

Probiotics Protect Poultry From Pathogens

Probiotics are live, nonpathogenic bacteria that contribute to the health and balance of the intestinal tract. They are given orally to poultry to help the birds fight illness and disease. Prebiotics are non-digestible foods or nutrients that probiotics need to stimulate metabolism. They feed the beneficial bacteria and modify the composition of intestinal microflora so probiotics can predominate.

Annie Donoghue is a poultry physiologist and research leader at the ARS Poultry Production and Product Safety Research Unit in Fayetteville, Arkansas. She's part of a team of researchers finding new healthful bacteria to feed poultry and beat back harmful pathogens while also making the poultry grow more efficiently.

Donoghue is leading and coordinating the research team in several areas of probiotic research. Her husband, Dan Donoghue, is heading the *Campylobacter* work at the Department of Poultry Science at the University of Arkansas. Billy Hargis is leading the *Salmonella* work there. Guillermo Tellez, a visiting

professor from the College of Veterinary Medicine at National Autonomous University of Mexico in Mexico City, was recently appointed as a researcher with the University of Arkansas and is exploring the interactions between the gut and bacteria. The team also includes several graduate students from both the United States and Mexico who have been integral team members on this project.

Pathogens such as *Salmonella* and *Campylobacter* are the main causes of foodborne illness from poultry consumption. The research team wants to reduce microbial populations typically found in live poultry before they're processed for food. They're trying to get a better understanding of how probiotics influence the microbial environment of the gut and how they interact with other bacteria.

On the Market and in the Pipeline

One of the ways they are attempting to do this is identify good bacteria (probiotics), test their ability to outcompete the bad bacteria in the laboratory, and then use them to protect poultry.

The concept of the good bacteria outcompeting the bad is known as competitive exclusion and has been around for many years. Bacteria are fed to newly hatched poults and these bacteria occupy sites in the intestinal tract that would be optimal for pathogen attachment and colonization. Since the nonpathogenic bacteria get to the intestinal sites first and are able to colonize the gut, they reduce the opportunity for pathogenic bacteria to establish in newly hatched poults when they are most susceptible to infection.

In fact, ARS scientists have been on the forefront of this research. The Food and Feed Safety Research Unit in College Station, Texas, developed PREEMPT, a blend of 29 organisms that can be sprayed over newly hatched chicks to keep *Salmonella* from settling in their intestines. It was licensed by FDA (U.S. Food and Drug Administration) and manufactured commercially as a prophylactic. And ARS scientists at the



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Understanding how probiotics influence development and health of a young turkey's gastrointestinal system is a major component of ARS collaborative research with Mexican scientists. Visiting scientist Memo Tellez (seated) and Mexican graduate students currently studying at the University of Arkansas work with Annie Donoghue (behind Tellez) to evaluate how these bacteria enhance the enteric function. Standing left to right are Alberto Torres, Gerardo Nava, and Vicente Salvador.

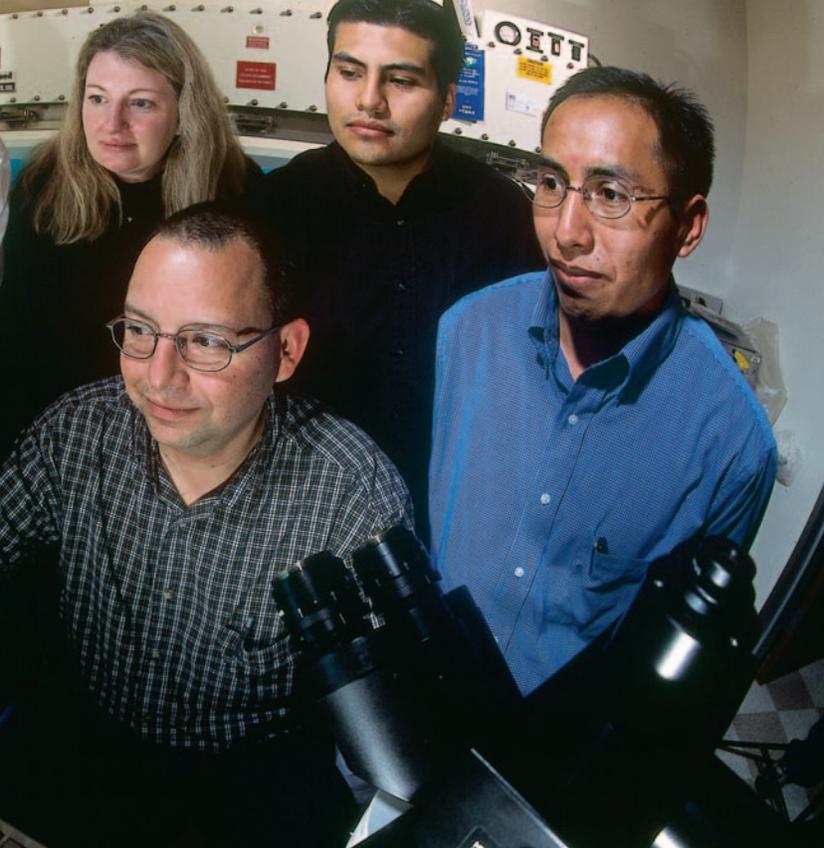
STEPHEN AUSMUS (K10911-1)



Candidate good bacteria outcompete pathogens in the laboratory. Here, physiologist Annie Donoghue gives a combination of these bacteria to a turkey poult to test their efficacy in the live bird.

Poultry Microbiological Research Unit in Athens, Georgia, developed the Mucosal Starter Culture to prevent the growth of *Salmonella* and *Campylobacter* in newborn chicks. It is awaiting FDA approval.

The Fayetteville team consisting of ARS and University of Arkansas researchers have added a new dimension to this process by testing the ability of potential probiotic bacteria to outcompete the pathogens in vitro. Previous cultures have been less stringently screened. Commercial producers in developing countries had some success, but questions arose because some cultures were undefined (meaning not all the bacteria have been identified) and there is a fear in the United States and Europe that they could contain emerging pathogens.



ARS's Reach Is Worldwide

Collaborations such as the Poultry Production and Product Safety Research Unit's partnership with the University of Arkansas and Mexican scientists to gain new insights into use of beneficial bacteria in poultry wouldn't be possible without support from the ARS Office of International Research Programs (OIRP).

Many ARS research projects are designed to tackle problems that have impacts felt around the world. OIRP helps ARS researchers conduct research in nations where mutual interests exist in areas including animal health, biotechnology and biosafety, protection of crop health and pest control, food safety, and water and environmental conservation.

With guidance from OIRP, ARS researchers throughout the United States and overseas are collaborating with scientists from several nations, including Brazil, Israel, and countries of the former Soviet Union. Besides investigating food safety, Mexican counterparts are collaborating on several projects.

For example, ARS researchers in Kerrville, Texas, are working with scientists from Mexico's National Research Institute of Forestry and Agriculture (INIFAP) in Cuernavaca, Morelos, to determine the nature and scope of resistance in southern cattle ticks and horn flies to pyrethroid and organophosphate pesticides. Their work includes developing practical guidelines to manage this resistance and protect livestock. They hope to create assays to monitor such resistance.

In another joint project, Mexican scientists in the Toluca Valley are screening potato genotypes that ARS scientists are developing for resistance to late blight (*Phytophthora infestans*), the most important potato disease worldwide. Since all known strains of late blight have occurred in the Toluca Valley, this cooperation is imperative if new varieties are to resist potential future strains.

Eileen Herrera is an international affairs specialist with OIRP. She indicates that many projects focus on issues that affect productivity, trade between the United States and Mexico, and natural resources management along our shared border. She says OIRP recently completed a pilot program to exchange graduate students and postdoctoral researchers between Mexico and the United States. She said the program not only increased cooperation between the neighboring nations, but it also had the added benefit of improving professional development within ARS, since the program emphasized participation from the agency's early-career scientists.

Herrera says the latest direction in their relationship with Mexican research institutions was to increase and enhance cooperation through a series of five workshops, in partnership with INIFAP, ARS's counterpart agency in Mexico. "The workshops are a mechanism for a more strategic approach to cooperation between ARS and Mexican research institutions," Herrera says. "My hope is that within the next few years, we will take what has already been a productive relationship between scientists and their respective research locations and build on it to make it more comprehensive at the agency level."—By **Jim Core**, ARS.

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Good for People Too?

Probiotics are good for people, too. All animals have naturally occurring beneficial probiotics in their guts. One commonly known probiotic, *Lactobacillus acidophilus*, is naturally present in foods such as yogurt, grains, and meat products. And prebiotics such as inulin have been used extensively—particularly in Europe and Japan where they're now included in many food products from sports drinks to baby formula.

“The biggest challenge is determining the correct types and quantity of probiotics because of the numbers and diversity of microbes and the poorly understood interactions between the

microbes and the intestine,” Donoghue says.

So far the team has screened more than 4 million enteric isolates to come up with several promising probiotic

combinations. The University of Arkansas and ARS have filed a patent on the selection techniques.

A Test To Identify Probiotics

“By using these preselected good microbes, we hope to produce inexpensive, defined cultures with the ability to reduce or exclude specific pathogens and enhance enteric health in poultry,” Donoghue says. “We’ve developed multiple in vitro selection systems for identification of candidate organisms.”

When they find potential probiotics, the researchers test and identify the individual microbes in their labs and send them to the Arkansas Livestock and Poultry Commission’s diagnostic laboratory in Springdale as a backup check. They also test these individual isolates to eliminate potentially harmful microflora by injecting them into turkeys and chickens and evaluating these birds for lesions and rates of disease and death.

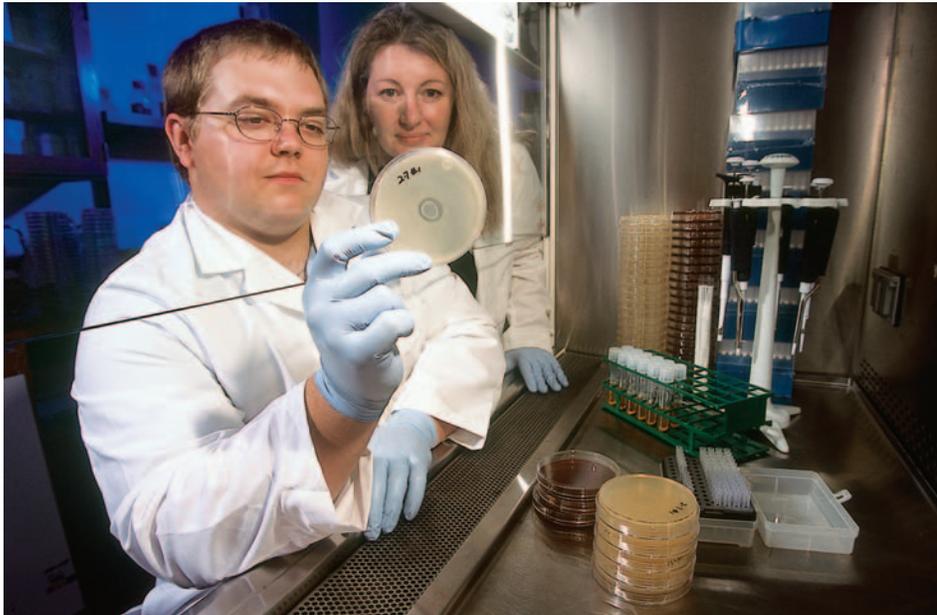
Donoghue says the organisms they are selecting are very easy to propagate in batch culture, using inexpensive growth media. These bacteria are all facultative aerobes, meaning that they are oxygen tolerant. Producing such organisms on a commercial scale is expected to be much less expensive than some cultures that include strict anaerobes requiring complex equipment and technology.

This new method makes it much less expensive to produce probiotics. This could both lower the price of poultry and make it less likely to be a source of foodborne illnesses.—By **Jim Core**, ARS.

This research is part of Food Safety (Animal and Plant Products), an ARS National Program (#108) described on the World Wide Web at www.nps.ars.usda.gov.

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Annie Donoghue and graduate student John Holliman inspect plates to identify bacteria that can inhibit *Campylobacter* growth. Candidate bacteria are placed in the center of a plate containing *Campylobacter*. Those that outcompete this pathogen form a clear zone (circle) of inhibition.

Memo Tellez adds a probiotic culture to the drinking water of turkey poult. This field trial is to test the culture’s ability to reduce foodborne pathogens and enhance growth and health of the birds.

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