Port Colborne Community Action Plan (PCCAP)

Guidance for Care of Copper-Sensitive Dogs in the Vicinity of the Port Colborne Refinery

Key Guidance

- Copper (Cu) concentrations in soils in the vicinity of Vale Canada's Port Colborne Refinery are elevated due to historical emissions from the refinery. The company accepted responsibility for the contamination and undertook the Port Colborne Community-Based Risk Assessment (CBRA). All CBRA documentation is available at http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx
- The Port Colborne Community Action Plan (PCCAP) was initiated to address certain issues that arose from the CBRA.
- The CBRA did not specifically address pets (dogs and cats), but elevated soil Cu in surface soils in the eastside community should be considered, as there has been an apparent increase in copper-overload (Cu-associated hepatopathy (CAH)) in North American dog breeds in recent years.
- Cu-sensitive dog breeds include the Bedlington, West Highland White, and Skye terriers, Labrador retrievers, Doberman Pinschers, and Dalmatians which require specific management of Cu intake from their diet. Cu overload appears to be rare among cats.
- Symptoms of copper overload can include lethargy, vomiting, diarrhea, and jaundice.
- Copper in pet food (added as the highly bioavailable form of copper sulphate) is the largest source of bioavailable Cu to pets. Copper water lines in homes can also be a source of ingested Cu via water supply. The copper in Port Colborne soils is largely present as less bioavailable forms (oxides, slags, and metallics) and likely contributes very little Cu to the diet of dogs.
- If your pet displays soil-eating behaviour and displays symptoms of CAH, contact your veterinary care team.
- The Vale Port Colborne information helpline is available by telephone (289-478-8253) or email (Ontario.questions@vale.com) to have questions answered.

Supporting Information

Copper (Cu) is an essential trace element/micronutrient for mammals. However, some species are known to be susceptible to copper poisoning, including several dog breeds (Bedlington, West Highland White, and Skye terriers, Labrador retrievers, Doberman Pinschers, and Dalmatians), all of which should receive specific management of Cu intake from their diet.

As a result of the historical contamination of soils from the Inco Nickel Refinery in Port Colborne between 1918 and 1984, the issue of potential effects of elevated soil Cu on these common pet breeds, should be addressed, as some pets from among the sensitive breeds could be present in the east side community near the refinery property.

Cu-associated Hepatopathy (CAH) in dogs

Copper is an essential micronutrient in mammals, with the homeostatic regulation of Cu in tissues and organs being centered in the liver (Strickland et al., 2018). When Cu overload occurs, excretory pathways become saturated and Cu accumulates in the liver. Cumulative hepatic Cu accumulation can lead to cirrhosis and death – a syndrome referred to as Cu-associated hepatopathy/hepatitis (CAH) (Strickland et al., 2018; Center et al., 2021). Symptoms of CAH include loss of appetite, vomiting, diarrhea, lethargy and jaundice (Hoffmann, 2008).

An increase in CAH has been documented in the United States in the past 20 years, the onset of which closely matches changes in guidelines for the Cu content of commercial dog foods (Strickland et al., 2018; Center et al., 2021). In 1997, the AAFCO (Association of American Feed Control Officials) changed the Cu supplementation guidelines for commercial pet feed to recommend supplementation with copper sulphate or Cu-amino acid complexes (Cu proteinate) (Center et al., 2021). Cu sulphate is significantly more bioavailable than copper oxide, the previously recommended Cu supplementation source, and the trend of increasing hepatic liver Cu concentrations coincides approximately with the change in pet feed Cu supplementation recommendations (Fig. 1).

The AAFCO Cu supplementation recommendations have been adopted in Canada. Two samples of dry dog food available in Southern Ontario were analyzed for Cu content (Table 1).

Table 1. Copper content in two commercial dry dog food brands available in the Ontario market.

Dog food brand	Form of Cu present	Cu concentration (mass basis)	Cu concentration (kcal basis)
PC nutrition first	Natural sources and copper sulphate	20.7 ± 1.4 ppm	6.2 mg/1,000 kcal
Royal Canin Labrador retriever	Natural sources only	5.0 ± 1.2 ppm	1.5 mg/1,000 kcal

Daily Cu intake recommendation is 1.83 mg Cu/1,000 kcal of food

The “President’s Choice nutrition first” dog food is supplemented with copper sulphate and contained 20.7 ppm (mg/kg) Cu (analysis by hand-held portable XRF). The Royal Canin Labrador retriever diet is formulated specifically for Labrador retrievers (a Cu-sensitive breed) was found to have a Cu content of 5 ppm (5 mg/kg). In the latter brand, the Cu content would

be from the components of the feed, including organ meats such as liver, known to contain Cu (i.e., natural Cu). Not only is the “Nutrition first” dog food supplemented with a highly bioavailable form of Cu (copper sulphate), but it exceeds the AAFCO recommendation for Cu supplementation in dog food (1.83 mg Cu/1000 kcal). The Royal Canin Labrador retriever dry food did not contain added Cu in a mineral form and did not exceed the recommended level of daily Cu intake.

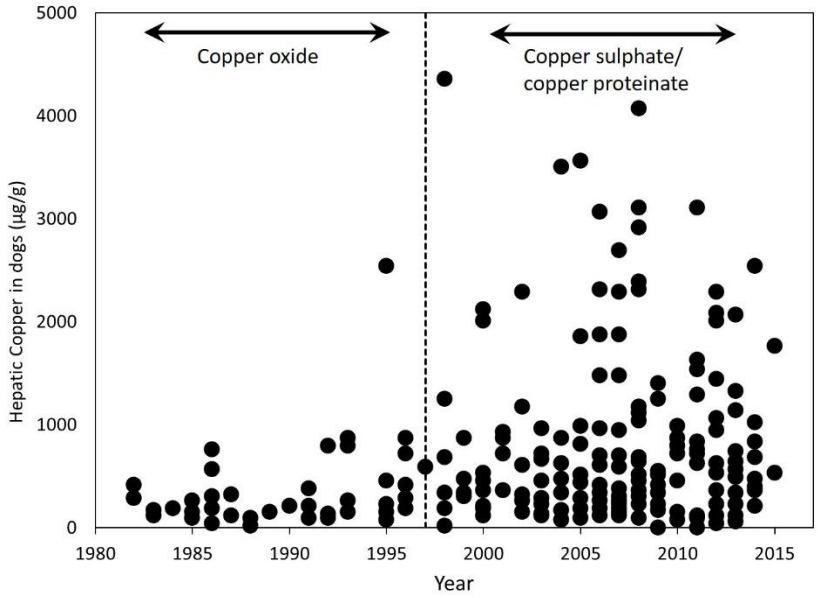

Fig. 1. Trends in hepatic copper concentrations in dogs in relation to changes in copper supplementation in commercial dog food. (After Strickland et al., 2018).

Speciation (chemical form) and expected bioavailability of Cu in dog food and Port Colborne soil

Cu in typical dietary items in a western (human) diet is believed to be 30-40% bioavailable, the cationic Cu^{2+} ion being bound to plant and animal proteins in dietary items (Wapnir, 1998). Copper salts such as copper sulphate are thought to be similarly bioavailable, as the Cu^{2+} ion is released into aqueous solutions in a pH-dependent manner as the Cu salt dissolves in water.

Assessment of risk of Cu intake by Cu-sensitive pets

The potential for Cu ingestion by dogs in the Port Colborne eastside community was estimated by apportioning Cu intake from food and soil as discussed below.

Cu in soil

The 2002 Rodney Street Risk Assessment (MOE, 2002) identified the following characteristics of its soil Cu data set from the assessment: Average soil Cu concentration – 246 mg/kg (0-20 cm depth); 90^{th} percentile soil Cu concentration – 471 mg/kg; maximum value – 2,720 mg/kg (10-20 cm depth).

Cu from Drinking Water

In the CBRA, the average Cu concentration in a survey of municipal drinking water supplies in the Niagara region was 22.4 µg/L (Stantec, 2014), which is a very minor exposure source and was therefore not considered in this brief assessment.

Ingestion of Cu due to incidental soil ingestion in dogs

Based on Calabrese and Stanek (1995), it was assumed that an adult medium-sized dog breed consumes 14.6 g of soil daily.

The daily Cu ingestion from incidental soil ingestion at the average soil Cu concentration (246 mg/kg) would be **3.6 mg**. At the 90th percentile soil Cu concentration (471 mg/kg), the daily Cu ingestion rate from soil would be **6.9 mg**.

Cu intake from the diet for a medium-size dog

The calculations here assumed a weight of 20 kg for a mid-size adult dog. The two dry dog foods considered here recommend feeding rates of 917.5 kcal (275 g) per day (PC nutrition first dry food) or 1,031.25 kcal (299 g) per day (Royal Canin Labrador retriever dry food). Based on the Cu contents in Table 1, the dog fed the PC nutrition first food would ingest **5.7 mg Cu/day**, while a dog fed the Royal Canin food would receive **1.5 mg Cu /day**.

Exposure limit

Liver effects in rats, similar to those seen in dogs under Cu overload, are seen at doses of water soluble Cu compounds above **16.3 mg/kg/day** (Taylor et al., 2019).

Findings

The highest (worst case) exposure to Cu would be expected from incidental soil ingestion of the 90th% soil Cu concentration (3.6 mg Cu) coupled with the Cu from the 'PC nutrition first' food (5.7 mg Cu), for an estimated total daily Cu ingestion of 22 mg/day by a 20 kg dog, giving an exposure rate of 1.1 mg/kg body weight/day – less than one tenth of the exposure limit of 16.3 mg/kg body weight/day. Other exposures would be lower, and for brevity have not been presented here.

Summary

The screening-level calculations here indicate that there is little concern for copper exposure due to elevated copper in soil from the historical contamination from the Inco Port Colborne Nickel Refinery.

This assessment did not take into account bioavailability, the bioavailability of Cu from soil being expected to be much lower than from the food, making soil ingestion component less important than the food exposure.

The choice of dog food will be an important consideration for owners of dogs that are Cu-susceptible breeds. The use of pet food that is specifically developed for Cu-sensitive breeds (i.e., without added Cu in highly bioavailable forms such as copper sulphate or copper proteinate) will reduce the largest component of daily Cu ingestion.

CAH is unlikely to be an issue as a result of historical copper contamination on the impacted lands in the vicinity of the Port Colborne Refinery site.

References

Calabrese, E.J. and E.J. Stanek, 1995. A dog's tale: soil ingestion by a canine. Ecotox. Environ. Safety, 32: 93-95.

Center, S.A., K.P. Richter, D.C. Twedt, J.J. Wakshlag, P.J. Watson, and C.R.L. Webster. 2021. Is it time to reconsider current guidelines for copper content in commercial dog foods? J. Am. Vet. Med. Assoc. 258: 357-364.

Hoffmann, G. 2008. Copper-associated chronic hepatitis in the Labrador retriever. PhD thesis, Faculty of Veterinary Medicine, Utrecht University. 209 pp.

MOE, 2002. Soil Investigation and Human Health Risk Assessment for the Rodney Street Community, Port Colborne. Ontario Ministry of the Environment. March, 2002. Queen's Printer for Ontario. PIBS 4255e (Public Information Banking System).

Stantec, 2014. Port Colborne Community-Based Risk Assessment 2014 Update Report. September, 2014. Stantec Consulting Ltd., 1-70 Southgate Drive, Guelph, Ontario. http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx

Strickland, J.M., J.P. Buchweitz, R.C. Smedley, K.J. Olstad, R.S. Schultz, N. B. Oliver, and D.K. Langois. 2018. Hepatic copper concentrations in 546 dogs (1982-2015). J. Vet. Intern. Med. 32: 1943-1950.

Taylor, A.A., J.S. Tsuji, M.R. Garry, M.E. McArdle, W.L. Goodfellow Jr., W.J. Adams, and C.A. Menzie. 2019. Critical review of exposure and effects: Implications for setting regulatory health criteria for ingested copper. Environ. Manag. 65: 131-159.

Wapnir, R.A. 1998. Copper absorption and bioavailability. Am. J. Clin. Nutr. 67(suppl.): 1054S-1060S.