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Serum Selenium Levels in Dromedary Camel (*Camelus dromedarius*) Orally Supplemented with Sodium Selenite and a Mixture of Sodium Selenite and Sodium Sulphate

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Abstract

Deficiency of selenium might occur due to their low intake and impaired bioavailability. No data were available concerning the exact selenium requirements in camels. Selenium and sulphur have similar physical and chemical properties, and a number of studies indicate that increased dietary sulphur reduces the bioavailability of selenium. The present study was carried out on 12 young male and female clinically healthy dromedary camels (*Camelus dromedarius*), 2–3 years old were brought from Sodari area. Camels were housed collectively in one large pen at the animal housing of the Central Veterinary Research Laboratories, Soba, Sudan. They were left for four weeks for adaptation. The experiment was conducted in dry season. Animals were randomly divided into three groups of 4 animals each. The approximate mean weight is 185.28 kg. A control group, a group drenched daily with 4.4 mg of sodium selenite and a group drenched daily with a mixture of 4.4 mg of sodium selenite and 6 mg sodium sulphate anhydrous for three consecutive months. Blood samples were taken weekly and sera were analyzed. Selenium concentration was determined by using Inductively Coupled Plasma Spectrophotometer. Mean serum selenium levels in the control group were not significantly different at weeks 1, 3 and 8 to 12, whereas the values at weeks 2, 4 to 7 were significantly higher ($P<0.05$). In the group drenched with sodium selenite, significant differences ($P<0.05$) were shown. Low levels were observed at weeks 1, 2 and 3, whereas high levels were shown at weeks 11 and 12. Camels in the group drenched with the mixture showed significant differences ($P<0.05$). Low levels were observed at weeks 1 and 6, whereas high levels were observed at weeks 10, 11 and 12. It was concluded that camels are responsive to selenium supplementation. It could also be the mark of a greater sensitivity to toxicity.

Key words: *Selenium, dromedary, camel, Sulphur, serum.*

Introduction

Selenium (Se) received little attention from biologists for years but eventually was identified as the toxic principle that induced hair loss, lameness, hoof sloughing, and death in grazing livestock in South Dakota and Wyoming (Franke, 1934). Retrospectively, it was deduced that similar signs in horses observed by Marco Polo during his travels in China in the 13th century (Polo, 1926) and by Madison (1860) at Fort Randall, Nebraska Territory (a condition he called "alkali disease") were probably caused by Se toxicity.

The Se-deficiency problem in animal agriculture, as it existed before Se supplements could be legally used, has been reviewed (Ullrey, 1974). In some swine herds, mortality in growing pigs was 15 to 20% and morbidity was 25% or more. Reproductive efficiency was reduced and resistance to environmental stress and infectious disease was diminished. Comparable death losses and declines in productivity were observed in poultry and other livestock species. Selenium is an essential microelement for the prevention of a number of deficiency syndromes in a variety of species (Underwood, 1981). It is an antioxidant element. Its role in the body is not completely known. It is, however, involved in the absorption and/or retention of vitamin E. It is an integral component of glutathione peroxidase. Selenium, probably, has other essential functions in the enzymatic processes. In mammals, ingested Se-Met is absorbed in the small intestine via the Na^+-dependent neutral amino acid transport system (Vendeland et al., 1994). Higher animals are unable to synthesize Se-Met and only Se-Cys was detected in rats supplemented with Se as selenite (Tapiero et al., 2003).

The minimum daily allowance of selenium in most species is 0.1 ppm (mg/kg) on a dry matter (DM) basis (Maas, 1983). The requirement of selenium in ruminants is approximately 0.1 part per million (ppm) DM. The dietary Se requirements for camelids are probably similar to other ruminants (Fowler, 1986; Smith, 1989; Dart et al., 1996). An alfalfa hay based diet containing 0.2 ppm Se appeared to meet the Se requirement for llamas, based on glutathione peroxidase (GSH-Px) activity and the lack of clinical signs of selenium deficiency disease (Dart et al., 1996). In the Bolivian Altiplano, one of the nutrients most likely to be deficient for grazing llamas was Se (Espinoza et al., 1982). Although forage Se was deficient (0.06 ppm) in greater than 90% of samples, all llamas sampled were considered to have adequate liver Se concentrations. Iatrogenic Se toxicity has been reported in a llama (Farrar et al., 1992), and Se toxicosis is possible due to excessive supplementation, in animals grazing pastures contaminated with Se-accumulating plants, and in areas where soils are high in Se (Fowler, 1989). Dietary Se greater than 1.5 ppm may produce Se toxicosis, especially if this amount is fed for an extended time (Pugh, 1993).

Material and Methods

Animals

Twelve young male and female camels (*Camelus dromedarius*) 2-3 years old were brought from Sodari area, North Kordofan. Animals were grazing and browsing naturally in Sodari area, North Kordofan State. The weights of the animals ranged between 147.74 and 217.40 kg. In the present work body weights were estimated according to Schwartz, et al. (1983). The weights of the animals were estimated every month in the morning before feeding, watering and selenium supplementation. They were housed collectively in one large pen at the animal housing of the Central Veterinary Research Laboratories, Soba. They were fed on sorghum (Abu Sabeen) hey and provided with water ad. libitum. They were left for four weeks before the experiment commenced for adaptation. During this period they were treated with Ivermectin (Kepromec, Kepro B.V., Holland) at a dose rate 0.2 mg/kg. b. wt. (1 ml/50 kg. b. wt.). Before the start of the experiment all animals were examined clinically for their freedom from external and internal parasites. The experiment was conducted in dry season from 15 February 2009 to 15 June 2009.

Experimental work

The experiment (182 days) consisted of three phases:
Adaptation period (days 1-60). During this stage, the animals received the basal diet without any mineral supplementation to equilibrate their mineral status. They did not receive any selenium supplementation.
Supplementation period (days 61-151). Animals were randomly divided into three groups of 4 animals each. The approximate mean weight is 185.28 kg. Approximate mean weights of the animals in each group were 741.11 kg.

- ***Control group:*** didn't receive oral selenium.
- ***Group orally drenched with*** 4.4 mg of selenium daily in the form of sodium selenite (Oligoselen Vitamine E, COOPHAVET, ANCENIS Cedex, France).
- ***Group orally drenched with*** 4.4 mg of selenium daily in the form of of a mixture of sodium selenite and 6 mg sulphur in the form of sodium sulphate anhydrous (Na_2SO_4) (Blulux Laboratories Ltd., INDIA-121001).

The selenium and the mixture of selenium and sulphur were drenched at 9 o'clock am. daily.
Post-supplementation period (days 152-182). During this last phase of the experiment, selenium supplementation was discontinued. Animals received the basal diet only.

Blood samples

Blood samples were collected from the jugular vein in non-heparinized tubes (NH) at 9 o'clock am. daily, centrifuged, the sera were separated, transferred to the Departments of Biochemistry, Central Veterinary Research Laboratories, Soba, and stored at -80°C.

Laboratory analysis

Selenium was done in Animal Health Research Institute, Egypt by using ICP Spectrometer. Sera samples were digested by the use of Microwave method and run by ICP against known concentration of selenium**.** Quantification of selenium was performed by the standard addition method, using 11 point standard curve. AccuTraceTM Reference Standard solutions used were Quality Control Standard #1AccuStandard® and Laboratory Performance Check Standard AccuStandard®. The analysis of selenium required the digestion of the samples to destroy proteins and amino acids in order to release the molecules of Se related to proteins. The serum (2 ml) was mixed in the tubes of rotator's digester with 10 ml Nitric Acid (HNO_3) then 5 ml Perchloric Acid ($HClO_4$). The acids used in samples preparation were high purity grad. The tubes were placed in the rotator then introduced into Microwave digestion system using Milestone MLS-1200 MEGA, Italy. After cooling, digested sample was transferred to volumetric flask and stored in refrigerator until analysis. The same digestion protocol was followed for urine, and faecal sample. For selenium determination in different samples Inductively Coupled argon Plasma – Atomic Emission Spectrometer (ICP AES), Varian Vista MPX – CCD Simultaneous was used.

Statistical analysis

The data were introduced according to excel sheet and coded. The SPSS software version 10 was used for analyzing the data. One-way ANOVA was run. The separation of means when applicable was done using least significant difference (LSD), where P values higher than 0.05 were considered insignificant.

Results

The weekly mean values of serum selenium concentration in the group of camels orally dosed with 4.4 mg of sodium selenite daily for 12 weeks showed significant differences ($P<0.05$). The low levels were observed at weeks 1, 2 and 3 (35.39±2.43, 36.14±2.00 and 35.69±1.59 µg/l), respectively, whereas the high levels were

observed at weeks 11 and 12 (56.30±1.25 and 55.42±2.18 µg/l), respectively. The minimum level was at week 1 (35.39±2.43 µg/l), and the maximum level was at week 11 (56.30±1.25 µg/l). The weeks 4 to 6 recorded significantly higher (P<0.05) mean values than those at weeks 1 to 3, and significantly lower (P<0.05) mean values than those at weeks 7 to 12. The weeks 7 to 10 recorded significantly higher (P<0.05) mean values than those at weeks 1 to 6, and significantly lower (P<0.05) mean values than those at weeks 11 to 10 (Table 1 and Figure 1).

The weekly mean values of serum selenium concentration in the group of camels orally dosed with mixture of 4.4 mg of sodium selenite and 6 mg sulphur in form of sodium sulphate (Na_2SO_4) daily for 12 weeks showed significant differences (P<0.05). The low levels were observed at weeks 1 and 6 (45.39±1.85 and 46.68±1.89 µg/l), respectively, whereas the high levels were observed at weeks 10, 11 and 12 (67.23±3.87, 65.82±2.15 and 66.44±4.35 µg/l), respectively. The minimum level was at week 1 (45.39±1.85 µg/l), and the maximum level was at week 10 (67.23±3.87 µg/l). The weeks 2, 3, 5 and 7 recorded significantly higher (P<0.05) mean values than those at weeks 1 to 6, and significantly lower (P<0.05) mean values than those at weeks 8 to 12. The weeks 8 and 9 recorded significantly higher (P<0.05) mean values than those at weeks 1 to 3 and 5 to 7, and significantly lower (P<0.05) mean values than those at weeks 10 to 12 (Table 1 and Figure 1).

Table 1: Changes in serum selenium concentration and range in parenthesis (ng/ml) in camels supplemented with selenium and a mixture of selenium and sulphur.

Weeks	Groups		
	Selenium*n=4	Selenium+Sulphurn=4	Controln=2
1	35.39±2.43$^{\alpha}$(32.35–38.28)	45.39±1.85$^{\alpha}$(42.75–46.69)	51.02±0.71$^{\alpha}$(50.51–51.52)
2	36.14±2.00$^{\alpha}$(33.96–38.78)	57.25±1.44$^{\beta\chi}$(55.58–58.61)	49.67±0.26$^{\chi}$(49.48–49.85)
3	35.69±1.59$^{\alpha}$(34.33–37.99)	56.94±1.37$^{\beta\chi}$(55.49–58.70)	50.82±0.62$^{\alpha}$(50.38–51.26)
4	44.80±0.96$^{\beta}$(43.64–45.85)	66.33±0.55$^{\varepsilon\phi}$(65.80–66.82)	50.54±1.39$^{\chi}$(50.56–50.58)
5	44.94±0.75$^{\beta}$(44.32–45.98)	56.34±1.72$^{\beta}$(54.04–58.11)	51.30±2.27$^{\chi}$(51.09–50.90)
6	44.70±4.23$^{\beta}$(40.85–48.88)	46.68±1.89$^{\alpha}$(43.96–48.11)	50.50±2.91$^{\chi}$(50.44–50.56)
7	51.74±1.14$^{\delta}$(50.24–52.81)	55.79±1.77$^{\beta}$(53.95–57.90)	50.58±0.85$^{\beta}$(50.18–50.98)
8	47.85±4.90$^{\beta\chi}$(41.27–52.50)	61.34±5.52$^{\chi\delta}$(53.79–65.70)	51.08±0.71$^{\alpha}$(50.58–51.58)
9	48.91±1.14$^{\chi\delta}$(47.78–50.49)	62.27±4.59$^{\delta\varepsilon}$(55.86–66.70)	51.54±0.97$^{\alpha}$(50.85–52.22)
10	50.61±0.06$^{\chi\delta}$(50.53–50.66)	67.23±3.87$^{\phi}$(61.50–69.96)	52.30±3.22$^{\alpha}$(50.02–54.58)
11	56.30±1.25$^{\varepsilon}$(54.95–57.72)	65.82±2.15$^{\delta\varepsilon\phi}$(63.30–68.56)	51.88±0.89$^{\alpha}$(51.25–52.51)
12	55.42±2.18$^{\varepsilon}$(53.50–58.54)	66.44±4.35$^{\varepsilon\phi}$(61.50–70.63)	51.82±1.00$^{\alpha}$(51.11–52.52)

Means in the same columns with different superscripts are significantly different at P<0.05. *n: Number of animals.

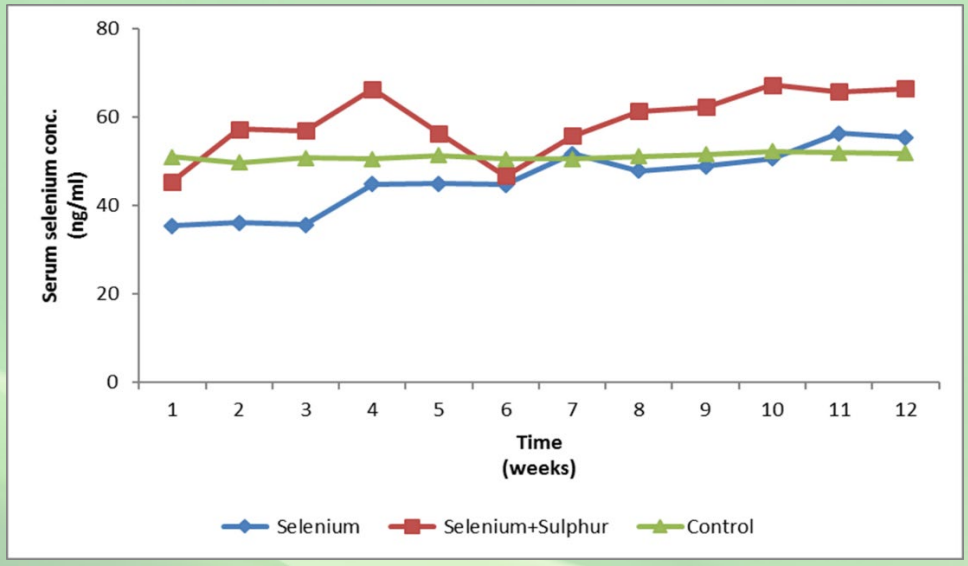

Figure 1: Weekly changes in serum selenium concentration in camels *(Camelus dromedarius)* orally suppleme

The weekly mean values of serum selenium concentration in the control group of camels were not significantly different at weeks 1, 3 and 8 to 12, whereas the values at weeks 2, 4 to 7 were significantly higher (P<0.05) (Table 1 and Figure 1).

Discussion

The mean concentration of blood/serum selenium reported in previous studies for large animals was around 100 ng/mL, a value considered as sufficient for the maintenance of suitable metabolic functions (Maas et al., 1990). In Saudi Arabia, serum Se values reported in young camels at the slaughterhouse varied between 5.3 and 131 ng/mL

with 30% of samples higher than 100 ng/mL (Barri & Al-Sultan, 2007). In recent experiments with different levels of Se supplementation, selenium content in serum for non-supplemented animals was on average 137.6 ± 18.7 ng/mL in non-pregnant, non-lactating camels (Seboussi et al., 2008), 109.3 ± 33.1 ng/mL in pregnant females, and 103.4 ± 28.7 ng/mL at milking period (Seboussi et al., 2009). Hamliri et al. (1990) observed in whole blood values between 109.1 and 117.8 ng/mL, Similar figures were recorded by Liu et al. (1994) in China, with concentrations varying from 97 to 112 ng/mL. Ma (1995) reported higher values: 274 to 288 ng/mL. In the United Arab Emirates (UAE), the mean value was 200 ± 90 ng/mL in animals with no Se supplementation (Seboussi et al., 2004). In small camelids such as llama (Herdt, 1995), the selenium concentration in serum ranged on average between 213 and 203 ng/mL depending on the physiological status. In Sudan, Abdel Rahim (2005) reported values in whole blood varying between 25 and 53 ng/mL. The analytical method used could also explain the observed differences. In Morocco, in dromedaries receiving probably a low Se basal diet, the plasma selenium concentration was quite lower, about 21 ng/mL (Bengoumi et al., 1998). In male adult camels in healthy conditions from Iran, the selenium concentration reported in serum was 12.6 ng/mL only (Nazif et al., 2009).
However, in most of the reported values, the selenium status of the diet was unknown even if Se supplementation was not distributed to the animals. Also, the analytical procedures were not described in all the cases and could differ between authors.

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