Winemaking waste proves effective against disease-causing bacteria in early studies

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Potential source of next-generation drugs against oral disease: Pinot noir

A class of chemicals in red wine grapes may significantly reduce the ability of bacteria to cause cavities, according to a study published recently in the Journal of Agricultural and Food Chemistry. The findings suggest that specific polyphenols, present in large amounts in fermented seeds and skins cast away after grapes are pressed, interfere with the ability of bacteria to contribute to tooth decay. Beyond cavities, the action of the wine grape-based chemicals may also hold clues for new ways to lessen the ability of bacteria to cause life-threatening, systemic infections.

Even better, the compounds embody an emerging philosophy in design of drugs against bacteria: take away their ability to cause disease without killing them. Current antibiotics often kill a strain of bacteria responsible for disease, only to create a vacuum quickly filled by related strains. The widespread overprescribing of antibiotics and the speed of bacterial evolution have greatly increased the likelihood that the strains most able to resist antibiotics will thrive and spread. This trend is evident in recent reports that one strain of bacteria has become resistant to all 18 antibiotics approved for use in childhood ear infections, while another now causes more U.S. deaths than AIDS. New approaches seek to take away bacterial capabilities that cause disease (virulence factors) without "selecting for" resistance or killing beneficial bacteria.

"Most foods contain compounds that are both good and bad for dental

health, so the message is not 'drink more wine to fight bacteria,'" said Hyun Koo, DDS, Ph.D., assistant professor of Dentistry within the Eastman Department of Dentistry and Center for Oral Biology at the Medical Center. "We hope to isolate the key compounds within the winemaking waste that render bad bacteria harmless, perhaps in the mouth with a new kind of rinse," said Koo, an author of the current study.

The findings are the result of collaboration between the University of Rochester Medical Center and the New York State Agricultural Experiment Station at Cornell University. Both institutions, with access to Finger Lakes wineries, have been looking at how compounds found in wine grapes impact human oral health. Together, they won a U.S. Department of Agriculture (USDA) grant in December 2005 to study the influence of grape polyphenols on oral bacteria, and today's publication is an early result.

Along with the potential value for medicine, the discovery that the waste products of winemaking may be useful in drug-making has economic implications. Grapes are one of the world's largest fruit crops, with more than 80 percent of grapes used to make wine. Fermented winemaking waste, called pomace, contains at least as many polyphenols as whole fruit, eliminating the need to use up perfectly good food to make any future drugs. Accordingly, the USDA is especially interested in the idea of bioprospecting in the winery versus the rainforest.

Study Details

Koo, who conducts his research at the Eastman Dental Center, concluded early in his career as an oral biologist that there are biochemical implications of foods on oral health – other than to say "sugar is bad for teeth." In recent years, his and other labs have examined whether chemicals from cranberries, cocoa and grapes for instance have a

therapeutic effect on bacterial pathogens. All contain polyphenols and the race is on to determine which may be the most useful medically.

The goal of the current study was to examine the make-up of polyphenols in red wine grape varieties and their ability to interfere with Streptococcus mutans (S. mutans), the bacteria that produces the substances most responsible for tooth decay: acid and the building blocks (glucans) of a dental biofilm called plaque.

Researchers prepared polyphenolic extracts from harvest season 2005 red wine grape varieties and pomace from wineries in the Finger Lakes region of New York state. These included Pinot Noir from Hosmer Winery in Ovid, N.Y., Cabernet Franc from Cornell Orchards in Lansing, N.Y., Baco Noir from Pleasant Valley Winery in Hammondsport, N.Y. and NoiretTM from Swedish Hill Winery in Romulus, N.Y. Varieties were pre-screened for their phenolic content, and grape pomace was chosen in general for its ready supply as an inexpensive source material. Red grapes have been shown to contain 40 percent more phenols content than white.

The team was most interested in examining the impact of grape polyphenols on two capabilities of S. mutans that enable it to thrive in the human mouth. First, it secretes enzymes known as glucosyltransferases (GTFs) that produce sugary, glue-like substances (glucans) that firmly attach bacteria to tooth surfaces and form a tough barrier around bacterial colonies. Such barriers, called the extracellular polysaccharide (EPS) matrix, protect the colony against environmental assaults, and make them, in some cases, hundreds of times more resistant to antibiotics. Bacteria living in these gunky fortresses are known as biofilms, whether they occur on teeth or elsewhere in the body. Many Streptococci (strep) and Staphylococci (staph) cause resistant forms of meningitis, pneumonia, staph aureus, as well as infections on heart valves and around stents, by forming biofilms. GTFs are a main

virulence factor responsible for S. mutans biofilm formation, but other pathogens use similar mechanisms to produce EPS matrix. The hope is that learning about one will suggest ways to interfere with many.

A second linked set of virulence factors for S. mutans are its abilities to secrete acid, and to survive in that acid. Having evolved to be “acid durable,” S. mutans can survive and out-compete other bacteria in the mouth. Better understanding of these mechanisms could also yield new ways to fight other biofilm related infections.

In the current study, researchers found that all polyphenol extracts inhibited two bacterial GTFs by as much as 85 percent (P