

**Novel way to produce safer drinking water**

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J. R. Swathy observing E. coli bacteria upon silver ion exposure. Live (green) and dead (red) bacteria are seen on the screen. *Special Arrangement*

Making drinking water a lot safer by killing an overwhelming number of bacteria and most viruses is now possible. A novel research to this end was carried out by a team led by Prof. T. Pradeep, Department of Chemistry, Indian Institute of Technology (IIT), Madras.

In May 2013, the same team was able to achieve only 100 times reduction in bacterial load and negligible reduction in viral load through sustained release of 50 parts per billion (ppb) of silver ions in drinking water.

But in the latest study, the team was able to achieve 1,00,000 times reduction in bacterial load and 1,000 times reduction in viral load by synergistically combining silver with carbonate ions. The drastic improvement in antimicrobial performance was achieved despite the team using only 25 ppb of silver ions, half the amount used in the earlier work.

“A novel way has been found to save 1,300 tonnes of silver annually, which would have been unrecoverable otherwise, amounting to a saving of Rs.4,600 crores,” Prof. Pradeep told this Correspondent.

The amount of carbonate and silver used was well below the permissible level in drinking water. Tap water was used for the experiments. The results of the study were published a couple of days ago in Nature Group’s journal *Scientific Reports*.

“A fundamental result that came out of our earlier study was that the antibacterial activity of silver can be tuned by simple methods,” Prof. Pradeep said. “Everybody was studying silver in isolation but we looked at synergistically combining silver with some other ions.”

Explaining what prompted him to combine silver with another ion, he said: “It was intuition (based on chemistry). When you say there is an effect of an ion on an organism, what it means is that the ion has to get into the body of an organism. The penetration has to go through several steps. Each one is a chemical binding process. Therefore, silver can be tuned by ions or molecules.”

The search for ions that can be combined with silver without causing toxicity to humans eventually led to carbonates.

“It’s a very common ion in water. It is also cheap and easily deployable. So we stayed with carbonate,” Prof. Pradeep said.

The team had earlier found that silver was able to destroy the integrity of the cell membrane and also damage the DNA. In the case of carbonates, several peripheral membrane-bound proteins get removed. “We found that the peripheral proteins of the organisms were cleaned up after treatment with carbonates,” he said.

As a result, more silver ions were able to penetrate the exposed cell surfaces of bacteria and virus much more effectively and quickly. Hence, a large quantity of pathogenic microorganisms was destroyed.

Antibacterial and antiviral effects were tested on *E. coli* and *Staphylococcus aureus* and MS2 bacteriophage (virus). Both bacteria and virus were destroyed within 15 minutes of contact time.

Carbonates and silver were released into water at the same time but their contact areas with water were controlled by playing around with their sizes. “By controlling the size of the particles, one can effectively control the concentration of ions in water,” he said.

Since carbonate gets dissolved more quickly than silver, carbonate particles were sand-sized while silver was nanosize. “We want more dissolved carbonates than silver in water as carbonates have to first remove the peripheral proteins of a cell,” he said. The amount of dissolved ions in water is 25 parts per billion (ppb) of silver and 20 parts per million (ppm) of carbonate.

Prof. Pradeep is confident that there is scope for more improvement. “You can still make it better by controlling the activity of silver by synergizing with other ions,” he said.

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