# Researchers explore natural solution to rid household plumbing of dangerous pathogens

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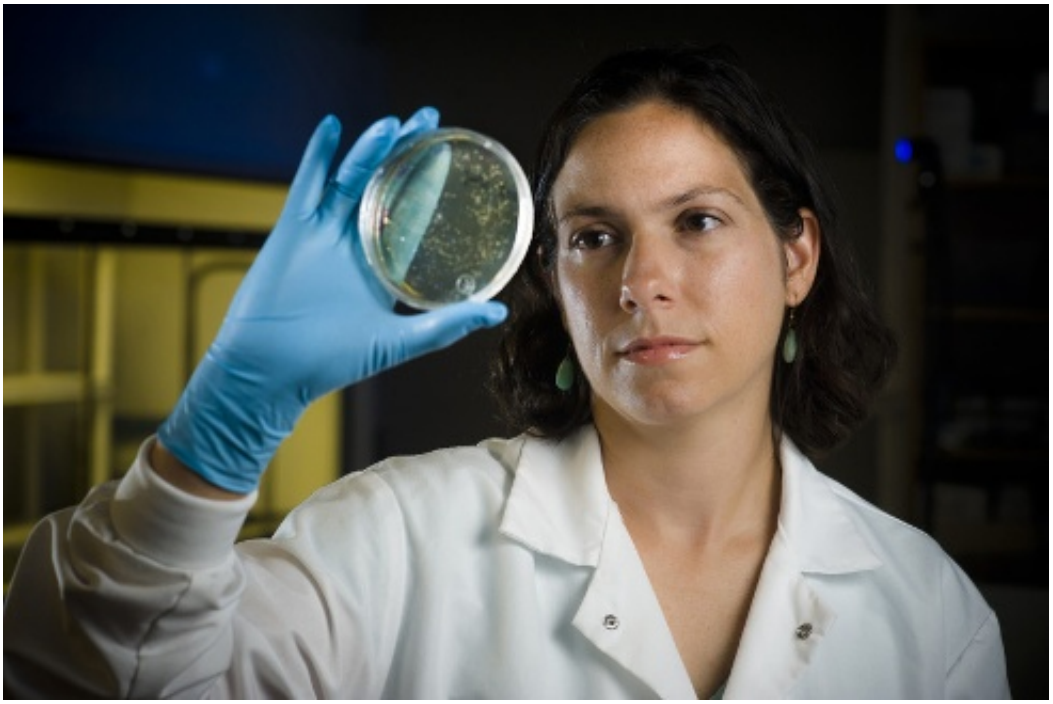

Amy Pruden examines a Petri dishAmy Pruden, a professor of civil and environmental engineering, investigates problems caused by pathogens in tap water.

(Phys.org) —Microbes are everywhere – thousands of species are in your mouth, and thousands are in a glass of tap water. The ones in your mouth are mostly harmless – as long as you brush and floss so they don't form a biofilm that allows gum disease a path into the blood stream.

Microbes in the tap water delivered by modern water systems in a developed country are also mostly harmless – with some notable exceptions.

A team of Virginia Tech researchers is investigating the challenges presented by four often deadly pathogens that have been documented in household or hospital tap water. They propose fighting these opportunistic pathogens with harmless microbes – a probiotic approach for cleaning up plumbing.

Writing in the American Chemical Society journal, *Environmental Science and Technology*, the researchers reviewed studies of opportunistic pathogens that have colonized water systems within buildings – between the delivery point and the tap. They define a probiotic approach as intentionally creating conditions that select for a desirable microbial community, or microbiome.

"We are putting forward a new way of thinking about waterborne pathogen control," said Amy Pruden, a professor of civil and environmental engineering whose sustainable water research is supported by the Institute for Critical Technology and Applied Science at Virginia Tech.

"We have new tools – the next generation DNA-sequencing tools, which have just come online in the last five years," Pruden said. "They are providing unprecedented information about microbes in all sorts of environments, including "clean" drinking water. These tools have really surprised us by showing us the numbers and diversity of microbes. There can be thousands of different species of bacteria in a household water supply."

The researchers focused on several opportunistic pathogens, including Legionella, the infamous cause of deadly Legionnaires' disease and

milder Pontiac fever; Mycobacterium avium complex, which causes pulmonary risks and is the most costly waterborne disease in terms of individual hospital visits; and Pseudomonas aeruginosa, the leading cause of hospital-acquired infections.

In addition, they looked at pathogenic free-living amoebae, which are host microorganisms that enhance the growth of bacterial pathogens in water, particularly Legionella and M. avium, by protecting them and providing a place for them to multiply.

Pruden, who still prefers to drink tap rather than bottled water, points out that these pathogens are "opportunistic" because they are most dangerous to people who are ill, such as those already in a hospital, and people with weaker immune systems, including the elderly.

"Pathogens from feces are dealt with by filtering or disinfecting. They are native to warm-blood animals and don't survive long outside that environment. These next-generation pathogens live in biofilms in water systems," Pruden said. "We need to develop a better understanding of conditions and types of bacteria in order to have a better opportunity to fight water-borne disease."

Hong Wang, a postdoctoral associate in civil engineering at Virginia Tech, is the first author of the article, "Probiotic Approach to Pathogen Control in Premise Plumbing Systems? A Review." Wang did her doctoral research on the factors that contribute to growth of opportunistic pathogens in building plumbing. She received her degree in civil engineering in February 2013.

Household plumbing, with lots of surfaces, overnight inactivity, and warmer temperatures, provides ideal ecological niches for opportunistic pathogens. They can readily form colonies, or biofilms. The biofilm then provides services to its resident microorganisms, such as adapting to the

environment and resisting disruption and disinfection.

Biofilms of opportunistic pathogens have been found in cold and hot water and on shower heads, water taps, eye-wash stations, and water filters.

"For example, M. avium were 100 times more prevalent in biofilms in shower-heads than in bulk water, illustrating their preference for biofilms," said article co-author Joseph O. Falkinham III, a professor of biological sciences in the College of Science at Virginia Tech and one of the first to link M. avium found in a shower to pulmonary disease.

The research team looked at methods to control opportunistic pathogens with disinfectants, such as chlorine or chloramine, and found barriers. Some pathogens shrug off the disinfectants, which have the unwelcome potential to damage plumbing and cause scaling and corrosion in pipes, which can release metals into the water and actually provide a nutrient source for some pathogens.

"The expertise and maintenance required are serious barriers," said co-author Marc Edwards, a professor of civil and environmental engineering.

Pruden said plumbing is inherently laden with a rich microbiome that is impossible to eradicate, and attempts to disinfect the environment could have ill effects on harmless, potentially helpful, microbes.

"We believe this microbiome can be harnessed to control opportunistic pathogens," Pruden said.

For example, benign microbes could out-compete the pathogens for nutrients, space, and other needs, such as the aid of amoeba as hosts. Limiting the number of amoeba with an amoebal virus or bacterial virus

is also a strategy, said Falkinham.

In addition, some microbes secrete substances that prevent pathogens from attaching to a surface, which prevents harmful biofilm formation. An alternative approach is chemical synthesis and screens of molecule-mimicking natural inhibitors to control biofilm formation.

"Of course, there would need to be a careful screening before these competitive organisms were introduced," Pruden said.

Virginia Tech researchers Wang, Edwards, Falkinham, and Pruden, who is the corresponding author, concluded in their article, "Further studies on the interplay between target opportunistic pathogens and other microbes under different drinking water conditions are critical."

**More information:** pubs.acs.org/doi/abs/10.1021/es402455r

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