

EFFECTIVE DURATION OF A COPPER OXIDE BOLUS ADMINISTERED ORALLY TO BONTEBOK (*DAMALISCUS PYGARGUS DORCAS*)

Michael L. Schlegel, PhD, PAS,^{1*} and Mark S. Edwards, PhD^{1,2}

¹Nutritional Services Department, Zoological Society of San Diego, P.O. Box 120551, San Diego CA 92112-0551 USA; ²Currently: Animal Science Department, California Polytechnic State University, 1 Grand Avenue, San Luis Obispo, CA 93407 USA

Abstract

Two male bontebok (*Damaliscus pygargus dorcas*) (70.5 kg) received a 12.5 g copper oxide bolus orally during anesthesia and were offered a diet of high fiber herbivore pellets with *ad libitum* access to Bermuda grass hay, water, and either a white salt or trace mineralized salt block. Blood samples were collected prior to bolus administration and every four weeks subsequently for one year. Serum was harvested and analyzed for calcium, copper, iron, magnesium, phosphorus, potassium, sodium, and zinc. A paired t-test was used to compare mineral concentrations determined on day 0 with concentrations on subsequent collection dates. Serum copper concentrations increased 28% within 30 days after bolus administration and remained above baseline (day zero) through the end of the study (day 364). Other minerals analyzed were transiently elevated and were not affected by the copper bolus. Serum zinc concentrations were below normal ruminant serum concentrations throughout the entire study. The copper oxide bolus increased serum copper within two months of administration and maintained elevated copper concentrations for a least 305 days.

Introduction

Clinical signs consistent with copper deficiency have been observed in individuals in a herd of blesbok (*Damaliscus pygargus phillipsi*) at the San Diego Zoo's Wild Animal Park. The individuals were housed in a 32 ha multi-species exhibit, with *ad libitum* access to a mixed species pasture (Bermuda grass, *Cynodon dactylon* (L.) Pers; kikuyu grass, *Pennisetum clandestinum*; and clovers, *Trifolium spp.*). Feeds offered to supplement the pasture included a high fiber (25% ADF) herbivore pellet and grass hays (Bermuda grass and Sudan grass, *Sorghum bicolor* (L.) Moench).

The alfalfa-based high fiber herbivore pellet was formulated to complement grass hays grown in southeast (Imperial County) California. The finished diet, when the herbivore pellets were fed in a 50:50 ratio with grass hay, provided 14.5 mg/kg copper (Cu) on a dry matter basis. The dietary copper requirement of beef cattle is 10 mg Cu/kg dry matter (DM).² Although the blesbok, in general, had *ad libitum* access to the formulated herbivore pellets and grass hay, they preferentially grazed the pasture.

Samples of pasture, representative of the material consumed, collected within the enclosure were high in sulfur (0.63% DM) and molybdenum (1.2 mg/kg DM) and low in copper (7.2 mg/kg DM). High dietary sulfur (S) and molybdenum (Mo) can interfere with copper absorption resulting in secondary copper deficiency.⁴ Because the blesbok prefer to graze rather than

consume the copper supplemented pellets, low serum copper was observed in adult animals, and mortality due to enzootic ataxia was observed in newborn calves. To improve adult animal copper status and calf survivability, females of breeding age were administered a 12.5 g copper oxide bolus (Copasure, The Butler Co., Dublin, OH 43017) six months prior to calving. Providing the supplemental copper improved copper status of the adults and calf survivability.

An increase in liver copper concentrations has been observed within 12 days after copper oxide bolus administration in beef steers.¹ Liver and serum copper concentrations were increased within 14 days after copper deficient heifers received a copper oxide bolus.⁵ Although improvement in copper status as indicated by increased liver copper concentrations demonstrated the boluses were effective for at least six months, but less than a year,³ the effective duration of the copper oxide bolus to elevate serum copper in nondomestic ruminants has not been evaluated. The objective of this study was to evaluate the effective duration of an orally administered 12.5 g copper oxide bolus to elevate serum copper in bontebok (*Damaliscus pygargus dorcas*), a related antelope subspecies to blesbok.

Methods

Two male bontebok (70.5 kg, good body condition), 4.5 and 6.5 years of age, were individually housed (4.9 m x 9.8 m pens) under dry lot conditions for more than one year. Each individual received a daily diet of 858 g high fiber herbivore pellets (copper = 22.6 ppm DM; Western Milling, Goshen, CA 93227) and *ad libitum* access to bermudagrass hay (copper = 6.4 ppm DM) and water. A white salt (American Stockman White block, North American Salt Company Overland Park, KS 66210) or trace mineralized salt (American Stockman, Big 6 Trace Mineral, North American Salt Company Overland Park, KS 66210; composition (as-is) 95.5 – 98.5% sodium (Na), 3500 ppm zinc (Zn), 2000 ppm iron (Fe), 1800 ppm manganese (Mn), 280 – 420 ppm Cu, 100 ppm iodine (I), and 60 ppm cobalt (Co)) block was also provided. The animals had no access to fresh pasture or other sources of long-stem forage throughout the trial. Diet consumption was not measured.

Animals were anesthetized and an initial blood sample collected (day 0) via jugular venipuncture into a 7 ml evacuated glass tube (BD Vacutainer trace element blood collection tube; Becton, Dickinson and Co., Franklin Lakes, NJ 07417). A 12.5 g copper oxide bolus (described above) was administered orally. Subsequent blood samples were collected every four weeks for a year by venipuncture while animals were manually restrained in a drop-chute. Serum was harvested from the blood by centrifugation and stored frozen (-80 °C) until all samples were collected. Serum samples were analyzed by inductively coupled plasma (ICP) spectrometry for Ca, Cu, Fe, Mg, P, K, Na, and Zn at the California Animal Health and Food Safety Laboratory (Davis, CA 95617). Descriptive statistics are provided to compare mineral concentrations from samples collected on day zero with concentrations from subsequent samples.

Results and Discussion

Copper concentrations (Fig. 1) on day zero were above normal ruminant ranges (0.6 – 0.96 mg/L).⁴ After the copper bolus was administered, serum copper concentrations increased (day

59) 28% within 30 days, increased to 118% above baseline (day zero) on day 280, and remained above baseline through the end of the study (day 364). The initial increase in serum copper was similar to previous studies.^{1,3,5} The initially (day zero) normal serum copper concentrations observed in the current study may explain why the magnitude of the response in serum copper was lower than the 94 – 189% increase observed in copper deficient bullocks by Rogers and Poole (1988). The other minerals analyzed were transiently elevated and were not affected by the copper bolus (Fig. 2 and 3). Serum zinc concentrations (averaged 0.47 mg/L) were below normal ruminant concentrations (0.8 – 1.2 mg/L) throughout the entire study.⁴ The diet provided 82 mg Zn/kg DM which exceeds the presumed 30 mg Zn/kg DM dietary requirement.² Underwood and Suttle (1999) state that zinc absorption can be impaired when copper is added to the diet. Serum zinc concentration was initially low at the start of the study and did not go lower after the copper bolus was administered. The copper oxide bolus effectively increased serum copper within two months of administration and maintained elevated copper concentrations for at least 305 days.

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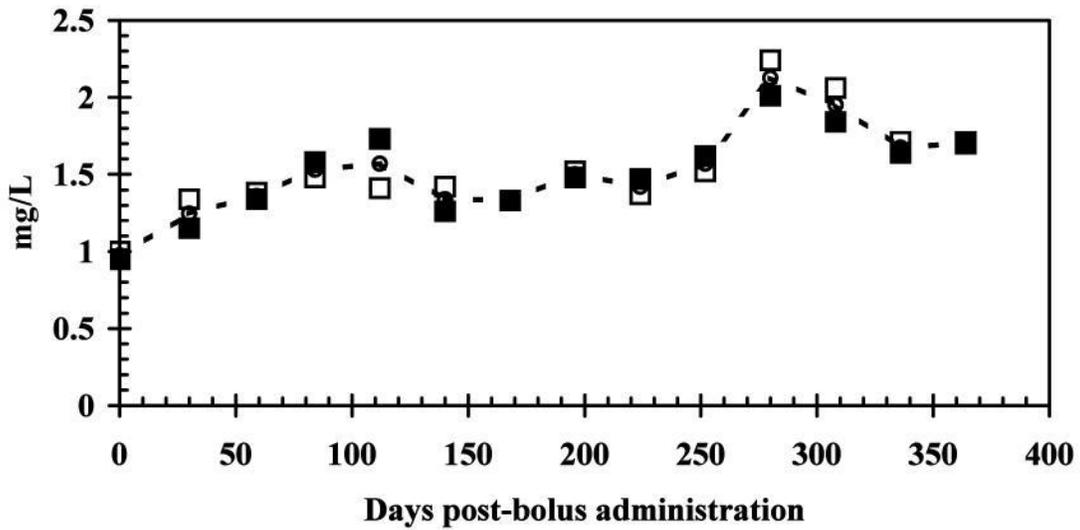


Figure 1. Serum copper concentrations of two bontebok (*Damaliscus pygargus dorcas*) males after copper oxide bolus administration (day zero). Open symbol = Animal 1, Closed symbol = Animal 2, Dashed line = average.

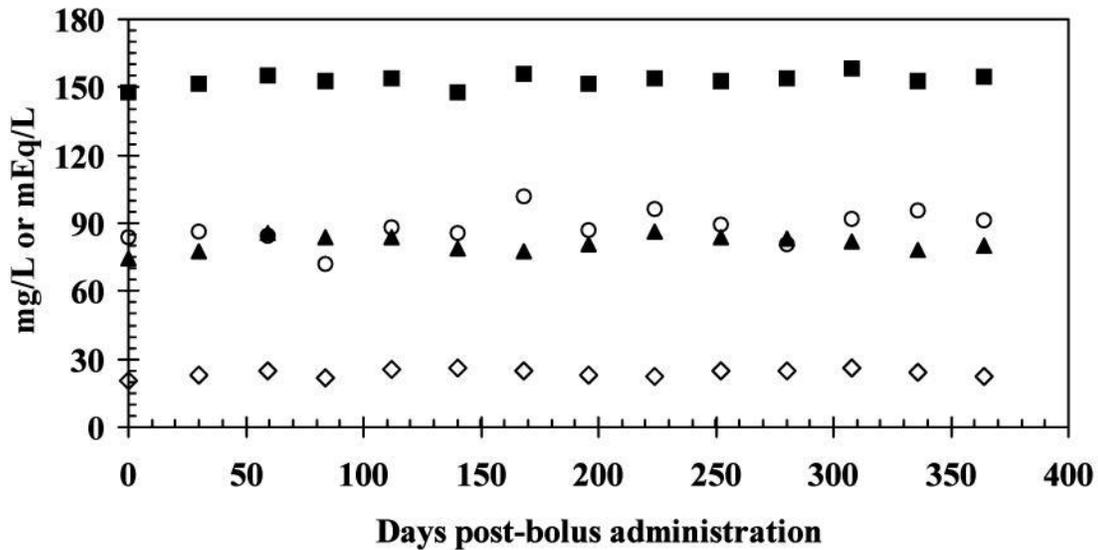


Figure 2. Average serum sodium (mEq/L, ■), phosphorus (mg/L, ○), calcium (mg/L, ▲), and magnesium (mg/L, ◇) concentrations of two bontebok (*Damaliscus pygargus dorcas*) males after copper oxide bolus administration (day zero).

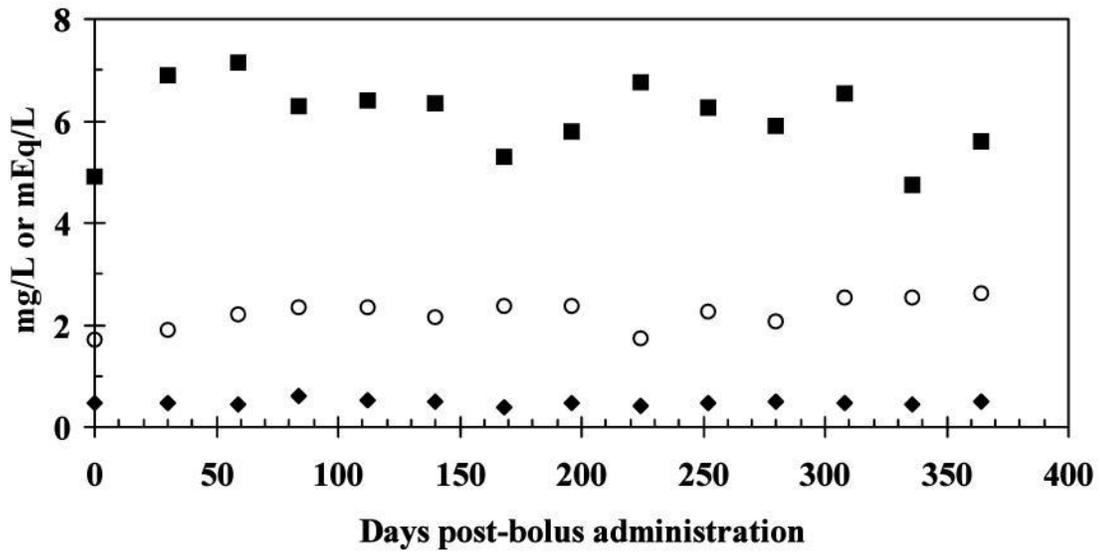


Figure 3. Average serum potassium (mEq/L, ■), iron (mg/L, ○), and zinc (mg/L, ◇) concentrations of two bontebok (*Damaliscus pygargus dorcas*) males after copper oxide bolus administration (day zero).