11	41.57 ± 1.06	39.43 ± 0.89	3.28 ± 0.18	2.28 ± 0.17
	9th	4.83 ± 0.21	4.43 ± 0.20	45.43 ± 1.06	41.71 ± 0.99	4.43 ± 0.19	3.43 ± 0.20	4.43 ± 0.21	3.43 ± 0.20	42.57 ± 1.02	40.71 ± 0.99	3.43 ± 0.21	2.43 ± 0.20
	10th	4.84 ± 0.12	4.76 ± 0.14	46.86 ± 1.01	44.28 ± 1.19	4.16 ± 0.14	4.00 ± 0.31	4.72 ± 0.15	3.86 ± 0.14	43.14 ± 1.18	41.86 ± 1.20	3.86 ± 0.14	2.71 ± 0.18

M = Morning, E = Evening ** Data 3rd week onward significant at 1 % level.

Cardinal physiological responses

Cardinal physiological responses and other behavioral frequency are presented in figure 1. The cardinal physiological responses like respiration rate (RR) and pulse rate (PR) increased significantly ($P<0.01$) during evening as compared to morning hrs in both groups. It is mainly due to diurnal variation. The average values of RR (morning and evening) of group I and group II were 6.57 ± 0.20, 8.43 ± 0.22 and 6.00 ± 0.38, 8.00 ± 0.38 per minute, respectively. The average values of PR (morning and evening) of group I and group II were 40.28 ± 0.29, 42.86 ± 0.51 and 40.43 ± 0.30, 43.28 ± 0.52 per minute, respectively. The variation of cardinal physiological responses between the two groups was non-significant, indicating that rutting signs were aroused with in the normal physiological conditions. High and low values of respiration rate and pulse rate were with in the normal physiological range for camel. Similar trend in these observations was reported by Bhakat *et al* (2003). Samee (1998) also found that hematological parameters (TEC, HB %, PCV, TLC) were non-significant in rutting and non-rutting season. From 3rd week onwards, the average frequency of urine spreading on it's back significantly ($P<0.01$) increased in group I as compared to group II.

Rutting behavioral intensity

Table 3 reveals weekly mean ± SE of rutting behavioral intensity before and during breeding season. The behavioral intensity of frothing of salivary secretion, making metallic sound and gurgling sound were very low during first two weeks in both groups. The significant ($P<0.01$) variation was found between the groups during the 3rd and 4th week onwards. During 3rd and 4th weeks, the intensities were fair (of noticeable degree), during 6th, 7th, 8th weeks, the intensities were medium to prominent and during 9th, 10th weeks, the intensities were very prominent. Flowler (2000) reported that rut utter is a unique blubbering or gurgling vocalization produced by blowing air through dulla (diverticulum of the ventral aspect of soft palate, that is protruded through the mouth). Saliva is also produced in abundance as a result of the vocal exercise and this is whipped into a froth that further modifies the sound. In both the groups, intensity of these parameters was significantly ($P<0.01$) higher during morning as compared to evening. Figure 2 expresses the other rutting behavioral intensity like "back leg separate apart", "flow of poll gland secretion" and "marking territory" in different periods. Significant ($P<0.01$) variation between groups was observed on 3rd week onwards. All the rutting behavioral frequencies were significantly ($P<0.01$) higher in group I as compared to group II. A regular exposure in front of female camels increased these frequencies significantly. In both the groups, behavioral frequencies were significantly ($P<0.01$) high during morning than during evening hrs.

Biological samples

The testosterone and cortisol levels in blood plasma during different periods of rut in Indian camel are given in Table 4. The level of testosterone greatly varied among studs in both groups, but during 1st and 2nd week, the variation of plasma testosterone level between two groups were non-significant. The testosterone level significantly ($P<0.01$) increased in the exposed group as compared to unexposed group from 4th

AVERAGE FREQUENCY VALUES

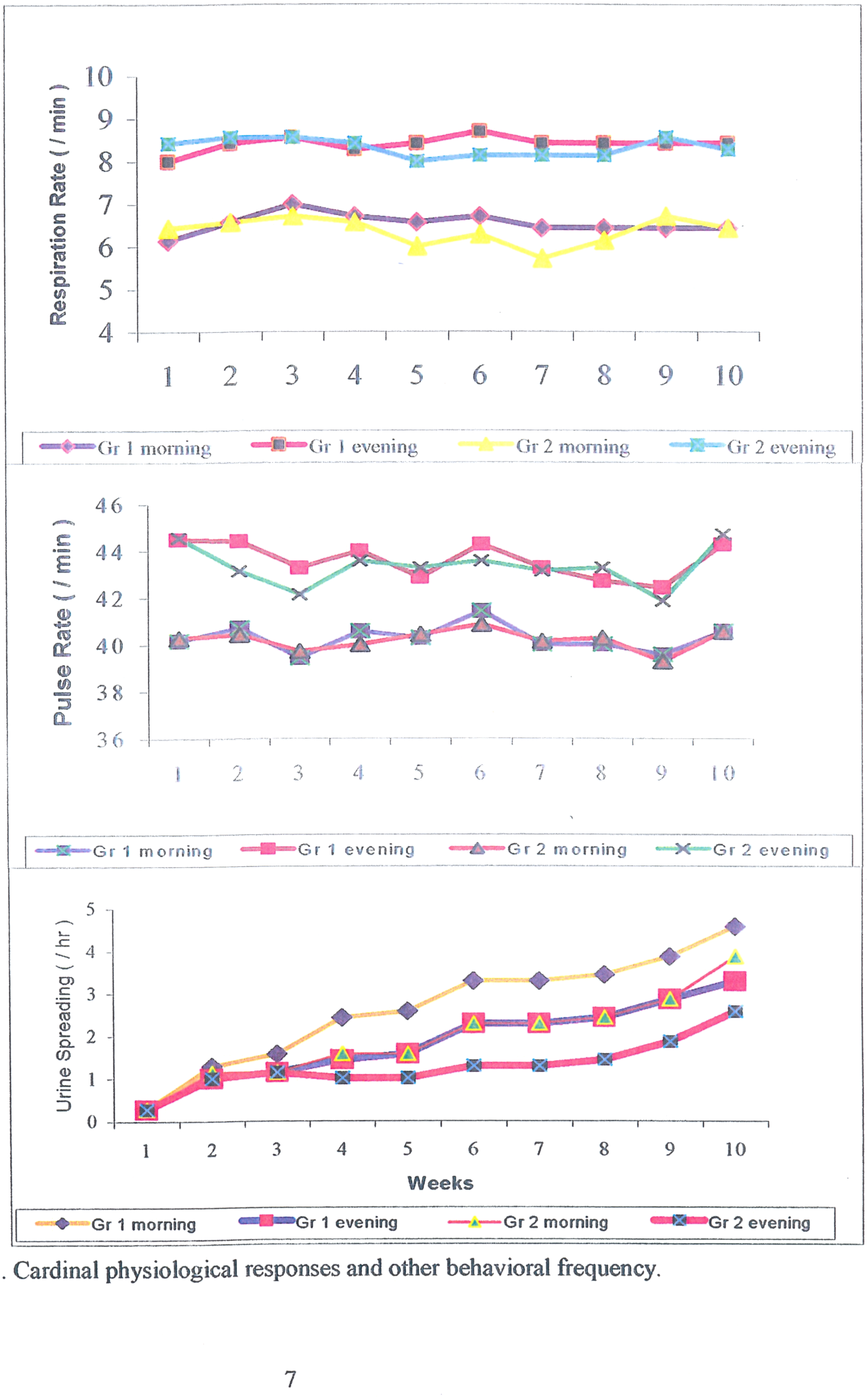

Figure 1. Cardinal physiological responses and other behavioral frequency.

week onwards. A regular exposure of the animal in group I in front of female camel contributed to the increase of testosterone level, as compared to unexposed group. When male camels were exposed in front of adult female camel, a visual sensation transmitted through occulo-motor nerves, which finally secrets more testosterone in circulating blood (Hafez, 1985). The increased testosterone level caused higher rutting behavioral frequency and intensity parameters. Agarwal (1996) also reported that testosterone concentration of studs increased during breeding season, as compared to non-breeding season. Higher level of circulating testosterone from late December to end of March was also found by Yagil and Etzion (1980).

The level of cortisol did not show variation upto 2nd week in both groups, but significantly ($P<0.01$) higher levels of cortisol were found after 4th week onwards in the exposed group, as compared to the unexposed group. Since during the rutting period the energy requirement of breeding male gets increased, the level of gluco-corticoid hormones like cortisol was also found to be increased. As this hormone has a physiological role in providing extra energy, by virtue of it's glycogenolytic and glucogenic property (Hafez, 1985).

Table 3. Mean ± SE of rutting behavioral intensity before and during breeding season.

			Exposed group (n=300)			Unexposed group (n=300)		
			Frothing of Salivary secretion	Metallic Sound	Gurgling Sound	Frothing of Salivary secretion	Metallic Sound	Gurgling Sound
			1st to 2nd weeks					
	M		1.0 ± 0.08 to 1.32 ± 0.11	1.00 ± 0.12 to 1.43 ± 0.19	1.00 ± 0.10 to 1.28 ± 0.17	1.0 ± 0.09 to 1.31 ± 0.12	1.0 ± 0.11 to 1.33 ± 0.20	1.00 ± 0.10 to 1.14 ± 0.12
Early rut		NS	1.0 ± 0.09	1.00 ± 0.13	1.00 ± 0.11	1.0 ± 0.10	1.01 ± 0.13	1.00 ± 0.11
	E		to 1.15 ± 0.12	to 1.14 ± 0.12	to 1.14 ± 0.13	to 0.11	to 1.00 ± 0.12	to 1.12 ± 0.14
	Overall		1.11 ± 0.07	1.25 ± 0.11	1.16 ± 0.09	1.00 ± 0.08	1.10 ± 0.09	1.07 ± 0.09
			3rd to 5th weeks					
	M		1.86 ± 0.12 to 3.14 ± 0.20	1.86 ± 0.13 to 2.86 ± 0.14	1.71 ± 0.16 to 3.00 ± 0.22	1.0 ± 1.11 to 2.00 ± 0.31	1.57 ± 0.19 to 1.86 ± 0.13	1.28 ± 0.17 to 2.00 ± 0.20
Mid rut		**	1.00 ± 0.10	1.0 ± 0.11	1.00 ± 0.10	1.0 ± 0.10	1.00 ± 1.12	1.00 ± 0.11
	E		to 1.86 ± 0.30	to 2.00 ± 0.07	to 2.00 ± 0.23	to 1.57 ± 0.19	to 1.14 ± 0.13	to 1.14 ± 0.13
	Overall		2.71 ± 0.09 **	2.57 ± 0.06 **	1.50 ± 0.09 **	1.15 ± 0.09 **	1.41 ± 0.11 **	1.15 ± 0.10 **
			6th to 10th weeks					
	M		3.71 ± 0.16 to 5.00 ± 0.13	3.85 ± 0.13 to 4.86 ± 0.14	3.71 ± 0.16 to 5.00 ± 0.14	2.71 ± 0.16 to 4.43 ± 0.19	3.14 ± 0.14 to 3.86 ± 0.12	2.71 ± 0.16 to 4.14 ± 0.15
Peak rut		**	2.71 ± 0.16	2.57 ± 0.28	2.71 ± 0.17	1.71 ± 0.16	2.14 ± 0.15	1.71 ± 0.18
	E		to 4.14 ± 0.25	to 4.00 ± 0.21	to 3.71 ± 0.18	to 2.28 ± 0.17	to 2.86 ± 0.14	to 3.14 ± 0.12
	Overall		3.86 ± 0.12 **	4.45 ± 0.12 **	4.27 ± 0.12 **	2.87 ± 0.14 **	2.95 ± 0.11 **	2.97 ± 0.11 **

** Data 3rd week onward significant at 1 % level, NS- Non-Significant, M = Morning, E = Evening

AVERAGE INTENSITY VALUES

Figure 2. Rutting behavioral intensity.

Table 4. Levels of Testosterone and Cortisol in blood plasma during different period of rut in Indian camel.

	Sample	Period weeks	Exposed Group		Unexposed Group	
			Testosterone (ng/ml)	Cortisol (ng/ml)	Testosterone (ng/ml)	Cortisol (ng/ml)
			n = 25	n = 25	n = 25	n = 25
Early rut	1	2nd	7.84 ± 2.08 **	8.26 ± 0.50 **	5.54 ± 1.31 **	6.30 ± 0.35 **
Mid rut	2	4th	23.40 ± 1.51 **	13.00 ± 0.89 **	8.42 ± 2.83 **	10.4 0 ± 0.82 **
Peak rut	3	6th	43.40 ± 6.01	11.20 ± 0.80	13.92 ± 5.26	9.20 ± 1.48
	4	8th	42.40 ± 4.49	13.40 ± 0.35	18.40 ± 4.31	10.90 ± 0.82
	5	10th	49.40 ± 5.28	12.60 ± 1.40	27.66 ± 6.71	9.80 ± 0.37

** Data 4th week onward significant at 1 % level

Physical parameters

Mean values of physical parameters of rutting camel at different weeks are presented in Table 5. During the first two weeks, DM (fodder) intake, water intake and body weight changes were non-significant between group I and group II. But from 3rd week onwards DM (fodder) intake and body weight were significantly ($P<0.01$) reduced in exposed group as compared to unexposed group. The water intake was also gradually reduced, but the variation between two groups was found to be non-significant. Since DM intake and water intake are positively correlated (Tandon et al, 1993), as DM intake reduced, the water consumption also was found to be reduced too. Regular exposure of breedable males in front of female camel enhanced all the rutting behavioral frequency and intensity parameters, which lead to reduced DMI (fodder), water intake and body weight of studs during 3rd week onwards. The concentrate mixture viz: molasses + mustard oil (1 kg + 1 kg) was consumed by all camels thoughtout the period to compensate higher energy requirement during breeding season. The overall decrease in DMI, water intake, body weight in group I and II were 45.48%, 29.82%, 9.63% and 33.80%, 26.57%, 8.41%, respectively.

Correlation (-) between physical, micro-climatic variables and behavioral frequency and intensity parameters are given in table 6. In both the groups, rutting behavioral frequency and intensity parameters were negatively correlated with DM (fodder) and water intake, body weight and with all micro-environmental variables.

From the above study, it may be concluded that early sexual behavior/ rut in adult mature male camel can be aroused by giving a regular exposure of 20 to 30 minutes in front of adult female camel at least for two weeks during the onset of winter season.

Table 5. Mean values of physical parameters of rutting camel at different weeks.

	Period WEEKS	Exposed Group			Unexposed Group		
		D.M (Fodder) Intake (kg)	Water Intake (kg)	Body weight (kg)	D.M (Fodder) Intake (kg)	Water Intake (kg)	Body weight (kg)
Early rut	n	100	100	50	100	100	50
	Initial	12.84 ± 0.10	28.50 ± 0.19	683.60 ± 9.67	12.81 ± 0.09	28.60 ± 0.22	685.20 ± 9.79
	1st	12.77 ± 0.09	29.15 ± 0.22	683.00 ± 10.29	12.46 ± 0.05	29.20 ± 0.14	680.00 ± 9.68
	2nd	12.06 ± 0.17	28.50 ± 0.60	679.40 ± 11.34	11.91 ± 0.19	28.75 ± 0.34	675.20 ± 10.02
		**	NS	**	**	NS	**
Mid rut	3rd	10.78 ± 0.05	27.25 ± 0.43	674.00 ± 8.74	12.45 ± 0.11	27.65 ± 0.34	678.20 ± 9.56
	4th	10.04 ± 0.16	26.25 ± 0.31	669.00 ± 10.19	10.35 ± 0.12	26.40 ± 0.34	676.20 ± 10.00
	5th	8.91 ± 0.14	25.75 ± 0.34	664.20 ± 10.45	10.29 ± 0.11	26.80 ± 0.20	674.20 ± 9.16
		**	NS	**	**	NS	**
	6th	8.14 ± 0.12	24.75 ± 0.33	654.60 ± 10.22	9.44 ± 0.16	26.25 ± 0.42	669.20 ± 8.11
Peak rut	7th	7.28 ± 0.06	22.55 ± 0.30	644.80 ± 10.11	8.73 ± 0.07	23.60 ± 0.29	654.20 ± 11.57
	8th	7.21 ± 0.07	21.15 ± 0.22	634.80 ± 9.45	8.51 ± 0.06	22.25 ± 0.24	644.20 ± 10.23
	9th	7.02 ± 0.16	20.25 ± 0.14	627.00 ± 11.38	8.49 ± 0.06	21.25 ± 0.12	634.20 ± 9.87
	10th	7.00 ± 0.14	20.00 ± 0.50	617.80 ± 10.00	8.48 ± 0.12	21.00 ± 0.34	627.60 ± 8.93
Overall decrease %		45.48	29.82	9.63	33.80	26.57	8.41

** Data 3rd week onward significant at 1 % level, NS – Non-Significant.
The average DM intake through 1kg Molasses + 1 kg Mustard oil mixture was 1.6 kg /day / camel.

Table 6. Correlation (-) between physical, micro-climatic variables and behavioral frequency and intensity parameters.

	Exposed Group		Unexposed Group	
	Morning	Evening	Morning	Evening
	Frequency parameters		**Frequency parameters**	
Fodder Intake	.90 to .96	.88 to .94	.83 to .92	.69 to .87
Water Intake	.87 to .97	.87 to .97	.80 to .95	.74 to .95
Body Weight	.86 to .98	.88 to .98	.81 to .98	.77 to .98
Maximum Temperature	.90 to .94	.85 to .93	.85 to .93	.74 to .91
Minimum Temperature	.92 to .97	.88 to .95	.87 to .95	.74 to .93
	Intensity parameters		Intensity parameters	
Fodder Intake	.93 to .96	.83 to .94	.86 to .93	.63 to .85
Water Intake	.89 to .94	.86 to .96	.83 to .90	.68 to .91
Body Weight	.88 to .96	.83 to .97	.77 to .94	.61 to .95
Maximum Temperature	.91 to .94	.86 to .94	.86 to .93	.71 to .90
Minimum Temperature	.94 to .96	.87 to .95	.87 to .93	.72 to .90

All values are significant at $P < 0.01$.

References

Agarwal, S. P. 1996. Hormonal manipulations for improvement of reproduction in camel. Annual Report, NRCC, Bikaner, pp. 66 – 67.

Bhakat, C. and M. S. Sahani. 2005. Studies on use of Indian dromedary camel in hot arid Thar desert ecosystem, Proceeding of National Symposium on Domestic Animal Diversity: Status, Opportunities and Challenges, 10 – 11 February 05, NBAGR, Karnal, Haryana, India. P 154-155.

Bhakat, C., R. Singh, N. Sharma and M. S. Sahani. 2003. Environmental stress and it's amelioration through shelter management. Annual Report, NRCC, Bikaner.

Bhakat, C. 1997. Effect of housing on the growth performance of crossbred goat. Ph.D. Thesis, N.D.R.I., Karnal, Haryana.

Doerges, B., J. Heucke and H. Klingel. 1992. Behaviour and social organisation of feral camels in central Australia. In: Allen WR, Higgins AJ, Mayhew IG, Snow DH and Wade JF (Eds). Proceedings of the 1st international Camel Conference, Dubai, UAE, Feb. 2-6. Newmarket, England R and W Publications. P 317-318.

FAO. 2002. Production Year Book, Rome, Italy.

Flowler, M. E. 2000. The influence of behaviour on the health and well-being of camels and their handlers. J. Camel Prac. and Res. 7(2): 129 – 142.

Fraser A. F. 1988. Sexual behaviour In: Farm Animal Behaviour. 3rd ed. Macmillan publishing co. Inc, "Sexual Behaviour", 10: 101 – 127.

Hafez, E. S. E. 1985. Reproduction in farm animals. 5th ed, Philadelphia, USA.

Khanna, N. D., A. K. Rai and S. N. Tandon.1990. Population trends and distribution of camel population of India. Indian J. Anim. Sci. 60(3): 331-337.

McDowell, R. E. 1982. Improvement of livestock production in warm climate. W.H. Freeman and Co., San Franscisco.

Sahani, M. S. and S. C. Mehta. 2004. Camel genetic diversity and it's significance in Indian economy. Proceeding of National Symposium on Livestock Bio-diversity, 11-12 February 2004, NBAGR, Karnal, Haryana. pp. 13 – 20.

Samee, E. I. A. A. A. 1998. The effect of rutting season on some hematological and serum biochemical parameters in male dromedary camel. Proceeding of International Seminar on Camel Applied Research and Development, 10 – 11 Aug at NRCC, Bikaner. P 49.

Snedecor, G. W. and W. C. Cochran. 1989. Statistical Methods. Oxford & IBH Pub. Co. New Delhi, India.

Steel, R .G. D. and J. H. Torrie. 1981. Principle and Procedure of Statistics. A Biometrical Approach. 2nd Edn. McGraw-Hill Book Company.

Tandon, S. N., N. D. Khanna and N. Sharma. 1993. To develop suitable management practices for rearing camels. Annual Report, NRCC, Bikaner, pp. 45 – 49.

Yagil, R. and Z. Etzion. 1980. Hormonal and behavioral patterns in the male camel. J. Repr. and Fert. 58: 61-65.