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Assessment of trace elements and metals status in imported camels

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ABSTRACT

The present study intended to investigate the profile of mineral elements and metals in camel serum. For this purpose, 50 camels (*Camelus dromedarius*) were examined to estimate the levels of Cr, Co, Cu, Fe, Mn, Ni, Zn, B, Al, Ca, Ba, Mg, Cd, Pb, Mo, Sr, Si and V. using Inductively Coupled Argon Plasma (ICAP). On average, the mineral contents were 0.116 mg/l (Co), 0.297 mg/l (Cr), 1.817 mg/l (Cu), 13.733 mg/l (Fe), 1.521 mg/l (Mn), 0.002 mg/l (Ni), 6.775 mg/l (Zn). While mean concentrations of other metals were 0.08 mg/l (B), 42.887 mg/l (Al), 258.973 mg/l (Ca), 1.520 mg/l (Ba), 28.385 mg/l (Mg), 0.02 mg/l (Cd), 2.183 mg/l (Pb), 1.523 mg/l (Mo), 1.243 mg/l (Sr), 478.617 mg/l (Si), 0.689 mg/l (V). Although a lack of data on camel species, these findings could contribute to understanding the status of trace elements and heavy metals in camels, and any deviation of some elements from their normal values might be an indicator for exposure of these camels to pollutant circumstances.

Introduction

Environmental contamination with heavy metals is a severe issue in the developing world due to the increment of human-made activities which lead to the presence of high levels of these metals in the environment (Chibuike and Obiora, 2014). Pollution in cultivated lands is attributed to the vehicle emissions that may pollute the crops in these areas thus they can reach and enter the food chain causing severe health hazards (Chen *et al*., 2010). However, it is challenging to eliminate heavy metals from the soils due to their persistence and non-degradability characteristics therefore monitoring of their concentrations in our environment is a critical concern (Nachana'a and Ezekiel 2019). Metals are "pollutants" when they are in forms or levels that induce negative impacts (Ali and Khan, 2018). Metals comprise lead, mercury, cadmium, copper, chromium, selenium, zinc, and nickel. Other less common metallic pollutant includes cesium, strontium, aluminum, cobalt, manganese, molybdenum, and uranium (Tchounwou *et al*., 2012). The neurological, cardiovascular, renal, and reproductive systems are all adversely affected by the high levels of these metals in the environment (Hwang *et al*., 2022). Reduced intelligence, attention impairment, and behavioral abnormality are risks of heavy metal exposure (Wong *et al*., 2022). Small amounts of copper and zinc are safe, but the presence of lead and cadmium in extremely low quantities in the environment is toxic (Willers *et al*., 2005).

In desert areas especially in the Arab and African World, camels represent a significant part of human food and the economy. Camel meat is a well-known healthy and organic food (Badiei *et al*., 2006). There was no study has previously conducted investigations over the last decades in the Aswan area to measure the level of trace elements and metals in camel serum thus there was a definite need to investigate the concentration of metals such as Boron (B), Aluminum (Al), Calcium (Ca), Barium (Ba), Magnesium (Mg), Cadmium (Cd), Lead (Pb), Molybdenum (Mo), Strontium (Sr), Silicon (Si), Vanadium (V) and trace elements as Cobalt (Co), Chromium (Cr), Iron (Fe), Copper (Cu), Nickel (Ni), Manganese (Mn), and Zinc (Zn) by ICP-OES technique.

Materials and methods

Ethical approval

The protocol of the study has been approved by the ethical committee in the Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt, according to the OIE standards for use of animals in research under No. 06/2023/0148.

Animals

This study used 50 healthy male imported camels (*Camelus dromedarius*) in Aswan governorate of Egypt with a mean age of 5-7 years.

Blood sampling and heavy metal and trace element analysis

Samples of blood were taken from the jugular vein using vacutainer tubes without anticoagulant. Serums were obtained by centrifuging them for 15 minutes at a speed of 3000 rpm, then packed into Eppendorf tubes and storing them at -20°C until analysis. Digestion of serum was performed by using a mixture of HClO4-HNO3 according to the method of Antoniou *et al.* (1995). Concentrations of Cr, Co, Cu, Fe, Mn, Ni, Zn, B, Al, Ca, Ba, Mg, Cd, Pb, Mo, Sr, Si, and V were estimated using inductively Coupled Argon Plasma (iCAP 6500 Duo, Thermo Scientific, England). Instrument standardization was done by using 1000 mg/L multi-element certified standard solution as a stock solution from Merck, Germany according to the method of García-Vaquero *et al.* (2011).

Statistical analysis

The results were presented in means±SE. The SPSS program, version 25 (2017) was used in statistical analysis.

Results

The findings of this study are shown in Tables 1-2 and Figures 1-2. The detected trace elements include Co, Cr, Cu, Fe, Mn, Ni, and Zn. The mean values of these elements were 0.116±0.056, 0.297±0.146, 1.817±0.525, 13.733±2.564, 1.521±0.282, 0.002±0.000, 6.775±1.437 mg/l respectively (table 1). With respect determined metals were B, Al, Ca, Ba, Mg, Cd, Pb, Mo, Sr, Si, and V. Their mean values were 0.080±0.000, 42.887±4.172, 258.973±24.982, 1.521±0.133, 28.385±2.815, 0.020±0.000, 2.183±0.668, 1.523±0.477, 1.243±0.1489, 478.617±33.209, 0.689±0.237 mg/l respectively (Table 2).

Table 1. Concentrations (mg/l) of trace elements of imported camels in Aswan governorate, Egypt (n=50).

Elements	Concentrations	Minimum	Maximum
Co	0.116±0.056	0.06	1.24
Cr	0.297±0.146	0.01	2.28
Cu	1.817±0.525	0.01	9.27
Fe	13.733±2.564	0.02	39.8
Mn	1.521±0.282	0.29	6
Ni	0.002±0.000	0.00	0.00
Zn	6.775±1.437	1.23	29.02

Data are expressed as mean±SE (n=50). Cobalt (Co), Chromium (Cr), Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni), and Zinc (Zn).

Table 2. Concentrations (mg/l) of metals of imported camels in Aswan governorate, Egypt (n=50).

Elements	Concentrations	Minimum	Maximum
B	0.08±0.00	0.08	0.08
Al	42.88±4.17	14.85	89.11
Ca	258.97±24.98	125.24	602.95
Ba	1.52±0.133	0.37	2.81
Mg	28.38±2.82	9.23	66.16
Cd	0.02±0.00	0.02	0.02
Pb	2.18±0.69	0.01	11
Mo	1.52±0.48	0.00	7.98
Sr	1.24±0.149	0.59	3.64
Si	478.61±33.21	226.74	871.6
V	0.69±0.24	0.01	3.17

Data are expressed as mean±SE (n=50). Boron (B), Aluminum (Al), Calcium (Ca), Barium (Ba), Magnesium (Mg), Cadmium (Cd), Lead (Pb), Molybdenum (Mo), Strontium (Sr), Silicon (Si) and Vanadium (V).

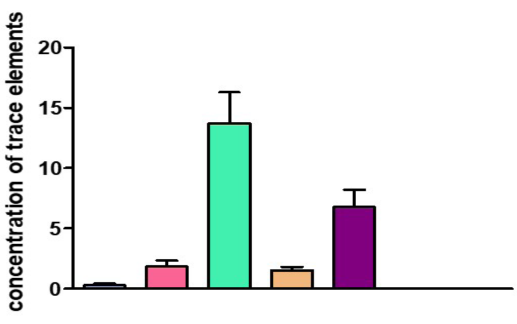

Fig. 1. The highest concentrations (mean±SE) of trace elements (Cr, Cu, Fe, Mn, and Zn) in imported camel serum in Aswan governorate, Egypt.

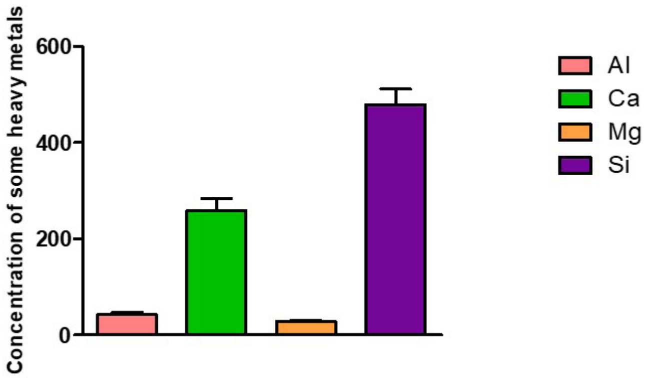

Fig. 2. The highest concentrations (mean±SE) of metals (Al, Ca, Mg, and Si) in imported camel serum in Aswan governorate, Egypt.

Discussion

The main trace element that has been described in camels is copper (Faye and Bengoumi, 1994). Normal copper values in ruminants range from 70 to 120 µg/100ml. The majority of the camel-reported readings were within such limits. (Faye and Bengoumi, 1994). In this study, the mean concentration of Cu in camel serum was 1.817 mg/l. In our investigation, the camel's copper level was at the deficient limit. Our findings were consistent with those revealed by Sharkawy *et al.* (2002). Jalal *et al.* (2010) and Abdou and Mohamed (2015) who found that the levels of Cu in camel serum were 1.95, 2.82, and 1.29 ppm respectively. While, higher levels of Cu (57.5 ppm) were shown by Abdelrahman *et al.* (2013).

The majority of the measured serum Cu values are within the same range but other values were deficient (Faye and Bengoumi, 1994; Faye *et al.*, 1991). The variance in mineral levels between different studies may be due to a variety of factors including geographical regions (Faye and Grillet, 1984), camel breed (Abdalla *et al.*, 1988), eating habitats (Rutagwenda *et al.*, 1989), age, sex, and physiological status (Faye and Bengoumi, 1994).

The most important component of blood is iron which enters in haemoglobin formation. The values of Fe in serum varied on average from 98 µg/100ml to 186 µg/100ml (Tartour and Idris, 1970). In this context, various publications have noted variations serum Fe levels; e.g., 44.75 (µmol/l) in Iran (Badiei *et al.*, 2006) and 190.3 g/100ml in the United Arab Emirates (Faye *et al.*, 2005) but in our study, Fe concentration in serum was 13.733 mg/l. The absorption of elements is impacted by pastures' exposure to industrial wastes and greater Pb concentrations. The presence of low levels of iron in our findings is because of improper grazing places and a lack of food supplements (Asli *et al.*, 2020).

The finding of this research on Mn concentration was 1.521 mg/l which was in contrast with Faye *et al.* (2005) who found that Mn level was 0.16 g/100ml in camel serum. Mean values of Mn varies from 8.4 µg/100ml (Bengoumi *et al.*, 1995) to 30 µg/100ml (Eltohamy *et al.*, 1986). The values of blood Mn in ruminants are generally below 10 µg/100ml (Lamand, 1987). Increased absorption of heavy metals and decreased absorption of minerals are due to the development of cities and the proximity of industrial areas to pastures. (Asli *et al.*, 2020).

Zinc is an essential trace element for animals. It is a component of several metalloenzymes and is used in protein synthesis. Zn is the second most prevalent trace metal in blood after iron and is crucial for the functioning of several enzymes and transcription factors (Fallah *et al.*, 2018), but consumption of excess Zn leads to hematological impacts such as anemia and decreasing the absorption of Cu causing its deficiency (ATSDR, 2005). As for copper, the majority of ruminants' plasma or serum zinc concentrations range from 70 and 120 µg/100ml (Faye *et al.*, 2008).

The average concentration of zinc in camel serum in the current investigation was 6.775 mg/l. This finding is in agreement with Abdou and Mohamed (2015) who recorded 1.96 ppm Zn in camel serum but these results are in contrast with Jalal *et al.* (2010) who reported higher levels of Zn (23.51ppm) in camel serum in Saudia Arabia. Also, a higher level of Zn (14.5 ppm) was noted by Sharkawy *et al.* (2002) in Egypt. Concerning variations in serum Zn levels, some literature indicated that Zinc levels are lower in young camels and its concentration depends on the age of the camel (Faye *et al.*, 2008). However, the Zn level varies according to the type of used fodder in different areas. Forages from tropical and subtropical regions usually lack zinc. however, the potential deficiencies of Zn in animals are common depending on the type of forage sources in the environment (Faye and Bengoumi, 2018).

Cobalt is a rare trace element and its level in the plasma is very low (Lamand, 1987) and according to Burenbayar (1989), Co values in blood ranged from 3.4 to 13.2 µg/100ml and this depends on the season and mineral supplementation. The average concentration of it in this study was 0.116 mg/l and this finding is in line with Badiei *et al*. (2006) and Faye *et al*. (2005) who showed that Co levels in camel serum were 0.06 µmol/l and 0.08 g/100ml respectively. Although chromium is necessary, an excessive amount of it might cause cancer. However, the full metabolism of glucose in the human body requires a low concentration of Cr (Ahmed *et al*., 2016). In our study, Cr mean concentration was 0.297 mg/l. Contradictory results were detected by Faye *et al*. (2008) who found a 2.0 [mu]g/100ml Cr mean concentration in camel blood of the United Arab Emirates

Vanadium and nickel are the two metals that are most prevalent in petroleum (Barwise, 1990), As well as, V is also used in the steel, electronics, and batteries industries. However, V emission at high levels from anthropogenic activities can be greater than that of many other heavy metals (Schlesinger *et al*., 2017). Although V is not a serious pollutant, it can be dangerous at high doses and damage the liver in rats that are exposed to it (Castellini *et al*., 2009). Ni is also utilized in food, Ni-Cd batteries, electroplating, and other industrial operations. High levels of Ni are present in the environment as a result of excessive utilization. Respiratory tract cancer, renal and cardiovascular diseases, and lung fibrosis may result from exposure to Ni-contaminated environments (Genchi *et al*., 2020). In this study, Ni and V mean concentrations in camel serum were 0.002 and 0.689 mg/l. these findings were inconsistent with Faye *et al*. (2005) who detected 1.8 [mu]g/100ml Ni in camel blood. Nickel toxicity in the Bactrian camel caused a "roll disease" in Mongolia (Tao *et al*., 1995). However, there was no information on the V concentration in camels.

Lead is a common environmental pollutant and induces poisoning in animals (Khalafalla *et al*., 2011). In the current study, the average concentration of Pb in serum was 2.183 mg/l. This is in correspondence with Jalal *et al*. (2010) who observed a higher Pb level (3.73 ppm) in Saudi Arabian camel serum. Our findings were greater than those obtained by Sharkawy *et al*. (2002) and Abdou and Mohamed (2015) who reported mean Pd concentrations of 0.15 ppm and 0.014 µg/ml respectively in serum. Even though no cases of lead intoxication in camels have been reported, we detected a high lead serum value that may be related to the use of fossil fuels and the existence of major transportation routes which lead to the increased dispersion and entrance of Pb into the body by breathing and thus affect grazing animals (Mehmood *et al*., 2014).

Cadmium is a toxic element for animal and human body (Akan *et al*., 2010). Cd represents an environmental threat and exposure to it is through the burning of remnant petroleum, phosphate fertilizers, the production of steel and cement, and the burning of municipal wastes (Morrow, 2010). In the current study, the mean level of Cd (0.020 mg/l) in the examined serum was lower than the findings found by Sharkawy *et al*. (2002) who recorded 0.15 ppm of Cd in camel serum. In addition, Jalal *et al*. (2010) found high concentrations of Cd (0.91 ppm) in serum. However, our results were higher than those shown by Abdou and Mohamed (2015) who detected the mean Cd level (0.007µg/ml) in the serum of camel.

Molybdenum and Cu are typically competitors. In our results, the Mo concentration was 1.523 mg/l. Mo concentration in Bactrian camel blood was between 19 to 23 µg/100ml according to Zong-Ping *et al*. (1994), and 0.43 to 0.53 µg/100ml according to Ma (1995). Our results were between those that have been published. Cases of molybdenosis were found in camels that were fed bush with Salvadora persica. (Faye and Mulato, 1991).

The two most hazardous components in radioactive liquid wastes arising from recycling facilities are barium and strontium (Mishra and Singh, 1995). Both are carcinogenic and bone-seeking elements. Ba compounds dissolve in water and aquatic organisms accumulate them in their bodies, which leads to hazardous impacts (Ghaemi *et al*., 2011). The majority of persistent Ba compounds in the environment are found in the sediment of water soils. Water-soluble Ba compounds in small amounts may cause breathing difficulties, elevated blood pressure, changes in heart rhythm, etc. (Celebi *et al*., 2009).

The body absorbs strontium, which tends to build up in the kidneys, lungs, and liver, and exposure to high levels may induce oxygen deficiency, anemia, and cancer (Tiwari and Lee, 2015). In the present study, Ba and Sr mean concentrations were 1.521 and 1.243 mg/l. These findings are in contrast with Faye *et al*. (2008) who found that Ba and Sr concentrations were 14.6 and 44.0 µg/100ml respectively in Arabian camel.

Plants require boron to produce cell walls, maintain structural integrity, and regulate the production of reactive oxygen species. (Camacho-Cristóbal *et al*., 2008). Also, boron is required for bone and brain functions, and to decrease risks of cancer in mammals. As well as B supplements are beneficial for vitamin D deficiency (Uluisik *et al*., 2018). The most common B-containing compound is boronic acid that used in many medical applications. WHO stated that B is an important element for humans and the FDA approved several drugs containing boronic acid (Chatterjee *et al*., 2021). However, B is toxic at high levels, whereas It has many positive impacts at low levels on biological systems. In our study, the mean B concentration was 0.080 mg/l in camel serum. This is in disagreement with Faye *et al*. (2008) who indicated that the B level in camel was 19.3 µg/100ml. B naturally occurs in water, rocks, and soil and is present at high concentrations in some regions of the World. Due to its part in the growth and development of plants, it is frequently utilized in agriculture. B has also been used as an antibacterial, antifungal, and insecticide (Uluisik *et al*., 2018).

In our world, aluminum is a naturally occurring and commonly utilized metal. Al powders are utilized in a wide variety of industrial applications, including paint and pigment additives, explosives, and propellants. In the brewing, paper, sugar-refining, and water-purification sectors, natural aluminum minerals are employed. (Niu, 2018). In the current study, Al concentration was 42.887 mg/l in the serum of the camel. This is not in line with Faye *et al*. (2008) who found that Al level is 3.7 µg/100ml in Arabian camel. Our result reflects a high Al concentration, which means exposure of camel to a polluting environment.

In the current study, Ca and Mg levels were 258.973 and 28.385 mg/l respectively. In contrast, another study conducted by Hassan *et al*. (2019) found that Ca and Mg levels were 2.629 g/dl and 1.069 mmol/l respectively in apparently healthy camel blood. Another finding showed that blood values of calcium in Saudi camels were 7.6-13.1 mg/dl and in camels, the stated reference values for calcium and phosphorus ranged from 8.4 to 12.4 and 4.8 to 8.4 mg/dl, respectively (Faye and Bengoumi, 2018). The presence of plants with high mineral content (ash content) during the wet season may be the cause of the observed significant increase in serum Ca values (Amin *et al*., 2007).

Si concentration in this study was 478.617 mg/dl. There was no previous literature that detected Si levels in camel serum. This level of Si may be due to Si being applied as a foliar spray to sorghum plants, increasing the plant's ability to absorb the beneficial element and exchange gases, which results in a high uptake of the element by the plants (de Oliveira *et al*., 2019).

Conclusion

This study provides information for public health on any disorder linked to a lack of trace elements or an excess of heavy metals, as well as the general health state of the camels. To assess the potential dangers of heavy metal and trace element deficiency or poisoning, additional research should be done to measure the concentrations of hazardous or trace elements in camel tissues. Our findings revealed that monitoring of heavy metals, particularly Pb, Al, and Si elements should be performed in camel feed to assess the safety of human food.

Conflict of interest

The authors declare no competing interests.

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