Compounds in cranberry juice show promise as alternatives to antibiotics

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Compounds in cranberry juice have the ability to change E. coli bacteria, a class of microorganisms responsible for a host of human illnesses (everything from kidney infections to gastroenteritis to tooth decay), in ways that render them unable to initiate an infection. The results of this new research by scientists at Worcester Polytechnic Institute (WPI) suggest that the cranberry may provide an alternative to antibiotics, particularly for combating E. coli bacteria that have become resistant to conventional treatment.

The new findings, which were presented on Sunday, Sept. 10, at the annual meeting of the American Chemical Society in San Francisco, for the first time begin to paint a detailed picture of the biochemical mechanisms that may underlie a number of beneficial health effects of cranberry juice that have been reported in other studies over the years.

Many of those studies have focused on the ability of cranberry juice to prevent urinary tract infections (UTIs), which each year affect eight million people–mostly women, the elderly, and infants--resulting in $1.6 billion in health care costs. Until now, scientists have not understood exactly how cranberry juice prevents UTIs and other bacterial infections, though they have suspected that compounds in the juice somehow prevent bacteria from adhering to the lining of the urinary tract. The new findings reveal how the compounds interfere with adhesion at the molecular level.

The research, by Terri Camesano, associate professor of chemical

engineering at WPI, and graduate students Yatao Liu and Paola Pinzon-Arango, and funded, in part, by the National Science Foundation, shows that a group of tannins (called proanthocyanidins) found primarily in cranberries affect E. coli in three devastating ways, all of which prevent the bacteria from adhering to cells in the body, a necessary first step in all infections:

-- They change the shape of the bacteria from rods to spheres.
-- They alter their cell membranes.
-- They make it difficult for bacteria to make contact with cells, or from latching on to them should they get close enough.

For most of these effects, the impact on bacteria was stronger the higher the concentration of either cranberry juice or the tannins, suggesting that whole cranberry products and juice that has not been highly diluted may have the greatest health effects.

The new results build on previously published work, in which Camesano and her team showed that cranberry juice causes tiny tendrils (known as fimbriae) on the surface of the type of E. coli bacteria responsible for the most serious types of UTIs to become compressed. Since the fimbriae make it possible for the bacteria to bind tightly to the lining of the urinary tract, the change in shape greatly reduces the ability of the bacteria to stay put long enough to initiate an infection.

More recently, Camesano and Liu have shown that chemical changes caused by cranberry juice also create an energy barrier that keeps the bacteria from getting close to the urinary tract lining in the first place.

New work by Camesano and Pinzon-Arango shows that cranberry juice can transform E. coli bacteria in even more radical ways. The researchers grew E. coli over extended periods in solutions containing various concentrations of either cranberry juice or tannins. Over time,

the normally rod-shaped bacteria became spherical--a transformation that has never before been observed in E. coli.

Remarkably, the E. coli bacteria, all of which fall into a class called gram-negative bacteria, began behaving like gram-positive bacteria--another never-before-seen phenomenon. Since gram-negative and gram-positive bacteria differ primarily in the structure of their cell membranes, the results suggest that the tannins in cranberry juice can alter the membranes of E. coli.

A final, more preliminary result that will be presented at the ACS meeting suggests that E. coli bacteria exposed to cranberry juice appear to lose the ability to secrete indole, a molecule involved in a form of bacterial communication called quorum sensing. E. coli use quorum sensing to determine when there are enough bacteria present at a certain location to initiate a successful infection.

"We are beginning to get a picture of cranberry juice and, in particular, the tannins found in cranberries as, potentially potent antibacterial agents," Camesano says. "These results are surprising and intriguing, particularly given the increasing concern about the growing resistance of certain disease-causing bacteria to antibiotics."

Source: Worcester Polytechnic Institute

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