LIVER COPPER CONCENTRATION IN CAPTIVE THOMSON GAZELLES (*GAZELLA THOMSONI*) IN THE UNITED ARAB EMIRATES.

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Summary: The objectives of the study were to survey the copper liver concentration status of Thomson gazelle's (*Gazella thomsoni*) population in Dubai, United Arab Emirates, to establish a reference mean value for liver and to investigate whether copper concentration is within the range for other wild and domestic ruminants. For this purpose, fifty liver samples from Thomson gazelles (23 males, 27 females) were collected during necropsy over a five year period from 2002 to 2006. Liver copper concentration was measured and evaluated as ppm wet weight. Liver copper concentration range from 3 to 143 ppm was found in Thomson gazelles with no signs of clinical copper imbalance. The results indicate that the reference range for liver copper concentration in Thomson gazelles in the semi-arid location in the Emirate of Dubai is similar to that previously reported for other selected species of antelope and domestic ruminants.

Keywords: Thomson gazelle**,** *Gazella thomsoni*, Dubai, UAE, liver copper, reference range.

INTRODUCTION

Antelope and gazelles belong to the genera within the Family Bovidae, and many species are routinely kept in captivity by zoos and private collections (Fowler and Miller, 2003). One of the most commonly maintained species is the Thomson gazelle (*Gazella thomsoni*).

Copper is an imperative molecule in the life of animals and humans (Smart et al., 1992, Larson et al., 1995), and is an essential component of several enzymes that are required to maintain host homeostasis (Radostits at al., 1994). Copper deficiency has been linked to a variety of clinical signs, including emaciation, anemia, poor growth, pale hair coat, spontaneous fractures, myocardial degeneration, hypomyelinisation of spinal cord, impaired reproductive performance, decreased resistance to infectious diseases, diarrhea and general ill-thrift (Gay et al., 1988; Goonerate et al., 1989; Smart et al.,1992; Radostits et al., 1994; Larson et al., 1995; Underwood and Suttle, 1999).

Laboratory diagnosis of copper in ruminants concentrates on the determination of serum and liver copper values. Liver values are more informative and consistent as blood levels may remain normal for longer periods after liver copper levels commence to fall indicating an early sign of copper deficiency (Radostits at al., 1994). The liver is the primary copper storage organ (Brewer,1987; Gooneratne et al., 1989; Radostits et al., 1994) and hepatic copper accounts for about 10% of the total amount of copper in the body (Evans, 1973).

The objective of this study was to survey and evaluate copper level in livers of captive, free ranging Thomson gazelles and to establish a reference range for this species, in particular climatic conditions and of specific geo-morphological characteristics. The authors also planned to compare the findings with those of other wild and domestic small ruminants, in order to determine adjustment of copper supplementation for this species in future.

MATERIAL AND METHODS

Animals

Between April 2002 and June 2006 fifty liver samples were collected during necropsy from gazelles lost or culled following diseases, traumatic injuries and population control measures. None of these animals had shown clinical signs of copper imbalance. The investigation was conducted on a herd of initial 170 animals housed in an 8 ha enclosure, located at 25˚15'N, 55˚16'E, over the last 15 years. Fenced enclosure had been partially sheltered from sun by trees and bushes. Artificial watering systems allow continuous vegetation of grass in half of the enclosure in this semi-arid geographical location. All animals were kept on the same diet. Gazelles free grazed all year round and in addition received a supply of alfalafa hay *ad libitum* and 25 kg of pellet feed daily (Deer Feed 21% Code: 288700, N.F.P.M Abu Dhabi. U.A.E Copper content 0.28 mg/kg). Gazelles had free access to a fresh water supply and mineral salt blocks. The age of sampled animals varied from newborn to adult.

Methods

The liver samples were tested at the Central Veterinary Research Laboratory (CVRL) in Dubai for evaluation of copper liver concentrations. Samples were deep frozen to avoid storage biodegradation (Bratton et al.,1985). Mineral concentrations were expressed as a ppm per liver tissue wet weight (ww). 0.3 – 0.5 g of the frozen liver sample was taken. It was digested in Milestone microwave lab station (Ethos 900 Microwave lab station) using 5 ml 65% nitric acid and 1 ml 31% H_2O_2. After the digestion the samples were cooled down, washed and diluted to a final volume of 10 ml.

Copper was analyzed in the digested sample using flame atomic absorption spectrophotometer (Unicam 969 AA Spectrophotometer). Standards in the range of 0.1 – 0.5 ppm were used. Samples were diluted accordingly to fall within the calibration range.

Statistical analysis

The data is expressed as a mean (sd). The data was analyzed using the unpaired *t* test allowing for unequal variances to determine whether there were significant differences in copper level between male and female groups of gazelles. A probability level of $P \leq 0.05$ was considered statistically significant. Data was entered and analyzed using Microsoft Excel charting.

RESULTS

The liver copper concentration results are presented in Table 1 and Figure 1. The liver copper concentration of all 50 liver's samples ranged from 3 ppm to 143 ppm, had a mean of 46.16 ppm and a standard deviation of 32.64. Copper concentration in livers did not differ significantly in Thomson gazelles of different sex.

TABLE 1. Mean ppm wet weight liver copper concentration in the 50 Thomson gazelles.

	Male, Female	Female	Male
x	46.16±32.64	46.62±36.63	47.96±27.93
n	50	27	23

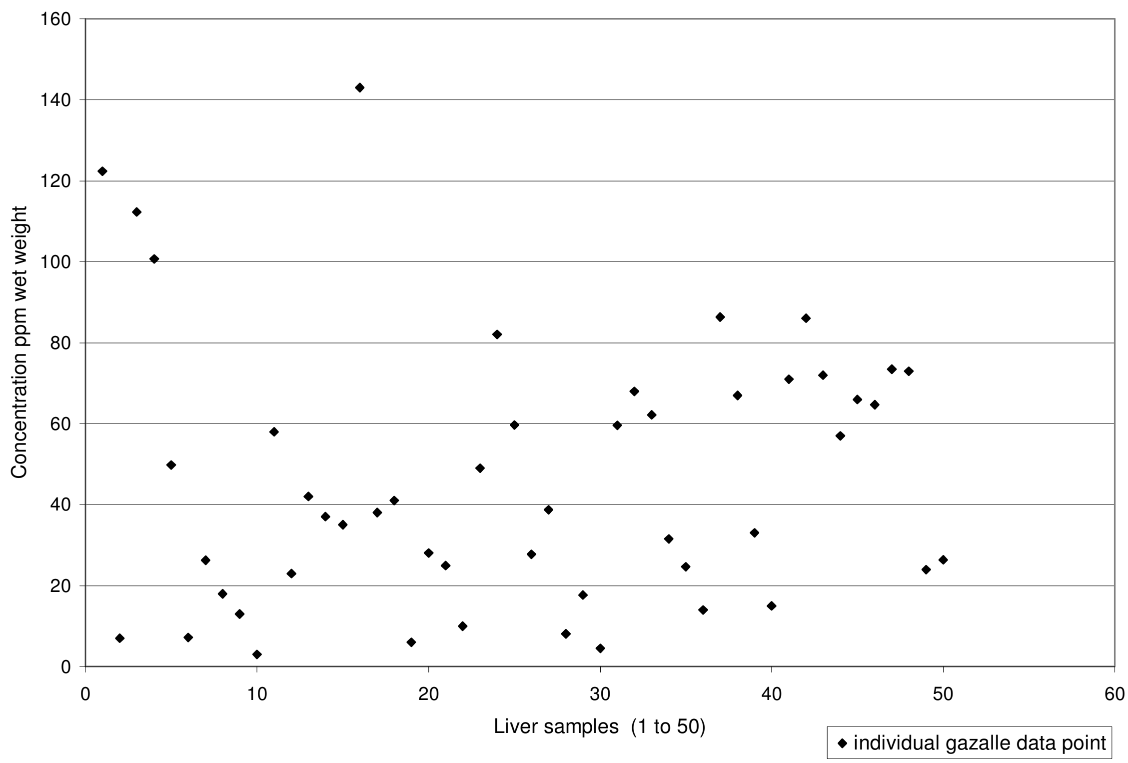

FIGURE 1.Scatter diagram of individual gazelle Cu liver concentration (50 Thomson gazelles).

DISCUSSION

Mean (±sd) liver copper concentration measured in the 50 Thomson gazelles kept in a free ranging fenced , semi-arid location in the Emirate of Dubai was 46.2±32.6 ppm (range, 3 to 143 ppm).

Published data on liver Cu levels of other gazelle species and some other ruminants are detailed enough for comparison with our findings in Thomson gazelles (Table 2). To compare our results expressed in wet weight (ww) with results in the literature given on dry matter basis (dw), we divided the literature value by 3.3 as it has been assumed that liver has a mean dry matter content of 30% (Long, 1991). The Cu levels of different ruminant species found in literature vary considerably as they also do in individual Thomson gazelles from our study. However, these levels were within the mean values for other gazelle species and domestic ruminants. The highest liver Cu values of 143 ppm, have been found in neonatal gazelles. Liver copper levels in fetuses and neonates are usually much higher than in adults, and a healthy foal has a level of Cu 7 times higher than that of adults (Radostits at al., 1994).

TABLE 2. Mean (sd) ppm wet weight liver Cu concentration in some gazelles species and domestic ruminants.

Species	*n*	mean *(sd)*	Methodology
Thomson gazelles	50	46.16± 32.64	flame atomic absorption
Blesbok gazelles group 1 (Turkstra et al., 1978)	8	30.7± 5.48 dw[a]	neutron activation analysis
Blesbok gazelles group 2 (Turkstra et al., 1978)	8	38.18 ±19.96 dw[a]	neutron activation analysis
Blesbok gazelles group 3 (Penrith et al., 1996)	5	21.6 ±18.1	
Bontebok gazelles (Turkstra et al., 1978)	8	139.5 ±41.9 dw[a]	neutron activation analysis
Blesbok gazelles group 4 (Quan, 2001)	37	53.6 ±36.7 dw[a]	flame atomic absorption
Blesbok gazelles group 5 (Quan, 2001)	11	29.07 ±19.7 dw[a]	flame atomic absorption
Norwegian Wild Deer (Vikoren et al., 2005)	245	26 ± 21	flame atomic absorption
Calves (Tessman, 2006)	105	75.8 ± 63.55 μg/g[b]	atomic absorption
Camel calves (Wensvoort, 1992)	10	9.9 ± 7.6 dw[a]	flame atomic absorption
Camel calves (Wernery et al, 1992)	10	12.43	flame atomic absorption
Camel young ½-1 year (Wensvoort, 1992)	6	7.54 ± 5.48 dw[a]	flame atomic absorption
Cattle (Radostits et al., 1994)		30.3 and above considered as normal	
Cattle (Puls, 1994)		25 – 110 level considered as adequate	
Camels (Puls, 1994)		18 – 140 level considered as adequate	
Sheep (Radostits et al., 1994)		60.6 and above considered as normal	

[a] Entries marked dw (dry weight) have been calculated according to wet weight (ww) = dry weight/3.3 (Long ,1961)

[b] μg/g = ppm

(Turkstra et al.,1978) described concentration of various trace elements in liver tissues of two species of South African gazelles, Blesbok (*Damaliscus dorcas phillipsi*) and Bontebok (*Damaliscus dorcas dorcas*) kept in the Mountain Zebra National Park at Cradock and in the Golden Gate Highlands National Park at Bethlehem. The mean copper concentration in liver samples of those two species was 101.3±16.4 ppm (*n* = 8) for Blesbok gazelle group 1, and 126.0±65.9 ppm (*n* = 8) for Blesbok gazelle group 2 in Table 2. All samples were stored in formalin and measured on dry matter basis. In another investigation by (Turkstra at al., 1978) in Bontebok National Park in South Africa, the copper level was 460.4±138.3 ppm (*n* = 8) for Bontebok gazelle. Hepatic copper levels were determined using neutron activation analysis. The higher hepatic copper concentration in the Bontebok than the Blesbok were ascribed to geographical and genetic differences. (Penrith et al., 1996) considered a normal copper level in Blesbok gazelle livers at 21.6 ppm wet weight, group 3 in Table 2.

(Quan, 2001) investigated two populations of Blesbok in South Africa. Apparently healthy gazelles had a mean liver copper concentration in dry mass 2785±1906 µmol/kg (n = 37) group 4 and 1510±1024 µmol/kg (n =11) group 5 in Table 2.

(Vikoren et al, 2005) analyzed 245 liver samples of Norwegian wild red deer (*Cervus elaphus)*. The mean liver concentration for all examined deer was 26±21 ppm wet weight (*n* = 245).They found no significant differences between sexes within the various age group. Similarly in our finding copper liver concentration did not differ significantly between Thomson gazelles of different sex.

(Tessman, 2006) analyzed liver and plasma copper in the 105 calves with wide range of diets and sources of calves to ensure that calves would have highly variable copper status. Mean liver copper concentration was 75.85±63.55 µg/g.

The Middle East is one of the copper deficient regions of the world and small ruminants in the region often show copper deficiency signs. Copper deficiency and posterior paralysis was described in goats and sheep in The Sultanate of Oman by (Ivan et al, 1990). There is soil - plant – animals interaction in relation to the incidence of trace elements disorders in grazing livestock. Copper, molybdenum and sulfur from organic and inorganic sources can combine in rumen to form an unabsorbable triple complex, and deplete the host tissue of copper (Suttle, 1991, 1986; Gawthorne, 1987).

Copper deficiency was diagnosed and investigated in dromedary calves in The U.A.E by (Wernery at al., 1992). The dromedary calves did not show any pathological lesions indicating a copper deficiency, but their liver average copper levels were low at 12.43 ppm wet weight. The camel calves died from Cl.perfingens and E.Coli septicaemia. Copper deficiency was a predisposing factor.

(Wensvoort, 1992) examined the copper status of local camels in the Emirate of Dubai by measuring liver copper concentrations. The mean liver copper concentrations in locally born camel calves were low at 9 ppm wet weight, however there were no apparent sign of deficiency. He concluded in his investigation that local camels have adopted to very low liver copper concentrations. The liver is a storage compartment for copper thus the concentration of liver copper indicate the sate of depletion rather than deficiency (Radostits, 1994).

(Wernery at al., 2002 b) demonstrated in a copper feeding experiment, that it took 5 months of treatment with 50 mg/day to reach copper reference values in 2 camel calves.

(Kinne at al, 2003) investigated long term exogenous copper supplementation in thirteen dromedary calves. He found that 100 mg/day of copper supplementation is necessary to increase low serum copper level to reference values in 4 to 6 weeks. And what seems most interesting copper supplementation had no increasing effect on serum copper levels and no toxic effect on camel calves with normal copper serum values.

CONCLUSION

Data that can be used to establish reference ranges for assessing trace element status in Thomson gazelles is limited. More robust reference values for gazelles need to be established through further studies relating biochemical data to health status. The diagnosis of copper status in a herd of gazelles should be based on the combination of analysis and interpretation of herd history, clinical signs, individual necropsy findings, laboratory tests on serum and liver samples whenever possible. However, from the afore mentioned, it is the knowledge of copper liver reference values that best allows for the assessment of herd copper status. The decision on long lasting exogenous supplementation should be taken based on these reference values.

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