PERCHLORATE IN THE DAIRY FORAGE SYSTEM

Michael Payne and Charles Sanchez [1]

Ammonium, potassium, magnesium and sodium salts of perchlorate are utilized in a variety of manufacturing processes. Perchlorate's primary application however is as an oxidant in munitions and solid rocket-fuel propellants. While large-scale production of ammonium perchlorate began in the United States in the mid-1940's, the full extent of perchlorate contamination from defense contractors, military operations, and aerospace facilities was not appreciated until the mid-1990s. At that time sufficiently sensitive methods were developed to allow the detection of perchlorate in surface and groundwater in the low parts per billion (ppb) level.

Perchlorate is known to bind to the thyroid glands sodium-iodide symporter. With sufficient exposure iodine uptake and subsequent thyroid hormone production become impaired. This effect has been recognized for years. Until recently potassium perchlorate was used to treat hyperthyroidism resulting from Grave's disease and perchlorate is still an accepted research method used to induce hypothyroidism is laboratory animals. For fetuses, infants and children, disruptions in thyroid hormone levels can cause lowered IQ, mental retardation, loss of hearing and speech, and motor skill deficits. These groups are generally considered to represent the most sensitive or at-risk population.

Perchlorate however is only one of a number of natural and artificial compounds so affecting the thyroid and the question of what regulatory limits should be established for drinking water and food remains hotly contested. As an emerging contaminant, many organizations which typically provide guidance on acceptable contaminant levels have thus far had inadequate information upon which to base recommendations. Neither federal organizations (The Food and Drug Administration, The Agency for Toxic Substances and Disease Registry, The National Toxicology Program) nor International organizations (The International Programme on Chemical Safety, International Agency for Research on Cancer, The World Health Organization) have proposed regulatory limits in food or water.

The US Environmental Protection Agency has proposed a reference dose of 0.00003 mg/kg body weight per day, an exposure which would be equivalent to approximately 1ppb in the drinking water. A National Academy of Science panel, whose report is expected this fall, is reviewing EPA's draft drinking water standard. California's Office of Environmental Health Hazard Assessment and CAL-EPA set a Public Health Goal for perchlorate in drinking water of 6 ppb earlier this year but have indicated that final establishment of a State Maximum Contaminant Level could be influenced by the pending NAS report. Interestingly, California's Public Health Goal allows for 40% of the total exposure to come not from drinking water but from foods. Other estimates of safe perchlorate levels in drinking water include 100 ppb by the University of

[1] Michael Payne, Specialist in Dept. of Environmental Toxicology, University of California, One Shields Avenue, Davis, CA 95616, mpayne@ucdavis.edu; Charles Sanchez , Resident Director and Research Scientist, University of Arizona, Yuma, AZ, sanchez@ag.arizona.edu In: Proceedings, 33rd National Alfalfa Symposium, 13-15 December, 2004, San Diego, CA.

California's Urban Water Research Center and as much as 200 ppb by the U.S. Department of Defense.

The wide divergence in estimations of what level of perchlorate exposure is safe arises primarily because of disagreement as to what physiological change or measured laboratory parameter constitutes an adverse effect. Proponents of a conservative (low) drinking water standard typically utilize the exposure level at which iodine uptake is altered. Conversely, advocates for higher regulatory tolerances suggest that actual reduction of thyroid hormone production is a more realistic measurement of harm. Cited in support of this later view are studies in Nevada and Southern California finding no adverse health effects in populations exposed to high levels of perchlorate in drinking water. Additional disagreement arises over the number and magnitude of safety factors needed to render an appropriately conservative regulatory level.

It is well established that some plants irrigated with contaminated water will take up and concentrate perchlorate, sometimes to high levels. Perchlorate uptake has been documented in a variety of crops including alfalfa, lettuce, wheat, various berries, soybeans, strawberries and cucumbers. Because some of these crops are utilized as animal feed and because perchlorate is known to concentrate from the blood and into the milk of rats, surveys into perchlorate contamination of cow milk were implemented.

To date, three surveys of perchlorate levels in cow milk have been made public. The first from Texas Tech University and sponsored by the Environmental Working Group was published in November 2003. This study found perchlorate in 7 of 7 fluid store milk samples (4 of which likely came from the same plant and 2 which were bottled out of state). Perchlorate milk levels in this study averaged 3.98 ppb and ranged from 1.7 to 6.4 ppb. In June of 2004 a similar survey sponsored by the Environmental Working Group of southern California store milk samples reported 31 of 32 samples to be positive with an average of 1.3 ppb and a range of 0.58 to 3.62 ppb. With the release of its California milk survey, the Environmental Working Group also reported the results of milk assays performed by the State of California on samples collected during assay development for perchlorate in milk. Obtained through a State Public Records Act request these data showed 34 milk samples collected from unspecified sources in Alameda, Sacramento and San Joaquin counties having a average perchlorate level of 5.8 ppb with a range of 1.5 to 10.6 ppb.

The Food and Drug Administration has recently completed its national sampling program for perchlorate in bottled water, lettuce and milk. While these data had not been released at the time of this writing, based on early results, the study is expected to demonstrate the widespread presence of perchlorate in milk at the low ppb level.

Initial results of perchlorate levels in alfalfa and the implications of perchlorate contamination in milk for the dairy industry will be discussed.