CERULOPLASMIN AND COPPER STATUS IN FREE-RANGING ALASKAN CARIBOU (*Rangifer tarandus tarandus*)

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Abstract

The copper status of caribou (*Rangifer tarandus*) in Alaska was evaluated by liver copper concentration [liver Cu] (*n*=70), serum copper concentration [serum Cu] (*n*=341), and the concentration of ceruloplasmin (*n*=31), a copper carrying protein found in the serum. We compared these results with respect to age class, gender, season, herd, region, and pregnancy status. Age class was defined as: fetus, neonate (≤1mo), calf (>1 mo and ≤ 10 mo), or adult (>10 mo). We categorized two seasons in our analysis: 1) a combination of winter and spring samples, and 2) a combination of summer and fall samples. Two arctic (Western Arctic and Teshekpuk) and two southern herds (Northern Alaska Peninsula and Mulchatna) were pooled to establish the northern and southern regions, respectively. An Analysis of Variance procedure was used to test for differences between covariates, where $\alpha = 0.05$ (SAS, PROC ANOVA). No serum samples from neonates or pregnant females, or liver samples from calves, were available so we were unable to test for differences within all categories of each variable. Age class was significant for both [serum Cu] ($p = 0.0001$) and [liver Cu] ($p = 0.0001$). [Serum Cu] from neonates (mean = 0.959, SE = 0.145) were significantly greater than calves (mean = 0.580, SE = 0.036) and adults (mean =0.544, SE = 0.01). [Liver Cu] from fetuses (mean = 224.2, SE = 78.6) and neonates (mean = 123.7, SE = 12.3) were significantly greater than adults (mean = 16.9, SE = 12.4). This was not unexpected since in domestic ungulates, fetal and neonatal liver storage is high to meet the Cu requirements prior to weaning. Herd was significant for [serum Cu] ($p = 0.0001$). [Serum Cu] from Western Arctic (mean = 0.692, SE= 0.031) were significantly greater than other herds. [Serum Cu] from Teshekpuk (mean= 0.576, SE = 0.018) were significantly greater than Northern Alaska Peninsula (mean = 0.515, SE = 0.013). Seasonal differences of [serum Cu] within a herd were only significant within the Northern Alaska Peninsula herd ($p < 0.0001$). [Serum Cu] winter/spring (mean = 0.445, SE = 0.014) was significantly less than summer/fall (mean = 0.578, SE = 0.018). This is consistent with this herd's poor health status and heavy parasite loads. These results lead to additional studies to elucidate the significance of the nutritional – parasite interaction on caribou herd health. A significant difference was found between genders for [serum Cu], particularly during the summer/fall season ($p = 0.0014$). [Serum Cu] for males (mean = 0.648, SE = 0.016) were significantly greater than females (mean = 0.577, SE = 0.041). While region wasn't statistically significant, the northern herds had a lower mean [liver Cu] (mean = 47.4, SE = 13.3) than the southern herds (mean = 64.9, SE= 10.9), despite all the high fetal liver copper included in the northern herds. Non-pregnant adults (mean = 18.4, SE = 2.0) and pregnant female (mean = 8.2, SE = 1.7) were significantly different for [liver Cu] ($p < 0.021$). Our observation of high fetal [liver Cu] and low pregnant female

[liver Cu] supports the conclusion that there is mobilization of copper stores from the cow to the fetus. In addition to these analyses, we also examined the correlations between [serum Cu], ceruloplasmin, and [liver Cu] (SAS, PROC CORR, Pearson). No correlation was detected among any combination of copper measurement, likely limited by the small sample size. Thus, until additional paired serum and liver samples can be evaluated, neither ceruloplasmin or [serum Cu] can be substituted as a direct measure of copper status in live-captured caribou. We were limited by opportunistic sampling but in the future, evaluation of more representative samples with respect to age class, gender, season, and herd, will allow us to better evaluate the variation in copper status and its implications for herd health in caribou.

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