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Clinical, Hematological and Blood Biochemical Features of Camels

Abstract

Camels are used as carriers of loads and of passengers, as well as for wool, milk, skin and meat. The single-hump camel is originated in Africa, while the double-hump camel is originated in Central Asia. The two species of camels are found in southern and western Asian countries such as India, Pakistan, Afghanistan, Iran, Syria and Saudi Arabia as well as North African countries such as Egypt. Despite the fact that there are many studies on the clinical, hematologic and blood biochemical characteristics of camels, these are usually regional studies; there is no study that presents camels as a whole globally. The clinical, hematological and blood biochemical values provided by this article can be used as reference values for veterinarians and academics who deal with camel diseases in different areas of the world.

Keywords: camel, clinical, hematological, blood biochemical, parameters

Volume 6 Issue 5 - 2018

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Received: November 01, 2018 | **Published:** November 28, 2018

Introduction

Like cattle, sheep, and goats, camels are classified as ruminants. However, unlike other ruminants, they have no horns, and have long necks and padded feet with two toes. They are capable of using water very efficiently. Camels are animals with a very high level of red blood cells, and these blood cells are oval in shape.[1–4] From the viewpoint of taxonomic levels, camels are tylopoda (ped-footed), and artiodactyla (hoofed nails) as a subtype, and belong to the camelidae family.[4–7] These mammals are nowadays classified as real dervishes (one-hump Dromedary and two-hump Bactrian), new world scenes (llama and alpaca) and South American (guanaco and vicuna).[8–9]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 hump. However, both groups can live in difficult desert conditions.[10–13] One-humped or Arabian camels (*Camelus dromedarius*) are well-adapted to hot and arid environments. Camel owners breed these animals for their milk, meat, wool, hair, transport and sometimes camel wrestling.[14–16] Domesticated camelids in South America belong to the Tylopoda suborder. These camelids are classified as llamas (Lama glama) and alpacas (Vicunja pacos), and originated from guanacos (Lama guanicoe) and vicunjas (Vicunja vicunja) respectively. Moreover, these four species have fertile offspring.[16–18] The animal is able to survive in a hot dry desert due to its anatomical structure and ecological adaptations. The dromedary camel has long double eyelashes and a nictitating membrane to protect the eyes from the sun and sand, and slit-like openings of closable nostrils.[19–22] The body temperature of the camel fluctuates from 34°C to 41.7°C and differs from other species of domestic animals. So, camels only sweat when the ambient temperature exceeds 42 °C, and excrete only a small amount of sweat, enough to decrease its body temperature (Table 1).[21]

a) Clinical reference values for camels

Results of various studies on characteristics and clinical reference values for camels are shown in Table 2 & 3.

b) Body temperature

It is reported that camels are able to withstand changes in body temperature and water consumption that would kill most other animals. Their temperature ranges from 34 °C at dawn and steadily increases to 40°C by sunset, before they cool off at night again, and these findings are mostly affected by climatic, housing and management conditions.[23–25] reported that the morning rectal temperature of a normal healthy camel varies from 34.0 to 40°C,[26] reported that the average temperature of a resting adult camel was 36.6 (35.1–37.6°C).

Table 1 Scientific Classification[9]

Kingdom	Animalia
Subkingdom	Metazoa
Phylum	Chordata
Sub-phylum	Vertebrata
Super-class:	Tetrapoda
Class:	Mammalia
Sub-class	Theria
Infra-class	Eutheria
Cobort	Ferungulata
Super-order	Paraxonia
Order	Artiodactyla
Sub-order:	Tylopoda- Camelids
Family	Camelidae
Sub-family	Camelinae
Genus	Camelus (Old World Camels)
Species	Dromedarius (Arabian Camels)
Species	Bactrianus (Asiatic Camels)
Genus	Lama (New World Camels)
Species	Glama (Hamas)
Species	Pacos (Alpaca)
Species	Guanicoe (guanaco)
Species	Vicugna (Argentine)

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Table 2 Characteristic of Camels[23]

Characteristic	Dromedary	Bactrian	Wild Bactrian
Breeds/ types	50 different breeds recognized Draft type: Heavy body , stocky legs Riding type: Slim body, long legs Racing type: Similar to riding	Geographical differences	Single type
Weight kg/ lb	300 – 650 / 661- 1432	450 - 700 /992-1543	450- 690/ 992-1521
Weight of newborn kg/ lb	26 – 45 / 57 - 100	35- 54 / 55-120	?
Height at shoulder cm/ in	180 – 210 / 71- 83	180- 195 / 71-77	180- 200 / 70.8-78.7
Body length cm/in	120 – 200 / 40 - 80	120-200/ 40- 80	140 – 156 / 55- 61
Shape	1 firm, upright hump	2 large humps, may be flopped over	2 small conical humps
Color	Cream to tan to dark brown	Cream to tan t dark brown	Cream to gray-brown
Unique anatomy	Male has a soft palet diverticulum (dulaa) which may protrude from mouth	No dulaa, ears15 cm	No dula, prominent toenail, small foot and falt sole for rapid gait to escape predation. Able to drink salty water, face narrow, ears 10 cm
Fiber/ hair	Diameter 20- 50 μ	Diamater 10-40μ, long staple, primary source for camel hair garments	Short fiber
Special adaptaions	Adapted to heat, aridity and sparse vegatation	Adapted to cooler, arid enviroments	Adapted to the deserts of northern China and Mongalia
Running speed	21.6- 40.3 kph	15-20 kph	40 kph

Table 3 Weights and Sizes of South American Camelids[25]

Characteristic		Vicuana	Alpaca	Guanaco	Llama
Weight	**Adults**	99-121/45-55	121-200/55-90	220-265/100-120	250-550/113-250
(lb/ kg)	**Birth weight**	9-13/4-6	13-20/6-9	18-33/8-15	18-40/8-18
Height at withers (inch/cm)	**Adults**	34-38/86- 96	30-38/ 76-96	43-45/ 110-115	40-47/102-119

Citation: Elitok B, Cirak AC. Clinical, Hematological and Blood Biochemical Features of Camels. *MOJ Immunol.* 2018;6(5):288–295. DOI: 10.15406/moji.2018.06.00245

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c) Respiration rates

Some researchers [23] claimed that respiratory frequency at rest is around 5 to 10 / min which is less than in some other species. However, this respiratory rate may increase to up to 12 / min in hotter temperatures (Table 4 & 5).

Table 4 AM/PM Normal Respiratory Values

Researchers	AM	PM
Sahal et al. (2015)	11±1.7	12 ±1.9
Schmidt-Nielsen (1964)	6 – 11	8 – 18
Higgins and Kock (1984)	5 – 10	12

Table 5 Cool Weather/Summer Respiratory Values[23]

Cool weather	Summer
5–8	≤12

d) Pulse rates

The pulse frequency at rest varies according to temperature changes during the day. For example, it has been reported that in Arabian camels, this pulse rate might rise to 30-45 / min in the evening hours.[13,26] reported that the upper and lower limits of the heart rate at rest in the resting phase were between 24 and 48 / min, but this change was mostly between 28 and 39 / min.

e) Digestive system

The stomachs of ruminating animals consist of 4 compartments (rumen, reticulum, omasum and abomasum)[27] but camels have stomachs which consist of 3 parts (C1, C2 and C3), even though they are ruminants.[18,28,29] The kidneys of camels are capable of concentrating urine markedly to reduce water loss. The normal blood glucose level in hydrated camels is in the range of 100–150 mg/liter, while in dehydrated camels; the blood glucose level reaches ten times the normal level without causing any physiological disturbance to the animal. Camels have a long large intestine, which absorbs every last drop of water from the digested food.[30–36] Although camels are an important source of milk, meat and wool and are widely used in transportation and for other working purposes, the changes in clinical and blood constituents in camels in different conditions have not been comprehensively studied.[37] This paper gives globally some important knowledge about camels come from the world's different areas, and different kinds of camels.

f) Normal hematological values camelids

Some hematological reference values of camels (Tables 6–10).

g) Normal serum biochemical parameters in camels

Serum biochemical parameters of camels are shown in Tables 11–18.

Table 6 Ranges of blood values for dromedary and Bactrian camels[28]

	C. dromedarius	C. bactrianus
Total leucocytes	2.9 - 9.7	8.6 - 16.5
Neutrophils	33.0 - 70.0	55.0 - 79.0
Eosinophils	0 – 4.0	0 – 9.0
Basophils	0 – 3.0	0 – 1.0
Lymphocytes	21.0 - 62.0	18.0 - 33.0
Monocytes	0 – 7.0	0 - 4
Total erythrocytes	7.6 - 11.0	8.5 - 13.4
Packed cell volume	24.0 - 42.0	25.0 - 39.0
Haemoglobin concentratian	11.4 - 14.2	11.1 - 17.4
Platelet	230 - 360	220 - 526
Reticulocytes	0 – 0.7	0 – 0.5
Mean corpuscular volume	27.5 - 29.4	25.3 - 31.6
Mean corpuscular haemoglobin	12.1- 13.7	10.6 - 14.3
Mean corpuscular haemoglobin concentration	42.1 - 49.6	37.0 - 47.0
Erythrocyte sedimentation rate	0 – 1.0	0
Fibrinogen	200 – 400	210 - 270

Table 7 Hematological values of normal camels[22]

Constituent	M±SD	range
Hemoglobin	11.0±3.0	8.0 - 16
PCV = Hematocrit	30±5	24 - 35
Erythrocytes	7.6±1.5	6.0- 9.2
MCV	40±3	36 - 55
MCH	18±3	16 - 22
MCHC	45±5	26- 50
Leukocytes	13±2	16-Nov
Neutrophils	50%	
Lymphocytes	41%	
Monocytes	4%	
Eosinophils	3%	
Basophils	1%	

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Table 8 Values for hematological parameters in adult camels[8]

Cbc parameter	Reference intervals	Comment
PCV (%)	27-45	Camels possibly slightly lower
RBC (×10⁶/uL	17-Oct	Camels possibly slightly lower
Hgb (g/dL)	19-Nov	Camels possibly slightly lower
MCV (fL)	21-31	Camels possibly slightly lower
MCHC (g/dL)	39-48	Camels possibly slightly lower
WBC (×10³ uL)	7.5-22	Camels possibly slightly lower
Band neutrophils (×10³ uL)	0-0.4	-
Segmented neutrophils (×10³ uL)	4.6-16	-
Lymphocytes (×10³ uL)	10-Jan	Up to 30 % granulated
Monocytes (×10³ uL)	<1.0	-
Eosinophils (×10³ uL)	0-5	Tend to have hyposegmented nuclei
Basophiles (×10³ uL)	<1.0	-
Platelets (×10³ uL)	150-800	-
Reticulocytes (×10³ uL;%)	12-79,000;0-0.6	0-3 Nucleated RBC/100 WBC

Table 9 Mean Hematological Values parameters of Male Dromedary Camels in Pre-rut, rut, Post-rut and Non-rut Seasons[14]

Parameter	Pre-rut (Novem-ber)	Non-rut (August)	Post-rut (May)	Rut (Februrary)
RBC(×10⁶µ L⁻¹	10.55±1.39[b]	10.90±1.04[b]	9.87±1.33[b]	8.90±1.450[b]
HGB (g dL⁻¹)	14.49±1.46[b]	14.80±1.15[b]	15.20±1.40[b]	14.20±1.550[b]
HCT (%)	33.10±1.39[a]	30.20±1.11[a]	24.49±1.29[a]	24.40±1.470[a]
PCV (%)	38.20±2.29[a]	39.80±1.99[a]	41.20±2.15[a]	39.50±2.650[a]
MCV (fl)	10.55±1.39[b]	40.10±2.86[a]	37.20±3.13[a]	36.40±3.390[a]
MCH (Pg)	39.60±3.18[a]	16.70±1.97[a]	16.40±2.21[a]	16.00±2.370[a]
MCHC(g dL⁻¹)	49.50±3.60[a]	49.30± 1.39[b]	47.40±3.44[a]	46.20±3.770[a]
PLT (10³ µ L⁻¹)	2660.00± 4.29[a]	245.00± 3.84[a]	231.00± 4.10[a]	189.00± 4.380[a]
MPV (fl)	4.02±2.33[a]	3.80±1.90[a]	3.7.0±2.13[a]	3.5.0±2.510[a]
WBC(10³ µ L⁻¹)	10.30±1.68[a]	10.10±1.20[a]	9.7.0±1.48[a]	10.5.0±1.890[a]
Differantial leucocytic count (%)				
Neutrophiles	27.00±1.53[a]	29.00±1.10[a]	30.00±1.34[a]	35.00±1.660[a]
Lympocytes	40.00±1.32[a]	45.00±1.05[a]	50.00±1.19[a]	54.00±1.480[a]
Monocytes	5.50±0.39[a]	6.80±0.12[a]	7.10±0.23[a]	8.00±0.490[a]
Eosinophiles	6.90± 0.28[a]	7.50±0.06[a]	8.20±0.17[a]	9.00±0.380[a]
Basophiles	1.30±0.22[a]	1.50±0.03[a]	1.70± 0.12[a]	1.9.0±0.270[a]
Granulocytes	4.26±0.42[a]	5.23±0.11[a]	5.40±0.28[a]	5.520±0.52[a]

Table 10 Levels of Some Hematological Parameters in Pregnant and Non-Pregnant Camels[32]

Parameter	Pregnant	Non-pregnant
PCV (%)	26.88±0.39	27.00±0.37
Hemoglobin(gm/100 ml)	12.43±0.19	12.43±0.18
WBC (X10³)	10.54±0.25	11.28±0.24
Neurophils (%)	61.15±1.79$_a$	53.63±2.38$_b$
Lymphocytes (%)	30.50±1.95$_a$	40.43±2.48$_b$
Monocytes (%)	2.78±0.21	2.88±0.74
Eosinophils (%)	5.43±0.45$_a$	3.60±0.35$_b$

Table 11 Ranges of serum chemistry values for dromedary and Bactrian camels (Dromedary values are from two distinct climatic zones[33]

	C. dromedarius	C. bactrianus
Total serum proteins g/100 ml	6.3 - 8.7	5.5 - 7.0
Albumen g/100 ml	3.0 - 4.4	2.8 - 3.3
Globulin g/100 ml	2.8 - 4.4	2.7 - 3.7
Glucose mg/100 ml	37.0 - 67.0	-
Blood urea mmol/1	2.6 - 8.05	2.5 - 10.2
Creatinine mmol/1	106.0 - 250.0	75.0 - 220.0
Bicarbonate mmol/1	-	22.0 - 30.0
Chloride mmol/1	-	107.0 - 115.0
Sodium mmol/1	129.3 - 160.7	147.0 - 156.0
Potassium mmol/1	3.6 - 6.1	3.6 - 4.7
Calcium mmol/1	1.58 - 2.75	1.6 - 2.57
Inorganic phospate mmol/1	1.26 - 2.19	0.87 - 2.8
Alkaline phospatese i.u./1	-	33 - 196
Aspartate transaminase i.u./1	-	69 - 98
Creatine kinase i.u./1	-	35 - 92
Copper µg /100 ml	0.09 - 0.1	0.08 - 0.09
Vitamine E µg/ml	-	0.4 - 1.5
Magnesium µmol/1	0.74 - 1.19	0.75 - 0.95
Iron µmol/1	15 - 20	15 - 27

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Table 12 Mean (±SD) and ranges of serum biochemical values in dromedary[7]

	Majaheem Camels		**Maghateer Camels**		**Awarik Camels**		**Mean of all camels (60)**	**Range**
Item	-20		-20		-20			-60
	Males	Females	Males	Females	Males	Females		
	-9	-11	-10	-10	-10	-10		
BUN (mmoL/L)	5.3±0.22	5.4±0.23	4.9±0.24	5.1±0.22	4.8±0.23	4.9±0.21	5.06±0.61	3.9-6.2
Creatinine (mmoL/L)	0.321± 0.04	0.41±0.051	0.35±0.012	0.39±0.021	0.31±0.022	0.38±0.031	0.35±0.051	0.160-0.533
Cholesterol (mmoL/L)	2.61±0.11	2.45±0.22	2.51±0.11	2.31±0.12	2.65±0.13	2.55±0.14	2.50±0.21	1.91-4.2
Na (mmoL/L)	160.3±16	140±20	155.1±19	162±14	167±15	146±14	155.03±19	100-190
K (mmoL/L)	4.6±0.23	4.1±0.22	3.9±0.23	4.3±0.33	4.4±0.31	4.5±0.34	4.3±0.61	2.9-6.2
Ca (mg/dL)	10.1±0.61	9.6±0.51	11.2±0.42	10.5±0.51	11.2±0.55	10.3±0.51	10.48±2.1	7.6-13.1
Cu (µg/L)	6.5±0.22	6.2±0.22	6.6±0.23	5.9±0.21	6.2±0.24	6.4±0.24	6.3±1.1	4.2-8.5
Zn (µg/L)	4.1±0.13	4.3±0.16	4.4±0.21	3.8±0.22	3.9±0.24	4.2±0.25	4.11±0.61	2.9-6.1
ALT (Iu/L)	10.2±0.54	11.2±0.56	13.4±0.57	10.6±0.58	10.1±0.56	12.1±0.55	11.23±1.6	8.8-14.5
AST LT (Iu/L)	27.2±1.3	31.2±1.6	25.7±2.1	30.1±2.4	31.2±2.1	28.5±2.2	28.98±3.1	24.1-35.1
LD LT (Iu/L)	250±15	240±4	260±15	266±16	255±14	251±15	253±26.1	225-280
CK LT (Iu/L)	25.3±1.6	24.9±1.4	25.5±2.1	25.6±1.7	25.4±1.8	25.8±1.6	25.4±1.1	29.1-30.3

Abbreviations Number of animals in parentheses, Bun, blood urea nitrogen; Na, sodium; K, potassium; Ca, calcium; Cu, copper; Zn, zinc; ALT, alanine amino transferase; AST, aspartate amino transferase; LD, Lactic dehydrogenase; CK, creatine kinase

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Table 13 Mean (±SD) and ranges of serum protein values in dromedary camels[7]

	Majaheem Camels		Maghateer Camels		Awarik Camels		Mean of all camels (60)	Range
Item	-20		-20		-20			-60
	Males	Females	Males	Females	Males	Females		
	-9	-11	-10	-10	-10	-10		
Total protein(g/dL)	7.75±0.21	7.81±0.12	7.78±0.20	7.68±0.22	7.72±0.20	7.76±0.19	7.74±0.68	4.9-10.2
Albumin(g/dL)	4.20±0.12	4.31±0.11	4.33±0.12	4.28±0.11	4.30±0.10	4.29±0.10	4.29±0.40	3.1-6.2
α-globulin(g/dL)	0.87±0.02	0.79±0.01	0.73±0.03	0.68±0.02	0.73±0.03	0.76±0.03	0.76±0.08	0.45-0.96
β-globulin(g/dL)	0.92±0.06	0.93±0.03	0.92±0.05	0.96±0.04	0.94±0.05	0.93±0.03	0.93±0.04	0.51-1.1
γ-globulin(g/dL)	1.76±0.03	1.78±0.02	1.77±0.03	1.76±0.02	1.75±0.04	1.78±0.03	1.76±0.03	0.76-2.1
Total globulin(g/dK)	3.55±0.16	3.50±0.17	3.45±0.15	3.40±0.16	3.42±0.16	3.47±0.15	3.46±0.18	1.5-5.4
A/G	1.18±0.02	1.23±0.03	1.25±0.02	1.26±0.03	1.25±0.03	1.23±0.02	1.23±0.07	0.8-1.6

Table 14 Mean±S.E activities of CK, LDH, AST, ALT, ALP and GGT in the Serum of Female Camels (n=5)[35]

Parameter	Unit	She camel
CK	U L^{-1}	408.6±127.6a
LDH	U L^{-1}	455.0±75.9b
AST	U L^{-1}	164.6±39.9a
ALT	U L^{-1}	17.2±3.6b
ALP	U L^{-1}	60.0±7.2b
GGT	U L^{-1}	25.6±7.8b

Note Duncan's Multiple Range Test was performed at P < 0.05 Means with the same letter are not significantly different.

Table 15 Mean±S.E. concentrations of Na, K, Cl, Mg, Ca, P and Fe in the Serum of female camels (n=5)[3]

Parameter	Unit	She camel
Na	mEq. L^{-1}	168.2±0.7a
K	mEq. L^{-1}	4.0±0.2b
Cl	mEq. L^{-1}	130.2±1.9a
Mg	mEq. L^{-1}	2.16±0.09b
Ca	mg dl^{-1}	9.0±0.1b
P	mg dl^{-1}	3.8±0.5b
Fe	mg dl^{-1}	80.2±16.0b

Note Duncan's Multiple Range Test was performed at P < 0.05 Means with the same letter are not significantly different.

Table 16 Mean±S.E. concentrations of glucose, cholesterol, triglycerides, urea, creatinine, total protein and albumine in the serum of female camels (n=5)[3]

Parameter	Unit	She camel
Glucose	mg dl^{-1}	134.4±11.0a
Cholesterol	mg dl^{-1}	58.4±8.6a
Triglycerides	mg dl^{-1}	31.4±3.0a
Urea	mg dl^{-1}	49.8±5.5a
Creatinine	mg dl^{-1}	1.5±0.1a
Total protein	g dl^{-1}	7.1±0.3b
Albumin	g dl^{-1}	3.7±0.3b

Note Duncan's Multiple Range Test was performed at P < 0.05 Means with the same letter are not significantly different.

Table 17 Serum Biochemical Parameters Of Male Dromedary Camels in pre-put, rut, post-rut and non-rut Seasons[35]

Total protein (mg dL^{-1})	7.25±0.20[a]	7.31±0.27[a]	7.44±0.22[a]	7.200±16[a]
Glucose (mg dL^{-1})	114.33±3.20[ab]	108.03±2.45[bc]	103.32±2.76[b]	118.700±1.25[a]
Creatinine (mg dL^{-1})	1.48±0.41[ab]	1.53±0.47[ab]	1.57±0.65[c]	1.450±0.66[a]
Total cholesterol (mg dL^{-1})	22.03±0.52[ab]	21.80±1.30[b]	16.89±1.34[c]	24.990±1.88[a]
Blood urea nitrogen (mg dL^{-1})	30.50±0.16[ab]	30.20±022[ab]	30.80±0.19[a]	30.200±0.14[b]
LDH-L (IU L^{-1}	357.00±1.55[ab]	355.00±2.01[ab]	350.00±1.33[a]	380.000±1.22[b]
ALT (IU L^{-1}	19.50±1.23[ab]	18.80±1.44[bc]	14.6.0±0.45[a]	14.3.0±0.610[b]
GGT (IU L^{-1}	25.20±2.02[ab]	24.90±2.13[ab]	20.90±1.03[c]	15.50±0.710[b]
Iron (µg dL^{-1})	69.80±0.10[ab]	71.40±0.33[bc]	70.50±0.51[a]	77.10±0.340[b]

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Table 18 Levels of Some Biochemical Parameters in Pregnant and Non-Pregnant Camels[1]

Parameter	Pregnant	Non-pregnant
Glucose (mg/100 ml)	96.58±1.53	100.55 + 1.03
Total protein (gm / 100ml)	6.43±0.04 $_a$	5.95 + 0.08 $_b$
Albumin (gm / 100ml)	2.70± 0.05 $_a$	2.49 + 0.02 $_b$
Globulin (gm / 100ml)	3.74±0.04	3.51 + 0.06
BUN (mg / 100ml)	15.48±1.45 $_a$	7.85 + 1.45 $_b$
Creatinine (mg / 100ml)	1.42±0.04 $_a$	1.20 + 0.06 $_b$
CK (U/L)	23.25±2.21 $_a$	55.96+ 4.54 $_b$
Alkaline Phospatase (U/L)	44.27±1.93 $_a$	73.75+ 2.42 $_b$
ALT (U/L)	13.13±0.36	18.56+ 0.24
AST (U/L)	53.88±0.88 $_a$	77.15+ 1.41 $_b$
GGT (U/L)	8.83± 1.40 $_a$	11.08+ 2.28 $_b$
LDH (U/L)	297.00±9.24 $_a$	428.58 + 13.0 $_b$

Conclusion

The examination and treatment of a camel, whether Dromedary or Bactrian, need not to be regarded as a daunting clinical challenge to veterinarians or others presented with this species under field conditions. Despite the fact that there are many studies on the clinical, hematologic and blood biochemical characteristics of camels, they are usually regional studies. The clinical, hematological and blood biochemical values provided by this article can be used as a reference values for veterinarians and academics who deal with camel diseases in different area of the world. This article will allow the veterinarians to compare all data related with this topic.

Acknowledgments

None.

Conflicts of interest

The author declares that there is no conflicts of interest.

References

1. Al Ani, FK Camel. Management and Husbundry.1st ed. Amman: Jordan;2004.
2. Ayoub MA, El Khouly AA, Mohamed TM. Some hematological and biochemical parameters and steroid hormone levels in the one-humped camel during different physiological conditions. *J Agric Sci*. 2003;15(1):44–55.
3. Al Harbi MS. Some Hematologic Values and Serum Biochemical Parameters in Male Camels (Camelus dromedarius) before and during Rut. *Asian Journal of Animal and Veterinary Advances*. 2012;7:1219–1226.
4. Osman TAE, Al-Busadah KA. Normal Concentrations of Twenty Serum Biochemical Parameters of She-camels, Cows and Ewes in Saudi Arabia. *Pakistan Journal of Biological Sciences*. 2003;6:1253–1256.
5. Khalid AA, AL Busadah. Some biochemical and hematological indices in different breeds of camels in Saudi Arabia. *Basic and Applied Science*. 2007;131–142.
6. Abu Samra MT. The one-humped camel (Camelus dromedarius) in health and disease. Camel breeding, protection and improvement in KSA. *Al Jouf*. 2008.
7. Bhatt FL, Kholi RN, Rathore. The normal body temperature, respiratory frequency. 1960.
8. Bogin E. Clinical pathology of Camelides: present and future. *Revue Méd Vét*. 2000;151:7:563–568.
9. Epstein, H. History and origin of the African camel. The Origin of the Domestic Animals in Africa. *African Publishing Corporation*.1971;558–564.
10. Faye B, Jouany JP, Chacornac JPET, et al. L'élevage des grands camélidés. Analyse des initiatives réalisées en France. *INRA Productions Animales*. 1995;1(8):3–17.
11. FAO. Food and Agricultural Organization, United Nations. Gee, P. *The camel in Australia. Journal of Camel Practice and Research* .1996;3:139–140.
12. Ji R, Cui P, Ding F, et al. Monophy letic origin of domestic Bactrian camel (Camel usbactrianus) and its evolutionary relationship with the extant wild camel (Camelus bactrianus ferus). *Animal Genetics*. 2009;40:377–382.
13. Lhote H, Le cheval et le. Chameau dans les peintures et gravures rupestres du Sahara. *Bulletin de IFAN*.1953;15:1212–1225.
14. Saalfeld WK, Edward GP. Distribution and abundance of the feral camel (Camelus dromedarius) in Australia.*The Rangeland Jour nal*. 2010;32:1–9.
15. Uerpman HP, Uerpman M. The appearance of the domestic camel in SE Arabia. *Journal of Oman Studies* . 2002:12:235–260.
16. Wilson RT. The Camel. *Longman Pub lishers*. 1984.
17. Fowler M. Medicine and Surgery of Camelids. 3rd ed. Wiley Blackwell Publishing. 2010.
18. Chapman MJ. Bactrian Camels–World animal review. *World animal review*. 1985;55:14–19.
19. Cloudley Thompson JL. Camel. Encyclop. Americana. 1969;5:261–263.
20. Fazil MA, Hofman RR. Haltung und Krankheiten des Kamels. *Tierärztl Prax*. 1981; 9:389–402.
21. Indra R, Magash A, Biichee N. Studies of Bactrian camel. *Ulaanbaatar Institution Press*. 1998;303.
22. Jirimutu, ZW, Guohui D. Genome sequences of wild and domestic Bactrian camels. *J. Nature communication*. 2012;3.
23. Macfarlane WV. Terrestial animals in dry heat: ungulates. In: Dill, D.B, editor. Handbock of Physiology.Adaptation to Environment. Washington DC. *American Physiological Society*.1964;509–539.
24. Schmit Nielson K, B Jarnum SA, Houpt TR. Body temperature of a camel and its relation to water economy. *American Journal of Physiology*. 1957;188:103–112.
25. Schmidt Nielsen K. Desert Animals. Adaptation and Environment. *Oxford University Press*.1964;277.
26. Wilson RT. The Camel. USA: New York Longman.1984.

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27. Leese AS. A Treatise on the one-humped camel. Haynes, Stamford, UK. Radostits. OM, CC Gay, KW Hinchcliff et al Veterinary Medicine-A textbook of the diseases of cattle, horses, sheep, pigs and goats, 10th Ed. Saunders Elsevier, Edinburgh, UK.1927.

28. Higgins AJ, RA Kock. A guide to the clinical examination, chemical restraint and medication of the camel. *Br vet J*.1984;140:485–504.

29. Abdelgadir SE, Wahbi AA, Idris OF. Camels International Foundation for Science. In *IFS Provisional Report No 6, Stockholm*.1979;365–382.

30. Wahbi AA, Abdelgadir SE, Awadelseid NA, et al. Camels International Foundation for Science. *In: IFS Provisional Report No 6, Stockholm, Sweeden*.1979;355–365.

31. Sahal KE. Socio economic Situation of Camel herders in North Kordofan State. 2015.

32. Vap L and Bohn AA. Hematology of Camelids. *Veterinary Clinics of North America Exotic Animal Practice*. 2014;2:42–49.

33. Gauly M, Vaughan J, Cebra C. Neuweltkameliden Haltung, Zucht, Erkrankungen. *3 Auflage, Enke Verlag, Stuttgard*. 2011;14–18.

34. Vallenas A, Cummings J, Munnell J . A gross study of the compartmentalized stomach of two new-world camelids, the llama and guanaco. *J Morphol*.1971;134:399–423.

35. Stolzl AM. Feeding behaviour of South American camelids. Doctoral Thessis. *University of Veterinary Medicine Hannover*. 2015.

36. Mohammad Salem Al Harbi . Some Hematologic Values and Serum Biochemical Parameters in Male Camels (Camelus dromedarius) before and during Rut. *Asian Journal of Animal and Veterinary Advances*. 2012;7:1219–1226.

37. Soliman MM, Hassan MY, Mostafa SA, et al. Protective effects of camel milk against pathogenicity induced by Escherichia coli and Staphylococcus aureus in Wistar rats. *Mol Med Rep*. 2015;12(6):830612.

38. Kamal AM. Some Biochemical, Hematological and Clinical Studies of Selected Ruminal and Blood Constituents in Camels Affected by Various Diseases. *Research Journal of Veterinary Sciences*. 2008;1:16–27.

Citation: Elitok B, Cirak AC. Clinical, Hematological and Blood Biochemical Features of Camels. *MOJ Immunol.* 2018;6(5):288–295.
DOI: 10.15406/moji.2018.06.00245