Manganese (Mn) in Drinking Water From Gravity Feed System: A Literature Review

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Abstract

Manganese (Mn) is an element of metals that exists in a huge number of metals in the Earth’s crust. Mn is not naturally found in its pure form; instead, it is usually forming a compound with iron. Mn is an important element that has a function in both animals and humans [1]. Mn is commonly used in the manufacture and as an ingredient in several products such as batteries, glass and fireworks. Besides, Mn compounds are also present in surface waters in dissolved and suspended forms [2]. Besides ores and rocks, Mn can also be found in groundwater and surface water due to reducing conditions in soils and rocks that contain Mn, which may erode and turn it into a soluble form that then enters the water naturally [3]. Thus, high levels of Mn are found in groundwater and some lakes as well as reservoirs due to these conditions. Mn can also be present in water in the environment through human activities such as mining and landfill leaching near the water [4]. Health Canada stated the prevalence of Mn in ground waters is higher than that of surface waters [5].

Inhalation and ingestion are the main routes of exposure, with inhalation mostly happening in workers due to occupational factors, and those who consume food or drinking water that contains high amounts of Mn are exposed through ingestion [4]. However, Mn is easily absorbed into the body when consumed with drinking water as compared to ingestion with food. Mn levels in drinking water should not be more than 0.1 mg/L, based on the Drinking Water Quality Standard [6]. Many enzymes including manganese superoxide dismutase arginase and pyruvate carboxylase require Mn as a cofactor; while in combination with vitamin K, Mn can aid in blood coagulation and hemostasis [7]. In addition, Mn is involved in the metabolism of amino acids, cholesterol, glucose and carbohydrates as well as bone formation, reproduction and immune response [8]. However, problems with memory, attention and motor skills exist when children and adults alike consume high levels of Mn for extended durations including consumption of drinking water [9]. There are no strong studies that show the results of the health effects of Mn in drinking water for adults. However, many studies have shown evidence of adverse health effects of Mn exposure on children especially in term of neurobehavioral effect.

A review was conducted on the literature on Mn exposure from drinking water, concentrating on the World Health Organization’s health-based Mn guideline value [10]. There is no study that has determined a lethal threshold of Mn for children and newborns, although data suggest that youngsters are more susceptible to poisoning than adults. Another study reported the association between Mn and arsenic exposure in drinking water among academic achievement of children in Bangladesh. It showed a significant association between water containing more than 400µg/L and decreased mathematical scores observed after adjusting the confounders [8]. There is a significant decrease in IQ scores of children that were exposed to higher levels of Mn from the earlier study [11]. Changes in the neurotransmitter system were shown to vary with the period of exposure during Mn intoxication.
in mice exposed to manganese chloride (MnCl2) through lactation and drinking water containing 3 mg/L Mn for 180 days, and male rats given 1000 mg/L water for 360 days. The studies also showed that Mn exposure increased the levels of dopamine, norepinephrine and tyrosine in the corpus striatum [5].

The gravity feed system (GFS) is a downstream distribution system that is powered by gravity to supply water to households without the need to use electricity [12]. It is commonly used by populations living in hilly areas. These include the Orang Asli communities which usually live in areas which cannot be supplied with centralized water supply system. GFS is suitable in areas with a continuous supply of spring water. In Malaysia, gravity feed system is a type of water delivery system that includes a secure catchment area, a weir or sluice, and a piped water supply network (Figure 1). Since the majority of the systems generate untreated but healthy water, rural residents are recommended to boil the water [13].

Keywords
Gravity feed system, Health, Manganese

References