RESEARCHER:

Common Foods May Be Potent Source of Dangerous Antibiotic Resistance

By Martha Filipic

An increasing number of disease-causing bacteria are becoming resistant to commonly used antibiotics, and research by an Ohio State University food microbiologist indicates a surprising culprit: harmless—or even beneficial—bacteria in foods people eat every day.

Hua Wang, an assistant professor of food science and technology in the College of Food, Agricultural, and Environmental Sciences, presented her findings in May at the annual meeting of the American Society of Microbiology in Toronto. She hopes her work will help develop counter-strategies to combat this health threat, especially for people most at risk: young children, the elderly, AIDS patients and those who take immuno-suppression drugs.

According to the Centers for Disease Control and Prevention, more than 70 percent of the bacteria that cause infections acquired in hospitals are resistant to at least one of the drugs most commonly used to treat them. An example made headlines earlier this year: A man with the rare "extensively drug-resistant tuberculosis" was the first to be put in federal quarantine since 1963. Another bacteria, Methicillin-resistant *Staphylococcus aureus* or MRSA, is a growing concern: In 1974, MRSA infections accounted for only 2 percent of the total number of staph infections; in 2004 they accounted for 63 percent. The CDC warns that people infected with antibiotic-resistant organisms such as MRSA are more likely to have longer and more expensive hospital stays, and may be more likely to die as a result of the infection.

Overuse of antibiotics in both clinical settings and in livestock has often been blamed for the increase in antibiotic resistance among disease-causing bacteria, Wang said. But until recently, antibiotic-resistant bacteria in foods weren't thought to be a problem. Although scientists had found some antibiotic resistance in food-borne pathogens, their numbers were so low that scientists believed that the risk of transmitting antibiotic resistance from food to humans was very limited.

"Our work is totally changing the picture," Wang said. Her findings indicate the possibility that antibiotic resistance may be spread not by the relatively uncommon disease-causing bacteria, but by the much more prevalent "commensal" bacteria in foods—microorganisms that are harmless or are thought to provide health benefits.

These genetically diverse bacteria are widely distributed in large quantities in the food chain, Wang said. In some cases, a gram of food can carry as many as 100 million resistant commensal bacteria. The abundance of such resistant bacteria significantly increases the chance of transmitting resistance genes to disease-causing organisms or to other bacteria residing inside humans, she said.

Commensal bacteria have rarely been studied for antibiotic resistance in the past, Wang said. But during a basic science investigation on a related issue, Wang's research group found that a laboratory strain of lactic acid bacteria can serve as an intermediary, enhancing the transmission of an antibiotic resistance gene 10,000 times more than without.

"This surprised us," Wang said. "As far as we know, it was the first time anyone had seen anything like this. And we wanted to see whether this kind of transfer happened outside of the lab, in the real world." The first step was to find out whether commensal bacteria in common foods contained resistance genes. So, Wang and her colleagues purchased a variety of food items from grocery stores

Every day, people consume millions of harmless—or even beneficial—microorganisms. But Ohio State food microbiologist Hua Wang (above) recently discovered many of these bacteria are resistant to antibiotics, and is concerned that they could pass this trait to organisms that cause disease.

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and tested them in the lab to see if they contained bacteria that was resistant to two common antibiotics, tetracycline and erythromycin.

They found antibiotic-resistant commensal bacteria in many of the food samples, Wang said, including seafood, meat products, produce and cheeses. Her team didn't find antibiotic resistance in two types of food—processed cheese, which is heat-treated after fermentation, and yogurt—but the testing methods she used recovered only certain types of bacteria, she said. "We believe our results are at the low end—there could be other resistant bacteria that we just haven't detected yet," Wang said.

In fact, at the Toronto ASM meeting, she learned that European researchers have found a resistance gene in a *Bifido* bacterium strain commonly used as part of yogurt cultures in both the United States and Europe, even though it was not detected in her screening.

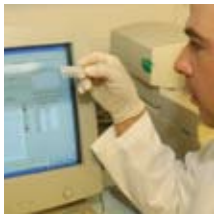
"Despite the fact that this study only screened for a limited number of resistance markers, it illustrated the prevalence of antibiotic-resistant commensals and antibiotic-resistance genes in retail foods," Wang said.

The discovery of the pervasiveness of antibiotic-resistant commensal bacteria in foods is sobering, Wang said. "We're finding it across the board—it's not just one type of food commodity," she said. She believes that researchers, federal agencies and the food industry must take the threat seriously to find ways to combat the problem.

Wang suspects that antibiotic resistance can be transferred from food-borne commensal bacteria to disease-causing bacteria and human residential bacteria through natural gene transfer mechanisms. Her research group showed that this occurs in the laboratory, while other researchers have found antibiotic resistance genes in the microflora in the human oral cavity and gut.

"We need more research to establish the direct correlation between the antibiotic-resistant microbes from foods and the antibiotic-resistant population in host ecosystems," Wang said, "but it is evident that a constant supply of antibiotic-resistant bacteria, partnered with occasional colonization and horizontal gene transfer, are at least partially responsible for the increased antibiotic resistance profiles seen in humans."

Thorough cooking destroys both food-borne pathogens and commensal bacteria, which minimizes the potential transmission of antibiotic resistance genes they may carry, Wang said. But many foods are eaten uncooked—such as fresh produce, salads or sushi—or as ready-to-eat processed foods—including cheeses, yogurt, and meats or shrimp from the deli. Many of these foods are susceptible to the proliferation of antibiotic-resistant bacteria during food production, processing and distribution, Wang said.



"Although initially our finding was a shock, now we believe that knowing of the presence of this resistance gene transmission pathway allows us to develop targeted strategies to combat the problem," Wang said. "One strategy is to focus our efforts on minimizing the emergence of resistant bacteria through proper food processing controls. Meanwhile, it is also important to realize that it is still essential to introduce beneficial bacteria to humans, as they have important functions in the human digestive tract and are critical for human health. But we need to screen for these bacteria more carefully to exclude those with potential risks."

Currently, Wang is studying possible modifications to the food industry's manufacturing processes to reduce the chance that some food products become home to antibiotic-resistant bacteria. For instance, fermentation processes rely on bacteria to make many types of foods, including cheese, yogurt, some types of sausage and sauerkraut. Data from Wang's research group has already shown that some fermented foods carry much less antibiotic-resistant bacteria than others, which supports her idea that minimizing antibiotic-resistant bacteria in ready-to-eat foods is achievable through proper processing control. If these processes can be improved, a significant source of antibiotic resistance from foods could be eliminated, she said. Wang is also examining other possible sources leading to the spread of antibiotic resistance. In a current study, Wang's research group has found antibiotic resistance genes in commensal bacteria in the digestive tract of young infants who had not yet eaten solid food.

"They must have gotten these resistance genes from somewhere else," she said. "The environment must have also played an important role."

Some of Wang's research presented at the ASM meeting has previously been published in the "Microbiological Letter of the Federation of European Microbiological Societies" (volume 254, issue 2) and the American Society of Microbiology's "Applied and Environmental Microbiology" (volume 71, issue 6). Seed funding for this research was provided by the Ohio Agricultural Research and Development Center.

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