Cranberry juice creates energy barrier that keeps bacteria away from cells, study shows

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For generations, people have consumed cranberry juice, convinced of its power to ward off urinary tract infections, though the exact mechanism of its action has not been well understood. A new study by researchers at Worcester Polytechnic Institute (WPI) reveals that the juice changes the thermodynamic properties of bacteria in the urinary tract, creating an energy barrier that prevents the microorganisms from getting close enough to latch onto cells and initiate an infection.

The study, published in the journal *Colloids and Surfaces: B,* was conducted by Terri Camesano, associate professor of chemical engineering at WPI, and a team of graduate students, including PhD candidate Yatao Liu. They exposed two varieties of E. coli bacteria, one with hair-like projections known as fimbriae and one without, to different concentrations of cranberry juice. Fimbriae are present on a number of virulent bacteria, including those that cause urinary tract infections, and are believed to be used by bacteria to form strong bonds with cells.

For the fimbriaed bacteria, they found that even at low concentrations, cranberry juice altered two properties that serve as indicators of the ability of bacteria to attach to cells. The first factor is called Gibbs free energy of attachment, which is a measure of the amount of energy that must be expended before a bacterium can attach to a cell. Without cranberry juice, this value was a negative number, indicating that energy would be released and attachment was highly likely. With cranberry juice the number was positive and it grew steadily as the concentration of juice increased, making attachment to urinary tract cells increasingly unlikely.

Surface free energy also rose, suggesting that the presence of cranberry juice creates an energy barrier that repels the bacteria. The researchers also placed the bacteria and urinary tract cells together in solution. Without cranberry juice, the fimbriaed bacteria attached readily to the cells. As increasing concentrations of cranberry juice were added to the solution, fewer and fewer attachments were observed.

Cranberry juice had no discernible effect on E. coli bacteria without fimbriae, suggesting that compounds in the juice may act directly on the molecular structure of the fimbriae themselves. This reinforces previous work by the WPI team that showed that exposure to cranberry juice alters the shape of the fimbriae, causing them to become compressed. Using an atomic force microscope as a minute strain gauge, the team also showed that the adhesive force exerted by bacteria on urinary tract cells declined in direct proportion to the concentration of cranberry juice in the solution.

"Our results show that, at least for urinary tract infections, cranberry juice targets the right bacteria—those that cause disease—but has no effect on non-pathogenic organisms, suggesting that cranberry juice will not disrupt bacteria that are part of the normal flora in the gut," Camesano says. "We have also shown that this effect occurs at concentrations of cranberry juice that are comparable to levels we would expect to find in the urinary tract."

Camesano notes that unpublished work has shown that while cranberry juice has potent effects on disease-causing bacteria, those effects are transitory. "When we takes E. coli. bacteria that have been treated with cranberry juice and place them in normal growth media, they regain the ability to adhere to urinary tract cells," she says. "This suggests that to realize the antibacterial benefits of cranberry, one must consume cranberry juice regularly—perhaps daily."

For those watching calories, Camesano says other recent work in her lab has shown that the effects of regular cranberry juice cocktail and diet (sugar-free) cranberry juice are identical. "That's good news for people who do not like to consume a lot of sugary juice," she says.

Source: Worcester Polytechnic Institute