Lichens may one day detoxify the air in your home

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Initial growth stage (left) and later growth stage of the "pre-harvested" lichen blocks on a 3D printed cork lattice for air detoxification reactivity maximization. Credit: University of California - Berkeley

When smoke from fires darken the skies as they did last summer, hunkering down indoors makes good sense. But on most days throughout the year, the air we breathe indoors carries far more pollutants than outdoor air. Exposure is highest in crowded homes where space is a luxury, leading the EPA to rank indoor air quality as one of the top five public health concerns.

Current ventilation systems—the "V" in HVAC—generally aren't designed to detoxify indoor air and can actually increase exposure to airborne pathogens. In any case, HVAC and more efficient indoor air

purifiers have high energy demands and are often unaffordable where they are needed most.

A new strategy has emerged to replace mechanical indoor purification systems with biological ones. Exterior "living walls" employ plants to remove carbon dioxide and other toxins from indoor air. Although still a bit under the radar, the market for living walls is already about $1 billion a year and projected to grow globally at more than 10 percent a year. But as with any emerging technology, they come with their own set of problems, particularly maintenance costs.

Maria Paz Gutierrez, associate professor of architecture, has begun to explore the potential of using lichens rather than plants as living air purifiers, and installing them along interior walls, rather than exterior walls. With support from the Bakar Fellowship Program, Dr. Gutierrez aims to fabricate small-scale "lichen building blocks" and test their capacity to purify indoor air. She describes her unorthodox approach and what drew her to it.

Q. What led to your interest in biowalls to detoxify indoor air?

I was born in South America, and I lived my first nine years in Rio de Janeiro, a city with a great cultural effervescence, but with a large population struggling for the most basic access to resources. It's impossible not to be influenced by that experience. It makes an indelible mark.

The populations most vulnerable to indoor air pollution are the elderly and people in crowded living conditions. We need to address the inequities of access to good air in developing countries, and here at home. And our solutions must be sustainable and environmentally safe.

Q. Why do you expect lichens will be a smarter strategy than using plants to detoxify air?

Air detoxification by plants occurs primarily on the rhizome—the main stem of a plant. The foliage takes up most of the plant's volume, but is not a surface for the reactivity with airborne toxins that purifies the air. Lichens have a very large surface area relative to their volume, and their entire surface can process toxins, making them much more efficient.

Most biowalls are made of ferns and other tropical plants. They have a significant evapotranspiration rates which increases humidity. You need electrical systems to dehumidify the air and to periodically pump in water as the plants grow. Lichens are adapted to every climate regime on earth, from the driest deserts of northern Chile to humid tropical rain forests. So they can be used to detoxify air in most any environment. A lichen block would be a zero-energy, zero-water, and virtually maintenance-free system.

Q. What is the makeup of lichen building blocks and how do you fabricate them?

A building block might be about the size of a brick, but instead of being solid, it would be made up of a network of lightweight and structurally resilient lattices, providing a large surface area for lichens to grown on. The lattices are fabricated from composites of recycled plant waste using 3D printing, and lichens would be deposited along the lattice surfaces to detoxify the air. The blocks could be assembled into biowalls, installed along the interior walls of rooms or buildings.

Q. The biowalls would conform to the size of a room's interior wall?

Not necessarily. The biowalls would be assembled to meet the decontamination needs of a given space. To detoxify a 10-foot by 20-foot room, for example, you might need a lichen wall roughly three feet by four feet by four inches—maybe about the size of an old-fashioned room radiator. But they could also be built to a much larger, industrial scale.

Q. How will the Bakar Fellowship support your project?

We need to optimize the building block design and fabrication. The blocks should provide a maximum lattice surface area while maintaining their structural integrity. We'll need to assure the lichen and the lattice are compatible.

In the first phase, we will develop a small prototype. In a second phase we will focus on scalability. The Bakar Fellows Program support offers us access to manufacturing expertise that can move us closer to developing a practical technology to meet a real need.

Provided by University of California - Berkeley