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7.2 Toxicology and Exposure

Arsenic can exist in both organic and inorganic compounds. Exposures to organic arsenic occur primarily in the food supply. Exposures through the consumption of fish (usually in the form of arsenobetaine and arsenocholine) have a relatively low level of associated toxicity (Sabbioni et al. 1991). Inorganic arsenic, however, is highly toxic and associated with risks to human health. Inorganic arsenic is ranked as the top chemical of concern on the Priority List of Hazardous Substances (ATSDR 2015). This list ranks substances that present the greatest risk to public health based on prevalence, toxicity, and potential for human exposure. Human exposure to inorganic arsenic can occur through dietary intake, which is primarily from rice consumption (Rahman and Hasegawa 2011), as well as ingestion of contaminated water or soils. Chronic exposure to arsenic has been associated with a variety of cancers (skin, lung, bladder, liver, and kidney), cardiovascular disease, and neurological impairments in exposed populations (ATSDR 2007a; Mitchell 2014).

▼*Read more*

The toxicity criteria for arsenic that are applied in human health risk assessments are based on exposure to arsenic solubilized in groundwater (USEPA 2015b). Absorption is highly influenced by solubility (Marafante and Vahter 1987); an estimated 95% of arsenic is absorbed following consumption of contaminated groundwater in healthy individuals (Zheng et al. 2002). The dose-response relationship for toxicity of a substance is directly related to how readily it is absorbed by the body (its bioavailability). The relative oral bioavailability of arsenic in soil is greatly influenced by the source of the arsenic and by mineralogical associations within the soil matrix and has a reported range from 3 to 100% (Freeman et al. 1995; Rodriguez et al. 1999; Juhasz et al. 2007; Bradham et al. 2011; Mitchell 2014; Meunier et al. 2010; USEPA 2012a).

Arsenic in soils is primarily inorganic arsenate, As(V) or arsenite, As(III). In most soils, aerobic conditions result in predominantly As(V). Trivalent As, As(III), has been reported to have higher toxicity than As(V) (Thomas, Styblo, and Lin 2001; Hughes 2002; Singh, Goel, and Kaur 2011). While valence state has been reported to affect toxicity, arsenic valence is not typically considered in human health risk assessments due to the reduction of As(V) to As(III) early in the biotransformation pathway (ATSDR 2007a). The arsenic valence information for a specific site could be addressed qualitatively in the uncertainty section of a human health risk assessment, although this is not common practice.