Chemical Properties

Al
Aluminum

Aluminum is the most abundant metal in the Earth's crust, but it is usually bound in insoluble oxides and silicates (Macdonald and Martin, 1988). Environmental acidification can increase levels of soluble aluminum (Al(III)), which is of concern as Al(III) is known to be toxic to many organisms (Williams, 1999). No biological role has been identified for aluminum, but aluminum can replace hydrogen with limited efficiency as an electron donor for methane production by methanogenic archaea (Belay and Daniels, 1990). Research into microbial interactions with aluminum has focused on corrosion of aluminum alloys, leaching of aluminum from materials, and aluminum accumulation, toxicity and detoxification.

Organic and inorganic acids produced by bacteria and fungi can mobilize aluminum from a variety of materials. Corrosion of aluminum alloys due to the growth of microorganisms was observed in aircraft fuel tanks in the 1960's (reviewed by Iverson, 1987), and remains a current area of research (Yang et al, 1998). Researchers have documented microbially-mediated aluminum leaching from the mineral spodumene (Karavaiko et al, 1980), red mud waste remaining after the alkaline extraction of alumina from bauxite ores (Vachon et al, 1994), incinerator fly ash (Brombacher et al, 1998), and electronic scrap (Brandl et al, 2000).

Phosphate has been shown to influence the mechanisms of aluminum tolerance in *Pseudomonas fluorescens* grown with aluminum-complexed citrate as a sole carbon source. In a phosphate-rich medium, *P. fluorescens* deposited aluminum in an insoluble extracellular residue composed partly of phosphatidylethanolamine (Appanna and St. Pierre, 1996). When phosphate was limiting, aluminum was found complexed with soluble extracellular metabolites (Appanna and St. Pierre, 1994). Iron concentration can determine which aluminum detoxification mechanism is used by *P. fluorescens* (Appanna and Hamel, 1996). Cellular phosphate concentration can also modulate aluminum toxicity in *Bradyrhizobium japonicum* (Mukherjee and Asanuma, 1998).

Aluminum binding and accumulation has been described in a variety of microorganisms. Isolated cell walls of *Staphylococcus aureus* were found to bind aluminum ions (Bradley and Parker, 1968), and *Anabaena cylindrica* was found to accumulate aluminum in phosphate granules in the cell wall (Pettersson et al, 1985). Cell surface and intracellular aluminum accumulation was observed in *Eschericia coli* (Guida et al, 1991). Aluminum uptake via hydroxamate siderophores can occur in the absence of iron in *Bacillus megaterium* (Hu and Boyer, 1996).

For more information:

Search Medline for aluminum metabolism AND bacteria

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