Heat-loving marine bacteria can help detoxify asbestos

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Asbestos materials were once widely used in homes, buildings, automobile brakes and many other built materials due to their strength and resistance to heat and fire, as well as to their low electrical conductivity. Unfortunately, asbestos exposure through inhalation of small fiber particles has been shown to be highly carcinogenic.

Now, for the first time, researchers from the University of Pennsylvania have shown that extremophilic bacteria from high temperature marine environments can be used to reduce asbestos' toxicity. The research is published in *Applied and Environmental Microbiology*.

Much of their research has focused on use of the thermophilic bacterium Deferrisoma palaeochoriense to remove iron from asbestos minerals through anaerobic respiration of that iron. "Iron has been identified as a major component driving the toxicity of asbestos minerals and its removal from asbestos minerals has been shown to decrease their toxic properties," said Ileana Pérez-Rodríguez, Ph.D., Assistant Professor of Earth and Environmental Science at the University of Pennsylvania.

D. palaeochoriense has also been shown to mediate transfer of electrical charge within the iron contained in asbestos, without changing its mineral structure. Doing so might enhance asbestos' electrical conductivity, said Pérez-Rodríguez.

Based on this observation, the bacterium could be used to treat asbestos' toxicity through iron removal. Alternatively, the new properties of electrical conductivity could enable reuse of treated asbestos for that purpose.

As with iron, the fibrous silicate structures of asbestos are also carcinogenic. Removal of silicon and magnesium from asbestos has been shown to disrupt its fibrous structure. The investigators tested the ability of the thermophilic bacterium Thermovibrio ammonificans to remove these elements from asbestos minerals by accumulating silicon in its biomass in a process known as biosilicification.

T. ammonificans accumulated silicon in its biomass when in the presence of "serpentine" asbestos, which has curly fibers, but not while growing in the presence of "amphibole" asbestos, which has straight fibers, said Pérez-Rodríguez.

This difference, along with the varying amounts and types of elements released during microbe-mineral interactions with different types of asbestos "highlights the difficulty of approaching asbestos treatments as a one-size-fits-all solution, given the unique chemical compositions and crystal structures associated with each asbestos mineral," Pérez-Rodríguez said.

Overall, these experiments promoted the removal of iron, silicon and/or magnesium for the detoxification of asbestos in a superior manner as compared to other biologically mediated detoxification of asbestos, such as via fungi, said Pérez-Rodríguez. However, further analysis will be required to optimize asbestos treatments to determine the most practical methods for the detoxification and/or reuse of asbestos as secondary raw materials.

More information: Jessica K. Choi et al, Microbe-Mineral Interactions between Asbestos and Thermophilic Chemolithoautotrophic Anaerobes, *Applied and Environmental Microbiology* (2023). DOI: 10.1128/aem.02048-22 journals.asm.org/doi/10.1128/aem.02048-22

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