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Effect of replacement of conventional roughage replacement with tanniferous tree leaves on agonistic behaviour of camel

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Abstract
Scientific knowledge concerning dromedary camel behaviour and welfare is still limited. To date, providing pens with adequate shaded areas is not regulated in camel husbandry. The objectives of this study were to evaluate the effect of change in diet on behaviour pattern of camel. Dromedary camels have a preference for tree leaves and describe how their behavior would change depending on the presence of different feeds. Effect of tannin containing tree leaves in the diet on camel behaviour was studied in fifteen lactating camels (average body weight 554 kg) in mid-lactation stage. The animals were distributed following randomized-block design into three groups on the basis of similar live weight and milk production. The control group (GG) was fed with a standard basal diet of roughage and supplemental concentrate in the ratio of 70:30, where in the roughage component included equal proportions (1:1) of Groundnut (*Arachis hypogaea* L.) straw (GS), Guar (*Cyamopsis tetragonoloba* L.) phalgati (GP). The treatment groups GGK received a similar ration with a varied roughage combination, one having tanniferous Khejri leaves (KL) at GS40:GP40: KL20 ratios and the other GGP received Pala leaves (PL) at GS40:GP40:PL20 ratios. The agonistic behaviour frequencies like not significantly affected. It may thus be concluded that incorporation of tanniferous tree forages of hot-arid climatic regions at 20% level by replacing the basal crop-residues in the diet of lactating camel do not have negative influence on behaviour of camel.

Keywords: Conventional roughage replacement, tanniferous tree leaves, agonistic behaviour, camel

Introduction
Camel husbandry is currently evolving from a pastoral towards to an intensive system, due to a selection process for the use of this species in meat and milk production (Faye, 2008) [2]. Captivity in intensive systems affects locomotion and social activities, limits the expression of various behavioural needs and causes the expression of abnormal behaviours in camels (Padalino *et al*., 2014) [5]; Studies in cattle have shown that intensive management systems, involving restricted space and high stocking densities, increase the risk of behavioural disturbances. Research is needed to understand camel behaviour in intensive housing system. Alterations in behaviour responsiveness are triggered by stress. Behavioural and physiological responses observed in disturbed animals reflect their emotional reactivity (Deiss *et al*., 2009) [6].

The camel population of India is concentrated mostly in the 'Thar Desert' of India (AHSD, 2019) [1] and the available forage biomass in this western arid Rajasthan comprises of seasonally grown pasture, salt bushes, browses and tree forages (Sharma and Sahoo, 2017) [9]. Therefore, suitable inclusion of alternate tree forages with conventional crop-residue based ration could be an economical way of sustaining lactation in camel. But, the tree leaves of this region are mostly tanniferous Khejri (*Prosopis cineraria*) and Pala (*Ziziphus nummularia*) leaves, which may exert antinutritional effect if not fed judiciously. But, various approaches involved in the use of these unconventional feed resources have delineated newer concepts that implies inclusion at low levels to explore pro-nutritional effect for improving animal production (Singh and Sahoo, 2004) [10]. The phytochemical-rich tree leaves have bioactive properties (Makkar *et al*., 2007; Durmic and Blache, 2012; Xiao and Bai, 2019) [3, 7, 11] But there is limited information on modulation of diet. The present investigation was thus aimed at incorporating 20% of tree leaves in the basal roughage diet of lactating camel to evaluate the effect on behaviour pattern of camel.

Material and Methods

All the behaviours of the lactating camels were recorded for 24 hours through Hikvision night vision closed-circuit television (CCTV) installed to record the behaviour at fortnightly intervals. CCTV camera was installed in shed. The following behaviours of lactating camels were recorded.

Agonistic behaviour

Abnormal behaviour such as biting, licking feeder and water pot, licking fences fixed around the shed and any inanimate object among group of experimental lactating camels was recorded. This frequency of agonistic behaviour was recorded with help of CCTV cameras which were installed in experimental shed.

Study Site and Animals

The experimental studies were performed from September 2021 to March 2022, when ambient temperatures varied from 4 to 45^{0}C. Different behavioural activities. In order to not affect the behavior of the penned camels, the measurements of the facilities were taken on a different day to when behavior was recorded. Pens were rectangular-shaped; in some cases, the area available to the camels was measured. In each pen, the numbers and shapes of feeding was same. The animals kept in the pens with no drinking points were watered using buckets either daily or every two days.

Animal Behavior and Environmental Parameters

Camels in each pen were recorded for 60 s by the same operator (BP). Recordings were made throughout the six months of sampling. Videos were taken using a Legria HF M46 camera (Canon Inc, Ōta, Tokyo, Japan) and durations were tracked with a stopwatch (Swatch, Swiss, Europe). Videos were recorded with a simultaneous commentary on the recording date and time, the number of camels in the pen, and pen conditions. During recording the behavior, the environmental parameters (i.e., temperature and humidity) were measured.

The videos were analyzed by two observers that were previously trained in analyzing the behavior of dromedary camels in videos recorded for other studies. Table 1. The frequency of the agonistic behaviour states (i.e., aggressive interaction, vocalization, bar-mouthing, head-shaking) were noted. Depicted Figure 1.

Statistical Analyses

The descriptive statistics were initially performed on all behavioral data, and then stratified by group and location of the camels (i.e., Group T0 sun, Group 1 shade, and Group 2 sun). The relative proportion (%) of the mutually exclusive locomotory behaviors was calculated, stratifying the camels by group and location, and the proportions are graphically displayed using pie charts. Descriptive statistics, in addition to diagnostic graphs, were also used to verify data distribution. Data were not normally distributed. Statistical analysis was performed using SPSS 25.0 (SPSS, an IBM Company, Chicago, IL, USA), and R environment. $p < 0.05$ were considered statistically significant.

Results and Discussion

Agonistic behaviour

The fortnightly observations on agonistic behaviour (f/24hr/fortnight) behaviour of lactating camels are presented in Table 4.26 and graphically represented in Fig 4.29. The average frequency of agonistic behaviour in T_0, T_1 and T_2 was 2.66±0.258, 2.06±0.181, 2.15±0.181 times respectively. The incidences of agonistic behaviour in lactating camels increased whenever there eating time was decreased and resting time was increased in group T_0. Group T_0 shown maximum (2.66±0.258) frequencies and group T_1 shown minimum (2.06±0.181) and group T_2 intermediate (2.15±0.181). The differences in agonistic behaviour frequencies in lactating camels of treatment groups differ non significantly. Results of present investigation was in accordance with Bhakat *et al.* (2004) [4] reported that the total average frequency of agonistic behaviour of camel were less in loose housing condition. Lower frequency of agonistic behaviour was due to higher involvement in feeding and other activities less time involvement in agonistic behaviour like activities in adult female camel. Similar results were reported by Kassilly *et al.* (2002) [8] in camel. Padalino *et al*. (2014) [5] reported that housed camels may develop stereotypies (which are repetitive, unvarying and apparently functionless behaviour patterns and indicators of poor welfare. In particular, locomotory stereotypy (e.g., head shaking and pacing) and oral stereotypy (e.g., bar mouthing, self-biting) have been described.

Table 1: Mean ± SE value of fortnightly agonistic behaviour (f/24hr/fortnight) of Lactating camels on different diet.

Fortnights	Treatments		
	T_0	T_1	T_2
0	3.8±0.860	3.4±1.290	3.6±0.872
1	3.4±0.980	2.8±0.490	3.2±0.583
2	3.2±1.240	2.2±0.490	3.0±0.949
3	3.2±1.460	2.4±0.872	2.8±1.200
4	2.2±0.970	2.2±0.490	2.2±0.800
5	2.8±1.360	2.0±0.950	2.2±0.583
6	1.8±0.200	1.2±0.200	1.6±0.400
7	2.0±0.550	1.6±0.250	1.0±0.000
8	1.8±0.800	1.4±0.245	2.0±0.000
9	1.6±0.400	1.6±0.927	1.8±0.490
10	2.6±0.250	1.6±0.245	1.4±0.245
11	2.6±0.250	2.2±0.200	1.2±0.200
12	3.6±1.661	2.2±0.735	2.0±0.000
Overall	2.7±0.258	2.06±0.181	2.15±0.181

Note: - Not significant

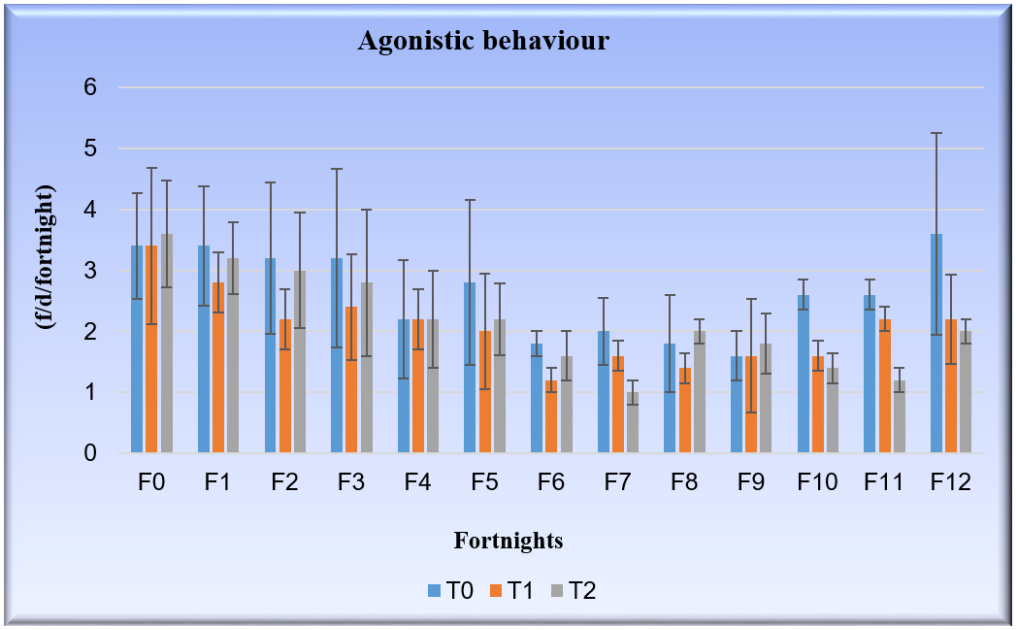

Fig 1: Average agonistic behaviour ((f/24hr/fortnight) of three different groups of lactating camels

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