Food Safety Consortium

10 Years of Service

1988-1998

University of Arkansas

▪

Iowa State University

▪

Kansas State University

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A Decade of Research

After 10 years of forming partnerships and bringing results to the table, the Food Safety Consortium finds itself as an organization in the right place at the right time. When representatives of the University of Arkansas, Iowa State University and Kansas State University met for the first time in 1989 to make plans for the newly-established FSC, they knew that food safety was becoming a greater national concern. During the 1990s, their foresight became even more evident.

Ten years ago there was much work to be done. The first special grant would be apportioned among the three universities. Projects would soon be funded. Research findings would be published. Contacts among peer scientists would be established. All that has happened and more.

In that time, the FSC has matured into an orderly research unit of investigators collaborating within their home campuses and with colleagues at the other member institutions. They compare and review their ideas with scientists in industry and in government. They are a recognized group whose expertise is sought throughout the nation.

The FSC has made its voice heard through its scientists' published research, their testimony before Congress and government agencies and their statements in the news media. They are a proactive group of investigators who seek solutions for the food safety problems that industry, government and consumers will face in years to come.

The scientists' impact has also been passed along to numerous graduate students who have worked with the faculty researchers and have gained valuable experience. The work of the principal investigators and their assistants is chronicled in the list of published articles produced by the Food Safety Conosrtium during the decade. That list is included in this history.

The careful and deliberate work of the Food Safety Consortium is an example of an appropriate response of the land-grant system to the public's concerns.

Many individuals among the scientists are deserving of thanks for the FSC's success. Two who stand tall among them are Richard Forsythe of the University of Arkansas and George Beran of Iowa State University. These two gentlemen are now retired, but their work was vital in establishing and tending to the growth of the FSC in its first several years. We are grateful for their contributions to this ongoing effort.

Through its annually renewed decisions to support the work of the FSC, Congress has shown its confidence in the organization and its expectations of it. Food safety has become a higher-profile topic among Americans in recent years. The careful and deliberate work of the Food Safety Consortium is an example of an appropriate response of the land-grant system to the public's concerns. ■

Charles J. Scifres

Coordinator
Food Safety Consortium

Food Safety Consortium: Origins and Development

The Food Safety Consortium was established by Congress through a Cooperative Research Service grant in 1988 to conduct scientific investigation in four areas of immediate concern to consumers, growers and processors:

- To determine the most effective intervention points to control microbiological or chemical hazards;
- To develop technology for rapid identification of infectious agents and toxins;
- To develop risk monitoring techniques to detect hazards in the distribution chain;
- To develop a statistical framework to evaluate the health risks posed by contamination of the food chain by infectious agents and toxins.

After the FSC was established, it expanded its mission to include three additional tasks:

- To develop risk assessment and interdiction actions in hazard reduction and control;
- To develop technology to reduce the hazards and improve the quality of animal food products, which will complement the development of HACCP programs by USDA;
- To develop, complement and maintain an aggressive technology transfer system that effectively communicates the work of the Consortium to consumers, industry, government and other scientific investigators.

The research work was divided to correspond to each university's area of strength: poultry at Arkansas, pork at Iowa State and beef at Kansas State.

The focus of the FSC in the initial stages was to develop the capacity in the scientific cadre at the University of Arkansas, Iowa State University and Kansas State University required to form the basis for future work in addressing the stated objectives. The initial focus of the FSC in 1991-92 was to define the prevalence of foodborne pathogenic bacteria associated with pork (*Salmonella, Staphylococcus aureus, Listeria monocytogenes*) and beef products (*Listeria monocytogenes*).

It is important to note that some of the early investigations also included work on the characterization of viral organisms at Iowa State. Limited work on the development of rapid identification techniques was initiated at the University of Arkansas (*Listeria monocytogenes* and *Salmonella*). The use of electronic cattle identification systems for tracking cattle through all stages of production, processing and marketing was evaluated at Kansas State University. The work on intervention strategies for poultry processing was initiated at the University of Arkansas in cooperation with the Southeastern Poultry and Egg Association and the National Broiler Council.

How the FSC Matured

In 1986, after the CBS newsmagazine "60 Minutes" broadcast a program about food safety, Arkansas poultry industry leaders were concerned that more work needed to be done on at least two fronts: to inform the public of industry's efforts toward safer food and to support a cohesive national food safety research effort.

The poultry leaders contacted Sen. Dale Bumpers of Arkansas and soon efforts were under way to establish a food safety research organization that would explore scientific solutions to problems in animal meats. In 1988, Congress approved the establishment of the Food Safety Consortium with the University of Arkansas, Iowa State University and Kansas State University as members.

One of the poultry industry leaders who met with Bumpers was Richard Forsythe, then an executive with Campbell Soup in Fayetteville, Ark., and chair of the Arkansas Poultry Federation's technical advisory committee. By 1989, Forsythe had joined the faculty of the University of Arkansas poultry science department and assumed duties as coordinator of the Food Safety Consortium. He began working with colleagues Curtis Kastner of Kansas State and George Beran of Iowa State to advance the FSC from an entity that existed only on paper to a working research organization.

In 1995, Richard Forsythe (left) received a plaque commemorating his service as the FSC's first coordinator. The plaque was presented by his successor, L.B. (Bernie) Daniels.

Forsythe, Kastner and Beran met with Clark Burbee of the U.S. Department of Agriculture Cooperative State Research, Education and Extension Service to prepare a budget request for allocation of the congressional appropriation for fiscal 1990-91.

As this process was under way in 1990, the FSC selected a steering committee and a technical advisory to oversee operations. The three universities' program leaders asked faculty at their respective campuses to submit proposals for FSC research projects. By mid-1991, the first dollars from the USDA grant began to flow to the universities for food safety research.

During the early years, the program leaders at the campuses knew which faculty members in various departments concentrated on particular areas of research that would be relevant to food safety. They were asked to develop proposals for FSC funding. The FSC grants also provided many faculty their first opportunity to hire post-doctoral students to assist in research projects.

During the second year of the FSC grant, Forsythe contacted the University of Arkansas for Medical Sciences in Little Rock, a separate institution from the Fayetteville campus, and Arkansas Children's Hospital in Little Rock. UAMS and ACH researchers were examining poultry-related projects such as studies of the prevalence and control of *Salmonella*. UAMS and ACH then began submitting proposals as partners under the University of Arkansas segment of the annual grant.

Forsythe continued as coordinator of the FSC until his retirement in 1995. Gerald Musick, the University of Arkansas associate vice president for agriculture-research, was the first chair of the FSC Steering Committee until 1993. Musick was succeeded as Steering Committee chair by L.B. (Bernie) Daniels, the associate director of the UA Agricultural Experiment Station. In 1995, Daniels also assumed the coordinator's duties upon Forsythe's retirement. Daniels returned to full-time faculty research the next year and was succeeded as coordinator and Steering Committee chair by Charles J. Scifres, the dean of the Dale Bumpers College of Agricultural, Food and Life Sciences at the University of Arkansas.

George Beran (left) served as Iowa State University's FSC program leader from the organization's early days until his retirement in 1998. FSC Coordinator Charles Scifres (right) congratulated him during a presentation at the FSC annual meeting.

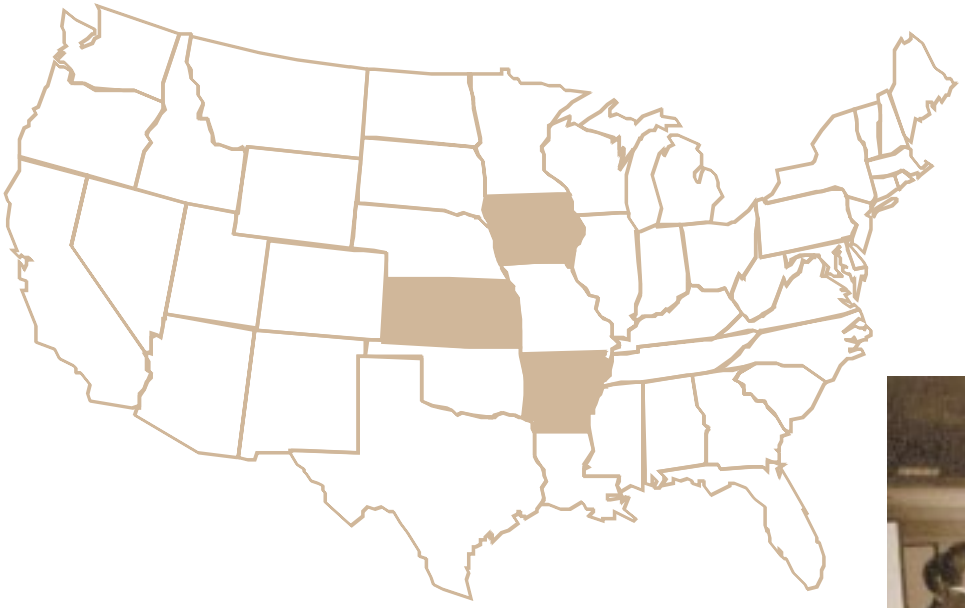
Today, Scifres' leadership team consists of campus program directors Curtis Kastner at Kansas State, James Dickson at Iowa State and Michael Johnson at Arkansas.

Over the past decade, the FSC has reported its work each year at a fall meeting in Kansas City. Each university's program leader has delivered presentations at the meeting reporting the year's research accomplishments. A written summary of the research highlights and a complete listing of each university's published articles and scholarly presentations has been published annually by the FSC.

"We wish we could say that 20 years ago we anticipated the public's heightened interest in food safety today," Kastner said. "Quite frankly, we did not. We knew that microbiological methods had to be enhanced. We knew that we had to control pathogenic bacteria in our meat supply. In those areas, we had expertise.

"But external influences and circumstances — including the Jack in the Box scare of 1993 — took place and made those areas extremely important. In that sense, we were lucky to have expertise in food safety and we were in the right place at the right time."

Kastner pointed out that several entities are responsible for promoting a safer food supply. "One of the misconceptions is that consumers think that USDA can solve all of the food safety problems. Universities do a lot that USDA can't do. We've got to do everything we can do at the live animal level, at the processor level and at the consumer level to ensure safety of all meat products. We've got major efforts to educate processors, retailers, food service personnel and also people at home. It's a total effort."



Rep. Vic Snyder (left) of Arkansas visits an FSC display at an exhibition in Washington held by the National Association of State Universities and Land-Grant Colleges in 1998. Discussing the FSC's work with him are Milo Shult (center), University of Arkansas vice president for agriculture, and James Denton (right), a UA representative to the FSC Steering Committee.

Consortium Leadership

In addition to the coordinators and Steering Committee chairs, the Consortium has been the beneficiary of guidance provided by members of the Steering Committee. The committee consists of representatives of each member university, the stakeholder industries and the USDA. The Steering Committee members, their affiliation and their years of service, are:

- Gerald Musick, University of Arkansas, 1991-1993
- Dell Allen, Excel Corp., 1991-1994
- Clark Burbee, USDA Cooperative State Research, Education and Extension Service, 1991-1995
- L.B. Daniels, University of Arkansas, 1991-1995
- Donald Derr, USDA Food Safety and Inspection Service, 1991-1994
- Thomas A. Fretz, Iowa State University, 1991-1994
- George Ham, Kansas State University, 1991-present
- Stan Harris, National Veterinary Services Laboratory, 1991-1994
- Mike Telford, Iowa Pork Producers Association, 1991-1997
- James Whitmore, Tyson Foods, 1991-1992
- Ellis Brunton, Tyson Foods, 1992-present
- Jack Riley, Kansas State University, 1993-present
- James Denton, University of Arkansas, 1995-present
- Frank Flora, USDA Cooperative State Research, Education and Extension Service, 1995-1998
- Richard Forsythe, University of Arkansas, 1994-1996
- Brenda Halbrook, USDA Food Safety and Inspection Service, 1994-1997
- Jim Riemann, Excel Country Fresh Meats/Certified Angus Beef Program, 1994-1999
- Colin Scanes, Iowa State University, 1994-present
- Lee Ann Thomas, National Veterinary Services Lab, 1994-1995
- Charles Scifres, University of Arkansas, 1996-present
- Irene Wesley, National Animal Disease Center, 1996-present
- Richard Ellis, USDA Food Safety and Inspection Service, 1997-present
- Rich Degner, Iowa Pork Producers Association, 1997-present
- Gregory J. Weidemann, University of Arkansas, 1997-present
- Craig Wilson, Costco Wholesale, 1999-present ■

University of Arkansas

James Denton

James Denton is a member of the FSC Steering Committee and director of the University of Arkansas Center of Excellence for Poultry Science.

Rapid Methods Development and Monitoring Techniques

Following the establishment of baseline information concerning prevalence in the early years of the FSC, the attention of the scientists became more focused on the development and evaluation of effective intervention strategies for reducing microbiological hazards and the rapid identification and risk monitoring techniques.

The progress reported in 1992-93 and 1993-94 reflected significant progress with regard to intervention strategies in poultry products through the application of counter current scalding, chemical sanitizers and electrical pasteurization systems. Cationic, anionic, and nonionic surfactants were found to be unsuccessful in removal of attached bacteria on poultry. Similar progress was noted in pork products through acid rinse systems and thermal destruction in beef products. Progress in rapid identification was reported through the use of oxyrase enzyme in culture medium, in vitro tissue culture.

The initial work on development of the statistical framework for evaluation of health risk was conducted for *Salmonella* by investigation of the epidemiology of *Salmonella* in Arkansas. Subsequent work indicated that children less than one year of age were infected at a higher rate than the national average. Preliminary work using naturally occurring bacteriocins showed promise as an effective intervention strategy. The use of chlorine and acid rinses on subprimal and retail cuts for beef products showed some promise as an effective intervention strategy.

Shifting Focus to Intervention Strategies

Beginning with the work conducted in 1994-95 and continuing in 1995-96, the scientists in the FSC became more focused on the improvement of intervention strategies for control of microbiological and chemical hazards while also maintaining the work in advancing rapid methods development and risk monitoring techniques which are essential to timely evaluation of the intervention strategies. Prevalence studies from on farm through the processing plant for nine pathogens formed the basis for evaluating the impact of mechanical meat stripping, the evaluation of feed additives and electrical pasteurization in the chill system as a means of reducing microbiological contamination in poultry products.

Comprehensive studies beginning on farm were extended through processing for pork products utilizing novel rearing systems, decontamination techniques including hot water/steam, bacteriocins, pediocin and irradiation. Work also continued on the development of the rapid detection models with special emphasis on the tissue culture model for *Listeria monocytogenes*, DNA and RNA probes specific to *Campylobacter jejuni*, monoclonal antibody detection of *Listeria* by ELISA, immunomagnetic and immunofluorescent staining analysis of *Salmonella*. The use of polymerase chain reaction (PCR) and genetic probes was also evaluated for detection of *Yersinia enterocolitica, Arcobacter*, and *E. coli* 0157:H7. Similar efforts were reported in beef products using low-dose irradiation. Improved methods for carcass sampling were achieved through the development of standardized methods and incorporation of improved rapid detection technology in the sampling protocol. The use of

Yanbin Li, a principal investigator at the University of Arkansas, explains a project during a poster presentation at an FSC annual meeting.

molecular epidemiology techniques, pulsed field gel electrophoresis (PFGE) for the subtyping of *Salmonella* was used to track Salmonellosis in Arkansas in children under four years of age. Work in using a model research oven for assessing cooking processes, microbial destruction, heat transfer and air impingement was also conducted.

Epidemiological Investigation of Risk Factors and Novel Intervention Strategies

Significant progress in the epidemiological identification of risk factors associated with foodborne illness outbreaks, novel intervention strategies for reducing microbial populations and rapid methods development continued to be the focus in 1996-97 and 1997-98. The findings that the source of Salmonellosis involving infants and children at the Arkansas Children's Hospital (ACH) is not directly associated with contaminated foods but with infected individuals in the environment. Of particular significance is the relationship between isolates from sick animals and the infected adult human contacts which most likely infected the child. The isolates were recovered from animals other than poultry. Novel intervention strategies involving on-site generation of chlorine, electrical pasteurization utilizing several electrolytes, naturally occurring bacteriocins and ozone have proven to be effective in reducing several types of microbiological concentrations in poultry products although not all were successful in reducing pathogens such as *Salmonella, Listeria* or *Campylobacter*. Pulsed field gel electrophoresis has been successfully integrated in the system for identification and fingerprinting of certain isolates of *Salmonella typhimurium*, but not *Salmonella enteritidis* while monoclonal antibodies have been used to enhance recovery and identification of *Listeria monocytogenes.*

Risk Assessment and Analysis

Beginning in 1997-98 work was also focused on the development of risk assessment models to predict relative reductions in the incidence of *Salmonella* positive carcasses. Evaluation of novel approaches for reducing microbiological contamination including several chemicals such as trisodium phosphate and sodium bisulfite and enzymes with limited success, while cetyl pyridinium chloride has proven to be successful in reducing *E. coli* and *Salmonella.* Mechanical stripping systems for meat removal from non-eviscerated carcasses have been evaluated for the potential to avoid cross contamination. Work also continued on the evaluation of rapid detection methods for isolating and quantifying *Arcobacter* and *Campylobacter.* In addition, work has concentrated on use of near infra red technologies for predicting the cooking time and temperature of cooked poultry, screening for determining the prevalence of *Salmonella DT-104* in poultry products as well as the predictive modeling of microbial behavior in cooked poultry. Additional work has also included the evaluation of image analysis with immunoelectrochemical and piezoelectric biosensors to detect pathogens directly on carcasses or in cooked product.

Debra Winters, a research associate in FSC projects at the University of Arkansas in food science and poultry science, examines a DNA sequence.

Educational Strategies and Pre-Harvest Food Safety

Significant effort was directed to addressing the educational needs of various clientele groups in the food safety continuum. It is particularly noteworthy to report that the use of HACCP principles form the foundation for the meat and poultry industry HACCP workshops and the Sanitation SOPs and GMP training programs conducted by the faculty in the FSC. Innovative collaborations involving FSC faculty, the Arkansas Department of Health, Arkansas Hospitality Association and Arkansas Cooperative Extension have developed for the delivery of similar training and workshops for food service clientele manager certification using the ServSafe education materials available through the National Restaurant Association. Faculty from the FSC have also worked in developing a strategy for providing educational materials for use in public schools through a partnership with the Arkansas Poultry Federation, Arkansas Department of Education, Arkansas Department of Workforce Education, Arkansas Division of Agriculture, Arkansas Hospitality Association and Arkansas Grocers and Retail Merchants Association. This curriculum has targeted grades pre-kindergarten to 12 in the Arkansas public schools through the Health Action Framework. It is the only statewide program which has the support of the legislature through a specifically targeted food safety legislative initiative. Fundamental research has also been initiated to investigate the prevalence of human pathogens in production environments with the goal of developing practical intervention strategies for on-farm utilization.

The maturation of the Food Safety Consortium began with a group building capacity to undertake food safety research through the various phases of conducting prevalence studies. Those studies focused on conducting rapid methods development research, implementing sophisticated monitoring strategies, designing and evaluating practical intervention strategies, conducting the epidemiological investigations of risk factors, investigating novel intervention strategies, accepting the challenge of conducting risk assessment and analysis and investigating pre-harvest food safety profiles.

The research also faced the most difficult challenge in dealing with food safety issues, the development of comprehensive food safety education strategies targeted to specific clientele at all levels of the food safety continuum. The Food Safety Consortium has made significant strides to addressing these issues and concerns. ■

Iowa State University

James S. Dickson

James Dickson is the professor in charge of the Food Safety Consortium at Iowa State University, where he is head of the Department of Microbiology.

The specific objective of the Iowa State component of the Food Safety Consortium is the enhancement of the safety of pork and pork products. Over the last 10 years, the researchers at Iowa State have evaluated many aspects of the safety of pork, quite literally from the farm to the consumer.

Enhancement of the Safety of Pork — Live Animal Production

Iowa State University researchers have examined many aspects of live animal production which relate to food safety. Projects from the early years of the Consortium activities included studies on the detection of and depletion rates of antibiotics from swine.

In addition, studies were conducted on the prevalence of zoonotic infections in swine. This research laid the foundation for an evolving series of research projects, beginning with the evaluation of a specific swine management technique (segregated early weaning) in relation to reducing the incidence of specific foodborne pathogens in the live animal. This project in turn led to an investigation of on-farm control measures to reduce the incidence of foodborne bacteria, specifically salmonellae, in the developing live animal. The latest research in this area takes a holistic approach to live animal production, by following individual animals from specific farms from birth through processing.

This project, jointly supported by the Food Safety Consortium and the U.S. Department of Agriculture – Food Safety and Inspection Service, is currently examining variables such as livestock management techniques and the season of the year on the incidence of several significant food borne pathogens in both the live animal and the processed carcass.

Ilze Matise, a graduate assistant at Iowa State University, tests meats for the presence of *E. coli* bacteria.

Much of the focus of the Live Animal Production research has been on salmonellae, which are viewed as a model for other bacteria of public health significance. However, other pathogens such as *Campylobacter*, *Listeria*, and the parasite *Toxoplasma gondii* have also been investigated. In the coming years, these organisms will likely take on an even greater importance because of the needs of the food safety community, the regulatory agencies, and most importantly, the health of the general public.

Enhancement of the Safety of Pork — Processing

The production of the live animal is the beginning of the chain of events which ultimately delivers fresh and processed pork to the dinner plates of the consumer. The conversion of the live animal into food for human consumption is an important link in this chain, and one at which food safety control

measures can be consistently applied. Because of this, Iowa State University has concentrated an important part of its Food Safety Consortium efforts on intervention strategies during processing. Early studies began with describing the levels of contamination which occurred on carcasses during processing. Since microbiological contamination is undesirable, but in many cases unavoidable, further research was conducted on direct carcass intervention strategies. These have included hot water and organic acids, along with novel compounds intended to destroy attached bacteria.

As the research into intervention strategies progressed, it became apparent that there was a gap in the knowledge of the fundamental mechanisms of contamination of hog carcasses. This has resulted in the initiation of a research project to examine mechanisms of contamination, with the specific goal of developing effective measures to reduce this contamination at a microscopic level. This will complement an existing body of data which led to an Iowa State patent on a procedure to reduce contamination on animal carcasses during processing.

Food irradiation has been proven as a safe and effective process for reducing bacteria in many types of foods. The Linear Accelerator Facility at Iowa State University has been an important component of food safety research, specifically evaluating electron beam irradiation ("cold pasteurization") of pork products. Iowa State researchers have been leaders in irradiation research since the Linear Accelerator Facility was commissioned in 1993.

One of the most significant changes in meat processing has been the introduction of HACCP-based inspection in the processing establishments. Through Food Safety Consortium sponsored research, Iowa State studied HACCP in meat processing establishments, for both its practical effectiveness as well as the costs of implementation. Risk assessment is a key component in the development of viable HACCP plans, and again through Food Safety Consortium sponsored research Iowa State has evaluated risk factors in pork processing, from the live animal through further processing.

Jacob Petrich, an Iowa State University associate professor of chemistry, looks for foodborne pathogens by using lasers.

A unique aspect of Food Safety Consortium research at Iowa State University has been ongoing projects on viruses associated with pork products. The ecology of foodborne viruses is poorly understood, and there is a significant gap in the knowledge on this subject. Iowa State researchers have researched several aspects of viruses in pork, beginning with the incidence in pork, to development of more sensitive methods, and finally to means of reducing or destroying viruses in processed pork products. Food Safety Consortium-sponsored research has provided one of the most sustained research programs on viruses of public health concern in pork, and has added significantly to the available data on this subject.

Enhancement of the Safety of Pork — Consumer Issues

The net result of all of the aspects of pork production is the meat which the consumer eats. For all of the management techniques, good processing procedures and testing methods, the consumer provides the ultimate bioassay, because at this point sampling and testing is 100 percent.

Any failures or deviations in the

system will ultimately be identified by the consumer. The Food Safety Consortium has sponsored research over the last decade to evaluate food safety from the consumers perspective, by researching consumer issues such as shelf life and cost of intervention strategies.

One of the more significant contributions of the Food Safety Consortium has been their support of a food safety World Wide Web page for consumers. This web page is maintained at Iowa State University by faculty in the College of Family and Consumer Sciences, and is intended to deliver a message of food safety to the average consumer. (http://www.exnet.iastate.edu/Pages/families/fs/homepage.html)

The Food Safety Consortium, in cooperation with the Linear Accelerator Facility at Iowa State University, has also conducted test markets of irradiated foods, to determine both the consumers openness to the technology and also their willingness to accept any costs associated with the technology. These studies demonstrated that the average consumer is willing to purchase irradiated foods when offered for sale in a conventional retail location, and that a portion of those consumers are willing to pay a premium for the perceived benefits of irradiated. ■

Kansas State University

Curtis Kastner

Curtis Kastner is the FSC program leader at Kansas State University, where he is a professor of animal sciences and industry.

Decontamination of Carcasses and Subprimals

To maximize safety and extended shelf life of meat and meat products, the meat industry and the Food Safety and Inspection Service strive to minimize carcass contamination during slaughter and subsequent processing. However, microbial contamination during slaughter cannot be avoided completely.

In addition to good manufacturing practices designed to minimize contamination and trimming of contaminated areas, spraying carcasses with hot water and sanitizers has been employed to reduce contamination. Although spraying/rinsing techniques have reduced microbial counts on carcasses, their effect does not necessarily carry over to resultant subprimal and retail cuts and trim used for further processing and meat byproducts.

The study was done on eviscerated beef at various control points during processing. Carcass rinsing decreased microbial counts, however, it did not carry through to resultant subprimal and retail cuts. Sprays tested consisted of water, 200, ppm chlorine, 3% lactic acid and combinations of these.

Lactic acid treatment of subprimal cuts appears to carry through to retail cuts during display and is more effective than treating carcasses, especially when retail cuts are packaged in oxygen-permeable film. Good temperature control enhanced the carryover effectiveness of lactic acid treatment at the subprimal level.

Methods to Enhance Microbial Detection

A limited number of surveys have indicated that about 4% of fresh retail ground beef is contaminated with *E. coli* 0157:H7. However, because the organism is difficult to recover from foods, the incidence may be higher. Several screening methods for the isolation and/or enumeration of *E. coli* 0157:H7 have been developed. Most are too complex and time-consuming to be useful in meat inspection. *E. coli* 0157:H7 is usually present in foods in low numbers and is accompanied by competitive microbial populations, including other *E. coli* strains requiring differentiation. These factors mandate selective enrichment procedures that allow *E. coli* 0157:H7 cells to repair injuries and grow to high enough numbers for detection, normally extending testing times by 18 to 24 hours. Techniques to reduce the time for enrichment, during which very low numbers of *E. coli* 0157:H7 are increased to detectable levels, are needed in regulatory detection of this pathogen.

Oxyrase enzyme derived from ruptured *E. coli* cells speeds up growth of several bacterial groups by removing oxygen from the growth medium. Current studies have shown that Oxyrase increases growth rates of certain bacteria, especially those found in the digestive tract of animals.

Jin-Man Kim (left) and Daniel Fung, a Kansas State University principal investigator, gather samples to examine ginseng's effects on pathogenic bacteria in food.

Carcass Trimming and Washing

Our research has shown that trimming of beef carcasses improves their microbiological and physical cleanliness. Additionally, when coupled with proper carcass washing, knife trimming produces a clean carcass. This finding is relevant for gross deposits of contamination. We have also shown that smaller deposits of contamination can be effectively removed by steam/hot water vacuuming. These findings provided the bulk of the evidence used by USDA/FSIS to approve the trim/vacuum procedure under the zero tolerance policy.

Steam Pasteurization

Researchers cooperated with a commercial manufacturer of steam pasteurization equipment and showed that steam pasteurization is the most effective bacterial reduction technology available to beef processors. KSU testing showed that a steam pasteurization system effectively kills nearly 100 percent of pathogens on the beef carcass surface, including *E. coli* 0157:H7, the causal agent in numerous foodborne illness outbreaks.

KSU scientists found that the steam pasteurization concept used for whole carcasses will also decontaminate raw ground meat products. This is a critical piece of research to reduce consumer risk because a significant percentage of meatborne bacterial illness has been traced to mixed or ground meat products.

Estimates are that within a few years, most processed meat will be steam pasteurized. The system will help processors meet the new governmental microbiological standards.

Steam pasteurization, a value-added technology, has now been adopted by the largest meat packers in Kansas. By conservative estimates, the technology will increase the value of each beef carcass processed in Kansas by approximately $10. In 1996, Kansas packing plants slaughtered nearly 7 million beef cattle. The value-added increment of steam pasteurization technology for Kansas, which slaughters about 20 percent of the nation's total beef supply, would be $69.9 million.

Dr. Randall Phebus' team noted that steam pasteurization is a viable intervention technique. The SPS 400™ steam pasteurization units were designed for medium to large slaughter facilities with the capacity of treating four sides of beef simultaneously on a moving rail system. However, the size and cost of the large unit may not be feasible for smaller slaughter facilities. Therefore, a smaller steam pasteurization unit, SPS 60™ has been tested at both the laboratory and commercial scale. The SPS 60™ prototype treats one beef side at a time in a vertical steam chamber.

Beef Degree of Doneness and Color

On behalf of consumers, KSU scientists have been instrumental in getting the cooking standards for ground beef revised. They studied the chemical and physical properties of ground beef that cause it to brown prematurely. Premature browning is an extremely critical issue in home and institutional preparation of ground beef patties. It is less of an issue in the fast-food industry where specific time-temperature heating is used.

The KSU research findings influenced the USDA Food Safety and Inspection Service, which in June 1997 revised the "doneness" standard for cooking ground beef to focus on endpoint temperature and disregard color change. The new standard says "ground beef must be cooked to 160 degrees Fahrenheit as gauged by a meat thermometer penetrating the thickest part of the hamburger."

Irradiation

Irradiation research at KSU has shown that low-dose irradiation at approximately 3.5 kGy results in minimal or no changes in beef and pork color, flavor and texture. These results are instrumental in encouraging the implementation of this technology, which can provide the means to satisfy the requirements of a critical control point in the HACCP system. This work is being expanded to investigate alternative electron beam energy sources.

Sausage Process Validation

KSU has also shown that standard commercial processes for Lebanon-style bologna can be used to achieve a 5-log reduction in *E. coli* 0157:H7. This result has been achieved in large (4.5 inch) and intermediate (3.5 inch) diameter products. This work involved identifying the pH, temperature, and time parameters necessary to monitor the process in a HACCP system. This work will be expanded to other products and will involve challenging the processes with not only *E. coli* 0157:H7, but also *Listeria* and *Salmonella* as required by USDA. ■

From left, Sharon Luchsinger, Donald Kropf and Claudia Garcia review laboratory samples at Kansas State University.

FSC Published Research
by University Affiliation
1991-98

University of Arkansas

1991-92

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