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Reference Concentrations of Blood Biochemical Indices of Marecha Camel (*Camelus dromedarius*) in Semi-Intensive Management System

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Abstract | This trial was undertaken at Camel Breeding and Research Station (CBRS) Rakh-Mahni to investigate the blood biochemicals in calves and adult animals of Marecha breed reared under semi-intensive management system (SIMS). About 40 animals were divided into two groups viz: 1st group (G1) of twenty calves (10 ♂ and 10 ♀) and 2nd group (G2) of twenty adult animals (5 ♂ and 15 ♀). The animals were kept in semi-open houses and fed with concentrate, gram straw and available jungle grazing/browsing. Watering was provided twice a day. The animals were vaccinated and dewormed after 3 months regularly according to farm routine practices. Blood biochemical parameters were analyzed by using standard kits on hematology/biochemistry analyzer. Haemoglobin (Hb), energetic parameters (glucose, cholesterol, triglycerides), protein parameters (total protein, albumin, globulins, urea, creatinine) and minerals (calcium, phosphorus) were determined. The haemoglobin means concentrations ($P<0.05$) were found to be 14.21±0.3, 13.98±0.2 and 14.86±0.68, 14.12±0.52 g/dl respectively for males and females of G1 and G2 being higher in male animals. In energetic and protein parameters; cholesterol, triglycerides and total proteins, albumins, globulins, urea mean concentrations were found to be significantly different ($P<0.05$) among groups being higher in males and adult animals. Regarding mineral contents, calcium and phosphorus mean concentrations were found to be significantly different ($P<0.05$) among groups being higher in males and adult animals. The results are discussed with relation to previous studies and could be used as primary database for future studies in camel science.

Keywords | Camel, Blood, Desert, Pastoral, Sex, Biochemicals

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INTRODUCTION

Camel is an even-toed ungulate of the genus *Camelus* having 3 species found in the world; *Camelus dromedarius* (single humped), *Camelus bactrianus* (double humped) and *Camelus ferus* (wild bactrian camel). Dromedary is term used for single humped or Arabian camel. They are the smallest of the three species and are well-known for racing, milk, meat, fiber and transportation (Faraz et al., 2019a). They are well adapted in deserts due to their ability to remain without drinking water for extremely long periods and having fluctuating body temperature (Fayed, 2001; Faraz et al., 2019b).

Camels are equipped well to survive, work and produce in harsh and hostile environments (Wu et al., 2014; Faraz et al., 2019c). About 94% of world camel population is dromedary type which is usually found in the Horn of Africa, Middle East and South Asia (Bernstein, 2009). India and Pakistan have 70% of the camel population of Asia (Rosati et al., 2005). Pakistan has a sizable population with increasing trend as 1.1 million heads among the 35

million camels of world and ranks number 8th (FAOSTAT, 2019; GOP, 2019-20).

Camels play very important role in the economy and social life of Bedouins and pastoralists in different localities of the world - Pakistan is not exception to this; where cameleers mainly depend on camel for their subsistence (Faraz et al., 2019b). Despite of its significant contribution to the livelihood of pastoral community, the camel is one of the most neglected species in Pakistan and few attempts have been made so far to characterize its production potential and related parameters (Faraz et al., 2019c).

The quantitative analysis of blood biochemicals may assist the clinician by providing normal reference values for easy evaluation of the health status and disease condition of animals (Osman et al., 2015). However, these constituents are variable in different climatic, physiological and pathological conditions (Mohamed and Hussein, 1999). While related measurable indices to body weight are very important for feed conversion performances and proper dozing of drugs for animals (Abebe et al., 2002).

The blood profile of camels in Pakistan is merely documented and little is known about the normal ranges of the biochemistry and blood references compared to the extensive studies conducted in other countries (Faraz et al., 2018). In Pakistan, mostly the research work on camel are survey reports under traditional management systems (Iqbal et al., 2001) and the previous studies not justify requirements of the subject. This study covers biochemical parameters about Marecha camel reared under semi-intensive management system (SIMS) in its natural habitat (Thal Desert).

MATERIALS AND METHODS

Trial location

The CBRS 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, continental and means monthly highest temperature goes up to 45.6 °C, while in winter it goes from 5.5 to 1.3 °C. Mean annual rainfall in the region ranges from 150-350 mm, increasing from South to North (Rahim et al., 2011).

Experimental animals and management

Forty animals reared under SIMS were divided into two groups; 1st group (G1) of twenty calves (10 ♂ and 10 ♀) and 2nd group (G2) of twenty adult animals (5 ♂ and 15 ♀). All animals were carefully examined before the start of experiment and only physically healthy were included in the trial. They were dewormed by injection 1% Ivermectin @ 1ml/50 kg body weight after every 3 months. Animals were sprayed with Ecofleece solution @ 1cc/liter water for animals and 2cc/liter of water for shed. They were vaccinated for Trypanosomiasis by injection Trypamidium (Samorin) 1 g sachet for 4 camels after every three months as per farm routine practices.

All animals provided same quantity of ration and other experimental conditions. The animals were fed concentrate @ 2-3 kg/d for adult and 1 kg/d for calves. The animals were sent for jungle grazing/browsing for 4-6 hr daily. They were fed gram straw (*Cicer arientinum*) *adlib* as manger feeding. Water was provided twice a day. Salt lumps were placed in mangers while 100 g DCP powder was fed per she-camel daily. The ingredients and chemical composition of concentrate is mentioned in Table 1 and the proximate analysis of gram straw and different grazing/browsing species in study area is shown in Table 3.

Table 1: Ingredients and chemical composition of experimental ration.

(a) Ingredients (%)	Exp-Ration	(b) Parameters (%)	Exp-Ration
Maize grain	9	DM	90.32
Wheat bran	24	CP	18.06
Cotton seed cake	25	NDF	29.09
Rape seed cake	6	ADF	14.41
Corn gluten 30%	20	TDN	70
Molasses	14	ME (Mcal/kg DM)	2.41
DCP	1		
Salt	1		

DM: Dry Matter, CP: Crude Protein, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, TDN: Total Digestible Nutrients, ME: Metabolizable Energy.

Sampling and lab analysis

Blood samples were collected from all animals by jugular puncture in two sets with and without EDTA for serum separation. The blood samples were studied for haemoglobin and biochemical analyses. Haemoglobin (Hb) in blood sample was analyzed by using standard kits (Spin-react, Spain) in haematology analyzer (BC 2300, Mindray Germany). Sugar, Cholesterol, triglycerides, urea, creatinine, total protein, albumin and globulin in serum samples were estimated by using standard kits in biochemistry analyzer (DL 9000, Italy), respectively. The digestion of blood samples for mineral analyses was done in Animal Nutrition Lab, Faculty of Animal Husbandry, University of Agriculture Faisalabad.

The 2 ml of plasma was mixed with equal volume of nitric acid in Kjeldhal digestion tube. The samples were kept overnight and then heated over digestion bench at

below 90 °C up to half. After that 5 ml of double acid mixture containing 3 parts of nitric acid and 1 part of 70% per-chloric acid were added to it and again digested, till white fumes were emanated and the volume was reduced to 0.5 ml. The digested sample was cooled and diluted to 50 ml with distilled water (Faraz et al., 2018). Ca and P concentrations were determined by using atomic absorption spectrophotometer (Method 965. 09A; AOAC, 1990) at High Tech Lab, University of Agriculture Faisalabad.

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 salincornicum*, *Calligonam polygonoides*, *Capparis decidua* and *Haloxylon recurvum*. The *Cicer arientinum* and forage species were analyzed for percent dry matter, crude protein, crude fiber, ether extract and ash (AOAC, 1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) was also determined (Van Soest et al., 1991).

Statistical analysis

Microsoft Excel (Microsoft Office 2010) was used for data compilation which was presented to analysis of variance for statistical analysis by using GLM of Statistix software. LSD test at 0.05 levels of significance was used to compare the differences among the treatment means (Steel et al., 1997).

Ethical approval

In the current study, camels were fed according to the farm routine practices having grazing/browsing and stall feeding available. They were provided fresh, clean water and salt lumps. Camels were vaccinated and dewormed according to scientific recommendations. All institutional and national guidelines for the care and use of experimental animals were followed.

RESULTS

The blood constituents like haemoglobin (Hb), glucose, cholesterol, triglycerides, total protein, albumin, globulin, urea, creatinine, calcium and phosphorus were determined in this experiment (Table 2).

Haemoglobin

The mean values of Hb ($P<0.05$) were found to be 14.21±0.3, 13.98±0.2 and 14.86±0.68, 14.12±0.52 g/dl for male and females of G1, G2 respectively in SIMS.

Energetic parameters

The mean values of cholesterol ($P<0.05$) were found to be 38.31±1.92, 37.92±2.16 and 59.22±4.34, 57.41±5.12 mg/dl in males and females of G1 and G2 being higher in males than females and adults than calves. The levels of triglycerides were also found to be significantly different ($P<0.05$) as 18.54±3.28, 17.72±2.96 and 36.57±4.36, 35.87±3.93 mg/dl in males and females of G1 and G2 being higher in males than females and adults than calves under SIMS. While the glucose was found to be varied ($P>0.05$) among groups in SIMS.

Protein parameters

The mean values of total protein (5.31±0.67, 5.12±0.73, 7.22±1.50, 6.38±1.32), albumin (1.48±0.78, 1.26±0.87, 3.07±1.02, 2.86±1.04), globulin (1.68±0.66, 1.46±0.48, 3.16±0.94, 2.98±1.06), urea (36.3±4.6, 31.3±5.04, 46.87±3.62, 46.10±4.64) were found to be significantly different ($P<0.05$) respectively, among groups G1, G2 being higher in males than females and adults than calves under SIMS while the levels of creatinine were found to vary ($P>0.05$) among groups in SIMS.

Minerals

The mean values of Calcium (7.04±0.28, 6.42±0.46, 9.73±1.36, 9.06±1.28) and Phosphorus (3.52±0.1, 3.26±0.1, 4.27±0.9, 4.10±0.7) were found to be significantly different ($P<0.05$) respectively among groups G1, G2 being higher in males than females and adults than calves under SIMS.

DISCUSSION

Haemoglobin was found to be higher in males compared to females probably due to testosterone effects on the kidneys to produce more erythropoietin that accelerates the erythropoiesis (Murphy, 2014). Current study values are close to the reported findings of Farooq et al. (2011), Abdalmula et al. (2018, 2019), Elitok and Cirak (2018) and Faye and Bengoumi (2018). However, Hb was ↑ than reported findings of Amin et al. (2007), Adah et al. (2017), Zaher et al. (2017), Ghafoor et al. (2018), Ebissy et al. (2019), Islam et al. (2019). Al-Busadah and Osman (2000) reported mean value for Hb as 13.3±0.6, 12±0.2 and 10.1±0.8 g/dl in Saudi dromedary dry-adult, lactating and calves, respectively. Reported range values for Hb was found to be 11.5 g/dl by Omer et al. (2006) while Omer et al. (2008) reported significantly higher Hb concentration in Sudanese dromedary suckling calves as 11.42±1.20 compared to their lactating dams as 10.69±0.62 g/dl. Amin et al. (2007) reported Hb concentration in Sudanese dromedary camel as 10.67±0.19, 10.73±0.18 g/dl respectively, in dry and green season. In Pakistan, Farooq et al. (2011) reported mean concentration and range for Hb as 12.00±0.63, 11.34±0.95; 7-17, 8-17 g/dl in Pakistani dromedary male and females, respectively. However, Hb was found at greater level in Indian dromedary camel (Narnaware et al., 2016). Reported Hb concentration was 14.80±1.15 g/dl in male dromedary camels (Al-Harbi, 2012).

Table 2: Blood biochemical indices of Marecha camel at CBRS Rakh Mahni Bhakkar, Punjab.

Parameters	G1, Calves		G2, Adult	
	Male (10)	Female (10)	Male (05)	Female (15)
Haemoglobin (g/dl)	14.21±0.3 ^{ax}	13.98±0.2 ^{ay}	14.86±0.68 ^{bx}	14.12±0.52 ^{by}
Glucose (mg/dl)	134.22±7.83 ^{ax}	136.31±6.72 ^{ay}	135.71±7.26 ^{ax}	136.82±8.88 ^{ay}
Cholesterol (mg/dl)	38.31±1.92 ^{ax}	37.92±2.16 ^{ay}	59.22±4.34 ^{bx}	57.41±5.12 ^{by}
Triglycerides (mg/dl)	18.54±3.28 ^{ax}	17.72±2.96 ^{ay}	36.57±4.36 ^{bx}	35.87±3.93 ^{by}
Total Protein (g/dl)	5.31±0.67 ^{ax}	5.12±0.73 ^{ay}	7.22±1.50 ^{bx}	6.38±1.32 ^{by}
Albumin (g/dl)	1.48±0.78 ^{ax}	1.26±0.87 ^{ay}	3.07±1.02 ^{bx}	2.86±1.04 ^{by}
Globulin (g/dl)	1.68±0.66 ^{ax}	1.46±0.48 ^{ay}	3.16±0.94 ^{bx}	2.98±1.06 ^{by}
Urea (mg/dl)	36.3±4.6 ^{ax}	31.3±5.04 ^{ay}	46.87±3.62 ^{bx}	46.10±4.64 ^{by}
Creatinine (mg/dl)	1.44±0.06 ^{ax}	1.49±0.08 ^{ay}	1.48±0.09 ^{ax}	1.45±0.07 ^{ay}
Calcium (mg/dl)	7.04±0.28 ^{ax}	6.42±0.46 ^{ay}	9.73±1.36 ^{bx}	9.06±1.28 ^{by}
Phosphorus (mg/dl)	3.52±0.1 ^{ax}	3.26±0.1 ^{ay}	4.27±0.9 ^{bx}	4.10±0.7 ^{by}

Means having different superscript in columns are significantly different (P<0.05); CBRS: Camel Breeding and Research Station; *Number of Animals in Parentheses

Table 3: Proximate analysis (%) of crop residue and different grazing/browsing species.

Feed/Forage Species	DM	CP	EE	CF	NDF	ADF	Crude ash
Gram Straw (*Cicer arientinum*)	93.53	9.72	2.60	44.4	68.7	47.6	7.83
Kikar (*Acacia nilotica*)	28.5	16.71	1.79	25.08	55.4	25.4	5.94
Phulai (*Acacia modesta*)	53.4	13.23	2.21	35.40	46.6	28.78	6.94
Beri leaves (*Ziziphus mauritiana*)	40.2	15.52	5.77	28.02	48.3	26.9	8.48
Siras (*Albizia labbek*)	37.3	16.17	6.58	27.25	43	29	16.33
Jand (*Prosopis cineraria*)	46.15	16.86	6.52	19.14	47.5	29	4.95
Khagal (*Tamarix aphylla*)	31.9	12.81	3.25	17.32	42.4	31.6	13.03
Dhaman (*Cenchrus ciliaris*)	31.9	14.69	3.94	26.51	38.53	18.15	15.71
Persain (*Suaeda fruticosa*)	30.3	10.57	5.52	33.14	48.7	27.6	7.54
Khawi (*Cymbopogon schoenanthus*)	34.6	9.53	2.01	35.67	62.1	43.5	7.14
Kali Bui (*Kochia indica*)	33.78	10.80	4.91	27.61	58.6	39.76	13.32
Bhakra (*Tribulus terrestris*)	32.1	8.76	4.58	32.63	46.7	35.4	9.64
Kari (*Capparis spinosa*)	36.7	17.84	1.18	30.75	51.8	33.5	6.97
Laana (*Haloxylon salincornicum*)	34.2	15.85	3.09	32.33	51.34	37.5	11.93
Phog (*Calligonam polygonoides*)	34.7	8.95	4.82	23.42	49.6	31.9	8.76
Karir (*Capparis decidua*)	49.4	16.75	1.52	24.64	53.6	37.8	14.76
Khar Laana (*Haloxylon recurvum*)	47.9	12.36	3.32	24.95	49.2	31.3	12.15

DM: Dry Matter, CP: Crude Protein, EE: Ether Extract, CF: Crude Fiber, NDF: Neutral Detergent Fiber, ADF: Acid detergent Fiber.

Hb concentration was found to be 14.06±0.24 g/dl in female dromedary camels (Zaher et al., 2017). The reported concentration of Hb is found to be varied in majority of the references between 9.3 and 15.5 g/dl (Faye and Bengoumi, 2018). Reported Hb concentration was 11.78±0.57 g/dl in Pakistani dromedary camels (Ghafoor et al., 2018). Elitok and Cirak (2018) reported Hb concentration was 12.43±0.19 and 12.43±0.18 g/dl respectively, in pregnant and non-pregnant she-camels. Reported Hb concentration and range was 12.55±0.27 and 7.28-17.70 g/dl, respectively in Libyan dromedary camel (Abdalmula et al., 2018). Reported Hb concentration was 11±0.41 and 13.44±0.27 g/dl respectively, in Libyan dromedary males and females (Abdalmula et al., 2019). Ebissy et al. (2019) reported Hb concentration as 10.62±0.55 g/dl in dromedary camel. Reported Hb concentration was 10.4 g/dl in Bangladeshi dromedary camel (Islam et al., 2019).

Glucose level in camels was found to be greater than other ruminants and this could be the reason for reported higher lactic acid contents in blood of camels (Osman and Al-Busadah, 2003) determined glucose, cholesterol

and triglycerides concertation as 134.4±11, 58.4±8.6 and 31.4±3 mg/dl in Saudi dromedary camel. Amin et al. (2007) reported triglycerides mean concentration as 4.81±0.13 and 26.71±1.51 mg/dl respectively, in dry and green season in blood of Sudanese dromedary camel. Contrary to our findings, Indian scientist Bhakat et al. (2008) reported significant differences for triglycerides as 34.8±3.7, 19.1±2.9 mg/dl in camel calves reared under intensive and semi-intensive system of management, respectively. Nagpal et al. (2012) reported glucose as 110.5±3.7, 105.5±0.8 mg/dl; cholesterol as 35.8±3.4, 28.0±1.4 mg/dl and triglycerides as 28.3±1.3, 48.4±2.8 mg/dl in Indian weaned dromedary calves at 6 and 9 months of age, respectively. In another study, Saini et al. (2014) found significantly lower glucose values in grazing pre-pubescent camels than stall-fed group under pastoral management in arid western Rajasthan. Kelanemer et al. (2015) reported glucose, cholesterol and triglycerides mean concentration as 0.91±0.02 g/l, 229.93±1.31 and 399.09±1.87 mg/l in pregnant Algerian dromedary she-camel.

Mean glucose concentration was found to be 88.68±1.66 mg/dl in female dromedary camels (Zaher et al., 2017). Abdelmula et al. (2018) reported mean concentrations and range of glucose, cholesterol and triglycerides (mg/dl) as 111.8±5.36, 26.14-240.9; 36.39±1.72, 5.72-77.60 and 31.60±1.81, 8.14-82.22 respectively in Libyan dromedary camel. Reported normal plasma glucose concentration varied between 60-140 mg/dl (Faye and Bengoumi, 2018). Elitok and Cirak (2018) reviewed blood biochemical features of camels and reported glucose concentration as 100.55+1.03 and 96.58±1.53 mg/dl in non-pregnant and pregnant she-camels. Reported glucose mean concentration was 228.0±5.21 mg/dl during transition period in Egyptian female dromedary camel (Ebissy et al., 2019). Reported glucose concentration of dromedary camels in Bangladesh was 114.9 mg/dl (Islam et al., 2019). Mohamed et al. (2019) reported glucose mean concentration as 176±10.7 mg/dl in Egyptian dromedary lactating camels.

The variations in the blood biochemical levels reported in literature data could be attributed to the availability of food and water and the remarkable adaptive mechanisms of camels to thirst and lack of food. The glucose level in camel blood increases from 20-80 % after 10 days of water deprivation and this hyperglycemia is accompanied with no glucosuria to reduce moisture loss and with decreased insulin level that inhibit lipolysis and lower the basic metabolism to decrease the glucose use. The plasma concentration of glucose in camels decreases with the reduction in available food during dry season (Aichouni et al., 2013) and feeding of camels after fasting was reported to increase the plasma glucose level (Amin et al., 2007). The lipid concentration in liver decreases by 13-25 % after dehydration and the concentration of cholesterol and triglycerides increases after 14 days of water deprivation (Aichouni et al., 2013). Moreover, the poor dietary condition during the dry season was related to the observed higher concentration of serum triglycerides in camels (Amin et al., 2007). In addition, lipid profile like human is influenced by age where it is higher in older animals and in advanced age (Nazifi et al., 2000).

Urea and creatinine are indirect tests for the proper kidney functioning and excretion. Creatinine which is an anhydride of creatine phosphate results by the muscle synthesis, a routine product formed due to muscle metabolism and excreted on regular basis (Brar et al., 2000). In their study, Osman and Al-Busadah (2003) determined urea, creatinine as 49.8±5.5 and 1.5±0.1 mg/dl while total protein, albumin as 7.1±0.3 and 3.7±0.3 g/dl in Saudi dromedary she-camels. Reported value for albumin was 3.3 g/dl (Omer et al., 2006) and 4.5 g/dl (Osman and Al-Busadah, 2000). Amin et al. (2007) reported mean concentrations of total protein, albumin, globulin (g/dl), urea, creatinine (mg/dl) as 8.43±0.08, 3.17±0.05, 5.83±0.39, 5.66±0.30, 74.26±4.42 and 7.08±0.08, 3.09±0.05, 4.0±0.38, 9.18±0.29, 136.14±3.54 respectively, in dry and green season in blood of Sudanese dromedary camel. Bhakat et al. (2008) reported significant differences for total protein as 6.3±0.3 and 4.7±0.4 g/dl in Indian dromedary camel calves in intensive and semi-intensive system of management, respectively while non-significant differences were found regarding urea and albumin. In another study, Nagpal et al. (2012) reported total protein as 5.7±0.2, 5.1±0.2 g/dl; albumin as 3.7±0.1, 3.7±0.1 g/dl and urea as 20.0±1.1, 25.4±1.7 mg/dl in Indian weaned dromedary calves at 6 and 9 months of age, respectively.

In another study, Saini et al. (2014) found significantly higher urea values in grazing pre-pubescent camels than stall-fed group under pastoral management in arid western Rajasthan. Kelanemer et al. (2015) reported total protein (g/l) and urea (mg/l) mean concentration as 57.84±0.46 and 372.65±1.83 in pregnant Algerian dromedary she-camel. Reported protein concentration was 73.00±2.20 g/l in Nigerian dromedary camel (Adah et al., 2017). Reported mean concentrations of total protein, albumin and creatinine were found to be 6.27±0.13, 3.82±0.14 g/dl and 1.12±0.05 mg/dl in female dromedary camels (Zaher et al., 2017). Reported range of normal urea concentration in blood varied between 5-40 mg/dl, creatinine 0.8-2 mg/dl, serum albumin concentration 25-45 g/l in camels (Faye and Bengoumi, 2018). Abdelmula et al. (2018) reported mean concentrations and range of total protein, albumin, globulin (g/l) and urea, creatinine (mg/dl) as 50.98±0.91, 31.09-67.82; 30.58±0.63, 17.51-39.52; 20.40±0.83, 4.42-46.05 and 43.31±1.39, 17.00-69.00; 1.50±0.02, 1.00-2.10 respectively, in Libyan dromedary camel. Reported concentrations of total protein, albumin (g/dl) and urea

(mg/dl) in dromedary camels of Bangladesh were to be 8.2, 4.4 and 25.04 (Islam et al., 2019). Mohamed et al. (2019) reported mean concentrations of total protein, albumin, globulin (g/l) and creatinine (mg/dl) as 5.8±0.08, 2.4±0.06, 3.47±0.19 and 0.88±0.07 in Egyptian dromedary lactating camels.

Reported total protein, albumin, globulin (g/l), blood urea nitrogen (mmol/l), creatinine (mg/dl) mean concentrations were to be 5.92±0.17, 2.65±0.19, 29.53±2.10, 17.09±0.46, 1.05±0.11 during transition period in Egyptian female dromedary camel (Ebissy et al., 2019). Camels are well adapted to decreased nitrogen diets by limiting the urinary excretion of urea and increase the nitrogen recycling in case of lower proteins in diet and/or dehydration (Gihad et al., 1989). Camels have high level of blood urea nitrogen when compared to other livestock species due to the ability of camels to utilize urinary nitrogen at times of poor grazing or water deprivation (AL-Busadah, 2007; Aichouni et al., 2010; Patodkar et al., 2010) and the urea is efficiently utilized for microbial protein synthesis (Abdalla et al., 1988; Haroun, 1994). The total protein values were higher in summer season compared to the other seasons in camels (El-Harairy et al., 2010). This increase was attributed to the stimulation of growth releasing hormone that cause increase in the plasma proteins which are important to maintain plasma water (Horowitz and Adler, 1983). The dehydrated camels also showed reduction in creatinine clearance and increased level of albumin that maintain higher colloid osmotic pressure needed for storing water in blood (AL-Busadah, 2007; Amin et al., 2007; Aichouni et al., 2013).

The importance of calcium and phosphorus losses in lactating or pregnant adult camels to milk or fetus explains obviously the sex difference in those minerals' status. Calcium metabolism under hormonal regulation of thyroid and parathyroid is more active in non-pregnant as the physiological condition like pregnancy imparts the stress in female (El-Khasmi et al., 2000). Al-Busadah (2007) determined blood values in Saudi camels and reported calcium as 7.6-13.1 mg/dl. Reported mean concentrations of Ca and P were 1.94±0.03, 2.03±0.02 and 2.35±0.03, 2.20±0.02 mmol/l respectively, in dry and green season in blood of Sudanese dromedary camel. There is an increase in P and Ca values in the serum of dromedary camels in the wet season due to the availability of plants rich in minerals (Amin et al., 2007). Bhakat et al. (2008) determined blood minerals in camel calves under different management systems and reported non-significant differences regarding calcium and phosphorus. Other authors recorded an increase in Na, Ca but decrease in K and P in the summer season compared to the other seasons (El-Harairy et al., 2010). Nagpal et al. (2012) reported Ca as 10.9±0.3, 11.1±0.5 mg/dl and P as 8.7±0.4, 7.0±0.6 mg/dl in Indian weaned dromedary calves at 6 and 9 months age, respectively. Kelanemer et al. (2015) reported Ca and P mean concentration as 73.68±1.89 and 62.70±0.97 mg/dl in pregnant Algerian dromedary she-camel. Reported mean concentrations of Ca and P were found to be 10.65±0.18 and 5.41±0.17 mg/dl in female dromedary camels (Zaher et al., 2017). Abdelmula et al. (2018) reported mean concentrations and range of Ca and P as 9.87±0.08, 7.65-12.81 and 5.20±0.24, 1.75-8.89 mg/dl respectively, in Libyan dromedary camel. Reported reference values of Ca and P varied between 8.4-12.4 and 4.8-8.4 mg/dl, respectively in camels (Faye and Bengoumi, 2018). Elitok and Cirak (2018) reviewed blood biochemical features of camels and reported Ca and P mean concentration as 9.0±0.1 and 3.8±0.5 mg/dl in dromedary she-camel.

CONCLUSION

This study has documented the normal values of blood biochemicals in Pakistani Marecha camels. These values were found within the normal physiological range as reported in literature data while the variations observed could be attributed to many factors. The effects of breed, age and physiological status on these values should be investigated in future studies that is very important to build the country's primary data base.

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AUTHORS 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, Hafiz Muhammad Ishaq reviewed the paper.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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