How household bleach works to kill bacteria

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Despite the fact that household bleach is commonly used as a disinfectant, exactly how it works to fight bacteria remained an open question. Now, a report in the November 14th issue of the journal Cell, a Cell Press publication, provides an answer.

The researchers found that hypochlorous acid, the active ingredient in bleach, causes the unfolding of proteins in bacteria in much the same was that heat stress or fever does. Those denatured proteins then clump together irreversibly into a mass in living cells, similar to what happens to proteins when you boil an egg, according to the researchers.

The bacteria aren't totally defenseless, however. Under those circumstances, a protein chaperone called heat shock protein Hsp33 springs to action, protecting proteins from the aggregation effect and increasing the bacteria's bleach resistance. Protein chaperones are generally defined as proteins whose function is to help other proteins.

" We found both in vitro and in vivo that bleach attacks proteins," said Ursula Jakob of the University of Michigan, Ann Arbor. "They lose structure much like they would under high temperature. Under those circumstances, the [Hsp33] protein is specifically activated to increase resistance." Jakob emphasized that this newly discovered mechanism is clearly one way bleach kills bacteria, but it may not be the only way.

Why would bacteria have a system specifically designed to deal with bleach?

" Hypochlorous acid is an important part of host defense," Jakob said. "It's not just something we use on our countertops."

In fact, the innate immune systems of mammals, and specifically immune cells known as neutrophils, release high concentrations of hypochlorous acid (aka bleach) upon recognizing microbial invaders. In addition, Jakob said, some evidence suggests that enzymes that produce bleach may help keep the bacteria in our guts in check.

The specific effects of hypochlorous acid on proteins help to explain why hydrogen peroxide is an inferior antimicrobial agent even though both chemicals are expected to act as strong oxidants, Jakob said. Hydrogen peroxide doesn't do much for your countertops, she said, because it doesn't provoke these effects on proteins.

Hsp33 also represents another example of an emerging concept in protein biology: that some proteins actually become activated through the act of partial unfolding. Indeed, chaperones react to stress by unfolding in the same way that other proteins do. Far from leaving them useless, however, that change in conformation is exactly what turns them on. " Usually, we think proteins need structure to be active, but here they must lose structure to be active," Jakob said.

As for whether the findings will have any practical implications, Jakob said she isn't yet sure. For instance, she has doubts that bleach could be made to work any more effectively than it does, particularly given that it works so rapidly and so well as it is even at low concentrations.

The findings in bacteria could perhaps offer new insight into the damaging effects of bleach on our own proteins, she added, noting that hypochlorous acid produced by the immune system has been suspected to play a role in chronic inflammation. The protein unfolding seen in bacteria might explain what the chemical agent is doing, perhaps

yielding clues about what might be done to stop it.

Source: Cell Press