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## Impact of various watering regimes on physiological and hematological parameters in intensively kept Marecha (*Camelus dromedarius*) she-camels in summer season

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### Abstract

**Background:** Camel is vital to daily life as a source of food and means of transportation, and just as importantly, its milk and urine have been used as medicine for diverse ailments since ancient times for people living in the desert region.

**Aim:** The current study was planned to investigate the effect of different watering regimes on physiological and hematological parameters of lactating Marecha camels during the summer season.

**Methods:** For this purpose, 12 lactating she-camels of almost similar age (8–13 years) and parity (2–5) were selected in a completely randomized design with four animals per treatment at the Camel Breeding and Research Station Rakh Mahni District Bhakkar. The trial was completed in 60 days, while 7 days were given as an acclimatization period for adaptation. The treatments were as follows: Group-1 (G-1) considered as the control had access to water once in a day; Group-2 (G-2) had access to water once in 4 days, and Group-3 (G-3) had access to water once in 6 days. Animals were housed individually for feeding and watering in an intensive management system. The same feed consisting of green fodder (*Lucerne*) and gram straw (*Cicer arietinum*) was offered to all animals. The average ambient temperature and relative humidity were 39°C–41°C and 55%–63%, respectively.

**Result:** The mean values ( $p < 0.001$ ) of water intake were found to be  $82.94 \pm 1.34$  l in G-3, which was higher than G-1 and G-2. Blood analysis showed that packed cell volume, white blood cells, and hemoglobin were affected significantly ( $p < 0.001$ ,  $p < 0.01$ , and  $p < 0.05$ , respectively).

**Conclusion:** No serious changes in complete blood count and physiological parameters were reported in this study. So, this shows that the camel is unique in its physiological adaptation in hot and hostile environments.

**Keywords:** Camel, Summer season, Hematology, Management system, Desert.

### Introduction

Camel being a valuable indigenous genetic resource can sustain life in hot and harsh deserts (Kgaudi *et al.*, 2018; Faraz *et al.*, 2021a, 2021b). Pakistan shares 1.1 million heads among 35 million worldwide camel population and ranks 8 in number (FAOSTAT, 2019; GOP, 2019–20). About 89% are single-humped (*Camelus dromedarius*) and 11% are double-humped (*Camelus bactrianus*). Camels were domesticated around 3,000 years ago and reared for milk and pack animals (Epstein, 1971). They are used to yield milk and meat for human consumption by changing their status from “ship of the desert” to “food security animal” (Faraz *et al.*, 2019a, 2019b, 2019c; Faraz, 2021). However, by the end of WW1, due to urbanization and army transportation, the primeval camel became the animal of the populace (Yagil *et al.*, 1994).

Camel watering is a laborious activity usually conducted jointly by several herders, especially when using well water (Faraz, 2020a). The existing water source for camel and other livestock in deserts like Thal and Cholistan is mainly the *Toba* system (a pond filled with water). Rainwater is stored in these *Tobas* and used during scarce periods (Raziq *et al.*, 2011; Faraz *et al.*, 2020). Water is considered the prime and chief important nutrient both physiologically and nutritionally; thus, it is not surprising that water metabolism may ultimately affect many nutritional and other management decisions. A sufficient amount of drinking water, adequate in quality and quantity, must be available for livestock to take full advantage of milk production (Murphy, 1992). Water is reflected as a more prime aspect for milk production in mammals and other livestock. It is the second most significant nutrient for

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milk production for lactating dairy cows (Beede, 2005), as they may consume up to 50 l frequently in a short period of time. The water balance of camels is more advanced than any other animal living in the desert ecosystem (Schmidt-Nielsen *et al.*, 1956).

When facing periods of water deprivation, camels have a natural aptitude to preserve their craving, prove the development in feed digestibility, and let their metabolic way debility to save energy reserve and water balance of the frame. These metabolic alterations keep the camels under an acceptable/healthy optimistic balance during the water deprivation period (Guerouali and Wardeh, 1998). Water scarcity is the major problem of pastoral people where, during drought conditions, water sources dry up and is unavailable. Due to these adverse conditions, Marecha camel herders migrate to irrigated areas, resulting in cultural disturbances and other problems with the agricultural farmers (Younas *et al.*, 2012).

Because of the importance of water in desert areas, the present study was designed to investigate different watering regimes' effects on physiological responses and hematological parameters of lactating Marecha camels in periods of water deprivation during summer.

## Materials and Methods

### Location of the study area

This study was conducted at the Camel Breeding and Research Station (CBRS), Rakh Mahni, Tahsil Mankera, District Bhakkar. This station is located in Thal area between 31°10' and 32°22' north latitude and 70°47' and 72° east longitude. Most of the area lies in the desert plain of Thal. This area is included in the agro-ecological zone-III A and B (sandy desert area), having narrow strips of sand ridges and dunes. The climate is arid to semi-arid, subtropical, and continental and the mean monthly highest temperature goes up to 45.6°C, while in winter it goes from 5.5°C to 1.3°C. The mean annual rainfall in the region ranges from 150 and 350 mm, increasing from South to North (Rahim *et al.*, 2011).

### Experimental plan and adaptation

Twelve lactating Marecha she-camels were selected for this experiment. The animals' health status was checked by examination of their previous routine health records and by monitoring the respiration rate, pulse rate, and body temperature. The animals were 8–13 months old, 2–5 parity, and in the early-mid lactation stage. The camels were dewormed and treated against both internal and external parasites. The animals were marked for identification by neck branding (freeze branding by liquid nitrogen gas). The camels were housed in semi-open pens throughout the trial. Twice a day, milking was carried out in routine (6 am/6 pm). The green fodder (*Medicago sativa*) and gram straw (*Cicer arietinum*) were offered to experimental animals *ad libitum*. Animals were divided into three groups, with each group consisting of four animals. The trial was completed in

60 days; 7 days were given as an acclimatization period for adaptation. The different watering regimes were G-1 = control (access to water once a day), G-2 = access to water once in 4 days, and G-3 = access to water once in 6 days. The dry matter, crude protein, ether extract, natural fiber, neutral detergent fiber, acid detergent fiber, and crude ash values of gram straw (*C. arietinum*) were 93.53%, 9.72%, 2.60%, 44.4%, 68.7%, 47.6%, and 7.83%. The dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF), and crude ash values of Lucerne (*M. sativa*) were 18.2%, 22.5%, 1.7%, 24%, 42.4%, 29.6%, and 12.4% (Van Soest *et al.*, 1991; AOAC, 1997).

Seven days were given for acclimatization and adaptation period, and each experimental animal was enclosed in a separate housing during the adaptation period. Their normal physiological parameters, feed intake, water intake, and body weight were recorded. The animals' health status was monitored, and all experimental animals were negative for a major parasitic disease like trypanosome infection.

### Daily routine practices

Physiological norms (respiration rate, rectal temperature, and pulse rate) were recorded. Feeding ration to lactating camels was offered at 10.00 am. According to their protocol, watering to control group (G-1) animals was conducted daily, while Group-2 (G-2) have access to water once in four days and Group-3 (G-3) access to water once in six days. Feed intake of all experimental animals was calculated on a daily basis.

### Meteorological data and physiological parameters

The farm area's temperature and humidity were recorded twice a day using a hygrometer placed in the shed area. Average ambient temperature and relative humidity during the research trial were 39°C–41°C and 55%–63%. The rectal temperature of all animals was recorded twice a day, first in the morning and then in the evening, using a digital thermometer. Respiratory rate was monitored by counting flank movement. Pulse rate was monitored by pulsating the coccygeal artery of each animal.

### Blood collection and analysis

Blood samples (5 ml each) were taken from the external jugular vein after cleaning each animal's puncture site. EDTA was used as an anticoagulant. Samples from G-1 were collected once a week. Sample from G-2 was collected on day 4 before watering. Sample from G-3 was collected on day 6 before watering. Blood Samples were analyzed using the hematology analyzer (Mindray, BC 2300 Germany) for complete blood count (CBC).

### Statistical analysis

The data collected on dry matter intake, physiological parameters, and CBC were subjected to analysis of variance using a completely randomized design using MINITAB (2000) software on a computer (Eyduran and Akbas, 2010; Gecer *et al.*, 2016).

**Ethical approval**

The procedures followed are in compliance with the ethical standards of the Animal Welfare Committee from the University of Agriculture Faisalabad.

**Results**

**Physiological parameters**

**Rectal temperature (AM and PM)**

Watering regimes had no significant effect on rectal temperature in the morning (Table 1). Rectal temperature was not increased in the morning in camels of groups 2 and 3. The mean value of rectal temperature remained almost similar among the groups and treatments, and no significant difference was observed. Diurnal variation in rectal temperature was observed in the afternoon. Watering regimes had no significant effect on rectal temperature in the evening. The mean values of rectal temperature for G-1, G-2, and G-3 were found to be 38.82°C ± 0.12°C, 38.38°C ± 0.11°C, and 38.63°C ± 0.13°C (Table 1). Rectal temperature was

recorded in the afternoon and was found to be increased (1°C). This increased temperature shows that the camel economizes the water balance by increasing its body temperature in hot desert conditions. Dehydration for 6 days (G-3) had no significant effect on the change in rectal temperature in the evening. Camel maintained its rectal temperature within the range of G-1 and G-2. Figure 1 shows a graphical representation of different watering regimes' effects on the morning and evening rectal temperature.

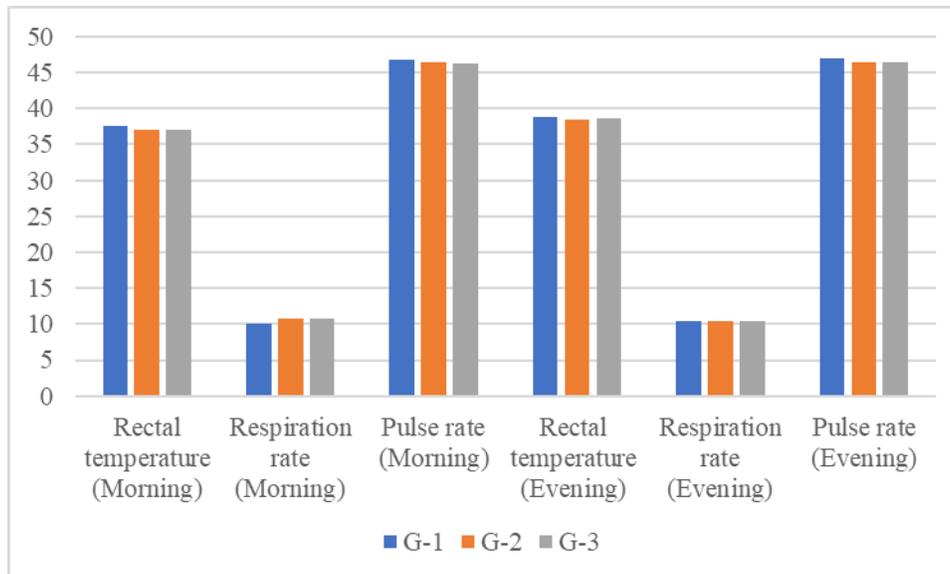
**Pulse rate (AM and PM)**

Watering regimes had no significant effect on pulse rate in the morning (Table 1). The morning's pulse rate did not change even when camels were deprived for 6 days (G-3). Camels of the breed were found to have great capability to maintain their physiological norms in the normal range, even when deprived of water. Watering regimes had no significant effect on pulse rate in the evening in any group. No significant difference was observed, among groups and within treatments, for change in

**Table 1.** Effect of different watering regimes on rectal temperature, respiration rate, and pulse rate.

| Parameters                      | G-1 (n = 4) | G-2 (n = 4) | G-3 (n = 4) | SEM    | p  |
|---------------------------------|-------------|-------------|-------------|--------|----|
| Rectal temperature (morning) °C | 37.51       | 37.00       | 37.00       | 0.03   | NS |
| Respiration rate (morning)      | 10.00       | 10.75       | 10.75       | 0.0034 | NS |
| Pulse rate (morning)            | 46.75       | 46.35       | 46.25       | 0.0256 | NS |
| Rectal temperature (evening) °C | 38.82       | 38.38       | 38.63       | 0.055  | NS |
| Respiration rate (evening)      | 10.50       | 10.50       | 10.50       | 0.0031 | NS |
| Pulse rate (evening)            | 47.00       | 46.50       | 46.50       | 0.089  | NS |

NS = Non-significant; SEM = Standard Error of Means; G-1 = Access to water once a day; G-2 = Access to water after 4 days; G-3 = Access to water after 6 days.  
p > 0.05.



**Fig. 1.** Effect of different watering regimes on rectal temperature, respiration rate, and pulse rate.

pulse rate in the evening. The pulse rate did not change during the evening (Table 1). Figure 1 shows a graphical representation of the effect of different watering regimes on pulse rate in the morning and evening.

**Respiration rate (AM and PM)**

No significant difference was observed among groups and within treatments for respiration rate in the morning. Camels of G-3 maintained their normal values of respiration rate to avoid respiratory water loss. These values were similar with G-1 and G-2. Watering regimes had no significant effect on respiration rate in the evening (Table 1). No significant difference was observed among groups and within treatments for respiratory rate in the evening. Water deprivation for 6 days did not change the evening’s respiratory rate, and values were in the range of G-2 and G-1. Figure 1 shows the graphical representation of different watering regimes’ effects on the respiratory rate in the morning and evening.

**Hematology (CBC)**

**Packed cell volume (PCV)**

A significant effect ( $p \leq 0.001$ ) had been found on the PCV of camel blood (Table 2). These findings showed that the PCV of blood was increased with an increase in water deprivation. Mean values were higher in G-3, which was deprived of water for 6 days. The effect of different watering regimes on PCV is shown in Figure 2.

**Hemoglobin (Hb)**

Watering regimes had a significant ( $p < 0.05$ ) effect on Hb level (Table 2). Values of Hb were higher in G-3, which was deprived of water for 6 days. The effect of different watering regimes on Hb levels is shown in Figure 2.

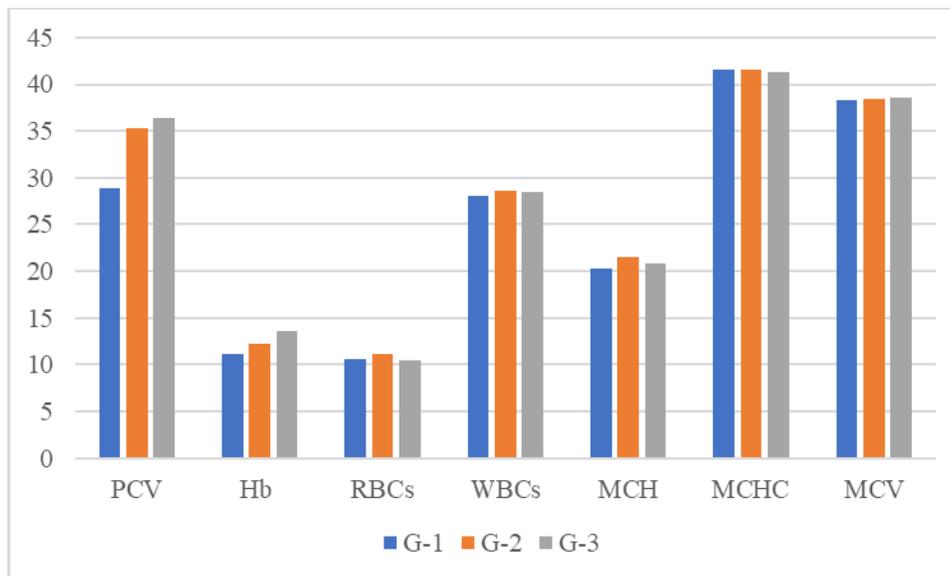
**Red blood cells (RBCs)**

Watering regimes had no significant effect on RBCs (Table 2). Higher values of RBCs were reported in G-2, which was deprived of water for 4 days. The effect of different watering regimes on RBCs is shown in Figure 2.

**Table 2.** Effect of different watering regimes on hematology and CBC.

| Parameters                  | G-1 (n = 4) | G-2 (n = 4) | G-3 (n = 4) | SEM    | p             |
|-----------------------------|-------------|-------------|-------------|--------|---------------|
| PCV (%)                     | 28.91       | 35.34       | 36.41       | 0.38   | <0.001        |
| Hb (g/dl)                   | 11.18       | 12.30       | 13.54       | 0.023  | <0.05         |
| RBCs ( $10^6/\mu\text{l}$ ) | 10.60       | 11.14       | 10.48       | 0.048  | NS $p > 0.05$ |
| WBCs ( $10^3/\mu\text{l}$ ) | 28.08       | 28.59       | 28.51       | 0.0024 | <0.01         |
| MCH (pg)                    | 20.33       | 21.55       | 20.86       | 0.29   | NS $p > 0.05$ |
| MCHC (g/dl)                 | 41.52       | 41.56       | 41.28       | 0.93   | NS $p > 0.05$ |
| MCV (fl)                    | 38.29       | 38.48       | 38.54       | 1.04   | NS $p > 0.05$ |

PCV = Packed Cell Volume; Hb = Hemoglobin; RBCs = Red Blood Cells; WBCs = White Blood Cells; MCH = Mean Corpuscular Hemoglobin; MCHC = Mean Corpuscular Hemoglobin Concentration; MCV = Mean Corpuscular Volume.



**Fig. 2.** Effect of different watering regimes on hematology and CBC.

### White blood cells (WBCs)

A significant ( $p < 0.01$ ) effect was found on WBC by different watering regimes (Table 2). The WBC increased in water-deprived animals of G-3, which were deprived for 6 days. The effect of different watering regimes on WBCs is shown in Figure 2.

### Mean corpuscular Hb

Watering regimes had no significant effect on mean corpuscular hemoglobin (MCH) (Table 2). Water deprivation had no significant effect on mean corpuscular Hb in lactating camels. The effect of different watering regimes on MCH is shown in Figure 2.

### Mean corpuscular hemoglobin concentration (MCHC)

No significant effect had been found on water deprivation on MCHC values (Table 2). Mean values were slightly higher in G-3, which was deprived of water for 6 days. The effect of different watering regimes on MCHC is shown by the graph in Figure 2.

### Mean corpuscular volume (MCV)

Watering regimes had no significant effect on MCV (Table 2). Mean values of MCV were slightly higher in G-3, which was deprived of water for 6 days. The effect of different watering regimes on MCV is shown in Figure 2.

## Discussion

### Physiological parameters

Schmidt-Nielsen *et al.* (1967) agreed that desert mammals could regulate their body temperature over a much wider range daily by some 6°C or 7°C, from about 34°C to 41°C, but this variation is only in cases of severe dehydration and heat load in severe environmental conditions. Body temperature and the respiratory rate decreased with increasing starvation, indicating a reduced metabolism (Zine-Filali *et al.*, 1995). Diurnal variation in the camel's rectal temperature was observed in all groups of this study, but water deprivation for 6 days did not show any significant effect on change in rectal temperature; however, diurnal variation was reported in lactating she-camels. The present findings are not in line with the findings of Schmidt-Nielsen *et al.* (1967), who worked on non-lactating camels and reported that the afternoon temperature in camel is increased with the degree of dehydration, and the body temperature of the camel is increased during periods of water deprivation.

The current findings are not in agreement with the results of Al-Haidary (2005) and Samara *et al.* (2012), who reported that the body temperature of the camels was not affected significantly in the initial 24 hours of the water deprivation period, but later the temperature increased significantly. The present findings are in line with Ayoub and Saleh's (1998) study, which reported that the rectal temperature and respiration rate changes were not significant in camels during water deprivation compared to goats. The rectal temperature of a lactating camel in the evening was

not significantly affected during water deprivation. The present results were supported by Bekele *et al.* (2011), who reported that the rectal temperature in the evening did not change with increasing levels of dehydration in lactating camels. Water deprivation for 6 days had no significant effect on the body temperature of Marecha camel. This may be due to breed tolerance and adaptation in desert conditions because the home tract of this breed is Cholistan and Thal deserts, and water scarcity is a common problem there (Faraz, 2020b). This contradiction is supported by Al-Haidary *et al.* (2013), who agreed that season and breed had a significant effect on physiological parameters in camels.

Pulse rate is the cardinal diagnostic sign of the dehydration status of the animal. Pulse rate was not decreased significantly in the Marecha camel during the water deprivation period and also in the evening time which shows its greater capacity to cope with dehydration stress. The present findings are not in line with the results of Ayoub and Saleh's (1998) study, which reported that pulse rate reduced in both camels and goats as a result of water deprivation for 72 hours. Al-Haidary *et al.* (2013) agreed that season and breed had a significant effect on camels' physiological parameters. Variation in physiological parameters may be a result of water scarcity in desert-like conditions. The rectal temperature in camel is increased when exposed to hot conditions in deserts during summer. Some camel breeds are more tolerant to thermophysiological responses when compared to others.

The current physiological parameters in camels are in line with Sarwar *et al.*'s (1998) study, which reported normal physiological parameters in Pakistani camels in the summer season. During their study, the average respiration rate was 7–16/minutes, average values of pulse rate were 31–72/minutes, and rectal temperature was 97.8–101.8°F. Six days of water deprivation had no significant effect on change in the respiration rate in camels. Respiration rate did not change significantly during dehydration of 6 days in Marecha camel. Bekele *et al.* (2011) supported the findings that during their research of lactating camels, respiration rate was lowered on day 16, and no significant change in respiration rate was observed for water deprivation in lactating camels.

Younas *et al.* (2012) reported that water scarcity is a major issue for the pastoral people of Cholistan, and during drought-like conditions, water sources dry up, and no water is available, which urges the Marecha pastoral people to migrate to irrigated areas. The physiological parameters (body temperature, respiration rate, and pulse rate) in lactating camels did not change significantly in the morning or evening during dehydration when deprived of water for 6 days. This shows the great capacity of the Marecha camel to cope with dehydration stress when no water is available in the desert.

### Hematology (CBC)

The present study's results were supported by the previous study by Siebert and MacFarlane (1975), who studied the comparative physiology of camel and beef cattle when deprived of water for 6 days; PCV was increased in camels during water deprivation. An increase in PCV was reported when the camels were deprived of water for 4 days in this study. Results were also supported by the study of Alhaj *et al.* (2011). The findings of the current study were also supported by Al-Haidary (2005), who reported that a significant increase in PCV of blood was found when camels were dehydrated (deprived of water for 4 days). The current findings contradict Ayoub and Saleh's (1998) study, who reported that PCV was not changed during a 72-hour water deprivation. Samara *et al.* (2012) also reported that PCV changes in camel were lower compared to goats in a comparative study between camel and goats during the water deprivation period.

The present findings are not in line with the previous work of Masoumi *et al.* (2011), who reported that 6 days of water deprivation had no significant effect on blood constituents in a one-humped camel. Mean values of Hb reported in our study were almost similar to  $12.00 \pm 0.63$  g/dl as reported by Farooq *et al.* (2011) working in Pakistan, while lower than that was reported by Faraz *et al.* (2020) at 14–16.6 g/dl in Pakistani dromedary calves. Ayoub and Saleh (1998) also agreed that the Hb level was found significantly increased in camels when deprived of water for 72 hours.

Variation in Hb values may be due to the seasonal effect (Babeker *et al.*, 2013). Nawal *et al.* (2012) reported that Hb percentage ranged from 4.1 to 11.9 g/dl in UAE camel breeds. The MCV of camel RBCs was relatively low, and after dehydration, it declined due to shrinkage of the cell. Hb mean values were 7.5, 8.4, and 9.7 g/100 ml of blood in dry summer. Breed variation had a significant effect on blood constituents (Nawal *et al.*, 2012). El-Harairy (2010) also reported that the season had a significant effect on hematological values of camel, and the highest ( $p < 0.05$ ) values of Hb was  $12.30 \pm 0.29$  g/dl.

The findings of the current study were supported by Alhaj *et al.* (2011), who agreed that there was a significant ( $p < 0.01$ ) increase in the leukocyte count ( $p < 0.01$ ) of dehydrated camels when compared to the control group having free access to water. Al-Toum and Al-Johany (2000), while working on the effect of water deprivation on Idmi Gazelle, agreed that water deprivation significantly impacted WBCs. Ayoub and Saleh (1998) also reported the same, that WBCs were significantly affected in camel when deprived of water for 72 hours. The present study did not agree with the findings of Masoumi *et al.* (2011), who reported that water deprivation did not have any effect on blood constituents.

### Conclusion

The present study's findings concluded that camels could live without water for 6 days in the desert ecology very

easily, but feed intake is decreased. No severe changes in CBC and physiological parameters were reported in this study. So, this shows that the camel is unique in its physiological adaptation in hot and hostile environments. The present results are limited to the desert ecology of CBRS Rakh Mahni Bhakkar Punjab, Pakistan.

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### Conflict of interest

The authors declare that there is no conflict of interest.

### Authors' contributions

All authors contributed to make the completion of this manuscript possible. Naeem Ullah Khan conducted the research trials; Muhammad Younas and Muhammad Yaqoob supervised the research; Muhammad Shahid Nabeel helped in conducting the research trials; Asim Faraz helped in the research trials and wrote the paper; Ayman Balla and Monjid Ahmed analyzed the data and reviewed the paper.

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