

Research Article



Haematological Profile of Marecha Male Camel (*Camelus dromedarius*) during Rutting and Non-Rutting Season under Farming System

ASIM FARAZ^{1*}, ABDUL WAHEED¹, NASIR ALI TAUQIR², RIAZ HUSSAIN MIRZA¹, MUHAMMAD SHAHID NABEEL³

¹Department of Livestock and Poultry Production, Bahauddin Zakariya University Multan, Pakistan; ²Department of Animal Science, University of Sargodha, Pakistan; ³Camel Breeding and Research Station Rakh Mahni, Livestock and Dairy Development Department, Punjab, Pakistan.

Abstract | This study was undertaken to investigate haematological parameters of Pakistani male dromedary camel in rutting and non-rutting conditions. Five clinically healthy male Marecha camels of 5-10 years old having average body weight of 690±40 kg were studied for haematology in non-rut (August) and rut (February) season. The animals were kept in semi-open pens throughout the experiment, fed with concentrate, fodder, gram straw and available jungle grazing/browsing daily for 4-6 hr. Water was provided twice daily. The animals were dewormed and vaccinated regularly after three months, according to routine farm practices. Haematological parameters were analyzed on haematology analyzer. Haemoglobin (Hb), red blood cell (RBC) counts, white blood cell (WBC) counts, granulocyte, lymphocytes, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined. The Hb concentrations ($P>0.05$) were found to be 14.86±1.28 and 14.26±1.12 gm/dl respectively in non-rut and rut season, being higher in non-rutting males. The values of RBC, WBC, PCV, MCV and MCHC were found to be differed-significantly ($P<0.05$) among groups being higher in non-rutting males except WBC which was higher in rutting camels. The values of granulocytes, lymphocytes and MCH were found to be non-significantly ($P>0.05$) varied among groups. The findings are discussed in relation to reported results and could be used as a primary database for future studies.

Keywords | Camel, Haematology, Desert, Pastoral, Physiological condition

Received | June 24, 2020; **Accepted** | September 04, 2020; **Published** | January 01, 2021

***Correspondence** | Asim Faraz, Department of Livestock and Poultry Production, Bahauddin Zakariya University Multan, Pakistan; **Email:** drasimfaraz@bzu.edu.pk

Citation | Faraz A, Waheed A, Tauqir NA, Mirza RH, Nabeel MS (2021). Haematological profile of marecha male camel (*Camelus dromedarius*) during rutting and non-rutting season under farming system. *Adv. Anim. Vet. Sci.* 9(2): 175-181.

DOI | <http://dx.doi.org/10.17582/journal.aavs/2021/9.2.175.181>

ISSN (Online) | 2307-8316; **ISSN (Print)** | 2309-3331

Copyright © 2021 Faraz et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Like other farm animals camels are classified as ruminants but pseudo-ruminant regarding the variation in stomach anatomy. Unlike other ruminants, they have no horns, have long necks and evenly padded feet with two toes (Al-Harbi, 2012). They are capable of using water very efficiently (Faraz et al., 2019a). Camels are animals with a very high level of red blood cells which are oval in shape and have the capacity to fill up to 230% at the availability of water. Due to this ability, camels have no match in thriving under hostile environments (Osman

and Al-Busadah, 2003; Faraz, 2020a).

These mammals are classified as real dervishes i.e. dromedary (single humped), bactrian (double humped), new world (llama and alpaca) and South American (guanaco and vicuna) (Bogin, 2000). As mentioned above, old world camels are basically divided into two groups as Dromedary or Arabian (*Camelus dromedarius*) and Bactrian (*Camelus bactrianus*). While Arabian camels have one hump, Bactrian camels have two humps (Faraz et al., 2019b). One-humped or Arabian camels are well-adapted to hot, harsh and arid environments. Cameleers breed

them for milk, meat, wool, hair, transport and sometimes for aesthetic preferences (Faraz et al., 2019c).

Investigation of blood constituents could provide valuable outputs and indications about the general health status and physiological condition of animals. Observation of deviation of certain blood parameters from normal range could be an indication for diagnosis/differential diagnosis of a diseased condition (Abebe et al., 2002). Realizing this, it is evident that increased fundamental knowledge of hemogram and blood metabolites contributes greatly to the understanding of physiology in dromedaries.

Male dromedary camels are known as seasonal breeders, where the breeding season is confined to the cool winter months of the year (Marai et al., 2009). In rutting condition, the male exhibits morphological, behavioral and endocrinological changes. In addition to this there are also haematological alterations (Dessouky, 1992). The rut stage in a male can last up to 100 days. However, the marked peak in sexual activity is during the breeding season. It is generally thought that the male is sexually quiescent for the remainder of the year but is still capable of mating and fertilizing the estrous female at any time of the year (Tibary and Anouassi, 1997).

As the haematological picture serves as an indicator of health and physiological status, many researchers studied camel hematology influenced by season, age, health status and lactation stage in Saudi-Arabia, Sudan and Iran (Al-Busadah and Osman, 2000; Babeker et al., 2013; Jalali et al., 2018). However, in Pakistan, only limited information on camel hematology is available, with most of the research work being survey reports under the traditional system (Faraz et al., 2018; Faraz et al., 2019d). The previous studies do not justify the requirements of subject; therefore, this study was planned to investigate haematological indices of the Pakistani Marecha male dromedary camel during rutting and non-rutting season, under the farming system at Thal desert. These results could be useful in building the country's database for future studies of this field.

MATERIALS AND METHODS

LOCATION OF STUDY AREA

The CBRS is located in the deserted plain of Thal. There is subtropical, continental, and arid to semi-arid climate, having mean summer temperature as 45.6 °C and winter as 5.5-1.3 °C. Annual mean rainfall is 150-350 mm increasing from South to North (Rahim et al., 2011).

EXPERIMENTAL ANIMALS AND MANAGEMENT

Five male camels of Marecha breed of 5-10 years old with average body weight of 690±40 kg reared under semi-intensive conditions were used for sampling. All animals

were found physically healthy and were dewormed by injection 1% Ivermectin @ 1ml/50 kg body weight after every three months. Animals were sprayed with Ecofleec solution @ 1cc/liter water for animals and 2cc/liter of water for shed. They were vaccinated for Trypanosomiasis by injection Trypanemedium-Samorine (Isometamidium chloride) 1 gm sachet for four adult camels after every three months as per farm routine practices. They were housed in semi-open pens at farm.

The animals were fed concentrate @ 4-5 kg/day having ingredients; maize grain (9%), wheat bran (24%), cotton seed cake (25%), rape seed cake (6%), corn gluten 30% (20%), molasses (14%), DCP (1%) and salt (1%). The percent chemical composition of concentrate was; dry matter (90.32), crude protein (18.06), neutral detergent fiber (29.09), acid detergent fiber (14.41), total digestible nutrients (70) and metabolizable energy (2.41 Mcal/kg DM). The animals were sent for jungle grazing/browsing for 4-6 hours daily. They were fed *Cicer arietinum* (gram straw) 5 kg daily as manger feeding. Twice watering was provided. Salt lumps were placed in mangers while 80-100 gm mineral mixture was fed per camel daily.

SAMPLING AND LAB ANALYSIS

Blood films from all animals were examined. Camels were properly restrained before collection of blood sample. The jugular vein was cleaned and treated with antiseptic (*spirit*) before and after collection of the blood. Blood samples were collected from jugular vein into test tubes; EDTA was used as anticoagulant and immediately analyzed. Haematological parameters were analyzed on haematology analyzer (BC 2300, Mindray Germany). Samplings were done weekly for the period of one month and all tests were performed in duplicate. Hb, RBC, WBC, Granulocytes, Lymphocytes, PCV, MCV, MCH and MCHC were determined.

The forage species available for grazing/browsing were *Acacia nilotica*, *Acacia modesta*, *Ziziphus mauritiana*, *Albizia labbek*, *Prosopis cineraria*, *Tamarix aphylla*, *Cenchrus ciliaris*, *Suaeda fruticosa*, *Cymbopogon schoenanthus*, *Kochia indica*, *Tribulus terrestris*, *Capparis spinosa*, *Haloxylon salicornicum*, *Calligonum polygonoides*, *Capparis decidua* and *Haloxylon recurvum* (Faraz, 2020b).

STATISTICAL ANALYSIS

The SPSS (SPSS, 2008) software was used to analyze the data statistically by applying t-test on different parameters (Gecer et al., 2016; Akin et al., 2017).

RESULTS AND DISCUSSION

HAEMOGLOBIN

The mean values of Hb (P>0.05) were found to be

14.86±1.28, 14.26±1.12 gm/dl respectively in non-rutting and rutting males being normal but higher in non-rutting camels (Table 1). Hb was found greater in males as compared to females, probably due to increased level of erythropoiesis which is accelerated by erythropoietin in response to the testosterone effects on kidneys (Murphy, 2014). Hb concentrations varied between 13 to 16 gm/dl, slightly higher compared to other domestic species.

Current findings are very near to the reported results of Farooq et al. (2011), Elitok and Cirak (2018), Abdalmula et al. (2018, 2019) and Faye and Bengoumi, 2018. While Hb was observed higher than documented results of Amin et al. (2007), Zaher et al. (2017), Adah et al. (2017), Ghafoor et al. (2018), Ebissy et al. (2019) and Islam et al. (2019). However, Hb was found at greater level in Indian dromedary camel as reported by Narnaware et al. (2016).

Amin et al. (2007) reported Hb concentration as 10.67±0.19 and 10.73±0.18 gm/dl respectively, in dry and green season in Sudanese dromedary camel. Farooq et al. (2011) reported mean concentration and range for Hb as 12.00±0.63, 11.34±0.95; 7-17, 8-17 gm/dl in Pakistani dromedary male and females, respectively in Cholistan Desert. Reported Hb concentration was 14.49±1.46, 14.80±1.15, 15.20±1.40 and 14.20±1.55 gm/dl in Saudi Arabian dromedary male camel during pre-rut, non-rut, post-rut and rut season (Al-Harbi, 2012). The Hb concentration in the present study was also found to be in same pattern, as lower values were reported in rutting season: Consequently, this indication may be used as diagnosis of rutting behavior and condition by testing this important parameter if we know about the normal parameters in non-rutting males.

Reported Hb concentration was 7.80±0.42 gm/dl in Sudanese nomadic dromedary camels (Babeker, 2013). Eltayeb et al. (2015) studied the effect of water deprivation on blood constituents of the Sudanese male dromedary camel and reported mean Hb concentration as 12.8±0.6, 11.7±0.5 and 10.1±0.4 gm/dl in groups not being deprived of water, deprived of water for 48h and 4hr after provision of water, respectively. On the other side, Hb concentration was found to be 14.06±0.24 gm/dl in female dromedary camels (Zaher et al., 2017). Adah et al. (2017) reported Hb concentration as 7.33±0.35 gm% in Nigerian dromedary camel. Reported Hb concentration in Bangladeshi dromedary camels was 10.4 gm/dl (Islam et al., 2019). The reported Hb values were found to be varied in the majority of the references between 9.3-15.5 gm/dl as documented by Faye and Bengoumi (2018).

Ghafoor et al. (2018) reported average Hb concentration as 11.78±0.57 gm/dl in Pakistani dromedary camels in Desert Thal. Elitok and Cirak (2018) reviewed haematological features of camels and reported Hb concentration as

14.8±1.2 and 14.2±1.5 gm/dl during non-rut and rut season in male dromedary camels, respectively. Abdalmula et al. (2018) reported Hb concentration and range as 12.55±0.27 and 7.28-17.70 gm/dl, respectively in Libyan dromedary camel. In a different preview, Abdalmula et al. (2019) reported Hb concentration as 11±0.41 and 13.44±0.27 gm/dl in Libyan dromedary males and females, respectively. While reported Hb concentration was 10.62±0.55 gm/dl in female dromedary camels (Ebissy et al., 2019).

RBC AND WBC

The mean values of RBC and WBC were found to be varied significantly ($P<0.05$) among groups, being a higher concentration of RBC in non-rutting and WBC in rutting males. The granulocytes and lymphocytes concentration were found to be varied non-significantly ($P>0.05$) among groups (Table 1).

The mean values of RBC counts are comparable to that reported by Al-Busadah and Osman (2000), Al-Harbi (2012), Adah et al. (2017), Zaher et al. (2017), Abdalmula et al. (2018, 2019), Elitok and Cirak (2018), Ebissy et al. (2019) and Islam et al. (2019). While values observed for RBC in present study are greater than reported by Amin et al. (2007), Farooq et al. (2011) and Ghafoor et al. (2018). These differences may be due to different geographical, climatic and genetic variations (Saeed and Hussein, 2008).

Reported RBC concentration in Sudanese dromedary camel was 6.41±0.15 and 5.79±0.14 $10^6/\mu\text{l}$ respectively, in dry and green season (Amin et al., 2007). In Pakistan, Farooq et al. (2011) reported mean concentration and range for total erythrocytic and leucocytic count as 6.83±0.38, 7.31±0.58; 4.3-12.4, 4.25-12.9 $10^6/\mu\text{l}$ and 12.38±0.97, 12.97±0.99; 4-22.3, 4.2-20.9 $10^3/\mu\text{l}$ in male and females; respectively, in dromedary camel in Desert Cholistan. Reported concentration and range of lymphocytes was 47.50±1.40, 48.60±1.50 and 40-55, 43-63 % in male and females, respectively. Reported RBC ($10^6/\mu\text{l}$), WBC ($10^3/\mu\text{l}$) and lymphocytes (%) concentrations were to be 3.03±0.08, 7.70±0.22 and 40.16±0.70 in Sudanese nomadic dromedary camel (Babeker, 2013).

Adah et al. (2017) reported erythrocytes and leukocytes concentration as 15.05±2.10 $10^{12}/\text{l}$ and 16.20±0.32 $10^9/\text{l}$ respectively, in Nigerian dromedary camel. Reported erythrocytic and leukocytic count of dromedary camels in Bangladesh was 5.3 million/cumm and 8.9 thousand/cumm respectively (Islam et al., 2019). However, total erythrocytic count was found at a higher level in Indian dromedary camel, as reported by Narnaware et al. (2016). Ghafoor et al. (2018) reported total erythrocyte count as 7.25±0.08 $10^6/\mu\text{l}$ in Pakistani dromedary camel in Desert Thal.

Reported concentrations of RBC ($10^6/\mu\text{l}$) and WBC ($10^3/\mu\text{l}$) were 10.55 ± 1.39 , 10.30 ± 1.68 ; 10.90 ± 1.04 , 10.10 ± 1.20 ; 9.87 ± 1.33 , 9.70 ± 1.48 ; 8.90 ± 1.45 , 10.5 ± 1.89 during pre-rut, non-rut, post-rut and rut season in male dromedary camels (Al-Harbi, 2012). Current study results are in agreement with these findings as RBC concentration was observed lower in rut season while the WBC concentration was found higher in rut season. The lymphocytes and granulocytes percentages in present study were also found to be higher in rutting males. These measurements could be used as indication of rut, so the breeding season of dromedary male can be diagnosed by testing these parameters.

While reported RBC concentration was 9.48 ± 0.16 $10^6/\mu\text{l}$ in female dromedary camels (Zaher et al., 2017). Elitok and Cirak (2018) reviewed haematological features of camels and reported RBC concentration as 10.90 ± 1.04 , 8.90 ± 1.45 $10^6/\mu\text{l}$ in male dromedary camels during non-rut and rut season, respectively. White blood cells were found higher in number as compared to previous results reported by Rezakhani et al. (1997), Singh et al. (1997) and Mohamed and Hussein (1999). The mean Lymphocyte percentage was found to be higher than the findings of Al-Busadah and Osman (2000), while lower than of Al-Busadah (2007). The mean Granulocytes percentages are lower than reported concentration by Al-Busadah and Osman (2000), while higher than that of Al-Busadah (2007).

Amin et al. (2007) reported lymphocytes concentration as 56.24 ± 1.57 and 34.93 ± 1.54 percent respectively, in dry and green season in Sudanese dromedary camel. Reported Lymphocytes concentrations were 40 ± 1.32 , 45 ± 1.05 , 50 ± 1.19 and 54 ± 1.48 % during pre-rut, non-rut, post-rut and rut season in male dromedary camels, respectively (Al-Harbi, 2012). Eltayeb et al. (2015) studied the effect of water deprivation on blood constituents of the Sudanese male dromedary camel and reported mean concentrations of RBC ($10^6/\mu\text{l}$) and WBC ($10^3/\mu\text{l}$) as 8.6 ± 0.5 , 10.8 ± 2.4 ; 11.6 ± 1.5 , 12.7 ± 1.9 and 7.9 ± 0.6 , 10.2 ± 2.0 respectively, in groups not being deprived of water, deprived of water for 48hr and 4hr after provision of water.

The reported value for lymphocytes in Nigerian dromedary camel was 6.05 ± 0.3 $10^9/l$ (Adah et al., 2017). Elitok and Cirak (2018) reported WBC concentration as 10.10 ± 1.20 and 10.5 ± 1.89 ($10^3/\mu\text{l}$) in males of non-rut and rut season, respectively. The reported range was 7.5-22 in adult camels, while lymphocytes concentration was 45 ± 1.05 and 54 ± 1.48 % in males of non-rut and rut season, respectively. Reported lymphocytes concentration for normal camels was 41%. On the other side, reported concentrations of RBC and WBC were found to be 10.74 ± 0.42 $10^6/\mu\text{l}$ and 9.96 ± 1.22 $10^3/\mu\text{l}$ in female dromedary camels during transition period (Ebissy et al., 2019).

Abdalmula et al. (2018) reported RBC ($10^6/\mu\text{l}$) and WBC ($10^3/\mu\text{l}$) concentration and range as 11.79 ± 0.36 , 10.98 ± 0.50 and 7.53-30.88, 4.75-21.20, respectively in Libyan dromedary camels while lymphocytes concentration and range was found to be 6.73 ± 0.38 and 2.60-18.05 $10^3/\mu\text{l}$, respectively. Islam et al. (2019) reported the lymphocytes percentage as 48.6 in Bangladeshi dromedary camels. Reported RBC and WBC concentration were to be 12.27 ± 0.89 $10^6/\mu\text{l}$ and 10.45 ± 0.86 $10^3/\mu\text{l}$ respectively, in Libyan male dromedary camels.

PCV, MCV, MCH AND MCHC

The mean values of PCV, MCV and MCHC were found to be varied significantly ($P < 0.05$) while MCH non-significantly ($P > 0.05$) among groups. All values were found to be normal but on the higher side in non-rutting camels (Table 1).

Table 1: Mean haematological profile of male Marecha camel (n=5) during rutting and non-rutting season.

Parameters	Non-rut (August)	Rut (February)
Haemoglobin (gm/dl)	14.86 ± 1.28^a	14.26 ± 1.12^b
RBC ($10^6/\mu\text{l}$)	10.55 ± 0.96^a	8.80 ± 0.88^b
WBC ($10^3/\mu\text{l}$)	26.35 ± 4.18^a	29.31 ± 2.93^b
Granulocytes (%)	56.47 ± 2.66^a	57.78 ± 2.32^a
Lymphocytes (%)	31.46 ± 1.50^a	32.66 ± 2.04^a
PCV (%)	38.36 ± 2.34^a	35.24 ± 1.45^b
MCV (fl)	38.47 ± 1.62^a	36.26 ± 1.44^b
MCH (pg)	21.49 ± 1.69^a	20.89 ± 1.28^a
MCHC (gm/dl)	54.53 ± 2.48^a	51.98 ± 2.78^b

Means having different superscript in columns are significantly different ($P < 0.05$); RBC: Red Blood Cell Count; WBC: White Blood Cell Count; PCV: Packed Cell Volume; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Haemoglobin; MCHC: Mean Corpuscular Haemoglobin Concentration.

In the present study, the values found are very close to the observed results by Al-Harbi (2012), Adah et al. (2017), Zaher et al. (2017), Abdalmula et al. (2018, 2019), Elitok and Cirak (2018), Ebissy et al. (2019) and Islam et al. (2019). Horse, cattle and camel showed higher number of RBC so MCV values are lower as compared to other species (Sarwar and Majeed, 1997). The reported MCH concentrations were higher than reported values by Al Busadah and Osman (2000), Amin et al. (2007), Al Busadah (2007) and Saeed and Hussein (2008). MCHC values are greater in the current study as compared to the values reported by (Al-Busadah, 2004; Saeed and Hussein, 2008). These higher values showed that the oxygen carrying capacity of camel blood is more, as reported by (Rezakhani et al., 1997; Al-Busadah and Osman, 2000).

Amin et al. (2007) reported mean concentration of PCV (%), MCV (fl), MCH (pg), MCHC (gm/dl) as 25.14±0.33, 25.95±0.32; 40.09±0.81, 46.43±0.79; 16.99±0.43, 19.44±0.42; 42.49±0.63, 41.62±0.61 respectively, in dry and green season in Sudanese dromedary camel. In Pakistan, Farooq et al. (2011) reported mean concentration and range for PCV (%), MCV (fl), MCH (pg), MCHC (gm/dl) as 37.21±2.48, 32.83±3.76 and 22-67, 24-50; 57.13±5.09, 50.24±7.72 and 27-140, 26-103; 18.69±1.45, 17.80±2.21 and 11-35, 7-35; 33.61±1.42, 34.81±2.16 and 22-46, 27-42 in dromedary male and females, respectively in Desert Cholistan.

Reported PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) concentrations were to be 38.20±2.29, 39.60±3.18, 15.90±2.30 and 49.50±3.60; 39.80±1.99, 40.10±2.86, 16.70±1.97 and 49.30±3.12; 41.20±2.15, 37.20±3.13, 16.40±2.21 and 47.40±3.44; 39.50±2.65, 36.40±3.39, 16±2.37 and 46.20±3.77 respectively during pre-rut, non-rut, post-rut and rut season in male dromedary camels (Al-Harbi, 2012). Current findings are in line with these results as higher concentrations were found in non-rutting males, so these indications could be used as diagnosis of breeding season in rutting dromedary camels.

Reported PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) concentrations were to be 19.48±1.28, 48.56±0.36, 26.26±0.15 and 75.54±0.11 respectively, in Sudanese nomadic dromedary camels (Babeker, 2013). Eltayeb et al. (2015) studied effect of water deprivation on blood constituents of the Sudanese male dromedary camel and reported mean concentrations of PCV as 28.7±1.5, 26.2±1.1 and 23.4±0.5 % respectively, in groups not being deprived of water, deprived of water for 48h and 4hr after provision of water. Reported concentrations of PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) were to be 28.62±0.31, 36.45±0.51, 14.02±0.17 and 42.23±0.19, respectively in female dromedary camels (Zaher et al., 2017).

The mean value for PCV % was reported as 25.71±0.13 in Nigerian dromedary camel (Adah et al., 2017). Islam et al. (2019) reported PCV concentration as 36.5 % in Bangladeshi dromedary camels while in Sudanese camel as 23.44 % (Ibrahim et al., 2015). Ghafoor et al. (2018) reported average concentration of PCV as 29.25±0.13 % in Pakistani dromedary camels in Desert Thal. Elitok and Cirak (2018) reviewed haematological features of camels and reported PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) concentration as 39.80±1.99, 39.50±2.65; 40.10±2.86, 36.40±3.39; 16.70±1.97, 16±2.37 and 49.30±1.39, 46.20±3.77 in males of non-rut and rut season, respectively.

Abdalmula et al. (2018) reported concentration and range of PCV (%), MCV (fl), MCH (pg) and MCHC (gm/

dl) as 33.47±1.01, 16.00-50.00; 29.24±0.93, 7.10-48.70; 11.06±0.32, 3.30-18.60 and 39.38±1.30, 21.60-87.30 respectively, in Libyan dromedary camel. Reported PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) concentrations were 29.71±1.67, 25.45±1.37, 9.68±0.61 and 39.76±2.76 respectively, in male dromedary camels (Abdalmula et al., 2019). On other hand, reported concentrations of PCV (%), MCV (fl), MCH (pg) and MCHC (gm/dl) were to be 32.10±1.44, 30.06±1.53, 8.98±0.54 and 26.65±0.95 in female dromedary camels during transition period (Ebissy et al., 2019).

CONCLUSIONS AND RECOMMENDATIONS

The study of blood parameters could serve as mirror of animal welfare and, consequently of general health status and physiological condition. Indeed, rutting season could affect animal welfare, which is considered related to animal's needs, influencing on nutrition, behaviour, and reproduction (Previti et al., 2016). This study has documented the haematological indices in Pakistani Marecha male dromedary camels in breeding and non-breeding season. The elevated levels of blood parameters like WBC, granulocytes and lymphocytes affected by rutting condition, while other parameters i.e. RBC, PCV, MCV, MCH and MCHC were found lower in rutting season which affect general physiological state and function including sexual performance. Consequently, these parameters could be used to detect the rutting dromedary males and the results will be a useful addition in primary database of country.

ACKNOWLEDGEMENT

The Authors gratefully acknowledge the cooperation and kind support of the management of Camel Breeding and Research Station (CBRS) Rakh Mahni district Bhakkar, Punjab Pakistan.

AUTHOR'S CONTRIBUTIONS

All authors contributed to make the completion of this manuscript possible. Asim Faraz conducted research and wrote the paper. Muhammad Shahid Nabeel helped in conduct of research. Abdul Waheed and Riaz Hussain Mirza helped in analysis. Nasir Ali Tauqir helped in write up.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

- Abdalmula AM, Benashour FM, Shmela ME, Alnagar FA, Abograra IM, Buker AO (2019). Blood profile in normal one humped dromedary (*Camelus dromedarius*) camels in Libya. Part 3: Effect of sex variation on biochemical and haematological blood profile. *Int. J. Sci. Basic Appl. Res.*, 48: 9-24.
- Abdalmula AM, Buker AO, Benashour FM, Shmela ME, Abograra IM, Alnagar FA (2018). Blood profile in normal one humped dromedary (*Camelus dromedarius*) camel breeds in Libya. Part 1: Determination of biochemical and haematological blood profile. *Int. J. Res. Med. Basic Sci.*, 4: 1-19.
- Abebe W, Getinet AM, Mekonnen HM (2002). Study on live weight, carcass weight and dressing percentage of Issa camels in Ethiopia. *Rev. Med. Vet.*, 153: 713-716.
- Adah AS, Ayo JO, Rekwot PI, Aluwong T, Arimic DI (2017). Haematological profile of the one-humped camel subjected to packing (load-carrying) in the harmattan season in the semi-arid region of Nigeria. *Bangladesh J. Vet. Med.*, 15: 39-44. <https://doi.org/10.3329/bjvm.v15i1.34053>
- Akin M, Eydurán E, Reed BM (2017). Use of RSM and CHAID data mining algorithm for predicting mineral nutrition of hazelnut. *Plant Cell, Tissue Organ Culture (PCTOC)*. 128(2): 303-316.
- Al-Busadah KA, Osman TEA (2000). Haematological parameters of adult dry, lactating and camel calves in Saudi Arabia. *Pak. J. Biol. Sci.*, 3: 1749-1751.
- Al-Busadah KA (2004). Effect of breed on haemogram of adult dromedary camels in Saudi Arabia. *J. Camel Prac. Res.*, 11: 115-118.
- Al-Busadah KA (2007). Some biochemical and haematological indices in different breeds of camels in Saudi Arabia. *Sci. J. King Faisal Univ. (Basic Appl. Sci.)*, 8: 131-142.
- Al-Harbi MS (2012). Some haematological values and serum biochemical parameters in male camels (*Camelus dromedarius*) before and during rut. *Asian J. Anim. Vet. Adv.*, 7: 1219-1226. <https://doi.org/10.3923/ajava.2012.1219.1226>
- Amin ASA, Abdoun KA, Abdelatif AM (2007). Seasonal variation in blood constituents of one-humped camel (*Camelus dromedarius*). *Pak. J. Biol. Sci.*, 10: 1250-1256. <https://doi.org/10.3923/pjbs.2007.1250.1256>
- Babeker E, Elmansoury Y, Suleem A (2013). The influence of season on blood constituents of dromedary camel (*Camelus dromedarius*). *Online J. Anim. Feed Res.*, 3: 1-8.
- Babeker EA (2013). Observation of certain haematological and biochemical parameters in nomadic camels (*Camelus dromedarius*) in the Sudan. *Univ. Bakht Alruda Sci. J.*, 6: 167-174.
- Bogin E (2000). Clinical pathology of Camelidae: Present and future. *Rev. Vet. Med.*, 151: 563-568.
- Dessouky MI (1992). Studies on the hemogram and blood biochemical constituents in camel in health and disease. *Proceedings of the training course on camel diseases*, April 11-30, 1992. *Arab Organ. Agric. Dev. Cairo*, pp. 333-344.
- Ebissy EA, El-Sayed AA, Mohamed RH (2019). Haematological and biochemical profile in female camels (*Camelus dromedarius*) during the transition period. *Slov. Vet. Res.*, 56: 571-577. <https://doi.org/10.26873/SVR-794-2019>
- Elitok B, Cirak AC (2018). Clinical, haematological and blood biochemical features of camel. *MOJ Immunol.*, 6: 288-295.
- Eltayeb R, Osman H, Babiker E (2015). The effect of water deprivation on blood constituents of the dromedary camel (*Camelus dromedarius*). *Am. Sci. Res. J. Eng. Technol. Sci.*, 14: 258-264.
- Faraz A (2020a). Portrayal of Camel Production in The Desert Ecosystem of Pakistan. *J. Zool. Res.*, 2: 15-20. <https://doi.org/10.30564/jzr.v2i3.2104>
- Faraz A (2020b). Growth potential of *Camelus dromedarius* calves reared under intensive and extensive feeding management systems. *Pakistan J. Zool.*, 52: 1493-1500. <https://doi.org/10.17582/journal.pjz/20190714150716>
- Faraz A, Waheed A, Mirza RH, Ishaq HM (2019a). The camel a short communication on classification and attributes. *J. Fisheries Livest. Prod.*, 7: 289.
- Faraz A, Waheed A, Mirza RH, Ishaq HM, Tariq MM (2019b). Socio economic status and associated constraints of camel production in desert Thal Punjab, Pakistan. *J. Fisheries Livest. Prod.*, 7: 288.
- Faraz A, Younas M, Lateef M, Muhammad G (2018). Effect of intensive and semi-intensive management systems on growth performance and economics of Marecha (*Camelus dromedarius*) calves reared under desert conditions. *Pak. J. Agric. Sci.*, 55: 625-632.
- Faraz A, Waheed A, Mirza RH, Ishaq HM (2019c). Role of camel in food security: A perspective aspect. *J. Fisheries Livest. Prod.*, 7: 290.
- Faraz A, Younas M, Waheed A, Yaqoob M, Ishaq K (2019d). Growth performance and hair mineral status of Marecha (*Camelus dromedarius*) calves reared under different management systems. *Pakistan J. Zool.*, 51: 503-509.
- Farooq U, Samad HA, Khurshid A, Sajjad S (2011). Normal reference haematological values of one-humped camels (*Camelus dromedarius*) kept in Cholistan desert. *J. Anim. Plant Sci.*, 21: 157-160.
- Faye B, Bengoumi M (2018). *Camel clinical biochemistry and hematology*. Cham: Springer, ISBN: 978-3-319-95560-5. <https://doi.org/10.1007/978-3-319-95562-9>
- Gecer MK, Akin M, Gundogdu M, Eydurán SP, Ercisli S, Eydurán E (2016). Organic acids, sugars, phenolic compounds, and some horticultural characteristics of black and white mulberry accessions from Eastern Anatolia. *Can. J. Plant Sci.*, 96: 27-33. <https://doi.org/10.1139/cjps-2015-0070>
- Ghafoor M, Deeba F, Qureshi AS, Qamar-un-Nisa (2018). Prevalence of haemoparasites of camels (*Camelus dromedarius*) in Thal desert Pakistan in winter. *EC Vet. Sci.*, 3: 246-249.
- Ibrahim AM, Ismail AA, Majid AMA, Rahman AHA, Angara TEE (2015). Packed cell volume values of Sudanese camels grazing under open system: with emphasis to its importance for "Guffar" management and control. Special issue in the occasion of the regional conference of camel management and production under open range system (RCCMPR), Khartoum-Sudan, 2nd-4th March 2015.
- Islam S, Ferdous J, Rahman MK, Akhtar S, Hassan MM, Islam A (2019). Reference values for haematological and serum biochemical parameters of dromedary camel (*Camelus dromedarius*) in sub-tropical climate of Bangladesh. *Adv. Anim. Vet. Sci.*, 7: 232-237. <https://doi.org/10.17582/journal.aavs/2019/7.4.232.237>
- Jalali SM, Hasani YN, Darabifard A, Mavadati AH (2018). A study of hematologic and biochemical profile in

- female dromedary camels during the breeding and non-breeding seasons. *Comp. Clin. Pathol.*, pp. 1-5. <https://doi.org/10.1007/s00580-018-2645-1>
- Marai IFM, Zeidan AEB, Abdel-Samee AM, Abizaid A, Fadiel A (2009). Camels reproductive and physiological performance traits as affected by environmental conditions. *Trop. Subtrop. Agroecosyst.*, 10: 129-149.
 - Mohamed HA, Hussein AN (1999). Studies on normal haematological and serum biochemical values of the 'Hijjin' racing camels (*Camelus dromedarius*). *Vet. Res. Commun.*, 23: 241-248.
 - Murphy WG (2014). The sex difference in haemoglobin levels in adults mechanisms, causes, and consequences. *Blood Reviews*. <https://doi.org/10.1016/j.blre.2013.12.003>
 - Narnaware S, Ranjan R, Sawal R, Nath K, Patil N (2016). A comparative study on haematological and blood biochemical profile of double humped (*Camelus bactrianus*) and single humped camel (*Camelus dromedarius*). *J. Camel Prac. Res.*, 23: 109-110. <https://doi.org/10.5958/2277-8934.2016.00017.5>
 - Osman TEA, Al-Busadah KA (2003). Normal concentrations of twenty serum biochemical parameters of She-camels, Cows and Ewes in Saudi Arabia. *Pak. J. Biol. Sci.*, 6: 1253-1256. <https://doi.org/10.3923/pjbs.2003.1253.1256>
 - Previti A, Guercio B, Passantino A (2016). Protection of farmed camels (*Camelus Dromedarius*): Welfare problems and legislative perspective. *Anim. Sci. J.*, 87(2): 183-189. <https://doi.org/10.1111/asj.12446>
 - Rahim SMA, Hasnain S, Farkhanda J (2011). Effect of calcium, magnesium, sodium and potassium on farm plantations of various agroecological zones of Punjab, Pakistan. *Afr. J. Plant Sci.*, 5: 450-459. <https://doi.org/10.5897/AJPS11.070>
 - Rezakhani A, Habibabadi SN, Ghogh MM (1997). Studies on normal haematological and biochemical parameters of Tuurkmen camel in Iran. *J. Camel Prac. Res.*, 4: 41-44.
 - Saeed A, Hussein MM (2008). Change in normal haematological values of camels (*Camelus dromedarius*): influence of age and sex. *Com. Clin. Pathol.*, 17: 263. <https://doi.org/10.1007/s00580-008-0736-0>
 - Sarwar A, Majeed MA (1997). Interrelationships between 30 parameters of blood in normal one humped camel in summer. *J. Camel Prac. Res.*, 4: 36-39.
 - Singh Y, Pathak KML, Kapoor M, Harsh D, Verma KC (1997). Clinohaematological studies in camel naturally infected with *Trypanosoma evansi*. *J. Vet. Parasitol.*, 11: 43-46.
 - SPSS Inc. Released (2008). *SPSS statistics for windows, version 17.0*. Chicago: SPSS Inc. Chicago, IL. USA.
 - Tibary A, Anouassi A (1997). *Theriogenology in camelidae*. 1st Edition, Ministry of Agriculture and Information, United Arab Emirates.
 - Zaher H, El-Zahar H, Al Sharifi S, Shety T (2017). Alterations in haematological and biochemical parameters affecting the reproductive performance in female camels (*Camelus dromedarius*). *Int. J. Vet. Health Sci. Res.*, 5: 155-160. <https://doi.org/10.19070/2332-2748-1700032>