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Serum Mineral Contents of the Omani Racing Arabian Camels (*Camelus dromedarius*)

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Abstract: Blood samples were collected from thirty, 2 years old female native camels from the Eastern Region of Oman. Camels were managed in the traditional way of racing camels in the Arabian Gulf region, primarily fed fresh alfa alfa and barley grain. Blood samples were collected from jugular vein in EDTA tubes and analysed for haemoglobin and Packed Cell Volume (PCV). Blood samples were collected in serum collection tubes and serum separated by centrifugation. Serum samples were analysed for concentrations of sodium (Na), Magnesium (Mg), Calcium (Ca), potassium (K), Phosphorus (P) and iron (Fe), Copper (Cu) and Zinc (Zn) using Inductively Coupled Plasma Emission Spectrometer (ICP-AES). Means±standard deviation and ranges were computed. Correlation coefficients (R^2) were generated between these minerals. Haemoglobin (Hb) and PCV ranges in Omani camels were 11.3-14.8 g dL^{-1} and 26-34%, respectively. The serum macro elements of Omani camel's ranges were: 97.8-246.1 mEq L^{-1} for Na; 2.0-4.0 mEq L^{-1} for Mg; 3.39-8.93 mEq L^{-1} for Ca; 3.22-8.70 mEq L^{-1} for K; 5.68-13.0 mg dL^{-1} for P. The micromineral ranges were: 54.0-214.0 μg dL^{-1} for Fe; 55.8-110.0 μg dL^{-1} for Cu; 67.5-177 μg dL^{-1} for Zn. There were significant correlation coefficient (R^2) values between macro elements (Na, Mg, K, Ca and P) with Na being a good predictor of values of these minerals. This study provides a baseline data that would be useful for clinical research with racing camels in Oman. These findings also indicated that Omani racing camel's serum values are within the range of those reported for racing camels in the Arabian Gulf region. The strong correlation between some elements allows analyses for fewer elements to economize analyses cost.

Key words: Oman, camels, serum, minerals, trace elements

INTRODUCTION

The dromedary camel (*Camelus dromedaries*) is mainly found in the dry tropics of Africa, Middle East and Indian sub-content, where it is of great importance to nomadic and rural communities for provision of high quality animal protein in the form of milk and meat and as a mean of transportation and resaerch. In the Arabian Gulf region, the camel gained popularity and importance in recent years as a racing animal. The camel is well suited to the harsh environments characterized by scarcity of water and vegetation as well as high ambient temperatures and rough terrain. This is because the camel is uniquely anatomically and physiologically equipped for living under such environments. There are 24,246,291 million one-humped camels in the world (FAO, 2009) with 80% of them in Africa and the highest population in Somalia (7 million) and Sudan (4.25 million). There are about 122,070 camels in Oman (FAO, 2009) with highest population in the southern part of the country (Dhofar) and sizable populations in Al-Sharqiyah (Eastern) and Dhahira regions (MAF, 2005).

Camels in the Eastern region of Oman are mainly kept for racing, where good racing camels produce high prices that may reach hundreds of thousands of dollars in the Arabian Gulf camel markets. Great care is taken into raising and training racing camels in the traditional way. That includes feeding camels a diet of green alfa alfa, barley grain and sometimes honey, gee, milk and eggs. Local camel herders are keen on investigating blood picture of their camels particularly haemoglobin and iron levels especially prior to racing season. Haematological and biochemical values are useful for evaluating health status in animals including camels.

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However, published information on these aspects in camel reflects a wide range of values, which was attributed to differences in breed, age, sex and sampling and analytical methods (Mohamed and Hussein, 1999). The metabolic profile of camels is affected by season, mineral supplementation and health status (Faye *et al*., 1995). Due to variations in haematological and biochemical parameters resulting from variations in these factors each laboratory are recommended to establish normal values for racing camels in their own region (Mohamed and Hussein, 1999). Haematological and serum mineral levels are also affected by degree of hydration, which is common in camels raised under traditional range grazing systems (Ayoub and Saleh, 1998).

Macro and micro minerals are essential elements for animal functioning and health. Trace elements such as cobalt, selenium, Cu, Zn and Fe are integral components of some enzymes and other important biological components. There are some published reports on haematological and biochemical values in camels. These include serum mineral values of Sudanese (Damir *et al*., 2008; Muna Ahmed *et al*., 2003; Mohamed, 2004), Saudi Arabian (Al-Busadah, 2007; Al-Shami, 2009; Osman and Al-Busadah, 2003), Kuwaiti (Mohamed and Hussein, 1999), Emirati (Faye *et al*., 2008; Wernery *et al*., 1999), Iranian (Badiei *et al*., 2006; Mohri *et al*., 2008), Pakistani (Zia-ur-Rahman *et al*, 2007), Nigerian (Sackey *et al*., 2007), Kenyan (Kuria *et al*., 2006) and even European (Faye *et al*., 1995) camels. There are also some reports on the serum mineral values in the Bactrian camel (Wernery *et al*., 1999).

Camel racing is a demanding process with animals being kept on strict diet and vigorous exercise prior to races and running for up to 10 km distances in some races. Certain post-race haematological and biochemical changes in racing camels that returned to original levels upon resting were reported (Mohamed and Hussein, 1999).

There is no published information on Omani camel serum mineral values. The current study aimed at determining major serum mineral values of Omani female racing camels.

MATERIALS AND METHODS

Animals and sampling: Blood samples were collected from thirty female, 2 years Omani native camels. The age of animals was determined by asking owners and dentition. The camels had been raised in Al-Sharqiyah region of Oman around Al-Mudaibi Township in the style adopted by most racing camel owners in the Gulf region. They were fed approximately three kg of alfa alfa plus 1 kg of soaked barley in the morning and 3 kg alfa alfa plus 2 kg of soaked barley in the evening. They were offered approximately 20 L of water daily. All animals were tested for Trypanosomiasis using buffy coat test and internal parasites using fecal egg counts. Five mL blood samples were drawn into EDTA tubes and immediately used to determine the haemoglobin and PCV values using a DL400 blood analyzer. An 8 mL of blood was drawn into serum vaccutainers from jugular venipuncture. Samples were centrifuged at 300 rpm for 5 min to separate the serum, which was subsequently transported in a cool box to the laboratory at Sultan Qaboos University, where they stored under 20°C.

Serum analytical methodology: Evaluation of mineral levels in serum was carried out in two phases, digestion of samples and analyses. Complete digestion was achieved using a microwave laboratory system type Milestone 1200 MDR, with a maximum working temperature of 250°C.

A mixture of concentrated HNO_3 and 30% H_2O_2 was used for the digestion of samples. Calibration graphs were prepared by the addition of known amounts of standard metal solutions to the samples and were subjected to the same acid digestion. The sample digestion procedures were also applied to the blank determination. The digestion procedure consisted of the following steps: 5 mL of conc. HNO_3 and 1 mL of 30% H_2O_2 were added to each digestion sample then placed in the microwave oven. They were then heated from room temperature to 220°C over a 5 min period and then held at 220°C for another 20 min. The digest obtained was collected in volumetric flasks, made up to volume and analyzed for a set of minerals by ICP-AES using the manufacturers recommended conditions. Values were expressed in conventional units (mEq L^{-1}), which are equivalent to SI units of mmol L^{-1}.

An Inductively Coupled Plasma Emission Spectrometer (ICP-AES) type Perkin Elmer Model 3300, equipped with a low-flow GemCone nebulizer in addition to an ultrasonic nebulizer for the detection of very low concentrations in the range of sub-ppb was used for chemical analyses.

All reagents used were of analytical reagent grade from BDH and Merck. Standard Solutions: Plasma-free Stock standard metal solutions of 1000 mg L^{-1} were purchased from BDH. Intermediate and working standard solutions were prepared by serial dilution immediately before use. Certified Reference Materials were obtained from the Marine Environment Laboratory (MEL-IAEA), Monaco and the Laboratory of the Government Chemists (LGC) in UK. In-house Reference Materials was used in situations where CRMS were not available.

Statistical analyses: Means, standard deviations and minimum and maximum values were calculated using Excel spreadsheets on Microsoft Office 2007. The SAS (2000) package was used to produce correlation coefficients (R^2)

between the eight serum mineral values. Excel spreadsheets on Microsoft Office 2007 were used to plot trend line showing relationships between Na and other macrominerals with R^2 and polynomial equations generated.

RESULTS AND DISCUSSION

General health: Body condition of experimental animals appeared to be excellent by the standards of racing camels in the Gulf region. They were well groomed and looked after. Racing camel owners in the Arabian Gulf region are well known to care for the health and body condition of their animals. All animals tested negatively for Trypanosomiasis (buffy coat test). Trypanosomiasis (Surra disease) is well spread among camels in the region and usually negatively affects their performance and blood picture. Faecal sample analyses (egg counts) showed no significant internal parasites infestation. The animals had been dewormed by Albendazole 2500 mg animal^{-1} by owners.

Haematology: The haemoglobin content of the Omani camels ranged between 11.3 and 14.8 with a mean 12.98 g dL^{-1} (Table 1), which was within the range reported for racing camels in the Gulf region (12-15 g dL^{-1}; Wernery *et al*., 1999). Al-Busadah (2007) reported a range of 9.2-14.1 g dL^{-1} for Majaheem, Maghateer and Awarik Saudi camels. Ayoub and Saleh (1998) and Saeed and Hussein (2008) reported a value of 14.5 mg% and 13 g dL^{-1} in United Arab Emirates (UAE) camels, respectively. Mohamed and Hussein (1999) reported a range of 11-16 g dL^{-1} in Kuwaiti racing camels. The values were also comparable to that of 11.2-11.8 g dL^{-1} reported for Sudanese camels (Omer *et al*., 2008).

PCV values in Omani camels ranged between 26.0-34.0% (Table 1) and were within the range reported for racing camels in the Gulf region. Wernery *et al*. (1999) reported a range of 26-38% PCV in 2-12 years old racing camels in the UAE. Al-Busadah (2007) reported a range of 23.6-30.1 g dL^{-1} for Majaheem, Maghateer and Awarik Saudi camels. Mohamed and Hussein (1999) reported a range of 0.16-0.4 L L^{-1} in Kuwaiti racing camels. Ayoub and Saleh (1998) reported a value of 31%, which increased after water deprivation to 34% in UAE camels. Hussein reported a value of 28.7% in UAE camels. PCV values of Omani camels were also comparable to that of 26.4% reported for Sudanese camels (Omer *et al*., 2008).

Therefore, haematology and PCV values in the Omani racing camels were within normal ranges of camels and indicated that theses animals were healthy. Camel owners in Oman as well as in many parts of the Gulf region are keen on running routine checks on these parameters in their camels as they believe that they reflects the ability of their camels for racing.

The dromedary Omani camel values for Hb and PCV were comparable to those reported for the 2-12 years old Bactrian camel (11.7-13.7 g dL^{-1} and 36-42.7%, respectively; Wernery *et al*., 1999). Compared to other species, the camel has higher RBC counts but lower PCV than the horse (Schalm *et al*., 1975). For instance, Ayoub and Saleh (1998) reported a value of 31% in camels compared 20.3% in goats. This is because of the smaller elliptical cells in the camel, which pack tighter, i.e., the smaller the cell size, the greater the number of units per volume (Al-Busadah, 2007).

Serum mineral contents: Table 1 describes the means, standard deviation, maximum and minimum values of eight minerals in Omani camel serum. Generally, the macro mineral with the highest concentration in the Omani camel serum was the Na and within trace elements Fe and Zn. The element had highest values, respectively.

Sodium: Na serum content in camel serum ranged between 97.8 and 246 with a mean 160 mEq L^{-1}. This value was comparable to that of 148.2 mEq L^{-1} reported in Kuwaiti racing camels (Mohamed and Hussein, 1999), 150-164 mmol L^{-1} in Emirate camels (Ayoub and Saleh, 1998; Wernery *et al*., 1999) and 100-190 mmol L^{-1}

Table 1: Means, standard deviations maximum and minimum values of mineral and trace elements contents of Omani racing camels

Parameters	No. of samples	Mean±SD	Minimum	Maximum
Blood analyses				
Haemoglobin (g dL^{-1})	30	1298±0.932	11.300	14.800
PCV (%)	30	29.43±2.239	26.000	34.000
Serum mineral content				
Na (mEq L^{-1})	30	160.12±28.917	97.800	246.100
Mg (mEq L^{-1})	30	2.74±0.518	2.000	4.040
Ca (mEq L^{-1})	30	5.60±1.042	3.390	8.930
K (mEq L^{-1})	30	5.75±1.145	3.220	8.700
P (mg dL^{-1})	30	8.70±1.745	5.680	13.000
Fe (μg dL^{-1})	30	119.81±0.672	54.000	214.000
Cu (μg dL^{-1})	30	75.51±12.048	55.800	110.000
Zn (μg dL^{-1})	30	106.81±28.660	67.500	177.000
Na K^{-1}	30	28.1±2.86	21.200	33.900

reported for Majaheem, Maghateer and Awarik Saudi camels (Busadah, 2007). Similar ranges of values were reported for Saudi (Al-Shami, 2009), Nigerian (Mohammed *et al*., 2007). However, although the upper value of the range (246 mEq L^{-1}) might looks higher, some studies reported a higher range of 300-390 mmol L^{-1} (Hassan *et al*., 1968 in Sudanese camels). Na values obtained in the current study were equivalent to those reported for Saudi camels by Osman and Al-Busadah (2003). The latter authors reported that Na levels in camels are higher compared to those in cattle and sheep, which were in agreement with previous reports (Abdalla *et al*., 1988). Na values in the current study, where female camels were studied were slightly lower than those reported for rutting and non-rutting male camels (Zia-ur-Rahman *et al*., 2007). However, Na serum levels in the Omani dromedary were comparable to those in the Bactrian camels of 148±32 mmol L^{-1} reported by Liu (2003) and 129-161 mmol L^{-1} reported by Wernery *et al*. (1999).

Potassium: K values in Omani camels of 3.22-8.7 mEq L^{-1} were comparable to those in Saudi (2.9-6.2 mmol L^{-1}, Al-Busadah, 2007; 4.2-6.8 mmol L^{-1}, Al-Shami, 2009; 4.0, Osman and Al-Busadah, 2003), Kuwaiti (3.0-4.7 mEq L^{-1}; Mohamed and Hussein, 1999), UAE (4.2 mmol L^{-1}, Ayoub and Saleh, 1998; 3.5-5.5, Wernery *et al*., 1999), Sudanese (Omer *et al*., 2008; McGrane and Kenyon, 1984), Nigerian (Sackey *et al*., 2007) and other camels (Higgins and Kock, 1986).

There were some reports on differences between camel and other species in levels of serum K contents. For instance Kamalu *et al*. (2003) reported that K was higher in cattle serum than in camels. K values in the current study were lower than those reported for rutting and non-rutting male camels (Zia-ur-Rahman *et al*., 2007). K serum levels in the female Omani dromedary were comparable to those in the female Bactrian camels of 4.23±0.66 mmol L^{-1} (Liu, 2003) and 2-12 Bactrian camels (Wernery *et al*., 1999).

The Na K^{-1} mean ratio was 28.1, which was lower than that reported for camels in the UAE (39.5) by Ayoub and Saleh (1998) mainly due to higher levels of Na in Omani camels compared to the Emirate ones.

Calcium: Ca values in Omani camels (3.39-8.9 mEq L^{-1}) were similar to those reported by Osman and Al-Busadah (2003) for Saudi camels (9.0 mEq L^{-1}) and Wernery *et al*. (1999) for UAE camels (9.5-11.5 mg dL^{-1}) but higher than the 2.8 mmol L^{-1} reported for Iranian camels (Mohri *et al*., 2008). However, values in Omani camels were of a lower range compared to Saudi camels (7.6-13.1, Al-Busadah, 2007), UAE camels (11.3 mmol L^{-1}; Ayoub and Saleh, 1998) and temperate camels (11.5 mg/100 mL, Faye *et al*., 1995). Nonetheless, extremely lower ranges (1.6-2.8 mmol L^{-1}) were reported in some studies (Higgins and Kock, 1986; McGrane and Kenyon, 1984; Sackey *et al*., 2007).

There were no differences between values obtained for female camels in the current study and values reported for non-rutting male camels (Zia-ur-Rahman *et al*., 2007). Ca serum levels in the female Omani dromedary were higher than those in the female Bactrian camels of 2.26±0.22 mmol L^{-1} (Liu, 2003) and 2.4-2.7 mg dL reported by Wernery *et al*. (1999).

Magnesium: Mg serum levels in Omani camel ranged between 2-4 mEq L^{-1}, which were comparable to those in camels in Kuwait (1.8-4.2 mg dL^{-1}; Mohamed and Hussein, 1999), UAE (1.8-2.4 mg dL^{-1}; Wernery *et al*., 1999), temperate (1.8-3.7 mg/100 mL, Faye *et al*., 1995). Lower Mg serum levels (0.9 mmol L^{-1}) were reported for Iranian camels (Mohri *et al*., 2008).

There were no differences between values obtained for female camels in the current study and values reported for non-rutting male camels (Zia-ur-Rahman *et al*., 2007). Mg serum levels in the female Omani dromedary were higher than those in the female Bactrian camels of 0.92±0.23 mmol L^{-1} (Liu, 2003) but similar to those reported for the species (1.8-2.9 mg dL^{-1}) by Wernery *et al*. (1999). Osman and Al-Busadah (2003) findings indicated that Mg levels in camel serum were lower than those of cattle and sheep.

Phosphorus: P serum levels in Omani camels ranged between 5.68-13.0 mg dL^{-1}, which at its upper level were higher than the upper range (3.4-7.7 mg dL^{-1}) reported for UAE (3.5-6.0 mg dL^{-1}; Wernery *et al*., 1999), Kuwaiti (Mohamed and Hussein, 1999) and Saudi camels (3.8 mg dL^{-1}) reported by Osman and Al-Busadah (2003). The latter researchers's findings indicated that serum P levels in camels are lower than those of cattle and sheep. There were some reports on differences between camel and other species in levels of serum P contents. For instance Kamalu *et al*. (2003) reported that P was lower in cattle serum than in camels. Values recorded for P in the present study were higher than those reported for the Bactrian camel (1.65-2.01 mg dL^{-1}) by Wernery *et al*. (1999) in UAE.

Iron: Iron is important for racing animals because of its role in haemoglobin synthesis in the blood. Fe had a wider range (54-214 μg dL) but its mean value was comparable to the range reported for Kuwaiti racing camels (63-170 μg dL^{-1}) by Mohamed and Hussein (1999).

Wernery *et al.* (1999) reported a range of 87-135 μg dL^{-1} in 2-12 years old racing camels in the UAE. Osman and Al-Busadah (2003) reported a Fe level of 80 μg dL^{-1} in Saudi camels. Lower values of Fe (46.2 μg dL^{-1}) were reported in Iranian 5 years old female camels (Badiei *et al.*, 2006).

There were no differences between values obtained for female camels in the current study and values reported for non-rutting male camels (Zia-ur-Rahman *et al.*, 2007). However, there are some reports that age has an effect on Fe levels in camels. For instance Faye *et al.* (2008) reported that older camels (>8 years) had highest Fe levels (283 μg/100 mL) compared to those of 3-7 years of age. The Omani dromedary camels had apparently higher levels of Fe compared to the Bactrian camel (49-57 μg dL^{-1}) as reported by Wernery *et al.* (1999).

Copper: Cu levels in Omani camels ranged between 55.8 and 110 μg dL^{-1}. Mohamed (2004) reported a comparable value of 57.6-72.4 μg/100 mL in Sudanese adult camels. Serum Cu levels could be quite variable as reported in temperate camels (7-114 μg 100 mL) by Faye *et al.* (1995). Normal Cu levels in ruminants range is 70-140 μg/100 or 11-22 μmol L^{-1} according to Damir *et al.* 2008) and 70-120 μg/100 mL (12-19 μmol L^{-1}) according to Faye *et al.* (2008). Plasma Cu levels were significantly lower in camels (61 μg/100 mL) than cattle (111 μg/100 mL) as reported by Bengoumi *et al.* (1998). Serum Cu levels below 50 μg/100 mL are regarded as Cu deficient. Consequently, the camels at the bottom of the range in the current study may be regarded as at a risk of being Cu deficient. Cu deficiency was observed in Oman in other animals such as goats with reports of ataxia. Copper deficiency in camels was also reported in East Africa (Faye and Bengoumi, 1997). Lower values of Cu (20.5 μg dL^{-1}) were reported in Iranian 5 years old female camels (Badiei *et al.*, 2006). Racing camels in Oman are usually kept in confined enclosure and their diet is strictly monitored.

The basic fodder is fresh alfa alfa, which contains higher levels of Cu compared to Rhodesgrass hay (4.6 vs. 2.8 ppm) the other common roughage (Damir *et al.*, 2008). However, alfa alfa has higher levels of molybdenum (2.2 vs. 0.6 ppm) and SO_4 (4.7).

It is well established that excess molybdenum, inorganic sulfate, iron or zinc interferes with copper absorption in ruminants (Damir *et al.*, 2008). As mineral supplementation is not widely used with camels in Oman, care should be taken to supplement these animals for Cu. Cupric oxide needle capsules, which are safe and effective compared to mineral blocks (Damir *et al.*, 2008) may be a supplement of choice for Cu. There were no differences between values obtained for female camels in the current study and values reported for non-rutting male camels (Zia-ur-Rahman *et al.*, 2007). Also, no sex effects on Cu levels were observed by Abdalla *et al.* (1988) and Bengoumi *et al.* (1995).

However, Faye *et al.* (2008) reported that females had higher levels of Cu than males (62 vs. 56.7 μg/100 mL). Sex differences in mineral contents in camels may be more related to physiological status effect rather than sex per se.

Zinc: Zn levels in Omani camels ranged between 67.5 and 177 (μg dL^{-1}), which was higher than that reported for temperate camels (17-63 μg/100 mL) by Faye *et al.* (1995). Mohamed (2004) reported a medium value of 62.5-80.0 μg/100 mL in Sudanese adult camels. The Zn levels in Omani camel are far above levels of deficiency. Normal serum Zn range for ruminants is 70-120 μg 100 mL and was lower for camel's 30-50 μg/100 mL (Faye *et al.*, 2008).

According to Bengoumi *et al.* (1998), plasma Zn levels were lower in camels (38 μg/100 mL) than cattle (83 μg/100 mL). However, special care should be taken in this regard as Zn deficiency had been reported in the UAE (Abdalla *et al.*, 1988).

There were no differences between values obtained for female camels in the current study and values reported for non-rutting male camels (Zia-ur-Rahman *et al.*, 2007). However, age was reported to have effects on Zn levels in camels which were related to sex and physiological status. Young camels <2 years had lower levels; suckling camel calves may have higher values due to milk feeding and decreasing Zn levels at the end of gestation (Faye *et al.*, 2008).

Correlations between serum mineral values: A correlation analyses was carried out between the eight minerals and R^2 was generated and shown in Table 2. In general, there was a significant high correlation between the macro elements Na, Mg, Ca, K and P.

Although, there are not many reports on this aspect, Kuria *et al.* (2006) reported a significant positive correlation between Na and Ca but a negative correlation between Na and P.

On the contrary there were no significant correlations within trace elements but there was a significant correlation between Mg and Fe and Cu. The latter element had no significant correlation with any of the elements. Zn had a significant negative correlation with the macrominerals (Na, Mg, Ca and P).

Table 2: Correlation coefficients and their significance between minerals and trace elements in Omani racing camels

Elements	Na	Mg	Ca	K	P	Fe	Cu	Zn
Na								
R^2	1.0000	0.7004	0.9667	0.8636	0.8412	-0.2311	0.2815	-0.0047
Signficiance		<0.0001	<0.0001	<0.0001	<0.0001	0.2191	0.1318	0.9803
Mg								
R^2	0.7004	1.0000	0.7450	0.6681	0.7380	0.0266	0.1239	-0.0765
Signficiance	<0.0001		<0.0001	<0.0001	<0.0001	0.8890	0.5141	0.6878
Ca								
R^2	0.9667	0.7450	1.0000	0.8801	0.85140	0.2060	- 0.2768	-0.0174
Signficiance	<0.0001	<0.0001	<0.0001		<0.0001	0.2747	0.1387	0.9271
P								
R^2	0.8412	0.7380	0.8514	0.8027	1.0000	-0.1764	0.1324	-0.1772
Signficiance	<0.0001	<0.0001	<0.0001	<0.0001		0.3511	0.4857	0.3490
Fe								
R^2	-0.2311	0.0266	-0.2060	-0.2312	-0.1764	1.0000	0.1230	0.4470
Signficiance	0.2191	0.8890	0.2747	0.2189	0.3511		0.5174	0.0133
Cu								
R^2	0.2815	0.1239	0.2768	0.1762	0.1324	0.1230	1.0000	0.3867
Signficiance	0.1318	0.5141	0.1387	0.3516	0.4857	0.5174		0.0348
Zn								
R^2	-0.0047	-0.0765	-0.0174	0.0105	-0.1772	0.4470	0.3867	1.0000
Signficiance	0.9803	0.6878	0.9271	0.9562	0.3490	0.0133	0.0348	

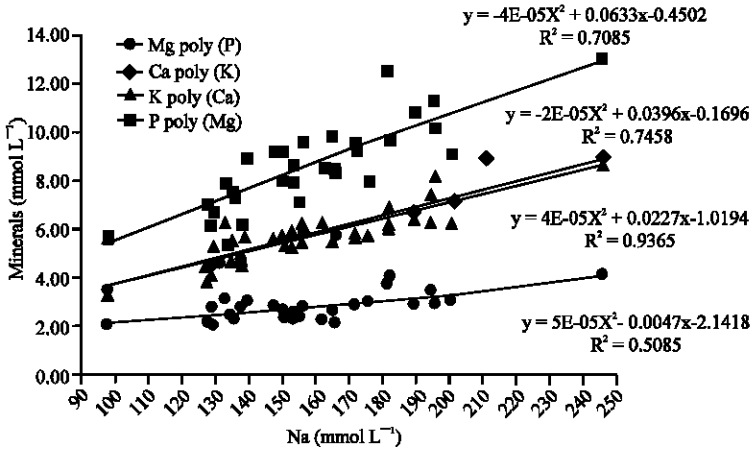

Fig. 1: Relationship between Na and Mg, Ca, K and P showing polynomial equations and R^2 values

From a practical point of view, correlations between certain elements would reduce the cost of analyses for these elements as values of some of them may be estimated from other elements using regression equations. Figure 1 describes the relationships between Na and other macro minerals and depicts equations that may be used for estimating their values.

CONCLUSION

Findings of the current study provide baseline values that may be used by clinicians for racing camels in Oman. Values recorded for Hb, PCV and serum mineral contents were within the ranges reported for racing camels in the Gulf region and indicated along with serum mineral values normal health of these animals. There were some significant correlations especially between macro minerals (Na, Ca, K and P) that may be used to estimate their values with less cost by reducing the number of elements to be analysed.

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