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Comparison of Anatomical and Blood Biochemical Parameters of Iranian Racing and Dual-Purpose Camels (*Camelus dromedarius*)

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Abstract

BACKGROUND: Animal breeds are often recognized through their specific characteristics, nevertheless, the breeds' anatomical and biochemical characteristics have not considered yet in many of the researches done on one-humped camels. There are some particular differences in camel breeds due to different climate conditions and rearing necessity.

OBJECTIVES: The aim of the current study was to compare differences in anatomical and plasma biochemical parameters of two Iranian one-humped camels, the Jammaz (racing) and Balouchi (dual-purpose) breeds.

METHODS: Anatomical parameters were body length (BL), neck length (NL), chest girth (CG), barrel girth (BG), hump circumference (HC), fore limb length (FLL), hind limb length (HLL), height at hump (HH), fore limbs interval (FLI), hind limbs interval (HLI), fore hoof circumference (FHC), hind hoof circumference (HHC), abdominal circumference (AC), shank circumference (SC) and leg circumference (LC). Moreover, concentrations of Glucose, blood urea nitrogen (BUN), creatinine, cholesterol, total bilirubin (Bili-T), direct bilirubin (Bili-D), calcium (Ca), phosphorus (P), magnesium (Mg), aspartate aminotransferase (AST), creatine kinase (CK), lactate dehydrogenase (LDH), total protein (TP), albumin (Alb), triiodothyronine (T3) and thyroxine (T4) were measured as plasma biochemical parameters. Data analysis was conducted through t-test statistics.

RESULTS: Results revealed significant differences between body type traits of breeds, especially in organs related to running ability, while the Jammaz breed has more height and longer limbs than the Balouchi breed. Some blood parameters (glucose, LDH, BUN, cortisol and T4) are considerably higher in Jammaz breed, too.

CONCLUSIONS: Results of the current study suggest some anatomical (especially fore and hind limb lengths, neck length and body height at hump) and physiological characteristics (lactate dehydrogenase, blood urea nitrogen, cortisol, glucose and T4) of Iranian racing and dual purpose camels as breed markers.

KEYWORDS: Body type traits, Dromedary camel, Plasma biochemical parameters, Pure breeds, Uncontrolled mating

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Introduction

Dromedary camels (*Camelus dromedarius*) are commonly considered as animals which have successfully adapted to the harsh environments especially in the Middle East (Noaman, 2018), sub-Saharan Africa (Legesse *et al*., 2018) and India (Narnaware *et al*., 2015). Camels are usually reared on poor pastures under extensive production systems and produce high-quality meat and milk. Hence, their rearing and production costs are relatively low. Furthermore, camels were largely utilized for transportation, while pastoral lifestyle in the tropics was also a remarkable reason of seasonal immigration. Therefore, camel plays a key role for immigrants especially in less-developed areas. In addition to transportation, camels are considered as a portable source of food for their owners (Kashongwe *et al*., 2017). Such situations during many centuries resulted in domestication of an animal with unique endurance that is able to survive in harsh environments (Mohandesan *et al*., 2017). Furthermore, due to vast deserts and far distances between cities and villages, most of the camel breeds are naturally adapted for long-distance marching with inadequate rest.

In Iran, especially in the south east of the country, camel raising is considered as an important occupation and different breeds of indigenous and exotic one-humped camels have often been reared for their meat, milk and/or wool production. However, during the last decades using camels for transportation has been limited in Iran through facilitated transportation by roads development even in deserts, and people's changing lifestyle. Among different indigenous breeds, "Balouchi" breed seems to be one of the dual-purpose camels which are widely spread over Afghanistan and Pakistan and south-east Iran (Salehi and Gharahdaghi, 2013). This breed is generally known for its moderate hump, good marching ability and appropriate meat and milk production. Actually, Balouchi camels move steadily over long distances. Besides Balouchi breeds, almost all of the dromedary camel breeds in Iran have been kept for meat, milk or both, and to a lesser extent, for wool. Nevertheless, a very limited population of dromedary camels in Iran have been selected for short-distance fast-running, so-called racing camels. Iranian racing camels have a relatively lighter weight than other breed types so are not slaughtered for meat. While camel population is decreasing globally, consideration of the racing camels due to their economic importance has become more important than before. Recently, considerable attention has been paid to Iranian racing camel, "Jammaz" breed, due to their introduction in several annual national and international race competitions. Hence, in the local market, Jammaz breed is 4 to 6 times more expensive than other breeds. However, this breed makes up a very limited proportion of the national camel population (Salehi and Gharahdaghi, 2013), and the breed is at risk due to uncontrolled mating with other breeds.

During the last decades, uncontrolled mating has been occurred between different indigenous and/or exotic one-humped camel breeds in Iran. Over thousands of years, each breed was formed based on its geographical distribution and human needs, hence uncontrolled mating is not acceptable based on the genetic diversity point of view (Cherifi *et al*., 2017). Essentially, crossbred camels with unknown genetic make-up and indefinite contribution of basic animals is not admissible (Chuluunbat *et al*., 2014). Uncontrolled mat-

ing also results in difficulties to find out pure breeds. In the case of camels, registration of individuals and pedigree formation under extensive production systems to identify parental lineage may be impossible. As an alternative way, while anatomical (body type traits) and physiological (especially blood biochemical parameters) characteristics of each breed seem to be specified, identification of phenotypic and intrinsic characteristics of each breed would be a practical way to ensure breed purity. Accordingly, pure Iranian adult Jammaz and Balouchi breeds were considered to compare their body type traits and blood biochemical parameters as the aim of this study.

Materials and Methods

Animals

This study was conducted following the general ethical guidelines of Animal Care and Use Committee (ACUC), Faculty of Veterinary Medicine, University of Zabol, Zabol, Iran. To support the aim of the current study, many camel herds were evaluated based on available historical information of the herds, the local veterinary inspectors' judgment, experience of vaccination technicians, and consultation with the herd owners to identify pure Iranian Jammaz and Balouchi camel breeds. Eventually, 32 Jammaz and 42 Balouchi pure breeds were identified at southern Sistan and Baluchistan province in November 2017. Camels were from different herds but all of them were reared on low-quality pastures under extensive production system. Camels were between 6 and 10 years old. None of the camels were pregnant. Lactating animals were not included in the study. Immediately, before body measurement and blood sample collection conventional veterinary practices were made to ensure the health status of the animals.

Body type traits

In the current study body type traits related to the camel marching/running ability were taken into account. Body measurements (cm) were body length (BL), neck length (NL), chest girth (CG), barrel girth (BG), hump circumference (HC), fore limb length (FLL), hind limb length (HLL), height at hump (HH), fore limbs interval (FLI), hind limbs interval (HLI), fore hoof circumference (FHC), hind hoof circumference (HHC), abdominal circumference (AC), shank circumference (SC) and leg circumference (LC) which were according to definitions described by Legesse *et al.* (2018). Body type traits (body measurements) description and abbreviations are shown in Table 1. Moreover, descriptive statistics of body type traits are shown in Table 2.

Table 1. Description of body measurements (type traits) and abbreviations

Body type traits	Description
Body Length (BL)	Horizontal distance from point of shoulder to pin bone
Neck length (NL)	Distance from lower part of mandible to sternum
Chest Girth (CG)	Circumference of the body immediately behind the shoulder blades in a vertical plane
Barrel Girth (BG)	Measurement of distance around abdomen over highest part of hump
Abdominal Circumference (AC)	Circumference of the body immediately in front of the hind limbs
Fore Limb Length (FLL)	Distance from surface of the ground level to front of sternum

Body type traits	Description
Hind Limb Length (HLL)	Distance from surface of the ground level to joint point of hind limb to the body
Hump Circumference (HC)	Perimeter of hump from a point at anterior end of hump to a point at posterior end
Fore Limbs Interval (FLI)	Distance between fore limbs at joint
Height at Hump (HH)	Height from bottom of front foot to highest point of hump
Hind Limbs Interval (HLI)	Distance between hind limbs at hook joint
Fore Hoof Circumference (FHC)	Average circumferences of fore limb hoofs around widest part
Hind Hoof Circumference (HHC)	Average circumferences of hind limb hoofs around widest part
Shank Circumference (SC)	Average circumferences of shanks around thinnest part
Leg Circumference (LC)	Average circumferences of legs around thinnest part

Table 2. Descriptive statistics of body type traits in Iranian Jammaz (racing camel) and Balouchi (dual-purpose camel) breeds (n = 74)

Body Type Traits	Mean ± SD	Minimum	Maximum	CV
Body Length (BL)	153.65 ± 6.72	138	167	4.37
Neck length (NL)	103.70 ± 5.94	91	117	5.73
Chest Girth (CG)	187.89 ± 9.22	170	212	4.90
Barrel Girth (BG)	244.05 ± 21.82	192	288	8.94
Abdominal Circumference (AC)	151.24 ± 16.66	71	178	11.01
Hump Circumference (HC)	106.14 ± 17.03	75	143	16.04
Height at Hump (HH)	189.14 ± 6.64	179	203	3.51
Fore Limb Length (FLL)	134.05 ± 4.40	124	144	3.29
Hind Limb Length (HLL)	142.28 ± 6.29	124	154	4.42
Fore Limbs Interval (FLI)	20.49 ± 1.70	14	24	8.29
Hind Limbs Interval (HLI)	21.10 ± 3.96	14	28	18.78
Fore Hoof Circumference (FHC)	56.54 ± 3.29	51	65	5.82
Hind Hoof Circumference (HHC)	64.35 ± 4.62	55	75	7.18
Shank Circumference (SC)	20.19 ± 1.60	17	24	7.94
Leg Circumference (LC)	18.34 ± 1.77	15	25	9.64

Plasma biochemical parameters

Blood samples (5 ml) were collected from the jugular vein of each individual in vacuum tubes with anticoagulant (EDTA) between 09:00 and 11:00 AM. Animals did not have physical activity during the 24 h before blood sampling. All blood samples were placed on ice immediately after collection, then transported to the laboratory. Plasma was separated by centrifugation (3000 rpm,

25 min and 8 °C). Collected plasma were frozen at −80 °C until biochemical analyses. Plasma concentration of Glucose, blood urea nitrogen (BUN), creatinine, cholesterol, total bilirubin (Bili-T), direct bilirubin (Bili-D), calcium (Ca), phosphorus (P), magnesium (Mg), aspartate aminotransferase (AST), creatine kinase (CK), lactate dehydrogenase (LDH), total protein (TP), albumin (Alb), triiodothyronine (T3) and thyroxine (T4) were measured with commercial biochemical kits (DiaSys Diagnostic Systems GmbH, Germany) using Selectra proM (ELITech Group, France) autoanalyzer. Globulin (Glo) concentrations was calculated through total TP minus Alb concentrations. Then, Alb to Glo ratio (Alb:Glo) calculated through Alb concentration was divided by Glo concentration. Descriptive statistics of blood biochemical parameters of camels in the current study are shown in Table 3.

Table 3. Descriptive statistics of blood biochemical parameters in Iranian Jammaz (racing camel) and Balouchi (dual-purpose camel) breeds (n = 74)

Blood Parameter	Mean ± SD	Minimum	Maximum	CV
Glucose (mg/100 ml)	89.69 ± 13.08	67.00	120.00	14.59
BUN (mg/100 ml)	22.17 ± 4.96	16.00	33.00	22.37
Creatinine (mg/100 ml)	0.88 ± 0.16	0.68	1.33	18.11
Cholesterol (mg/100 ml)	29.42 ± 8.24	11.00	46.00	28.01
Bili-T (mg/l)	0.60 ± 0.02	0.56	0.63	2.81
Bili-D (mg/l)	0.06 ± 0.02	0.04	0.16	37.12
Ca (mg/100 ml)	7.74 ± 2.18	5.10	9.30	35.48
P (mg/100 ml)	6.06 ± 1.06	2.84	8.43	17.55
Mg (mg/100 ml)	0.56 ± 0.47	0.17	2.66	84.16
AST (U/l)	110.03 ± 23.36	67.00	175.00	21.23
CK (U/l)	117.97 ± 53.98	32.00	273.00	45.76
LDH (U/l)	803.60 ± 341.84	311.00	1515.00	42.53
Alb (gr/dl)	3.45 ± 0.27	2.91	3.95	7.76
TP (gr/dl)	6.70 ± 0.53	5.37	7.94	8.02
Glo (gr/dl)	3.24 ± 0.46	2.32	4.08	14.22
Alb:Glo	1.09 ± 0.17	0.77	1.38	15.98
Cortisol (ng/ml)	1.92 ± 0.64	0.93	3.39	33.55
T3 (ng/ml)	3.03 ± 2.08	1.00	9.68	75.20
T4 (ng/ml)	12.50 ± 5.00	5.37	25.20	40.00

BUN: Blood Urea Nitrogen; Bili-T: Total Bilirubin; Bili-D: Direct Bilirubin; Ca: Calcium; P: Phosphorous; Mg: Magnesium; AST: Aspartate Aminotransferase; CK: Creatine Kinase; LDH: Lactate Dehydrogenase; TP: Total Protein; Alb: Albumin; Glo: Globulin: Alb:Glo: Albumin to Globulin ratio; T3: Triiodothyronine; T4: Thyroxine

Statistical Analysis

Statistical significance of differences between body type traits and plasma biochemical parameters of Iranian racing (Jammaz) and dual-purpose (Balouchi) camels was compared through the non-paired Student's t-test in SAS (SAS Institute Inc., 2008).($P < 0.05$) was considered significant.

Results

Body type traits

Comparisons of body type traits of Iranian racing (Jammaz breed) and dual-purpose camel (Balouchi breed) are shown in Table 4. In general, it seems that body size of Balouchi breed is greater than Jammaz breed. Therefore, BL in Balouchi breed is almost 5% taller than Jammaz breed, while this difference was not statistically significant ($P < 0.05$). About a 5% longer neck in Jammaz breed (105.36 cm) than Balouchi breed (100.93 cm) was statistically significant ($P \geq 0.05$). According to the approximately larger feature and estimated heavier weight of Balouchi camels, wider CG in this breed was expected, but this trait between two breeds was not significantly different ($P \geq 0.05$). Expectedly, BG in Balouchi breed was almost 20 cm wider than Jammaz breed ($P < 0.05$). In spite of developed CG in Jammaz camels, AC in this breed was almost 8% thinner than Balouchi breed ($P < 0.05$). Comparison of two breeds for their HC showed no statistically significant differences (103.79 vs. 108.07 for Jammaz and Baluchi breeds, respectively) Table 4.

Table 4. Comparison of body type traits of Iranian Jammaz and Balouchi camels

Body Type Traits (cm)	Jammaz breed	Balouchi breed	SEM	P value
Body Length (BL)	152.71	155.29	1.00	0.076
Neck length (NL)	105.36[a,*]	100.93[b]	0.89	0.001
Chest Girth (CG)	186.21	189.21	1.64	0.200
Barrel Girth (BG)	232.79[b]	252.71[a]	3.79	0.000
Abdominal Circumference (AC)	144.14 [b]	155.79 [a]	3.50	0.041
Hump Circumference (HC)	103.79	108.07	3.25	0.219
Height at Hump (HH)	192.07[a]	187.43[b]	1.23	0.010
Fore Limb Length (FLL)	137.86[a]	132.71[b]	0.82	0.009
Hind Limb Length (HLL)	148.71[a]	142.07[b]	0.98	0.041
Fore Limbs Interval (FLI)	20.71	19.86	0.31	0.059
Hind Limbs Interval (HLI)	19.57[b]	22.79[a]	0.70	0.002
Fore Hoof Circumference (FHC)	52.49[b]	58.21[a]	0.52	0.000
Hind Hoof Circumference (HHC)	60.64[b]	65.93[a]	0.87	0.049
Shank Circumference (SC)	19.93[b]	21.00[a]	0.30	0.014
Leg Circumference (LC)	17.71[b]	18.79[a]	0.33	0.028

* Means with different letters are significantly different from each other.

Height of Jammaz camels at hump (HH) was on average only 4.64 cm taller than Balouchi breed, though, difference of breeds for this trait was significant ($P < 0.05$). In addition, FLL and HLL were approximately 5 and 6 cm more in Jammaz breed than Balouchi breed ($P < 0.05$). Comparisons showed no differences for FLI between two breeds, although HLI in Balouchi breed was almost 16.5% more than Jammaz breed which obviously indicate bigger AC and probably wider pelvic region in Balouchi breed. In the case of Jammaz camels, FHC and HHC were 5.72 and 5.29 cm smaller than Balouchi breed, respectively, which were statistically significant ($P < 0.05$). Shank and leg circumferences (SL and LC, respectively) in Balouchi breed were also thicker than Jammaz breed (19.93 vs. 21.00 cm and 17371 vs. 18. 79 cm, respectively).

Plasma biochemical parameters

Based on Table 5, blood glucose level in Jammaz camels was almost 20% more than in Balouchi breed (96.60 vs. 80.56 mg/100 ml) which was considerably different ($P < 0.05$). In our study, cholesterol concentration in Jammaz camels (27.53 mg/ 100 ml) was higher than in Balouchi breed (25.67 mg/100 ml), although the differences were not significant ($P \geq 0.05$).

Table 5. Comparison of plasma biochemical parameters of Iranian Jammaz and Balouchi camels

Blood Parameter	Jammaz breed	Balouchi breed	SEM	P value
Glucose (mg/100 ml)	96.60[a,*]	80.56[b]	2.01	0.007
Cholesterol (mg/100 ml)	27.53	25.67	1.45	0.378
Ca[**] (mg/100 ml)	7.93	7.22	0.42	0.480
P (mg/100 ml)	5.57[b]	6.26[a]	0.20	0.017
Mg (mg/100 ml)	1.45	1.50	0.10	0.718

.Means with different letters are significantly different from each other*
.Ca: Calcium; P: Phosphorous; Mg: Magnesium**

According to our results, mineral concentrations between studied breeds did not show statistical significance except for plasma P ($P < 0.05$), which was higher in Balouchi breed (6.25 mg/100 ml) than in Jammaz breed (5.57 mg/100 ml). In the current study, plasma level of Ca in Jammaz breed (7.39 mg/100 ml) is higher than in Balouchi breed (7.22 mg/100 ml) but it is not significantly different between two breeds ($P \geq 0.05$).

Table 6. Comparison of liver enzymes, nitrogen parameters and plasma proteins of Iranian Jammaz and Balouchi camels

Blood Proteins	Jammaz breed	Balouchi breed	SEM	P value
AST[*] (U/l)	114.08	100.44	5.56	0.077
CK (U/l)	123.80	103.89	10.21	0.176
LDH (U/l)	1015.40[a,**]	609.56[b]	55.06	0.000
Bili-T (mg/l)	0.61[a]	0.58[b]	0.01	0.011
Bili-D (mg/l)	0.06[a]	0.04[b]	0.00	0.016
BUN (mg/100 ml)	26.47[a]	18.44[b]	0.80	0.031

Blood Proteins	Jammaz breed	Balouchi breed	SEM	P value
Creatinine (mg/100 ml)	1.01[a]	0.77[b]	0.02	0.032
TP (gr/dl)	6.79[a]	6.18[b]	0.10	0.009
Alb (gr/dl)	3.34	3.38	0.05	0.595
Glo (gr/dl)	3.45[a]	2.80[b]	0.08	0.010
Alb:Glo	0.99[b]	1.22[a]	0.04	0.011

[*]AST: Aspartate Aminotransferase; CK: Creatine Kinase; LDH: Lactate Dehydrogenase; Bili-T: Total Bilirubin; Bili-D: Direct Bilirubin; BUN: Blood Urea Nitrogen; TP: Total Protein; Alb: Albumin; Glo: Globulin: Alb:Glo: Albumin to Globulin ratio.
[**]Means with different letters are significantly different from each other.

As shown in Table 6, liver enzymes in Jammaz breed were higher than Balouchi breed. Nevertheless, while AST (13.58 %) and CK (11.92%) both in Jammaz breed were higher than Balouchi breed, just the difference for LDH was significant ($P < 0.05$). In fact, plasma levels of LDH in Jammaz camels was almost two times higher than Balouchi breed (1015.40 U/l in Balouchi breed vs. 609.56 U/l in Jammaz breed). Differences in both Bili-T and Bili-D in two breeds in our study were strongly significant ($P < 0.05$ for Bili-T and Bili-D), while there were no considerable differences between values in Balouchi and Jammaz breeds (0.03 and 0.02 mg/l for Bili-T and Bili-D, respectively). Plasma concentration of BUN and creatinine in Jammaz breed was higher than in Balouchi breed (43.5% and 31%, respectively), which resulted in a statistically significant difference for both parameters ($P < 0.05$). While plasma levels of Alb in two breeds were very similar (3.34 vs. 3.38 gr/dl in Jammaz and Balouchi breeds, respectively), however, TP concentration in Balouchi breed was almost 9.87% lower than Jammaz breed. Accordingly, Glo concentration in Jammaz breed was also 0.65 gr/dl higher than Balouchi breed ($P < 0.05$). The lower amounts of Glo concentration in Balouchi breed resulted in higher amount for Alb:Glo in this breed than in Jammaz breed which was strongly significant ($P < 0.05$) Table 7.

Comparing plasma concentrations of hormones (Cortisol, T3, and T4) between Iranian racing and dual-purpose camels (Table 7), all of the values for Jammaz breed were higher than Balouchi breed, while the difference for T3 between two breeds was not significant ($P \geq 0.05$). For Balouchi breed, cortisol, and T4 concentrations were lower than Jammaz breed, 0.42 and 3.89 ng/ml, respectively, while comparison of T3 concentrations between two breeds was almost equal.

Table 7 Comparison of plasma hormones of Iranian Jammaz and Balouchi camels

Blood hormones	Jammaz breed	Balouchi breed	SEM	P value
Cortisol (ng/ml)	2.07[a,*]	1.65[b]	0.13	0.028
T3[**] (ng/ml)	3.10	3.05	0.49	0.949
T4 (ng/ml)	14.07[a]	10.18[b]	0.98	0.012

.Means with different letters are significantly different from each other[*]
.T3: Triiodothyronine; T4: Thyroxine[**]

Discussion

Body type traits

Mean of body lengths in 8 breeds of Ethiopian camels was calculated as 148.7 cm, while separate BL for each breed was not reported (Legesse *et al*., 2018). Their reports for BL were similar to the BL of Iranian racing and dual-purpose camel breeds, while Iranian camels have slightly longer bodies. Feed quality and quantity in particular at earlier stage of life influenced positively on BL (Saini *et al*., 2014), therefore, shorter body length in Jammaz breed may be due to controlled feeding during the growing period of the camels. Camels naturally lower their heads during running, therefore, longer neck in Jammaz camels helps them maintain balance, whereas, neck movements during running result in balanced locomotion. The NL for Ethiopian camels was reported as 106.67 cm (Legesse *et al*., 2018). No significant difference of CG indicates developed respiratory system and larger lungs in Jammaz breed than Balouchi breed. Accordingly, short-distance fast running activity needs rapid respiration and Jammaz breed is well adapted for this purpose. Since camel weighing is not always possible, some body type traits, especially CG, height at withers and hump girth are usually taken into account for estimation of body weight in camels (Boujenane, 2018). Chest girth measurement of Iranian camels in the current study was lower than that of Legesse *et al*. (2018), which reported 207 cm for this trait.

Larger size of BG in Balouchi breed is related to both its larger body and its hump size. It should be considered that in Jammaz breed to keep running ability, higher weight is assumed as an unfavorable characteristic. Therefore, Jammaz breed owners usually give limited feed to the camels to control bodyweight. Consequently, fat and protein storage in hump of Jammaz camels is limited. Legesse *et al*. (2018) reported 244.89 cm for BG in average on 535 individuals of different Ethiopian camel breeds, which was approximately in the middle of our values for Iranian racing (232.79 cm) and dual-purpose (252.71 cm) breeds.

Wider CG and thinner AC in racing animals have also been seen in some breeds of racing dogs such as Greyhound breed. Thinner AC in Jammaz camels helps them to run more easily and allows the hind limbs to move effortlessly. Considering HC in studied breeds suggests that Jammaz camels also can initially store substantial amounts of fat while due to the aim of rearing (racing ability) they are fed ad libitum and their HC is more limited. Considering taller FLL and HLL in Jammaz breed, it is concluded that higher HH in this breed is due to its longer limbs. Longer limbs in Jammaz camels help them to jump higher and therefore run faster. Average HLL in Ethiopian camels (148.34 cm) (Legesse *et al*., 2018) was very similar to Iranian racing camels (148.71 cm) and they are taller than Balouchi breed (142.07 cm). Hoof style plays a key role in running/marching performance of camels. Moreover, circumference of this organ is associated with the animal's weight. Smaller FHC and HHC in Jammaz camels is rooted in their evolutionary history. Smaller hoofs result in lesser friction with the ground, which helps them to run faster.

Plasma biochemical parameters

The normal range for plasma glucose in camel is reported as 60–140 mg/100 ml, while except for camels, basal plasma glucose in mono-gastric animals is considerably higher than adult ruminants such as sheep (Faye and Bengoumi, 2018). Camels are ru-

minants, therefore fermentation of glucose occurs in their rumen. However, they are exceptional with regard to their carbohydrate metabolism, while plasma glucose levels in camels are in the range of single stomach animals or even higher (Abdel-Fattah *et al*., 1999). Plasma level of glucose is widely influenced by feeding time, season, age, rutting season, physical activity reviewed by (Faye and Bengoumi, 2018). Considering rapid running and needs for available energy sources for muscular function, it seems that higher amounts of blood glucose in Jammaz camels is reasonable. Cholesterol is an essential lipid with structural role (both integrity and fluidity) in cell membranes. Basal plasma concentration of cholesterol in camels are very variable (18–150 mg/100 ml), nevertheless, plasma cholesterol concentration in one-humped camels is lower than other animals reviewed by (Faye and Bengoumi, 2018). According to the data of the literature, extremely broad variation in plasma concentration of cholesterol in camels could be because of breed and climate differences which are often not taken into account. Consequently, all of the one-humped camels are compared together without considering the effect of breed.

Higher values of P in Balouchi breed than Jammaz breed (12.38%), might to be due to intrinsic characteristics of this breed. The concentration of P in Hijin racing camel was 5.02 mg/100 ml (Mohamed and Hussein, 1999), which was lower than Iranian Balouchi and Jammaz camels. Normal ranges for Ca, P and Mg in camel for different breeds are reported as 8.4–12.4, 3.8–8.4 and 1.8–2.8 mg/100 ml, respectively (Faye and Bengoumi, 2018). Therefore, our measurements were in the range of other breeds, except for Mg which were lower in both Jammaz (1.45 mg/100 ml) and Balouchi (1.50 mg/100 ml) breeds. Like Ca, P is also an essential macro-mineral for animals and occurred and various biological pathways. Plasma levels of Ca, P and Mg are related to multiple factors such as age, ovarian activity, pregnancy stage and even mineral content of feedstuffs available for animals. Ca is proposed as the main macro-mineral in animal body, which plays an essential role in various biological systems. For example, Ca is necessary for muscular contraction.

The AST basal levels in different breeds of one-humped camels were reported from 37 to 131 U/l (Faye and Bengoumi, 2018). The AST is an index for liver health status, and in the current study, the AST level for both breeds was in the normal range. The enzymatic activity of CK in the muscle fibers is important for the production of energy. Therefore, relatively higher values for CK are expected in Jammaz camels (19.91 U/l) in comparison with Balouchi breed. Lactate dehydrogenase is an enzyme that works mainly in muscles and erythrocytes and catalyzes the reversible conversion of lactate to pyruvate. Plasma levels of LDH increase after anaerobic catabolism of glucose during intense physical activities such as marathon running (Knechtle and Nikolaidis, 2018). Higher levels for LDH in Jammaz breed obviously reflect the need of this breed to provide pyruvate from lactate after racing. Therefore, according to LDH level, it is suggested that Jammaz camels ran faster than other breeds.

In vertebrates, bilirubin is the normal yellow pigment that occurs in the catabolic pathway during breakdown of the red blood cells (Lam *et al*., 2017). Therefore, this metabolite is greatly influenced by the longevity of erythrocytes. According to the review of

Faye and Bengoumi, (2018) basal bilirubin concentrations in different breeds of camels normally range between 0.5 and 8.6 mg/l, which suggests a variety of factors influence on blood bilirubin concentration (Gao *et al*., 2018; Chen *et al*., 2018). Measurements for BUN and creatinine were in the normal range, as according to Faye and Bengoumi, (2018) range of BUN and creatinine for different breeds of camels are 8–30 mg/100 ml and 0.8–2 mg/100 ml, respectively. During protein digestion and turn over (amino acids catabolism), urea as the main non-protein nitrogen is produced through urea cycle in the kidneys and mainly in the liver. Actually, waste ammonia in the form of urea carries in the blood and excretes from the animals' body through urine. Although blood urea in camels (as a ruminant) returns to rumen through the rumen wall or saliva. It has been demonstrated that urea excretion via urine in camels rarely occures (Schmidt-Nielsen *et al*., 1957). Specifically, while diet with poor nitrogen content is available, camels have a very efficient mechanism that allows them to reuse blood urea by means of microbial potential to protein synthesis (Emmanuel *et al*., 1976). While, BUN is an indicator of renal or even liver health, some other factors such as diet protein content or increased protein catabolism may influence on BUN concentration. According to different sources and variation in BUN, difference between Jammaz and Balouchi the breeds is not clear, while camels of both breeds were healthy at the time of sampling. Afterward, Jammaz camels have, to some extent, access to green herbage, Balouchi breed is reared on poor roughage. Therefore, higher content of protein in the Jammaz camels diet could be the reason of this difference. Besides BUN, creatinine is typically considered as a biochemical indicator of kidney function. One-humped camels are usually known for their water resistance, therefore the creatinine dosage is an indicator for the normal kidney function.

The animal dehydration status and feed nitrogen content are the main factors influencing blood total protein (Bouaouda *et al*., 2014). While Alb and Glo are the main fractions of the blood proteins, factors influencing these two parts directly influence blood protein concentration. For instance, infectious disease results in enhanced plasma Glo concentrations. Differences between Glo concentrations in Jammaz and Balouchi breeds may not be due to infection, while health status of the camels was approved before blood sampling. According to Faye and Bengoumi, (2018) normal values of TP and Glo are 6.3–8.3 gr/100 ml and 2–5 gr/100 ml, respectively. Therefore, our measurements did not exceed the standard range. TP concentration in a former report to Iranian dromedary camel (unknown breed) was 6.8 gr/100 ml (Ghodsian *et al*., 1978), which was very similar to TP in Jammaz camels (6.79 g/100 ml). The Alb:Glo ratio would be a useful parameter to evaluate proportion of plasma protein fractions. In the case of camels, the normal value for this parameter is recommended as 1.03 (Jassim Ram and Shahsavari, 2015).

Cortisol releases in plasma response to stress and/or low blood glucose concentration in all of the mammalian species. In camels, different sources of stress result in higher secretion of cortisol, too (Saeb *et al*., 2010; Sid-Ahmed *et al*., 2013). Plasma concentrations of cortisol in Jammaz breed was almost 25% higher than Balouchi breed. Higher levels of cortisol lead to immune system suppression (Philip and Vijayan, 2015).

Nevertheless, higher levels of cortisol in Jammaz camels did not adversely influence Glo concentrations in comparison with Balouchi breed. Higher values for cortisol in Jammaz camels may be due to the readiness of this breed for explosive running. Thyroid hormones (T3 and T4 which contain iodine), are mainly involved in the metabolism of regulatory mechanisms (Yavuz *et al*., 2019; Hernandez, 2019). In general, lower measurements of T4 in Balouchi breed may be because of the calmness of the animal and lack of need for quick and sudden running.

According to the data of the literature, several studies have investigated the type of traits and in particular blood biochemical parameters in one-humped camels, while effect of breed/ecotype in these studies is often neglected. Results of our study suggested the significant effect of camel activity (long-distance marching or short-distance running) on breed characteristics. Therefore, anatomical and physiological assessments of Iranian racing (Jammaz) and dual-purpose (Balouchi) breeds in the current study suggest that there are some signs to identify pure breeds based on their body type traits especially differences between their limbs length. Moreover, some blood parameters such as glucose, LDH, BUN, cortisol and T4 blood concentrations seem to be breed-specific. The mentioned parameters are considerably higher in Jammaz breed.

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Conflict of interest

The authors declared that there is no conflict of interest.

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مجله طب دامی ایران، ۱۳۹۹، دوره ۱۴، شماره ۳، ۲۸۹-۳۰۴

مقایسه پارامترهای آناتومیکی و بیوشیمیایی شترهای دونده و دومنظوره ایران (*Camelus dromedarius*)

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چکیده

زمینه مطالعه: نژادهای مختلف حیوانات اغلب بواسطه خصوصیات ویژه آنها شناخته می‌شوند. با این حال در بسیاری از مطالعات انجام شده بر روی شتر یک کوهانه اثر نژاد در نظر گرفته نشده است. برخی تفاوت‌های شاخص بین نژادهای شتر قابل تشخیص است که به دلیل اقلیم پرورش و نوع بهره‌مندی از آنها می‌باشد.

هـــدف: مطالعه حاضر مقایسه شاخص‌های آناتومیکی و پارامترهای بیوشیمیایی پلاسمای خون دو نژاد شتر یک کوهانه ایران، شتر جماز (مسابقه‌ای) و بلوچی (دومنظوره) است.

روش کار: پارامترهای آناتومیکی شامل طول بدن (BL)، طول گردن (NL)، عمق سینه (CG)، عمق شکم از ناحیه کوهان (BG)، محیط کوهان (HC)، طول دست‌ها (FLL)، طول پاها (HLL)، ارتفاع بدن از کوهان (HH)، فاصله دو دست (FLI)، فاصله دو پا (HLI)، محیط کف دست (FHC)، محیط کف پا (HHC)، دور شکم (AC)، دور ساق دست (SC) و دور ساق پا (LC) بودند. همچنین، غلظت گلوکز، نیتروژن اوره‌ای خون (BUN)، کراتینین، کلسترول، بیلی‌روبین تام و مستقیم (Bili-T و Bili-D)، کلسیم (Ca)، فسفر (P)، منیزیم (Mg)، آسپارتات آمینو ترانسفراز (AST)، کراتین کیناز (CK)، لاکتات دهیدروژناز (LDH)، پروتئین تام (TP)، آلبومین (Alb)، تری یدوتیرونین (T3) و تیروکسین (T4) نیز به عنوان پارامترهای بیوشیمیایی پلاسما سنجیده شدند. آنالیز داده‌ها با استفاده از آزمون t-test انجام شد.

نتایج: نتایج نشان داد که اختلافات معنی‌داری بین صفات تیپ بدن در دو نژاد، بویژه اندام‌های مرتبط با دویدن وجود دارد، بصورتیکه نژاد جماز نسبت به نژاد بلوچی دارای قد کشیده‌تر و دست و پای بلندتری می‌باشد. همچنین سطوح برخی پارامترهای بیوشیمیایی (گلوکز، لاکتات دهیدروژناز، نیتروژن اوره ای خون، کورتیزول و تیروکسین) بطور قابل توجهی در نژاد جماز بالاتر است.

نتیجـــه گیری نهایی: نتایج مطالعه حاضر برخی پارامترهای آناتومیکی (بویژه طول دســـت و پاها، طول گـــردن و ارتفاع بدن از کوهان) و بیوشیمیایی (فعالیت آنزیم لاکتات دهیدروژناز، نیتروژن اوره‌ای خون، گلوکز، کورتیزول و تیروکسین) را به عنوان شاخص‌هایی برای تمایز بین نژادهای مسابقه‌ای و دومنظوره پیشنهاد می‌کند.

واژه‌های کلیدی:

صفات تیپ بدن، شتر یک کوهانه، پارامترهای بیوشیمیایی پلاسما، نژادهای خالص، آمیخته‌گری کنترل نشده.

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