Popcorn-shaped gold particles gang up on Salmonella

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Take an ounce of lettuce, test it for 17 hours, and the results show whether that mainstay ingredient in green salads is contaminated with *Salmonella*, the food poisoning bacteria that sickens millions of people each year. Another traditional test takes 72 hours to complete. How about a test that identifies *Salmonella* in five minutes, so that shipments of lettuce can be confiscated before they reach the table?

Scientists today described development and successful testing of just such a test in a presentation here at the 243rd National Meeting & Exposition of the American Chemical Society (ACS).

Paresh C. Ray, Ph.D., who led the research, explained that the test fulfills an urgent need for a faster way to detect *Salmonella*, especially the multiple-drug resistant (MDR) strains that cause the most serious disease in both food and drinking water. In the U.S., *Salmonella*-contaminated food causes at least 1.6 million cases of food poisoning annually. Elsewhere in the developing world, drinking water contaminated with MDR *Salmonella* causes terrible outbreaks of typhoid fever, which strikes at least 17 million people annually.

"The test for lettuce requires just a tiny sample of lettuce leaf," Ray explained. "It doesn't take a trained laboratory technician to perform the test or read the results. If the color changes from pink to bluish, that signals the presence of *Salmonella*. The test is suitable for use in farm fields and in remote areas of the developing world. We believe it may have enormous potential for rapid, on-site pathogen detection to avoid

the distribution of contaminated foods."

To find the bacteria faster, Ray and colleagues at Jackson State University in Mississippi enlisted gold nanoparticles, vanishingly small bits of gold so tiny that more than 25,000 would fit across the width of a human hair. The researchers attached antibodies, molecules similar to the ones that help the immune system find and fight infections with *Salmonella*, to the nanoparticles. Viewed under a powerful microscope, the gold nanoparticles look somewhat like individual pieces of popcorn.

When these antibodies encounter *Salmonella* bacteria, they attach to the outer surface of the bacteria, carrying along their cargo of gold popcorn-shaped nanoparticles. The nanoparticle-antibody package is much smaller than an individual *Salmonella* bacterium, and several attach to each bacterium. The test, with its pink-to-blue color change, detects those gold nanoparticle-antibody-*Salmonella* structures, which Ray calls "aggregates."

The approach also has potential for killing MDR *Salmonella*, Ray said.

"When you shine the right wavelength of light into contaminated water, for instance, the gold nanoparticles absorb that light and heat up," he explained. "Those hot particles burn through the outer membrane of the *Salmonella* bacteria, killing the bacteria."

Ray and colleagues first developed the popcorn-shaped particles to find and fight cancer. The shape was chosen because it boosts the signal for detection using something called Raman spectroscopy, which looks at the light given off after atoms or molecules absorb energy. Ray explained that this detection method is useful in other applications of the particles. "In science, we call that the lightning rod effect," said Ray, describing how the splayed "tips" of the popcorn shape enhance the signal and make it easier to see. The group has also used the

nanoparticles to detect other microbes, like *E. coli*.

Despite gold's stature as a precious and very costly metal, only tiny amounts are needed, Ray noted. About $90 worth of gold is enough to make gallons of the solution containing the nanoparticles. And only a few drops of the solution are needed seek out Salmonella bacteria.

Ray said the technology can be commercialized, and a patent is pending. With concerns about the potential health and environmental effects of many kinds of nanoparticles, Ray's team is investigating the effects of gold nanoparticles remaining in purified water, for instance. So far, they have found no short-term toxicity and will be checking on any potential long-term toxicity.

More information:

Abstract

Outbreak of food poisoning by MDRB Salmonella is very common in USA and other countries. As a result, new approaches for the detection, separation and treatment of infectious food sample is very urgent. Here we will discuss our recent report on how gold nanotechnology can be used for the above purpose. We have shown that monoclonal M3038 antibody–conjugated popcorn shape gold nanotechnology-driven approach for quick highly selective screening and photothermal killing of MDRB Salmonella typhimurium DT104 from water and infected romaine lettuce. We have also shown that, M3038 antibody–conjugated popcorn shape gold nanoparticles based SERS assay can detect MDRB Salmonella typhimurium DT104 at 10 CFU/ml level from water sample. We believe that, ultimately this nanotechnology driven assay could have enormous potential applications in rapid, on-site screening of MDRB in food sample.

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