

The Food Safety Consortium Newsletter

University of Arkansas, Iowa State University and Kansas State University • Vol. 15, No. 4 • Fall 2005

Immunosensors Put the Speed in Rapid Pathogen Detection

Food processors have ways to rapidly detect whether their products have any pathogenic bacteria on them. The problem is that the definition of “rapid” can mean a matter of hours. Yanbin Li’s research team at the University of Arkansas Division of Agriculture is closing in on a way to reduce that to minutes — one hour at most.

The key is the immunosensor. Li, a biological and agricultural engineering professor who leads the project for the

Food Safety Consortium, said the team has modified some existing technology with immunosensors to target foodborne bacteria quickly.

Immunosensors are compact analytical devices that use antibodies (protein substances produced in tissues) to produce a digital electronic signal that scientists use to determine if a particular pathogen is present. The deadly *E. coli*

O157:H7 pathogen has been one target of Li’s research.

“We make the sensor very specific and very sensitive,” Li said. “We use electrochemical sensing technology. We measure the electrical current. The magnitude of the current is proportional to the cell number of target bacteria. That way we link the electronic signal to the biological signal.”

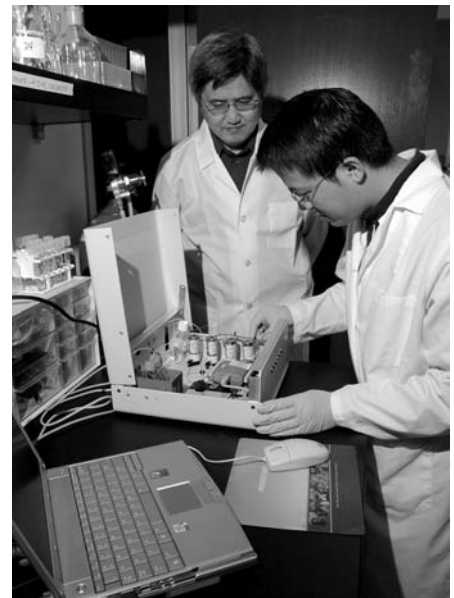
To apply the procedure to foodborne pathogens, Li’s group turned its attention to a couple of available technologies used in

immunosensors: QCM (quartz crystal microbalance) and SPR (surface plasmon resonance). The QCM technology measures small amounts of particles on an electrode’s surface based on its mass, while SPR accomplishes the task based on an optical sensor.

“We have those technologies in the equipment, but they are not designed for

Continued on page 2

‘We link the electronic signal to the biological signal.’



Dr. Yanbin Li (left), professor of biological and agricultural engineering, and Dr. Zunzhong Ye, assistant professor, use a biosensor they developed at the University of Arkansas to test samples of poultry processing chill water for the presence of harmful bacteria.

Grovac Processing Offers Small Retailers a Way to Block Pathogens

The longtime way of making ground beef — mixing pieces trimmed from larger beef cuts and grinding them — creates some food safety challenges for processors trying to stay a step ahead of the troublesome *E. coli* O157:H7 pathogen. A Kansas State University project may have found a way to use a popular processing system to make the ground beef safer.

It’s the Grovac process, developed

and trademarked in the mid-1980s by Grovac Systems of Pine Bluff, Ark. Food Safety Consortium researcher Randall Phebus of the KSU food science faculty found that it delivers a modest reduction in the level of pathogens in ground beef and that it is especially well suited for small retail operations in addition to larger retail firms.

“The beauty of the Grovac system is that it’s so simple,” Phebus said. “It’s not

expensive. It would be appropriate and plausible for small retailers to use it. It’s not being used at all (by small retailers) now as far as I know for beef. It has become more widespread in the seafood industry. They’re using it for poultry. We’re trying to break into the red meat side of it.”

It would be an important development for red meat because retail meat

Continued on page 2

Immunosensors...
continued

the detection of bacteria,” Li explained. “They are basically designed for detecting some particular chemical compounds or small molecules substances.”

Li’s group developed its own protocol to integrate the technology into their immunosensors for biodetection. “We can modify this technology to be able to detect the pathogenic bacteria.”

Detecting biological signals and comparing them to electronic signals

is difficult because the researchers are looking for ultralow concentrations of bacteria in a sample (fewer than 10 cells per milliliter). Li’s group determined that both QCM and SPR immunosensors are capable of finding their target bacteria in an hour. The research group is attempting to adapt other technologies, including nanomaterials and microfluidics, to biosensor design and is seeking to improve a final product’s sensitivity to finding the bacteria.

The experiments were geared

toward the detection of *E. coli* O157:H7, but it can be applied to other pathogens on a variety of foods. “This technology should be ready for any other pathogenic bacteria and for any meats and vegetables,” Li said.

Li hopes to develop the technology further based on their five pending patents and to work with industry for transfer of the technology to commercial use in the next two to three years. ■

Grovac Processing...
continued

grinders have not had an antimicrobial intervention strategy available to them that minimizes their risk of having contaminated beef. A validated intervention technology such as the Grovac system at the final production stage of ground beef would place a significant hurdle in pathogens’ way, Phebus explained.

The Grovac system treats beef trimmings in a mixture of citric acid and a hypotonic salt solution while tumbling under a vacuum. The citric acid kills the bacteria. Meanwhile, the citric acid also acts as an antioxidant and preserves the ground beef’s bright red color for a longer shelf life.

Additional shelf life and better protection from pathogens could make the Grovac process a popular one among small-retail meat processors who cannot

compete with the larger stores’ more cost-efficient overhead.

“If you were able to demonstrate that treated trim and store-generated ground beef had even a single day of extra color, they (small stores) would go

with it because they throw away so much product that has gone off color after one day,” Phebus said. “The main problem with ground beef and even subprimal steaks is that after a day in the lighted display case, it goes off color. They either have to mark it down drastically

or use it for something else and they lose a lot of money on that.”

One of the giants, Costco Wholesale, enlisted KSU to test the process on its ground beef and also conducted its own in-house studies that showed continued microbial reductions and longer shelf life.

Although the reduction in pathogens is considered modest, that’s not a problem. The KSU study pointed out

Additional shelf life and better protection from pathogens could make the Grovac process a popular one among small-retail meat processors.



Randall Phebus

that pathogen contamination level in finished ground beef tends to be low and infrequent, particularly for *E. coli* O157:H7. Effective pathogen control programs must be used earlier in the processing, with the Grovac intervention being a final degree of control as an end-of-the-process treatment, Phebus said. ■

Irradiated Food Still Faces Hurdles in School Lunchrooms

Irradiated meat products remain slow to appear in the marketplace, and that includes the nation's school lunchrooms. A national survey by Iowa State University found that more than 95 percent of the responding school food service managers indicated that irradiated foods are not available from their distributors.



Dan Henroid

While the managers also noted that they would be likely to serve irradiated food in their schools if available, they also reported that students and parents would probably be concerned if irradiated food was offered. The managers also believed that students should be informed if their schools are serving irradiated food.

"There is not a lot of interest across the country in irradiated food products in school lunch programs," said Dan Henroid, a former ISU Extension specialist in hotel, restaurant and institution management and current faculty member at the University of Houston, who supervised the survey for the Food Safety Consortium. He explained how the system works and why irradiated products do not figure in prominently.

The 2002 Farm Bill authorized irradiated food to be served in the federal school lunch program and permits — but does not require — USDA to include irradiated food in its commodity distribution. The Child Nutrition and WIC Reauthorization Act of 2004 reiterated that irradiated foods may be served in schools but only at the request of states and school food authorities.

Schools that receive federal assistance for their lunch programs can get

free commodity food products from the U.S. Department of Agriculture via the state agency supervising child nutrition programs. Ground beef is the main irradiated food product that is currently available through the USDA. The supervising state agency must request that irradiated ground beef be added to their distribution list. Once it is added, schools can then request it like any other commodity food product.

The demand for irradiated ground beef in schools is not very high, and several states including Iowa have opted not to make it available to schools in their state. However, if a school district wants to use irradiated ground beef, it can purchase it from a local food service distribution company.

Although state agencies and school food service managers might be expected to be attracted to the extra margin of safety that irradiation would provide for its food, they also have costs to consider. "When you're talking about 16 cents a pound more for irradiated ground beef compared to non-irradiated, they can stretch their food dollars further," Henroid said.

With costs as a factor and the reluctance of much of the public to embrace irradiation if they are not well informed about it, food service managers would face the prospect of educating their patrons.

"School food service managers generally did not feel like that they were knowledgeable enough to educate the general public," said Jason Ellis, an extension specialist in the hotel, restaurant, and institution management program at Iowa State and the study's co-author. Schools usually have some controversial issues to face at any given time.

"Why would school districts take on another controversial issue to add to their already overburdened plate?" Henroid said. "That's the attitude I sense from some people. I think it may take a major outbreak in the schools, God forbid, for that to happen."

Though the survey was conducted before the fall of 2004 when irradiated ground beef was available to school

districts, Henroid believes that several main issues still must be addressed before irradiated foods are commonly found in schools.

"The demand for irradiated food must greater," Henroid said. "The costs

for irradiated food must be comparable to non-irradiated food. And interested people in the community outside of the school systems need to be more informed before we see more schools using irradiated foods." ■

Several states have opted not to make irradiated food available to their schools.

Report from the Coordinator



Gregory J. Weidemann

It's no secret that we support greater emphasis on food safety research and that we have said so a few times in this space. We are not alone in this regard.

The American Academy of Microbiology (a division of the American Society for Microbiology) has released a detailed report on the topic, "Research Opportunities in Food and Agriculture Microbiology." Its authors are three eminent food safety researchers well known to many in the Food Safety Consortium and beyond: Michael Doyle, Lee-Ann Jaykus and Matthew Metz. Their report can be found on the ASM web site at <http://www.asm.org/academy/> under the title "New Colloquia Report Released."

The 17-page report represents the sum of findings by 19 scientists convened by the Academy for a two-day colloquium. It spells out several challenges to food and agriculture and the role of research opportunities in meeting those challenges. Although the costs of additional basic research often turn out to be a barrier to such funding, the report notes that it would be an investment that pays back.

"Estimates on the return on investment in agricultural research, based on a purely economic level, range from approximately 30 percent to 60 percent," the authors say. "This means that for every dollar invested in agricultural

research, there is an annual net flow of return to society of 30 to 60 cents."

But support for such research has been decreasing nationally, the report says. It identifies particular problems that should be addressed and overcome. Raising the profile and priority of agricultural research through designated centers of excellence is one of its suggestions. It also calls for creating new prestigious fellowships for graduate students and postdoctoral fellows to address problems in recruiting and maintaining new scholars.

The report also says national policies should favor a shift to more long-term research. Industry research is usually by necessity focused on achieving near-term results. "By nature, many agriculture and food research endeavors are long-term, but competitive funding for long-term projects is more or less unavailable," the report states. "An expansion of research priorities to emphasize basic long-term research and dedicated funding to back this expansion will help revive agricultural research."

The authors point out that aside from government funding, issues within the research community should also be addressed. A specific issue is too much compartmentalization among fields of research. "Research opportunities will expand as scientists become more aware and more engaged across fields dealing

with microbiology, veterinary and human medicine, plant diseases (pathology), epidemiology, statistics and mathematical modeling, environmental sciences and engineering, to name a few."

The Food Safety Consortium has taken care to encourage multiyear projects among its researchers and has since its inception made interdisciplinary research a cornerstone. There is much that can be discussed and debated about the details of how to encourage more of the kind of research-focused enterprise practiced by the FSC. Such discussions need to include all the relevant parties. The Academy's report says it best: "Changes that are needed will have to be advocated by scientists, research institutions, professional societies, non-governmental institutions and companies that are committed to food and agriculture."

That covers a long list of potential participants. Together, they make up the food safety research community. Their time to engage each other in substantive discussions appears to have come. ■

Raymond Appointed Food Safety Under Secretary

Richard Raymond was appointed as U.S. Department of Agriculture undersecretary for food safety in July. Raymond is responsible for overseeing the policies and programs of the Food Safety and Inspection Service (FSIS), and he chairs the U.S. Codex Steering Committee, which provides guidance to U.S. delegations



Richard Raymond

to the Codex Alimentarius Commission.

Prior to joining USDA, Raymond served as the director of the Nebraska Department of Health and Human Services Regulation and Licensure Division where he oversaw regulatory programs involving health care and environmental issues.

While serving as

Nebraska's chief medical officer, Raymond directed a large number of public health programs including disease prevention and health promotion. He also developed several anti-bioterrorism initiatives and a statewide health care alert system. He also played an integral role in developing health districts in each of Nebraska's 93 counties.

Raymond served as president of the Association of State and Territorial Health Officials (ASTHO) and has been

Continued on page 7

Ricke Named to Arkansas Wray Chair in Food Safety

Steven C. Ricke, a professor of poultry science at Texas A&M University, will be the first holder of the new Donald “Buddy” Wray Chair in Food Safety and director of the Center for Food Safety in the Institute of Food Science and Engineering at the University of Arkansas.

Dean and Associate Vice President Greg Weidemann said Ricke will join the faculty in January.

“Dr. Ricke is one of the leading young scientists in the fields of food safety and microbiology,” Weidemann said. “He has an excellent track record of working with colleagues in a variety of disciplines to address food safety issues.”

Weidemann added that the Center for Food Safety is designed to facilitate cooperation by university scientists, other agencies and the food industry. “Working together is essential to developing, delivering and implementing new information and technology that will lead to safer products for consumers,” he said.

The center is a unit of the U of A System’s statewide Division of Agriculture.

Ricke said, “I look forward to the tremendous opportunities in this appointment for developing an outstanding program that will represent the cutting edge of food safety and microbiology.”

The Donald “Buddy” Wray Chair in Food Safety is supported by a \$3 million endowment provided by matching gifts from Tyson Foods and a fund created from the Walton Family Charitable Support Foundation’s \$300 million gift to the U of A in 2002.

Investment earnings from the endowment will be used to help support Ricke’s teaching and research in the department of food science and the

Center of Excellence for Poultry Science as well as the Center for Food Safety.

Wray, who retired in 2000 as Tyson Foods president and chief operating officer, is a 1959 graduate of the U of A with a degree in agriculture. He has served as industry advisor to the Food Safety Consortium, which funds research at the U of A, Iowa State University and Kansas State University.

Ricke grew up on a dairy and grain farm near Bingham, Ill. He has B.S. and M.S. degrees from the University of Illinois and a doctorate from the University of Wisconsin with a co-major in animal science and bacteriology. He held a USDA-ARS post-doctorate position in microbiology at North Carolina State University from 1989 to 1992. He joined the Texas A&M poultry science faculty in 1992 and rose to the rank of professor in 2004.

In addition to teaching and research duties in poultry science, Ricke is also a professor of veterinary pathobiology in the College of Veterinary Medicine and a member of the graduate molecular and environmental science faculty, the graduate nutrition faculty, the Institute of Molecular Pathogenesis, the Graduate Food Science and Technology faculty, and the Center of Food Safety in the Institute of Food Science and Engineering at Texas A&M.

Ricke received the Poultry Science Association National Research Award in 1999 and the title of Faculty Fellow of the Texas Agricultural Experiment Station in 2003. His publications include 153 research articles in refereed journals



Steven C. Ricke

and 37 review papers and book chapters. He is editor in chief for *Bio-resource Technology* and has been a member of the editorial board of the *Journal of Food Protection* and three other scientific journals.

Ricke teaches undergraduate and graduate students and has been the major professor for more than 20 students who received M.S. and Ph.D. degrees. One of his

students, Dr. Young Min Kwon, is now an Arkansas faculty member and was recently awarded a \$541,368 grant from the National Institutes of Health for research on *Salmonella enteritidis*.

Salmonella enteritidis, a bacterium that causes more than half of the food-borne illness cases in the United States, has been the major focus of Ricke’s research. His research team recently reported findings that led to dietary changes for laying hens to prevent *Salmonella enteritidis* infection during molting, which is a periodic shedding of feathers. ■

FSC Announces Poster Competition Winners

Six graduate students were awarded prizes for their research posters during the Food Safety Consortium annual meeting Oct. 3 in Manhattan, Kan. About 40 posters were judged by a panel of FSC researchers from the three member universities. The winners and their posters are:

■ Abani Pradhan, University of Arkansas, first place, for the poster “Interactive Predictive Modeling of Pathogen Kinetics, Heat and Mass Transfer for Thermal Inactivation of *Listeria* in Ready-to-Eat Poultry Products.”

■ Lawrence Cobb, Iowa State University, second place, for the poster “Fate of *Listeria monocytogenes* Following Electron-Beam Irradiation of Vacuum-Packaged Frankfurters Formulated with Sodium Lactate and Sodium Diacetate and Stored at 4° and 10° C.”

■ Mohammed Obaidat, Kansas State University (now at the University of Georgia), third place, for the poster “Chalk and Fluid Inoculation Methods in Studying the Percent Recovery of *Clostridium perfringens*, *Escherichia coli* and *Enterococcus faecalis* from Raw Ground Beef.”

■ Oleksandr Byelashov, Iowa State University, honorable mention, for the poster “Impact of Sodium Lactate,



Winners of the FSC graduate student poster competition are (from left) Oleksandr Byelashov of Iowa State, Bwalya Lungu and Abani Pradhan, both of Arkansas, and Lawrence Cobb of Iowa State. Not pictured are Mohammed Obaidat and Chaowaree Ruengwilysup, both of Kansas State.

Lactic Acid, Sodium Lauryl Sulfate and Electron Beam Irradiation on Viability of *Listeria monocytogenes* and Quality of Vacuum-Packaged Frankfurters.”

■ Bwalya Lungu, University of Arkansas, honorable mention, for the poster “Control of *Listeria monocytogenes* on Raw or Cooked Ground White or Dark Turkey Meat Using Nisin, Sodium Diacetate and Sodium Lactate at 4° C.”

■ Chaowaree Ruengwilysup, Kansas State University, honorable mention, for the poster “Effect of Lactacel 115, Natural Cultures and Temperature on the Control of *Salmonella* Typhimurium, *Escherichia coli* O157:H7, *Yersinia enterocolitica*, and *Listeria monocytogenes* in Vacuum-Packed Nham (a Thai-style Fermented Pork Sausage).” ■

Masters Named to Head FSIS

Agriculture Secretary Mike Johanns announced in August the appointment of Dr. Barbara Masters as administrator of the Food Safety and Inspection Service (FSIS), overseeing the regulation of meat, poultry and processed egg products.

Masters had served as the acting administrator of FSIS since March 1, 2004. During that time, she raised the scientific training investment in the 10,000-employee workforce to a record \$20 million, as well as enhanced communications with both internal and external audiences so that



Barbara Masters

information regarding food safety programs is timely and accessible. She also implemented documented management controls that have improved efficiency and effectiveness in the agency, which has 7,400 inspectors working in 6,200 slaughter and processing plants.

“Dr. Masters is a veteran public health official who brings a wealth of knowledge, passion and commitment to FSIS,” said Dr. Richard Raymond, USDA undersecretary for food safety. “I am thrilled and pleased she has agreed to

Continued on page 7

James Denton, Arkansas, was recently selected to serve on the Secretary of Agriculture's Advisory Committee on Meat and Poultry. The appointment was effective in May and will run until March 2007. The purpose of the committee is to provide advice concerning state and federal programs with respect to meat and poultry inspection and other matters. Denton is a past director of the UA Center of Excellence for Poultry Science.

Yanbin Li, Arkansas, presented a seminar on biosensors for biodetection at China Agricultural University in Beijing in May. He also presented a seminar that month on biosensors for rapid detection of pesticide residues in foods at Zhejiang University in Hangzhou, China.

Li also received the Award of Outstanding Research in Biological and Agricultural Engineering from the University of Arkansas College of Engineering.

Li also published this article:

Yang, L., and Y. Li. 2005. Quantum dots as fluorescent labels for quantitative detection of *Salmonella* Typhimurium in chicken carcass wash water. *Journal of Food Protection*, 68 (6): 1241-1245.

Joseph Sebranek, Iowa State, received the Distinguished Research

Award from the American Meat Science Association in August and the Meats Research Award from the American Society of Animal Science in July.

Sebranek also published these articles:

Lu, Z., J.G. Sebranek, J.S. Dickson, A.F. Mendonca and T.B. Beasley. Application of predictive models to estimate *Listeria monocytogenes* growth on frankfurters treated with organic with organic acid salts. *Journal of Food Protection*, 68: 31-37.

Lu, Z., J.G. Sebranek, J.S. Dickson, A.F. Mendonca and T.B. Beasley. Effects of organic acid salt solutions on sensory and other quality characteristics of frankfurters. *Journal of Food Science*, 70 (2): S123-S127.

Houser, T.A., J.G. Sebranek, W. Nunez-Maisonet, J.C. Cordray, D.U. Ahn and P.M. Dixon. Irradiation-induced cured ham color fading and regeneration. *Journal of Food Science*, 70 (4): C281-C285.

Houser, T.A., J.G. Sebranek, W. Nunez-Maisonet, J.C. Cordray, B.R. Wigand, D.U. Ahn and E.J. Lee. The effect of irradiation at 1.6 kGy on quality characteristics of commercially produced ham and pork frankfurters over extended storage. *Journal of Food Science*, 70 (4): S262-S266.

Daniel Fung, Kansas State, delivered a presentation on "KSU Excellence in Food Science" Sept. 16 at KSU and was the keynote speaker on "Current Conceptions in Foodborne Pathogens and Rapid and Automated Methods in Food Microbiology" Oct. 15-19 at the University of Wisconsin-River Falls.

Fung also received the 2005 KSU College of Agriculture Excellence in Graduate Teaching Award. The Food and Drug Administration Center for Food Safety and Applied Nutrition cited Fung with the Exceptional Achievement and Founder of the KSU International Workshop on Rapid Methods and Automation in Microbiology Award. In June, he also received the Citation of Excellence and Medallion from the KSU Division of Continuing Education and a panel of distinguished scientists for 25 years of conducting the international workshop.

Fung's paper "Rapid Methods and Automation in Microbiology," which was published in 2002 in the inaugural issue of *Comprehensive Reviews in Food Science and Food Safety*, was recently reported to have received at least 2,967 hits on the Institute of Food Technologists web site in the three years that it has been available online. ■

Masters... continued

lead FSIS during these exciting and challenging times. I look forward to working closely with her and our management team in protecting the public health of Americans."

Masters began her FSIS career in 1989 as a veterinary medical officer near Hot Springs, Ark. She has since held a variety of posts throughout the agency, both in the field and at headquarters. Her previous positions include director of slaughter operations staff, branch chief in processing operations and a staff officer in the technology transfer and coordination staff.

Masters received her doctor of veterinary medicine degree from Mississippi State University and served in a food animal internship at Kansas State University. ■

Raymond... continued

a member of the association's Preparedness Committee for three years.

A lifelong resident of Nebraska, Raymond practiced medicine in rural Nebraska for 17 years. He established and directed a community-based family practice residency for Clarkson Medical Center, served as president of the Nebraska Medical Association, chaired Nebraska Gov. Mike Johanns' Blue Ribbon Panel on Infant Mortality and served on numerous state committees related to public health.

Raymond graduated from Hastings College and earned his medical degree from the University of Nebraska Medical Center. ■

Food Safety Digest

by Dave Edmark

Some meetings are cancelled for lack of interest. This one was put off because of too much interest.

Milwaukee was going to host the Great Lakes Agro-Security Symposium in early November. The conference organizers had planned for 1,000 people to attend the gathering that would focus on protecting the U.S. food supply from terrorism and natural disasters.

But the response was so strong that doubts arose as to whether the host hotel would be able to accommodate the crowds. So the conference has been postponed until March 28-30. Details are still emerging and registration information is available at <http://www.glass.wispro.org/>

■ ■ ■

Two European research efforts, both involving the Institute of Food Research in the United Kingdom, have found more information about the ability of *Salmonella* to cause foodborne disease.

A study by the IFR with Uppsala University in Sweden found *Salmonella* can evolve more rapidly than had been thought. The Medical News Today web site reported that scientists tracked *Salmonella* over 6,750 generations and

found that one quarter of its genes could be lost in only 50,000 years. Project leader Dan Anderson said scientists had earlier thought it would take millions of years.

“For bacteria to do well, they have to react very fast, and we have shown *Salmonella* to be remarkably dynamic,” said Jay Hinton of the IFR faculty.

Another study by IFR’s Hinton with University College London revealed that at low temperatures *Salmonella* switches off the genes required for infection and switches them on again when inside a warm animal body. “These findings help to explain the success of this pathogen in infecting so many different species of animals and reptiles, as well as man,” Hinton said.

■ ■ ■

In August, the World Health Organization presented its first Food Safety Award to Queen Sirikit of Thailand. The award was “in recognition of her majesty’s outstanding and notable efforts in promoting food safety in the country.” The award will be presented every two years to eminent persons who promote food safety at the national or world level.

■ ■ ■

The government has determined that a Texas cow that had BSE likely became infected before the government banned meat and bonemeal feed in 1997. Meatnews.com said that in a report released in September, two agencies examined the circumstances surrounding the cow.

The U.S. Department of Agriculture and the Food and Drug Administration said a 12-year-old cow was sold through a livestock sale in November 2004 and transported to a packing plant, where it was dead on arrival. It was shipped to a pet food plant where it was sampled for BSE. The plant did not use the animal in its product and its carcass was destroyed.

The agencies checked the farm where the cow was raised and identified 21 feeds or feed supplements that were used there since 1990. The probe concluded that no feed or feed supplements used since the 1997 ban contained any prohibited protein. So FDA concluded that the infection took place before the 1997 ban.

“The U.S. maintains an interlocking system of safeguards designed to prevent BSE from entering the human and animal food chain,” a USDA spokesman said. “USDA also remains vigilant in its attempt to find BSE in the United States. To date, there have been more than 450,000 animals tested in the last 14 months and only two BSE positive animals were found in this country.” ■

The Food Safety Consortium Newsletter

is a production of the three member schools of the consortium:
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Iowa State University and
Kansas State University.
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