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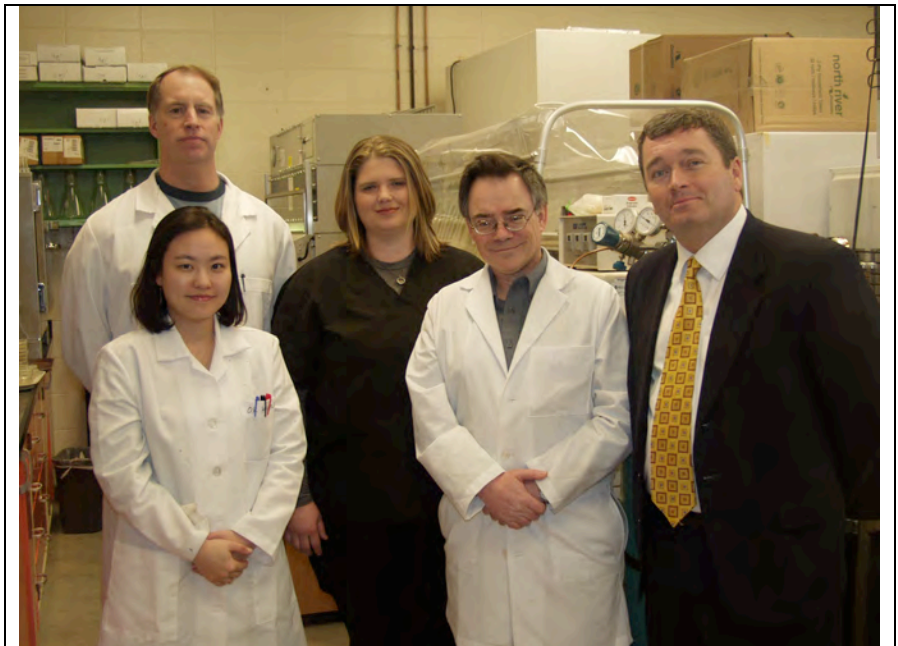
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UA Announces Collaboration to Protect Consumers From Food Contamination



Personnel from the UA Center for Food Safety (CFS) and Litmus Rapid-B met recently in a food science laboratory at the Fayetteville campus. From left are Robert Story, CFS program specialist; Ok Kyung Koo, CFS postdoctoral associate; Melinda Miller, Litmus Rapid-B staff scientist; Steven C. Ricke, CFS director, and Brian Umberson, Litmus Rapid-B sales and marketing manager.

The University of Arkansas Division of Agriculture's Center for Food Safety (CFS) has entered into a public-private collaboration with Litmus Rapid-B, LLC (LRB), a Little Rock-based biotechnology company, to develop research that will lead the fight against consumer sickness and death attributed to food contamination.

Each year roughly 3,000 Americans die from foodborne illnesses. Forty-eight million get sick. More than 100,000 are hospitalized. The Centers for Disease Control estimates that one out of six people is affected by this growing issue.

The collaborative research is intended to improve identification of foodborne bacteria such as *E.coli* and *Salmonella* throughout processing and distribution points to create value for the food processing industry and consumers. LRB recently placed its system

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at the Center for Food Safety, which is the first LRB system deployed to any university in the United States.

"The LRB system allows us to pinpoint specific bacteria faster than any other current methods," said Litmus Rapid-B president Ted Moskal. "Ultimately, this allows for earlier detection and management of food contamination inside the processing plant."

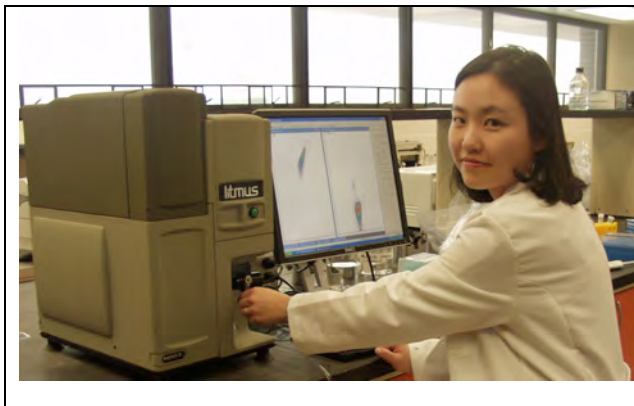
Moskal added that this is a win/win for the food processors and the public – less risk of exposure to the public, less product loss for the processors.

Steven C. Ricke, Center for Food Safety director, said, "Developing collaborative relationships with commercial partners such as Litmus Rapid-B really enhances the Center's ability to more closely interface with the food industry to solve not only current food safety issues but develop solutions for potential issues before they become a major problem."

LRB developed the system in conjunction with scientists at the National Center for Toxicological Research, an agency of the Food and Drug Administration in Jefferson, Ark.

"Our partnership with Litmus Rapid-B could advance research and development efforts for the CFS and our industry partners as well as create new protocols for maintaining clean processing environments," Ricke said.

The goal of the collaborative research effort is to provide the quickest and most accurate data to develop bacterial controls that protect consumers from sickness and death.



*Ok Kyung Koo,
CFS
postdoctoral
associate,
works with the
new Litmus
equipment at a
Food Science
Department lab.*

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The 20-Hour March Through Microbiology

Food Industry Personnel Find Essential Knowledge Base in UA Workshop



Robert Story explains the theory behind the lab work during the food microbiology workshop at the UA Center for Food Safety. A small class of students allows for personal instruction.

The white, loose-leaf binder that's about a few inches thick gets frequent mention by Robert Story when he teaches a workshop that might be the next best thing to private tutoring. The binder is commonly known as "the manual" and has roughly the equivalent of a full-semester course in food microbiology.

Story condenses and teaches it in two and a half days.

"The manual has all the details," explains Story, who supervises laboratory activities at the University of Arkansas Division of Agriculture Center for Food Safety. For 17 years he has taught the laboratory portion of a full-semester Food Microbiology course on which the workshop is based. Story has taught the workshop for four years.

People with jobs in the food processing industry around the nation come to Fayetteville to take the workshop – no more than six at a time allowed and usually fewer – and pay close attention as Story unloads a mountain of data, experiments, tutorials and instructive tips to those who go through the hands-on experience.

In the approximately 20 hours of instruction, students will learn about laboratory biosafety,

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the microscope, cultures, bacterial growth and enumeration, petri dishes and petrifilm and an introduction to yeasts and molds. Those 20 hours have their roots in the Food Microbiology full-semester course that Michael Johnson, emeritus professor of food science, taught from 1984 until his retirement in 2009.



Amanda Makowski (left), a UA Center for Food Safety staff member, and Alisa Beasley, a microbiology lab technician at a Boar's Head meat processing plant in Jarratt, Va., were students at a recent food microbiology workshop.

From his own industrial work and consulting experiences, Johnson set out with the key help of Story and Jim Goff to develop the course's lab portion to focus on preparing people with a minimum of previous experience to be able to respond to practical questions that he was asked by food

processing managers. The key focus was for the student to be able to design a good biological experiment to help answer the question at hand.

“The overarching goal for the student was twofold,” Johnson said. “One was to be a good problem solver in food microbiology and also to be a good bus driver.” That includes being a team leader who gets fellow employees to better understand and focus on the problem at hand, ask the appropriate questions needed for solving the problem and steer the company successfully through the microbiology issues at hand.

“Before you can defeat or control the enemy – the microbes of public health and spoilage significance – one must first know the enemy,” Johnson said. “The condensed and sharply

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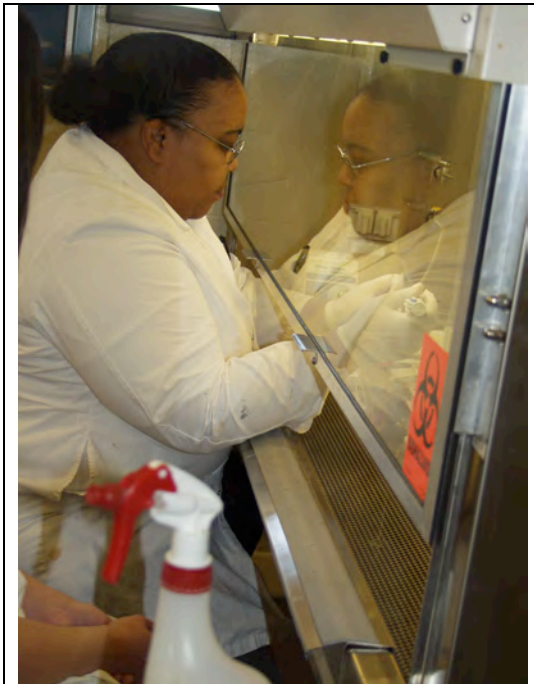
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focused workshop and manual so ably developed and enhanced by Robert Story does just

that. It helps the student get to better know the microbial enemy and thus how to defeat or at least keep it in check.”

Those enrolling in the workshop, offered seven times a year, range from people with food science degrees who may need a refresher to those with little to no academic background in microbiology. Those with no experience with microbiology have included food processing plant managers. “One supervisor told me he really appreciates the lab personnel more,”

Story said.



Alisa Beasley applies lab techniques from the food microbiology curriculum.

One plant employee who recently took the workshop class has 10 years of on-the-job experience as a microbiology lab technician at the Boar’s Head meat processing plant in Jarratt, Va., but never studied it in college. Alisa Beasley, who learned about the UA workshop from a Boar’s Head colleague, made the trip to Fayetteville to become better acquainted with the science that governs what she’s been doing all these years.

“I hope to take back something that I can use,” Beasley said. “It’s good to have the background knowledge behind what you’re doing.” She was also grateful to have the manual to take home for reference at the Boar’s Head lab.

Before getting into actual lab work on an experiment, Story held short class sessions for Beasley and her lab partner Amanda Makowski. Makowski is a UA Center for

Food Safety staff employee who graduated a year ago with a bachelor’s degree in food science and who will enter graduate school this fall in poultry science. The workshop served as a way for her to learn more about how food-specific situations relate to microbiological problems through a “hands-on” approach that taught her many concepts that she did not know.

“I frequently assign student staffers to participate in the workshops,” said Steven Ricke, director of the UA Center for Food Safety. “The students can help familiarize the industry

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people with our lab procedures, plus the workshop also serves as a very nice complementary component of their undergraduate or graduate school education here by being able to actually interact with fellow workshop participants from industry. It certainly gives the students a chance to get reacquainted with the whys and hows of day-to-day science that serves as the foundation for the complex problems in food safety that we explore in the research center all year long.”

Ricke emphasized that the real value for students as they interact with participants from the food industry during the workshop is that they get to see first hand the issues that people already working in the industry are encountering. “It's the next best thing to actually being in a food industry lab,” he said. “Likewise, the industry participants certainly enjoy interacting with the students and appreciate the knowledge and enthusiasm that they bring.”

Brian Umberson is marketing and sales manager with Litmus Rapid-B, a Little Rock biotechnology company that recently began collaborating on projects with the UA Center for Food Safety. Although not a scientist, he took the workshop to familiarize himself with the material.

“Given the changing nature of foodborne pathogens, sources of outbreaks and new regulations, everyone needs to continue learning new techniques.”

-- Steven Ricke

"I have a marketing degree but communicate with microbiologists every day," Umberson said. "I needed to understand lab fundamentals, plating, and the details of various organisms. I needed intense training that allowed a beginner's status trainee to feel comfortable enough to learn. We are like many companies that are running very lean, thus some employees can't afford to be gone for a whole week of training. We looked around at some training facilities and this is the most intense training we could get in such a short block of time. The quite intense

but not overwhelming workshop gave me a tremendous respect for microbiology."

Bio-Tech Pharmacal, a nutritional supplement manufacturer in Fayetteville, also sends personnel to the workshops. Levi Simpson, the company's quality manager and laboratory director, was pleased with the results.

“Like the food and pharmaceutical industries, we follow good manufacturing practices that include the control of potential microbiological contamination,” Simpson said. “This workshop was an excellent way to augment our understanding of the principles and practice of microbiology and to discover ways that we can improve our quality system. The workshop also provided an opportunity for us to establish important contacts with academic partners. We are pleased that the University of Arkansas is supporting industry with this type of program.”

Workshop directors are eager to provide more industry personnel with the benefits of small-

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class

instruction. Besides the food microbiology course, workshops are offered at various

times of the year on molecular biology and biotechnology, new product development, food protection and other topics. The current offerings are listed online with enrollment information at <http://www.uark.edu/ua/foodpro/Workshops>.

"The beauty of this workshop is that no prior knowledge is really needed for a person to benefit from taking it," Ricke said. "The completeness of the material presented and the personal touch that Robert brings as an instructor guarantees that a person will walk out of the workshop with a comprehensive knowledge of food microbiology equal to much longer and larger classroom laboratory offerings.

" But they can incorporate this information wherever they go. They'll understand the physiology of these organisms and get more tools to use in their tool box."

-- Robert Story

"In this economic climate we offer some of the best value for dollars spent and can ensure that employees with nontraditional backgrounds can quickly get up to speed and go back to their company with a newfound expertise to not only do the necessary work required for food safety but now have the knowledge required to help management make critical decisions."

Ricke added that more experienced people can get a refresher on techniques they may not have used lately and add more techniques to their current laboratory expertise. They can also get a more in-depth rationale for

techniques that they have been using, although they may not have understood why they were using those techniques. "Knowing why can make lab personnel much more effective as troubleshooters when assays don't behave the way they are supposed to," he said.

"Given the changing nature of foodborne pathogens, sources of outbreaks and new regulations, everyone needs to continue learning new techniques," Ricke said. "In short, there is something for everybody."

Students who make the journey over the three days of the food microbiology workshop will likely feel as if they've been through a whirlwind. "They get a lot of information and can feel overwhelmed," Story said. "But they can incorporate this information wherever they go. They'll understand the physiology of these organisms and get more tools to use in their tool box."

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Center Hosts Seminar on New Pathogen Detection Technology



Conferring after the seminar are (from left) Steve Stroud, Beacon Food Safety president; Fred Mitchell, Beacon executive vice president; Bill Locatis, Beacon CEO and chairman; John Marcy, UA Extension food scientist; and Steven Ricke, director of the UA Center for Food Safety.



Fred Mitchell of Beacon Food Safety discusses the BrightSPOT technology during a seminar at the UA campus.

Representatives of Beacon Food Safety of Greenwood Village, Colo., visited the UA Center for Food Safety on May 4 to explain the workings of its BrightSPOT technology. Fred Mitchell, Beacon executive vice president, showed the cartridge developed by the company – about the size of a USB thumb drive – containing a chip that can analyze 112 different pathogens or conditions. Thanks to the highly sensitive luminescent protein *Gussia luciferase*, light is generated when a pathogen biomarker is detected. The results become available when the device is plugged into a computer.

About 20 people from the UA and local industry gathered at the Pauline Whitaker Animal Science Center to hear the presentation and meet with Beacon executives. More information about the BrightSPOT technology is available from the company at <http://beaconfoodsafety.com>.

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Implementation of New Food Safety Law Will Take Time

A new food safety law went on the books in January, but much more remains to be done before its full effect is felt. Specific regulations authorized by the law are still to be written over the coming months and years. Memoranda of understanding with other government agencies will be drafted. Perhaps most importantly, funding of the law's provisions will need to be determined by Congress each budget cycle.

The Food Safety Modernization Act applies to food regulated by the Food and Drug Administration – everything except meat, poultry and eggs, which are covered under U.S. Department of Agriculture rules. One significant aspect of the new law is that it approaches preventive measures similar to USDA's regulation of products.



Harrison Pittman

“There’s a clear parallel,” said Harrison Pittman, director of the National Agricultural Law Center, a unit housed at the University of Arkansas School of Law that operates under the statewide U of A Division of Agriculture. Since the mid-1990s, USDA has required processors under its jurisdiction to develop Hazard Analysis and Critical Control Point (HACCP) plans that outline what in-house steps are being taken to prevent and control contamination before a product leaves the plant. The new FDA law has a similar requirement.

All facilities governed by the law must be registered on a two-year basis. “The law gives FDA the authority to suspend or revoke the registration, which in effect would put it out of business,” Pittman said. “You couple that with a new provision that has changed from voluntary recall authority on FDA’s part to mandatory recall authority.”

The new FDA law is targeted at situations in which foodborne illness has been discovered after a food product has left the processor. Previously, Pittman said, there was no provision allowing for mandatory recalls. Instead, FDA would coordinate with and encourage the company to voluntarily recall the product. FDA’s leverage was that it could also inform the company that it would publicize the discovery of contamination if the company didn’t recall the product. Pittman explained that

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“FDA has made clear it wants to continue to use the voluntary recall approach, but reserves the right to use mandatory recall if the situation arises.”

“It gives consumer groups and watchdog groups the ability to put pressure on FDA,” Pittman said of the authority to order recalls. “If there’s an outbreak they can say, ‘You have this authority. You should use it.’ It’s definitely an added tool in terms of foodborne outbreak.”

One major change in the law is its requirement that high-risk plants must be inspected within five years of the law’s enactment and every three years after the first inspection. These inspections will give FDA access to the facilities’ records in cases where it believes a product could cause serious health problems.

Pittman said this provision places the FDA in a more proactive position than previously and more power to perform inspections. “This is supposed to be proactive and science-driven and as part of that they’re supposed to allocate time and resources toward facilities and food products that are known scientifically to have a higher risk or have a history of particular problems,” Pittman said.

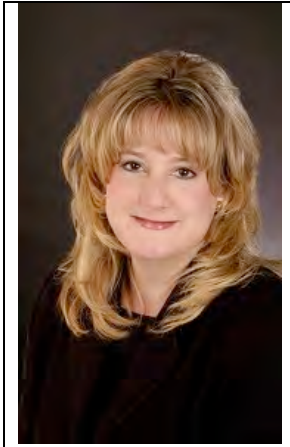
The law exempts smaller operations from certain requirements, such as farmers who sell less than \$500,000 worth of food annually and who sell to farmers markets or restaurants. Pittman said congressional supporters of the exemption argued that foodborne illness outbreaks from such plants are likely to be localized events. He said the issue might be revisited if a future foodborne illness outbreak is traced back to an exempted small food processor that engages in direct marketing.

FDA authority over imported food now extends to the right to inspect foreign facilities that are making products bound for the United States. “The new import requirements are some of the most important provisions in the new law,” Pittman said. He added, “Like other aspects of this law, though, much remains to be seen in terms of funding and, therefore, regulatory implementation.”

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Johns Hopkins Researcher Explains Work With UA on MTB, PTB



Nicole Parrish

Just like it's been said for a long time, traveling to national conferences actually does bring back tangible results. An encounter a few years ago over a poster session led to a collaboration that has proven effective against two tuberculosis strains that have been deadly to ruminants.

It began at the 2007 annual meeting of the American Society for Microbiology, where Vesela Chelova, who was then a post-doctoral associate at the Center for Food Safety in the University of Arkansas Division of Agriculture, met Nicole Parrish, associate director of clinical mycobacteriology at the Johns Hopkins Hospital and University. Prompted by the poster before them, they began discussing tuberculosis strains. Chelova's interest was from the standpoint of animals and Parrish's interest was oriented toward humans, but they soon began to see there could be common solutions.

During a visit to the Center for Food Safety in February, Parrish explained the research progress that has resulted since that meeting at ASM.

After learning about the Arkansas food science research on citrus, Parrish contacted Phil Crandall, professor of food science at the U of A. She then collaborated in experiments on the effects of Valencia orange oil against aerobically-grown *Mycobacterium tuberculosis* (MTB). The Valencia treatments proved to be effective.

The research team also studied *M. paratuberculosis* (PTB), a related species of *Mycobacterium*.

MTB is one of the causative agents for the 2 billion cases of tuberculosis infections that were estimated to have arisen in 2009, Parrish said. Among those cases, MTB's infections also causes Johne's disease, a fatal gastrointestinal disease in cattle that causes chronic wasting of cattle and other ruminants which can lead to the need to kill a herd. Johne's disease costs the United States about \$1.5 billion a year.

Parrish explained that the antimicrobial effects of essential citrus oils have been found to be effective against MTB. Her collaboration with the Arkansas scientists went on to find that all strains of MTB and PTB were susceptible to the high concentrations of orange oil that were tested, with the Valencia orange oil providing the decisive results.

Additional studies are planned to further characterize the mechanism of action of these oils

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against the *Mycobacteria* in an effort to find new drugs and drug targets for these diseases in humans and animals, Parrish said.

Trust Drops in Food Industry, but Still Outranks Most



Jason McGrath

Fifty-four percent of Americans questioned for a survey of confidence in various institutions said they trust the food and beverage industry, a decline of 10 points from a year ago. The survey, the Edelman Trust Barometer, annually seeks the opinions of college-educated people in 23 countries whose income is in their age group's top 25 percent.

"Trust really has become a required line of business," said Jason McGrath, vice president of StrategyOne, the Washington-based

research firm for the public relations firm Edelman. McGrath discussed the survey's findings in April during a seminar at the UA Center for Food Safety.

On a global basis, the trust level for the food and beverage industry was 66 percent, topped only by the technology, automotive and telecommunications industries among the 16 industries listed. The United States trust level of 54 percent was greater than that of four countries – China, Russia, Sweden and Germany – but exceeded by 18 countries. The highest levels of confidence were in Mexico, Brazil and Indonesia, which each registered 89 percent.

The reason for the disparity among the nations – Germany's low level of trust was 37 percent – was probably due to food safety issues, McGrath said. "There have been some significant food safety concerns in some countries over the past few years, Germany being one that's had some significant issues in the past few months." (In December, dioxin was discovered in eggs Germany.)

In the United States, 51 percent of respondents said the food that American buy has become safer in the past 10 years and 57 percent said unhealthy foods should be more heavily regulated to discourage their consumption. Sixty-six percent said the foods they eat make a

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statement about their values and 67 percent said they avoid processed foods as often as possible.

“As we look at leading healthier lifestyles and how food fits into that, there is a desire for increased regulation on government’s part to insure that consumers are leading healthier lifestyles,” McGrath said.

Twenty-one percent said they buy mostly organic foods, which McGrath said is known not to be true; the actual number is about 4 percent.

“In this data, what we’re seeing is a general sense with American grocery shoppers that there’s a feeling that they need to answer in a certain way,” McGrath said. “There’s an expectation that society has of them that organics are good, so I want to purchase mostly organic foods, so I want to tell this interviewer on the phone with me that, of course, I buy mostly organic foods.”

While the survey number is exaggerated, it does show that purchasing trends for organic foods will increase. The tendency to identify as a consumer of organic foods also shows the need for the industry to educate consumers about natural foods, organics and sustainable food production.

Asked their levels of trust to do the right thing on food-related issues, consumers gave farmers the biggest vote of confidence at 72 percent. That put farmers ahead of government agencies, academics, grocery stores, other consumers, restaurants, food companies, media and Congress.

According to some focus group feedback, McGrath said, “farmers evoke an image of a return to the land; natural, wholesome food production. We’re starting to see companies use farmers in advertising.”

Within government, the two food regulatory agencies – the U.S. Department of Agriculture and the Food and Drug Administration – are close behind farmers with trust levels of 61 and 59 percent, respectively. Congress had the lowest level of trust of all institutions listed at 18 percent.

Trust in an institution on food safety issues comes from “partnerships, consistency and collaboration,” McGrath said. Once trust is lost, it is difficult to restore. Foodborne illness outbreaks in particular can erode trust in companies. Consumers tend to presume food safety as a given for a product, McGrath said.

“Food safety becomes an issue when there’s a crisis. That’s when the communication around

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food safety is absolutely critical to insure that the mechanisms are in place to demonstrate food safety procedures, to be able to communicate about those procedures and why a food safety presence may actually have occurred.”

OFPA Hears of Progress and Problems in Food Safety

Standards for food safety plans, the nation’s new food safety law, product fraud and agriterrorism highlighted the educational presentations April 6 at the annual Ozark Food Processors Association Convention and Exposition.

The Global Food Safety Initiative reviews food safety schemes and encourages retailers, food service and manufacturers to choose from those plans, said Rena Pierami, vice president of auditing at Silliker, Inc. By benchmarking these standards, GFSI promotes a vision of “once certified, accepted everywhere.” GFSI seeks to reduce food safety risks and manage risks through certification of industrial food safety schemes.

At companies using food safety plans built from commonly recognized benchmarks, “when something does break, it enables us to go in and find what caused it,” Pierami explained. Auditors from the GFSI examine the approved schemes, which are then adopted by certified suppliers.

In the United States, the Food Safety Modernization Act went into effect early this year but its full effects won’t be known for years to come as the regulatory process begins implementing its provisions, said Harrison Pittman, director of the National Agricultural Law Center at the University of Arkansas.

The new law, which Pittman described as shifting policy from reacting to food safety problems to preventing them, amends the 1930s law that has governed the federal Food and Drug Administration. It does not affect areas of meat and poultry that are regulated by the U.S. Department of Agriculture.

In addition to implementing the law through the development of agency rules and regulations, which Pittman said “is intended to be a long-term process,” the law must also be funded before its provisions can be effective. Meanwhile, the law mandates the FDA to establish comprehensive risk-based and prevention-based controls across the food supply chain. Food processing facilities must write plans that show areas for preventing pathogenic contamination, Pittman said.

Other provisions of the law include requirements that high-risk facilities must be inspected within five years of the law’s enactment. It also allows FDA to mandate a processor to recall contaminated food, a contrast from earlier law that permitted companies to voluntarily recall products but that didn’t give the government the authority to require recalls.

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Pittman added that food importers must now verify that their foreign suppliers have implemented adequate preventive controls to keep food safe. Foreign facilities that export food to the United States must register with the FDA every two years.

The Grocery Manufacturers Association recently led a study of “economic adulteration” of food products, which could become a serious health and economic issue, said Stefan Ehling, an analytic chemist for GMA. Economic adulteration includes the fraudulent addition of unapproved enhancements to products, mislabeling, dilution of products and counterfeit labeling. Ehling said such adulteration can be done by anyone with access to the process starting with the producer. The solution is for processors to verify all the sources within their supply chains. Ehling said the FDA has implemented a program called PREDICT (Predictive Risk-based Evaluation for Dynamic Import Compliance Targeting) to score the level of risk associated with imported products that could have been economically adulterated.

Agri-terrorism – intentional criminal acts on the food system and agricultural industry -- would be easier to cause in the United States than people might think, said Dustan Clark, a U of A Extension poultry health veterinarian. American agriculture is vulnerable through points of animal movement, animal production methods and crop destruction.

Diseases from foreign animals would be efficient agents for agri-terrorism. The transfer of those diseases to American livestock could be accomplished through low-cost and low-technology means that would be difficult to trace, Clark said. Results could be devastating,

Clark cited the deaths of 10 million animals from foot-and-mouth disease in the United Kingdom. An FMD outbreak in the United States would take five days to be detected, would spread to 40 states within 30 days and could result in the loss of 23 million animals, Clark said.

Avian influenza can have similar impact on poultry. Clark said the accidental release of the H7N1 virus in the Netherlands in 2003 led to the deaths of 28 million birds.

Mark Cochran, U of A vice president for agriculture, welcomed the audience to the convention and commended OFPA for its partnership with the university in research efforts and support for scholarships.

The OFPA convention opened April 5 with its annual golf tournament held at Shadow Valley Country Club in Rogers. Eighty-two golfers played in the event with proceeds benefiting the OFPA scholarship fund. The day's activities included U of A food science students' research poster competition. Scholarship recipients and poster competition

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winners were recognized at that evening's banquet. Scholarships sponsored by OFPA and its members were awarded to 15 students.

The OFPA Exposition this year attracted 64 exhibitors with more than 300 people attending.

Workshops at the UA Institute of Food Science and Engineering

Microbiological Laboratory Logistics and Fundamentals - This workshop will be held on several dates (May 17-19, June 14-16, July 12-14, Aug. 16-18, Sept. 13-15 and Oct. 11-13, 2011). See http://www.uark.edu/ua/foodpro/Workshops/Micro_Lab.html

Molecular Biology and Biotechnology; Workshop for Beginners - This workshop will be held on several dates (to be determined in 2011). See <http://www.uark.edu/ua/foodpro/Workshops/Molecular-lab.html>

Better Process Control School - This 3.5-day workshop will be held Nov. 1-4, 2011. For more information and registration form, go to <http://www.uark.edu/depts/ifse/bpcsrev1.html>

New Product Development Workshop - This workshop will be held May 24-25, 2011 at the Food Science Building at the University of Arkansas. This workshop is for people wanting to know more about developing and marketing new food products. See http://www.uark.edu/ua/foodpro/Workshops/New_Product_Development_Workshop.html

Food and Nutritional Labeling Workshop – This workshop will be held in June 2011 in Kansas City, Mo. Details will be available at a later date. See http://www.uark.edu/ua/foodpro/Workshops/Food_Labeling_Workshop.html Steve Seideman has several copies of the workshop manuals available for sale for \$60. E-mail for details at seideman@uark.edu.

Sensory Evaluation of Foods – This workshop will be held June 2012. For details and registration information, see http://www.uark.edu/ua/foodpro/Workshops/Sensory_Evaluation_Workshop.html

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CFS Publications and Presentations

Publications

Over, K., P.G. Crandall, C.A. O'Bryan and S.C. Ricke. 2011. Current perspectives on *Mycobacterium avium* subsp. *paratuberculosis*, Johne's disease, and Crohn's disease: a Review. Crit Rev Microbiol 37: 141-156.

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