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The Influence of Different Dietary Levels of Copper on Copper Status, Cholesterol and Milk Profile in Camels (*Camelus dromedarius*)

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Abstract: The study was undertaken to determine the effects of dietary copper (Cu) on copper status and lipid metabolism in camels (*Camelus dromedarius*). Six primiparous and 11 multiparous camels were used in this investigation. Camels were randomly assigned to one of three treatments: 1) control (no Cu supplementation; 2) 15 mg of Cu kg^{-1} of DM from copper sulphate, CuSO4); 3) 45 mg Cu kg^{-1} of Dry Matter (DM). Plasma Cu concentrations were similar across all treatments. Total plasma cholesterol concentrations were higher in she camels supplemented with Cu at the end of the 2-months period. Camels receiving 45 of Cu had higher plasma cholesterol than camels receiving 15 mg. No effect of treatment on DM intake, mean milk production, milk lipid and protein was observed. The study suggests that Cu supplementation changes lipid metabolism in dairy camels.

Key words: Camel, copper, lipid, milk, plasma

INTRODUCTION

Copper, an essential trace element playing a number of physiological functions related mostly to its catalytic effect[1]. It also plays an indirect role in the antioxidant systems as Superoxide Dismutase (SOD), which is a copper-dependent intracellular enzyme[2]. Copper status can be assessed in animals by the plasma and liver contents as well as cholesterol concentration. Juvenile llamas develop signs of poisoning at lower hepatic copper concentrations, compared with adults[3]. Copper deficiency in dromedary has been reported in East Africa[4] and in Bactrian camels at Genzu region[5,6] and in New-World Camelids (NWCs)[7]. However, its toxicity is difficult to diagnose[8]. It was clearly indicated that copper deficiency causes an elevation in plasma cholesterol[9].

Previous studies indicated the significant role of copper on lipid metabolism in ruminant[10-12]. It is of interest to speculate whether same findings are applied for the pseudoruminant animal; the camel. The main objective of the current investigation was to document the influence of dietary copper on copper status and lipid metabolism in lactating camel (*Camelus dromedarius*).

MATERIALS AND METHODS

Animals and feeding: Six primiparous and 11 multiparous camels were used in this study. Camels were housed in individual premises and were assigned randomly to one of three treatments; 1) control (no copper supplement), 2) 15 mg of copper/kg of DM from copper sulphate and 3) 45 mg kg^{-1} of DM from copper sulphate. The feeding protocol adopted comprised of assimilated desert vegetation such as *Acacia mellifera*, *Acacia nilotica*, *Blepharis perisca*, *Aristida funciculata*. Camels were fed ad libitum of different parts (leaves, roots and stem); no mineral-vitamin supplements were used. Camels were milked twice, once in the morning at 0700 hr and 1700 pm by two camel herders at a time and milk weights were recorded at each milking.

Sample collections and analysis: Blood samples were collected from the jugular vein in heparinized and non-heparinized vacutainers on day 0 and day 6 of the study. Milk and blood samples were transported to the laboratory on ice. Blood samples were centrifuged at 1730 x g at-5°C for 30 minutes and the plasma samples were removed, frozen at-70°C prior analysis. Plasma Cu levels were determined by flame atomic absorption, in which samples were diluted 1:3 (vol/vol) in deionised water. Plasma samples were analysed for total cholesterol using the method adopted by Franzini and Luraschi[13]. Protein and fat contents of milk were determined using lipid extraction via the chloroform: methanol procedure of Bligh and Dyer[14].

RESULTS AND DISCUSSIONS

Plasma Cu concentrations showed no differences irrespective of treatment before and at the end of the trial

Table 1: Effects of supplemental copper on copper (ug/100 mL) and cholesterol (mmol L) serum levels in Camels (*Camelus dromedarius*)

Item	0	15	45	SE
Cu initial	53	62	59	10
Cu final[a,b]	69	71	70	9
Cholesterol initial[c]	1.64	1.55	1.66	0.21
Cholesterol final	1.59	1.60	1.73	0.19
Adjusted[1,c,d]	1.58	1.57	1.71	0.14

Values are expressed as means±SE [a]Control versus copper ($p<0.001$) [b]15 versus 45 mg of copper of DM ($p<0.001$) [c]Control versus copper ($p<0.05$) [d]15 versus 45 mg of Cu kg^{-1} of DM ($p<0.03$) [1]Adjusted by covariance analysis for initial serum cholesterol

Table 2: Effects of supplemental copper on DMI, milk production and milk composition in camels (*Camelus dromedarius*)

Item	0	15	45	SE
DMI/day	15.9	15.0	15.1	2.5
Milk Kg/Day	6.5	5.3	6.1	1.4
Milk composition				
Fat (%)	3.61	3.50	3.54	0.1
Protein (%)d	3.45	3.48	3.48	0.2

Values are expressed as means±SE Data presented were not significantly influenced as a function of copper treatment

(Table 1). Camels receiving supplemental Cu had higher ($p<0.05$) plasma cholesterol levels than controls on day 61 (Table 1). Camels receiving 45 mg of Cu kg^{-1} of DM had higher ($p<0.05$) plasma cholesterol levels than camels receiving 15 mg of Cu. Plasma Cu concentrations ranged between 53 to 69 ug/100 mL. Dry matter intake, milk production and composition are not affected by Cu treatment (Table 2).

The objective of the present investigation was to assess the effects of different supplemental levels of copper on copper status and cholesterol in camels. Complex inter-relationships exist between certain micronutrients, immune function and disease resistance in animal. Several micronutrients have shown to influence immune responses. Deficiencies of copper in cattle reduce the ability of isolated neutrophils to kill bacteria[15] and affect productivity of cattle in Sudan[16]. Copper supplementation given to Simmental steers increased copper status, but had no effect on lipid or cholesterol metabolism[11].

The study indicated that copper was deficient in forage during the dry season (8.1±2.4 mg kg^{-1}), but adequate during the mid-rainy season (26.1±1.5 mg kg^{-1}). Plasma copper values in the present study were higher than that have been reported in camels, but lower than in cows[17]. She camel receiving supplemental copper had higher serum cholesterol concentration than control on day 60. In dairy Holstein cows, similar findings were obtained[10].

Copper supplements resulted in normal and similar plasma copper concentrations in cows post calving. Discrepancies of reported literature may relate to genetic and gender effect[18]. In line with studies carried on dairy Holstein[10], our present investigation indicated no significant effect of copper supplementation on milk yield, composition and dry matter intake.

Factors affecting Cu content include age, reproductive cycle, season, but no effect of sex[19] and region[20]. Comparative studies between the camelidae and ruminants indicated that lower plasma level[17], higher liver and similar milk in camel[22] as compared to cattle and sheep.

It could be concluded from the present data that copper status affects lipid metabolism in camels. However, further studies warranting reaching concrete interpretation of the results.

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