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Food Protection Trends

Science and News from the International Association for Food Protection

Isolation and Infectivity of Potential Foodborne Viral Pathogens

General Interest Paper – Re-engineering the United States Food Safety System

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VOLUME 29, NO. 9

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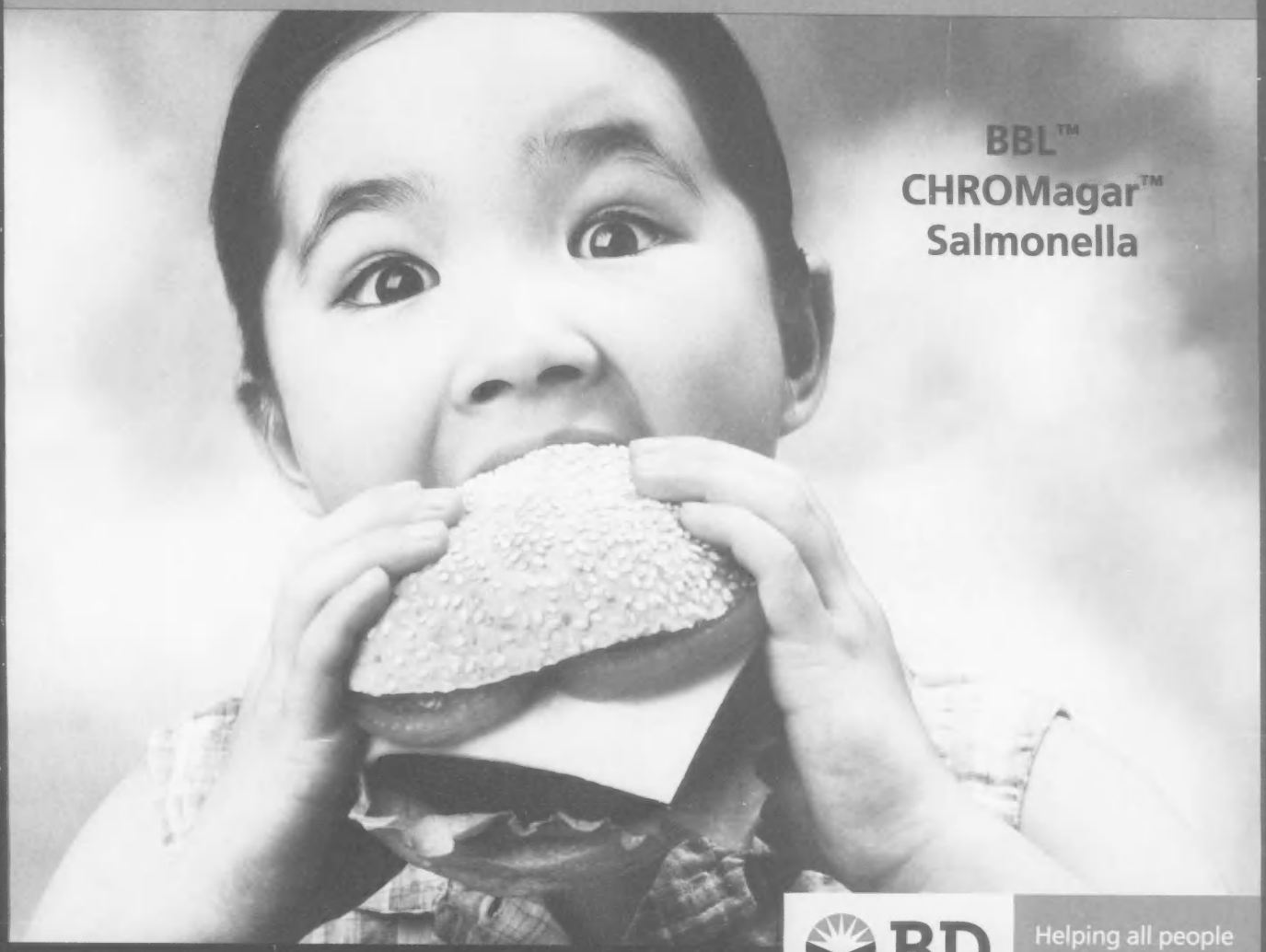

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FOOD PROTECTION TRENDS
SCIENCE AND NEWS
FROM THE INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

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"VICKIE'S VIEW" FROM YOUR PRESIDENT

By VICKIE LEWANDOWSKI
PRESIDENT

"Performing a series of basic activities will result in the successful production of safe, high-quality food"

The summer is flying by! IAFP had a very successful Annual Meeting at the Gaylord Resort in Grapevine, Texas, in July. Notably, we did not experience the huge decrease in attendance that many other meetings are experiencing in these tough economic times. The technical and poster sessions, symposia and exhibit hall were full of interactive, enthused attendees, exhibitors had many new technologies and services on display, and friendships were rejuvenated and new acquaintances were made as knowledge sharing continued at the networking and social events.

It was a remarkable meeting but it was also good to get back home to my family. After all the work and excitement of the meeting I needed a relaxing weekend with my boys! My two sons, 8-year-old Max and Jack, 6 years old, and I had the ultimate summer day following my return from Grapevine. We played a board game on the deck in the warm summer sun, played hide-and-go-seek around the neighborhood, and had foot races down the path. It started to rain while the sun was still shining so we set out, bare-footed, splashing through warm puddles, to find the elusive pot of gold at the end of the rainbow. As it grew darker we started a bonfire, which led to s'mores, of course! As we sat by the fire, little flickers of light started appearing across the lawn. Fireflies! Max and Jack ran around and around trying to catch them all, laughing with excitement at their success. Relaxed and exhausted, they eventually fell asleep. As I thought about our ultimate summer day, it struck me how each of our activities, individually basic and simple, added up to make one successful day.

And so it is with food manufacturing: Performing a series of basic activities will result in the successful production of safe, high-quality food. It's easy to get caught up in the latest and the greatest technologies, shortcuts, and cost-saving activities. However, from farm to fork, we must never forget or neglect the basics of food safety and safe food manufacturing. I asked a few coworkers and colleagues for their "Top Ten Basics of Food Safety" lists, and here's the resulting compiled Top Ten:

1. **Buy-in By All!** Everyone involved in the manufacturing of food, from the most senior management all the way to the line workers, must truly believe that food safety is not just a program, a practice or a vision but that it is the right thing to do, that it is a value.
2. **Product and Process Design.** Chemical, physical, and microbial hazards can be eliminated or minimized through formulation and process design. It is also important to define specifications for the raw materials and the finished goods to ensure that they are meaningful and will confer food safety.
3. **Ingredient Suppliers.** It is crucial to know and trust your ingredient supplier and your supplier's supplier and brokers. Suppliers should be audited at each facility using a risk-based auditing approach. Whether this is a company-based or third-party audit, the auditors should be knowledgeable of the product and process they are assessing.
4. **Sanitary Design of Equipment.** Equipment should be designed to be easily cleaned, without dead-ends, corners, etc. Cleaning chemicals can be damaging to some metals and plastics, so choose appropriately. When possible, utilize automated clean-in-place (CIP) equipment since manual cleaning increases the potential for contamination.
5. **Separation of Raw and Ready-to-Eat (RTE).** Ingredients and process streams should flow through from dirty to clean without cross-contact. Complete separation and segregation of raw from processed/RTE product is essential.

This separation includes ingredients, processing streams, packaging, equipment and people (shipping/receiving, line workers, maintenance, etc.).

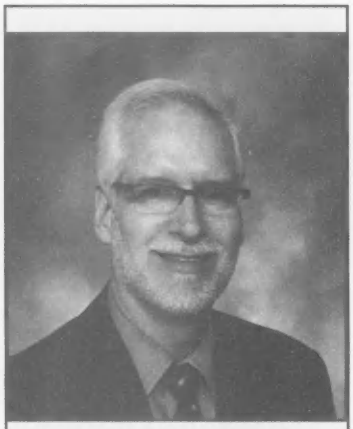
6. **Prerequisite Programs and Hazard Analysis Critical Control Points (HACCP).** The foundation of HACCP is solid prerequisite programs. These programs should be validated and documented as part of a HACCP plan. The development of an accurate HACCP plan is imperative for the control of chemical, physical and microbiological hazards. A thorough risk assessment and hazard analysis of ingredients, packaging and processing steps should be done, backed up by solid scientific evidence. Validation should be done on a regular basis thereafter (i.e., every other year or every year).
7. **Good Manufacturing Practices (GMPs).** Although this is considered a prerequisite program by some, the GMP program deserves to be called out as a stand alone "basic" of food safety. It encompasses many of the other basics for safe food production: personnel (clothing, training, etc.), plant and grounds condition, sanitation, utilities (air, water, etc.), equipment maintenance and calibration.
8. **Environmental Monitoring.** Look for it, and then look again. The goal is to find harborage sites and routes of microbe entry and eliminate them.
9. **Effective Sanitation.** Effectiveness of sanitation actions should be verified by microbiological testing, the use of ATP technology and periodic equipment teardowns and inspection. These inspections should be documented with results and corrective actions, as necessary.
10. **Recall/Traceability Program.** A system to trace all ingredients and components of finished goods is critical. An assessment of the system should be done on an annual basis through the use of a mock recall.

As I write this column, the US House of Representatives has passed H.R. 2749, The Food Safety Enhancement Act of 2009. The hope is that this act will strengthen our food safety system. A similar bill, S.B. 510, the FDA Food Safety Modernization Act, will go to the Senate soon. Some of the provisions of this new bill reinforce the call to remain mindful of the basics of food safety: HACCP, sanitation, supply chain, record-keeping, environmental monitoring, and traceability.

Again, as with my family's ultimate summer day, the successful realization of the whole is the sum of its parts, and each of these individual basics of food safety must be included in the mix to ensure the development and implementation of successful science-based laws and regulatory policy that improve public health protection. I am excited to be a part of the food safety community as we enter into the next chapter of history, and I encourage all of my IAFP colleagues to remember that our association is also only as successful as the sum of its parts. Another Annual Meeting is in the history books, but our work as a community of food safety professionals continues apace!

As always, feel free to E-mail me at vlewandowski@kraft.com with your suggestions or feedback. And, if you can, try to get in one more s'more with your beloveds before the autumn chill sets in!

"COMMENTARY" FROM THE EXECUTIVE DIRECTOR



By DAVID W. THARP, CAE
EXECUTIVE DIRECTOR

"Technology is a big part of our lives today and one that we cannot avoid"

This month, it might be appropriate to touch on a subject that affects each person in a variety of ways. That is "technology." Technology is a big part of our lives today and one that we cannot avoid. Many times technology is credited with saving lives, saving time and saving the world! Today I want to talk about electronic technology in the form of our software and use of the Internet.

In the association world, we need a few systems capable of working together that can provide our members with the conveniences they expect from a great organization like IAFP. You probably know that we recently redesigned our Web site and in doing so, established a new member directory. To implement the new member directory, we had to rework our membership database software and make a substantial investment to this system.

Of course, each upgrade of a system means that reports and items you relied on for years now have changed or must be rewritten (at additional time investment or direct cost). Renewal notices to IAFP members were totally reworked to allow for many, "automated" functions to be implemented. It is nice that our computers can do this work for us now, but there was some comfort in the prior system knowing that we had control over what the system was going to do, because we had to "tell it" what to do before it would perform! Now, the new system does operate under a set of instructions, but they are more automated and directly tied to the online member directory.

One nice feature of our new Web site is that a new member can now go to IAFP's Web site and join; then have immediate access to the member directory and other member only services. Under the old system, a new member would wait between 3 and 10 days to have access to their benefits! Once we get used to the new system and new reports, all will go very well – we think!

The next part of our technology improvements involves the Annual Meeting registration system. Because this is a more "specialized" need for IAFP, it must be handled by a separate system. We integrate the information generated by this system into our membership database to keep an ongoing record of your member activities. We have found the system to be fairly easy to use for our meeting attendees, but surely have found it has its "quirks."

In addition to our membership and Annual Meeting systems, we have the abstract submission system for technical presentations at Annual Meeting. This one entails a whole separate management system to operate.

So, to come back to my thoughts about technology, which I know are nothing new; when things are working well together – technology is great. But when things are not working together, technology can cause many pains!

We recently experienced a chain of events which caused us great pain, technologically speaking. Our router decided (by itself) that it needed to upgrade its software and in doing so, it reset all settings to its base, initial settings. This wiped out all of our custom settings that told our Web site e-commerce pages how to perform their functions. For almost a week, we were following up with three or four separate technicians from our various vendors to piece this all back together so that the proper functions could be reestablished. Each one, as helpful as they really are, would indicate their part of the system was working correctly – so check elsewhere for the problem.

Eventually, the system was repaired and all works well again, but the staff time investment in a problem like this is immense. That is not to mention the direct charges we will receive from the three or four vendors for the time they spent "fixing" the problem. And all of this, because the router decided to upgrade itself!

Needless to say, we have now replaced the router so it won't be doing this to us again. But, what will be the next "technology related" problem we encounter? We know technology is a necessary part of life today, but sometimes we long for the days when we had a little more control over our technologies!

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Isolation and Infectivity of Potential Foodborne Viral Pathogens by Immunomagnetic Capture

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ABSTRACT

Cases of foodborne illness attributed to viruses are likely underreported because of difficulties associated with detection of viruses in foods. Flow-through immunomagnetic capture allows for rapid detection of bacteria from relatively large food samples by recirculation. This study assessed a similar technique using cationically charged beads for initial isolation followed by tests of virus infectivity to determine the amount of infectious virus recovered. The effect of recovery from differing food matrices was tested, including a low-pH solid, salsa, and a neutral-pH liquid, milk. Food samples were inoculated with virus from 3 families (*Caliciviridae*, *Poxviridae*, *Picornoviridae*). After sampling, the beads were suspended in Hanks balanced salt solution, H_2O, a basic elution buffer (3% beef extract) or a 0.1N HCl solution to determine the effect on infectivity by $TCID_{50}$. Results indicated that picornaviruses (HAV and AiV) could be recovered in both milk and salsa. Viruses were able to infect cell culture while bound to the cationic beads, and there was little difference in the percent recovery between food samples or in the solution used. These data suggest that some viruses can be recovered from food matrices by immunomagnetic capture and that cell culture analysis of the cationic beads allows for the determination of the active virus present in foods.

INTRODUCTION

Viral foodborne pathogens are a significant problem, worsened by the fact that foods are rarely tested for viral contamination *(28, 31)*. Issues with testing foods for viral contamination are linked to the amount of time and cost of viral detection in foods *(26)* as well as the lack of legal regulations on testing foods for viral contamination *(25)*. Most viral extractions from foods require at least 3 hours for completion, and overall costs could easily exceed $100 per food sample *(26)*, making regular testing cost-prohibitive. Sensitivity of these detection methods is also a concern, since only a few virus particles can cause illness. The infectious dose of HAV is estimated to be less than 100 virus particles *(15)*, and the infectious dose of norovirus is estimated to be as few as 10 virus particles *(5)*. Recently developed methods of viral testing in foods involve molecular-based methods, in contrast to cell culture assays which can take several days *(2, 8, 10, 13, 28, 29)*. Molecular-based methods involve complex extractions, usually through ultra-centrifugation, that remove the virus from foods, followed by nucleic acid extraction and purification for RT-PCR *(26)*. Food samples present challenges for these current detection methods because of the high sample volumes required, the low levels of contamination and the presence of some residual food components that can act as enzyme inhibitors *(28)*.

A peer-reviewed article

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Pathatrix™ (http://www.matrixmsci.com/) is an innovative technology used for rapid detection of pathogenic microorganisms in food through the use of antibody-coated paramagnetic beads that selectively bind and purify the target microorganisms. It is currently the only commercially available detection system that has the ability to analyze a large food sample (225 ml + 25 g) with recirculation occurring every 30 seconds through a capture phase in which the antibody-coated magnetic beads are immobilized. These detection systems have been successfully used for microbial extraction from foods for microorganisms such as *Escherichia coli, Cronobacter sakazakii (Enterobacter sakazakii)*, *Shigella sonnei* and *Salmonella (1, 23, 32, 38)*. Pathatrix™ is being used more and more for foodborne bacterial detection in industry by companies such as Kraft Foods *(20)*, ConAgra *(18)*, and Cadbury Schweppes *(19)* and is also becoming a means of bacterial detection for the governmental agencies being utilized by the California Department of Public Health for detection of *E. coli* O157:H7 during recent outbreaks in spinach *(21)*. Although immunomagnetic capture is increasingly used for bacterial detection, viruses are not routinely tested for, despite the fact that cationic beads are available for virus detection. This method of immunomagnetic capture has been demonstrated to be an effective means of detecting foodborne viruses in ready-to-eat foods, combined with RT-PCR *(14, 24)*.

Viruses are estimated to be the causative agent of over half of the foodborne disease cases in the United States *(16, 31)*. Enteric viruses are usually transmitted through the fecal-oral, route, and foods can become contaminated environmentally or through food-handlers with poor hygiene practices. Viruses need be present in only small amounts to cause disease and cannot multiply in foods. Foods of primary importance for viral detection are those likely to be contaminated at the pre-harvest stage. Foods that have been implicated in large outbreaks include bivalve mollusks, salad crops such as lettuce and green onions, and soft fruits such as raspberries and strawberries *(25)*. These cases may be attributed to a variety of enteric human pathogens, including norovirus, hepatitis A virus, adenovirus, rotavirus, and Aichi virus.

Noroviruses are the leading cause of nonbacterial gastroenteritis. Cell culture systems for human norovirus are not available, since the 3D model has not yet been replicated. More than 56% of norovirus outbreaks are associated with eating salads, sandwiches or fresh produce, indicating that contamination of foods requiring handling but lacking a heating step is an important source of norovirus infection *(34)*. Since human noroviruses cannot be routinely and easily propagated in cell culture, the study of their basic virology and survival under environmental stress is difficult *(4)*. Norovirus surrogates, feline calicivirus and murine norovirus, are currently used as substitutes for human norovirus, because they can be routinely and easily propagated in cell culture. In this study, feline calicivirus (FCV) was used because of its ability to be assessed in cell culture.

Enveloped viruses such as those that cause influenza, both avian and swine, have the potential for foodborne transmission, and for this reason the ability to detect them in foods is important. This study used raccoon pox virus (RCN), an enveloped virus, as a means of determining if the immunomagnetic capture system is able to detect these enveloped viruses.

Picornaviruses used in this study were Aichi virus (AiV) and hepatitis A virus (HAV). Incidences of HAV infection are well documented, and it is estimated that approximately 84,000 cases of infectious hepatitis occur per year in the United States *(22)* despite the availability of a vaccine. Most outbreaks of HAV occur from a single food establishment and are the result of contamination by a foodhandler; however, occasionally more widespread foodborne outbreaks are associated with food contaminated before distribution. Several outbreaks of HAV have occurred in which foods were environmentally contaminated and widely distributed. An outbreak of HAV-infected clams harvested from polluted waters in China caused approximately 300,000 illnesses *(11)*. In other HAV outbreaks, green onions *(33)*, iceberg lettuce *(27)*, and frozen strawberries *(12)* have been implicated. AiV is a picornavirus, like hepatitis A, and is a member of the genus *Kobuvirus* that causes gastroenteritis; AiV was first recognized in Japan in 1989 as the cause of oyster-related gastroenteritis; the virus was first isolated from a stool specimen from a patient with oyster-associated nonbacterial gastroenteritis in Aichi, Japan *(35, 36)*. Oysters are the most common vehicle of AiV transmission; however, it has been suggested that there are other vehicles for AiV transmission, although they have yet to be identified *(37)*.

The objectives of this study were to assess the ability of cationic beads in an immunomagnetic capture system to detect foodborne viruses in foods and subsequently use cell culture for the detection of infective viruses. This study focused on the effect of the food matrix, virus type and factors influencing viral infectivity. The foods used in this study were ready-to-eat salsa and ultra-pasteurized 1% low-fat milk, which have very different properties. Salsa is a semi-solid food with a low pH of 4.2, while milk is a liquid food with a neutral pH of 6.6. Both foods were used in this study as representatives of different food matrices. Viruses under study included raccoon pox virus (RCN), feline calicivirus (FCV), aichi virus (AiV) and hepatitis A virus (HAV). Factors influencing infectivity, such as the removal of the virus bound to the beads, was determined by varying the elutant pH. Viral recovery for varying inoculum titers was assessed to determine the loading capacity of the virus-bound cationic beads.

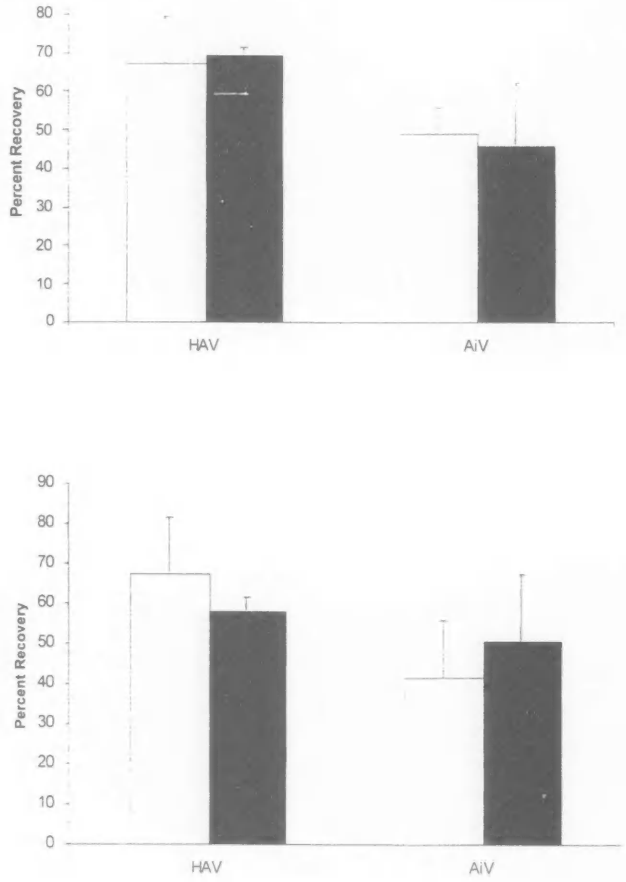
MATERIALS AND METHODS

Virus propagation, cell culture and viral quantification method

HAV (ATCC VR-1402) was propagated in fetal Rhesus monkey kidney cells (FRhK-4) (ATCC CRL 1688), using Dulbecco's modified Eagle's medium (DMEM) (Mediatech, Manassas, VA). FCV (ATCC VR-651) was propagated in Crandell Reese feline kidney cells (CrFK) (ATCC CCL-94), using minimal essential medium (MEM) (Mediatech). AiV (strain A846/88) was propagated in African green monkey kidney cells (Vero) (ATCC CCL-81), using MEM. RCN (ATCC VR-2212) was propagated in African green monkey kidney cells (Vero) (ATCC CCL-81), using MEM (Mediatech). Media were supplemented with 1% penicillin/streptomycin/amphotericin B (Mediatech), 1% sodium bicarbonate (Mediatech), 1% sodium pyruvate (Mediatech), and 1% MEM non-essential amino acids (Mediatech). Media were also supplemented with 2% fetal bovine serum (FBS) (Mediatech) for maintenance and 10% FBS for cell growth. All cells were maintained at 37°C in an atmosphere of 5% CO_2.

Viral titers were determined by tissue culture infectious dose for 50% of the cultures ($TCID_{50}$) and calculated using the Reed Muench method *(3)*. Cell monolayers were grown for 24 h in 96-well cell culture plates containing media with 10% FBS. Confluent cell monolayers were inoculated with serially diluted virus in Hank's balanced salt solution (HBSS) (Mediatech) and incubated (37°C) for 2 h. After a 2-h incubation,

FIGURE 1. Average percent recovery of virus. The comparison of average recovery by cationic beads in salsa from both the supernatant (□) and pellet (□) in virus elution buffer (pH 9.6) (A) and 0.1N HCl (pH 2.0) (B) for HAV and AiV determined by virus cell culture infectivity by $TCID_{50}$.



medium containing 2% FBS was added to the plates *(7)*. Plates were incubated at 37°C for specific times according to virus type, and cytopathic effects were observed microscopically and virus titers calculated. HAV was read for cytopathic effect 14 days post-inoculation (dpi), and FCV, AiV, and RCN were read 3–5 dpi.

Food sample preparation

Fresh salsa (containing tomatoes, green onions, green chilies, spices) was purchased at a local grocery store in Newark, DE. A 25-g sample of salsa was added to 225 ml of distilled deionized water according to the manufacturer's instructions for the regular-size sample cups used in the machine. Samples were inoculated with one virus type (10^7–10^8 $TCID_{50}$/g) including HAV, AiV, FCV and RCN. Milk (UHT, 1% low-fat) was purchased from local grocery stores in Newark, DE. Milk (250 ml) was inoculated with HAV, AiV and FCV virus (10^7–10^8 $TCID_{50}$/ml). Samples were placed in sterile stomacher bags (Fisher Scientific, Pittsburgh, PA) and placed in one of the sample pots of the Pathatrix™ machine according to manufacturer's directions.

Magnetic capture of foodborne viruses

Samples were run on Pathatrix™ for 60 min at room temperature (25°C), using 50 µl of positively charged cationic beads (ZCCB-CAT, Matrix MicroScience) according to manufacturer's instructions. After recirculation, the beads were washed with sterile water and recovered on a magnetic rack. Infectivity was determined by use of a tissue culture infectious dose 50% ($TCID_{50}$) assay and Reed Meunch calculations *(3)*.

To determine if viruses bound to beads are able to infect cell culture, salsa samples were inoculated with virus (HAV, AiV, FCV and RCN) and run on Pathatrix™ as previously described. After washing, beads were recovered in HCl (0.1N) or virus elution buffer (VEB) comprised of 100 mM Tris–HCl, 0.05M glycine, and 3% beef extract at pH 9.6 (Dubois et al., 2002). The eluted beads and solution were rocked for 24 h at room temperature. The beads were then pelleted using magnetic forces, the supernatant (1 ml) was collected, and the bead pellet was resuspended in 1 ml sterile water. The pH of both the supernatant and pellet samples were adjusted to 7.4 with 0.1 N HCl or 0.1 N NaOH. Infectivity was determined by $TCID_{50}$ and calculated by the Reed Meunch method.

Different virus elution solutions for virus recovery

The effect of different recovery media of varying pH on viral recovery was determined. Salsa and milk samples were inoculated with HAV and AiV (10^7 log $TCID_{50}$/g or ml) and run on Pathatrix™ as previously described. After the beads had been washed with sterile water, 1 ml of either HBSS, distilled deionized water (ddH_2O), virus elution buffer (100 mM Tris–HCl, 0.05 M glycine, 3% beef extract, pH 9.6) or HCl (0.1N) was added to the cationic beads. Samples were rocked for 24 h at room temperature, pH was adjusted to 7.4, and infectivity of bead samples was determined by $TCID_{50}$ and calculated by the Reed Meunch method. Viral recovery (%) was calculated, using the initial $TCID_{50}$ value of the inoculated virus as 100%.

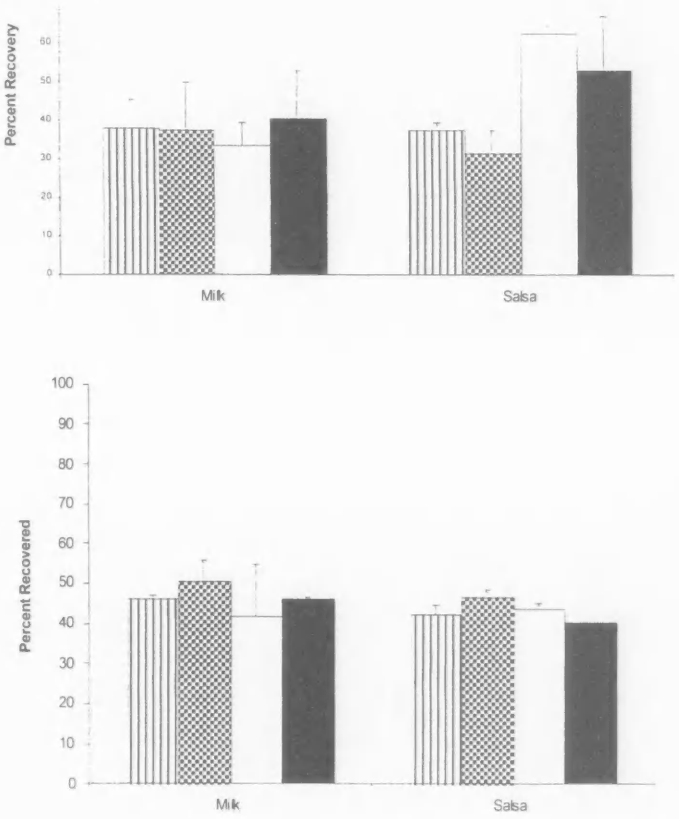
Viral loading capacity of the cationic beads

The viral loading capacity of the beads was investigated in inoculated milk samples (25 ml of UHT milk plus 225 ml of dH_2O) with $>10^7$, 10^6, 10^5, 10^4, and 10^3 $TCID_{50}$/ml of HAV and AiV. Samples were run on the Pathatrix™ and infectivity was determined as described previously.

Statistical analysis

Experiments were performed in triplicate on different days and are recorded as the means and standard deviations of these results. Difference of means *t*-tests were performed using Microsoft Excel 2007, and *P* values ≤ 0.05 were considered significant.

FIGURE 2. Percent recovery of virus. Comparison of recovery by cationic beads for HAV (A) and AiV (B) in both 1% low-fat UHT milk and salsa using Hank's Balanced Salt Solution (▥), distilled deionized H_2O (▩), virus elution buffer (pH 9.6) (□), and 0.1N HCl (pH 2.0) (□).



RESULTS

Variability in virus recovery

Viral recovery by flow-through immunomagnetic capture was shown to be dependent upon the type of virus used. The picornaviruses used in this study, HAV and AiV, were recovered best by cationic beads and detected by cell culture infectivity. FCV was recovered from the salsa when the cationic beads were treated with virus elution buffer in 1 out of 3 trials at 28.4%. FCV was recovered at a low percentage from salsa (28.1%) and was not recovered at all in milk samples (data not shown). RCN was not recovered in either food matrix (data not shown).

Removal of virus from cationic beads

The first elution method tested involved removal of the virus from the cationic bead surface by treatment with extreme pH solutions (Fig. 1). After recirculation in salsa, beads were treated with virus elution buffer (pH 9.6) or HCl (pH 2.0). After overnight rocking of the beads in solution, cationic beads were separated magnetically from supernatant solution and added to cell cultures separately. Beads added to cell culture without virus did not have any cytopathic effect on the cells, and therefore pelleted beads were added directly for viral infection. HAV and AiV recovery in supernatant and pellet samples after treatment with virus elution buffer and with HCl did not differ significantly. Varying amounts of HAV was recovered, between 67.2 and 69.6% in virus elution buffer and between 58 and 67.5% in HCl. There is a significant difference in recovery from pellet samples of HAV between virus elution buffer and HCl (P value < 0.05). AiV was recovered between 41.6 and 50.6% from all samples. No significant difference was observed between pelleted beads and the supernatant (P value > 0.05), indicating that viruses can infect cell culture while bound to the cationic beads. Collectively the recovery of virus from supernatant and pellet samples may be >100% because of biological variability of the cell culture infection assay.

Effect of food matrix and recovery medium on viral recovery

Virus recovery of the picornaviruses by cationic beads was tested in both milk and salsa, using four different virus recovery media of varying pH: Hank's Balanced Salt Solution (pH 6.5), sterile water (pH 6.0), virus elution buffer (pH 9.6) and 0.1 N HCl (pH 2.0) (Fig. 2). In all four virus eluting solutions, HAV recovery from milk was between 33.6 and 40.7%, and no significant difference was found between eluting solutions. HAV recovery from salsa samples was greatly affected by the type of elutant solution, so that the percent recoveries with all elutant types differed significantly (P value < 0.05), with the exception of H_2O and HBSS. HAV recovery from salsa was greatest when treatment was with virus elution buffer (62.3%), followed by treatment with HCl (53.3%). HAV from salsa samples showed an approximate 2–3 log increase in recovery when the cationic beads were subjected to the virus elution buffer, compared to when they were subjected to neutral pH elutants such as HBSS and dH_2O. HCl treatment of the beads showed a 1–2 log greater recovery of HAV. AiV recovery from milk and salsa ranged from 40.5 and 50.5%. Results with different eluting solutions used on the cationic beads did not differ significantly (P value > 0.05). Both milk and salsa samples showed a 3-log recovery when cationic beads were treated with HBSS.

Effect of virus concentration on recovery from milk

To evaluate if the low recovery of virus (< 50%) from the cationic beads (on average 3-log $TCID_{50}$/ml recovery) was due to the relatively large load of the virus added to the food sample (10^7 $TCID_{50}$/g or ml), the viral inoculum concentration was varied. Both AiV and HAV were not detected by the cell culture infectivity assay when milk was inoculated with $\leq 10^3$ $TCID_{50}$/ml. For both HAV and AiV,

TABLE 1. Viral recovery by cationic beads for varying viral inocula in milk (1% low-fat UHT). Cationic beads were resuspended in HBSS

	Recovery (Average %)	
Inoculum	**HAV**	**AiV**
> 7 log $TCID_{50}$/ml	33.8 ± 6.8	43.6 ± 11.4
6 log $TCID_{50}$/ml	49.0 ± 4.7	50.9 ± 15.9
5 log $TCID_{50}$/ml	Not detected	52.1 ± 4.2

virus recovery was significantly different between a 7-log inoculum and a 6-log inoculum (P value < 0.001) (Table 1). Variability in recovery detected by cell culture was observed for both picornaviruses at varying inoculum levels.

DISCUSSION

This study assessed the recovery of viruses from food samples by use of an immunomagnetic capture system. A major advantage of the Pathatrix™ immunomagnetic capture system is that large volumes of the food sample can be analyzed (25 g of food plus 225 ml of buffer) and the resulting sample is concentrated up to 500 fold *(24)*. Positively charged magnetic particles (cationic beads) were used in this magnetic capture system for the concentration and purification of enteric viruses from both salsa and milk. The negatively charged virus capsid is believed to be responsible for the attachment of the virus to the positively charged cationic beads *(24)*.

Viruses recovered from food matrices by immunomagnetic capture are able to infect cell culture when bound to the cationic beads. Recovery among the various virus families was shown to differ, most likely as the result of differences in viral capsid structure and available surface charge among the families. Both picornaviruses were recovered in higher concentrations than the caliciviruses, which were not consistently recovered by the cationic beads. Initial experiments with FCV, recovery in salsa showed no recovery of FCV, with the exception of one experiment out of three in which 28% of the FCV inoculum was recovered (data not shown). Because FCV is a respiratory virus and not an enteric virus like HAV and AiV, it is more sensitive to factors such as acidity *(4)*, and this sensitivity could have affected its recovery in salsa; however, because FCV was also not recovered in milk samples, it is unlikely that the low pH of the salsa played a role in the attachment of FCV to the cationic beads. This overall poor efficiency of FCV recovery from salsa indicated that FCV may not bind to the cationic beads as well as the picornaviruses (HAV and AiV). Caliciviruses have a cup-shaped morphology *(6)* that may affect the binding of the virus to the cationic beads. The raccoon pox virus could not be recovered with use of the cationic beads, most likely because of the lipid envelope, which lacks the negative charges that unenveloped viruses such as the picornaviruses and caliciviruses possess. This further demonstrated the mechanism of virus concentration by Pathatrix™. The neutral charge of the lipid envelope of RCN is most likely not attracted to the positive charge of the magnetic beads. A previous study suggested that the binding stability of the cationic beads with the virus may be a result of charge density of the viral capsid *(24)*.

To test whether the presence of the cationic beads interfered with cell culture infection, HAV and AiV recovered from salsa were removed from beads using extreme pH solutions: virus elution buffer (3% beef extract, pH. 9.6) and 0.1 N HCl (pH 2.0). Changing the pH of the eluting solution likely affected the electrostatic interactions between the viral capsid proteins and the cationic beads. Virus elution buffer is routinely used in studies to elute virus from food samples, including fruits and vegetables *(9)*, and it was shown to aid in the removal of viruses from acidic foods. After a 24-h treatment with extreme pH solutions, the cationic beads were pelleted and resuspended in sterile water. The supernatant and the pelleted beads were separately added to cell culture for infection. The average percent recovery of the supernatant and pellet samples, did not differ significantly (P value > 0.05) for both of the picornaviruses from salsa. Recovery of HAV and AiV was similar for both virus elution buffer and HCl samples, indicating that neither eluting solution was more effective than another (Fig. 1). These results also show that approximately the same amount of virus is present in both the supernatant and the pelleted beads (Fig. 1), indicating that it is unnecessary to remove the virus from the cationic beads before cell culture infection.

The average viral recovery of treating cationic beads post-circulation with various eluting solutions (Fig. 2) shows that with the exception of HAV in salsa, the eluting solution used did not affect recovery. In salsa, HAV was recovered to a greater extent with the extreme pH solutions. The percent recovery is consistent with the recovery seen for HAV with the virus elution buffer and HCl when supernatant and the pelleted beads were separated (Fig. 1). It is likely that the pH of the salsa and the pH of the elutants played a role in the attachment of the cationic beads to HAV. HAV-inoculated milk and AiV-inoculated milk and salsa had an average recovery of > 37% and < 50% with an average of > 3 log recovery (Fig. 2). HBSS showed consistent recovery for both viruses in both food samples, which indicates that HBSS is an ideal recovery medium. Other than HAV recovery in salsa with virus elution buffer and HCl treatment, the food matrix did not affect the percent recovery of virus. HAV recovery between milk and salsa samples using HBSS and H_2O were not significantly different; however, results with virus elution buffer and HCl were significantly different (P value < 0.05). AiV recovery between milk and salsa did not differ significantly by (P value > 0.05).

HAV showed greater recovery from salsa, compared to AiV, in the supernatant and pellet experiment for both virus elution buffer and HCl treatment (Fig. 1). This was also observed with HAV recovery from salsa when samples were treated with VEB and HCl (Fig. 2). This greater recovery of HAV in both virus elution buffer and HCl indicated that a strong acid or base helps to detach HAV from the cationic bead before infection, increasing recovery. AiV was consistently recovered in different media over a range of 40–50% (Fig. 1 and 2), indicating that AiV may not need a strong acid or base for detection by cell culture infection.

Recovery was qualitatively affected by the food matrix, as repeatedly more beads were visually collected from the milk samples compared to the salsa; however, this was not qualitatively observed, since the infectivity rates did not differ (Fig. 2). One potential pitfall is that virus bound to the beads will remain within the initial capture phase. For example, the viruses

could get trapped alongside food pieces or within the sponge that is in contact with the food sample being tested. This was observed in the qualitative recovery of virus from salsa as compared to milk. The low recoveries of viruses (< 50% average recovery) observed could have been caused by a high virus:bead ratio, virus particle aggregation, and/or virus-bead association that subsequently inhibited the virus infection process, pitfalls that all have been previously suggested *(24)*.

Limited recovery (< 50%) could be due to having too much virus present in the food sample for the amount of beads circulating through the food, causing virus to be left in the food sample, thus affecting the recovery percentage. This high virus-to-bead ratio hypothesis was tested by varying the amount of virus (AiV and HAV) added to the milk food sample. It is unknown how many virus particles can bind to the beads. Viral concentrations of 3 log $TCID_{50}$/ml up to 7 log $TCID_{50}$/ml were added to milk samples. A greater recovery of both picornaviruses at an inoculum of 6 log $TCID_{50}$/ml indicated that the inoculum used in this study (1×10^7 $TCID_{50}$/ml) may have been too high and ultimately could have resulted in a lower percent recovery of virus (Table 1). AiV and HAV detection by the cell culture infectivity assay showed varying results when low titers of virus were added to the milk samples. Varying viral inoculum amounts, as would be found in naturally contaminated food products, showed inconsistent detection via immunomagnetic capture system.

By using both salsa and milk to determine viral recovery, we used two very different food matrices. Salsa has a low pH (4.2) and is a physically complex food matrix that contains chunks of tomatoes, onions and peppers. The vegetables in the salsa are also composed predominately of carbohydrates, in contrast to the milk, which is composed of proteins and fats as well as the carbohydrate lactose and is a liquid medium with a moderate pH (6.6). It has been shown that the composition of the food matrix can impact the recovery of viruses during extraction procedures, even when Pathatrix™ recovery is coupled with RT-PCR *(2, 17)*. Because the cationic beads are nonspecific, it is possible that they can bind to food components, and this in turn could affect viral recovery with the beads.

In this study, AiV recovery was between 31 and 62%, varying with the food matrix and elution buffer used; HAV recovery was 36–70% in all trials. The cationic beads were able to recover HAV in greater amounts than these recovered in previous studies utilizing other methods of extraction and detection *(9, 17)*. Dubois et al. *(9)* showed that 15.3–25% of HAV was recovered from raspberries with use of a virus elution buffer (100 mM Tris-HCl, 50 mM glycine and 3% beef extract, pH 9.5), PEG precipitation and concentration by chloroform/butanol. Percent recovery of virus was evaluated by cell-culture assay with an initial inoculum of 4×10^5 $TCID_{50}$/100 g. Leggitt and Jaykus *(13)* recovered HAV in a range of 2–19% in lettuce and from 2–13% in hamburger meat. Inoculum titers of 1×10^3 PFU was the limit of detection for both lettuce and hamburger. Recovery of viruses from foods via cationic beads had a greater yield than yields obtained with previous research methods.

The ability of viruses to infect cell culture while bound to the cationic beads indicates that cells are unaffected by the presence of the beads and that cytopathic effects can be observed (Fig. 1). Being able to use cell culture infectivity assays for viruses while these are still bound to cationic beads allows for the determination of infectivity and demonstrates that the virus is able to perform the cytopathic effects necessary to lead to illness. Viruses present in foods may be inactive due to partial degradation during storage or processing *(26)*, and such damage would be anticipated in viruses that are exposed to stresses such as high salt content, freeze-thaw cycles, heat, chlorination, chemicals and physical stresses. Current foodborne virus detection methods include isolation, purification and detection by RT-PCR; however, these research methods for virus detection are diverse, complex, poorly standardized and restricted to specific laboratories *(25)*. With RT-PCR methods, a positive signal indicated an intact segment of viral genomic RNA but does not tell anything about infectivity of the virus. False-negative results of virus testing are a potential problem and occur as a consequence of inefficient virus and/or nucleic acid extraction and inhibition of the reverse transcription reaction through nucleic acid detection techniques *(25)*. The extraction of enteric viruses from foods by immunomagnetic capture is an attractive option because of the few steps necessary and high recovery percentages of picornaviruses. Cell culture assay for viral detection provides a means of determining infectivity of the virus, which makes this an ideal extraction method of viruses from foods for inactivation studies.

Viral agents are frequently suspected as the cause of foodborne outbreaks; however, because of the lack of sensitive and reliable detection methods, the viral cause is rarely confirmed through direct isolation of the virus from the implicated foods (Sanchez et al., 2002). Detection of viruses in foods has posed a problem, and more research is required to develop cost-effective reliable methods, especially the extraction of virus particles from large food samples. Through the use of cationically charged magnetic beads on a flow-through capture system, picornaviruses such as HAV and AiV were recovered from two different food matrices. Viruses recovered were able to infect cell culture, and the use of varying pH elutants did not affect recovery of viruses in the food matrix, with the exception of HAV in salsa when the virus elution buffer and HCl were used.

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GENERAL INTEREST PAPER

Re-engineering the United States Food Safety System

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SUMMARY

The current food safety system is broken, with a patchwork of surveillance systems and over 15 agencies in charge of food safety; this was made clear in February with the Peanut Corporation of America *Salmonella* contamination. In this article, we describe a new approach to risk management that can potentially support re-engineering the United States food safety system. The model, based on systems theory, departs from the traditional chain-of-events models and uses a systems engineering approach to tackle the problem.

INTRODUCTION

Every year, one in four Americans will suffer from food poisoning, according to the US Centers for Disease Control and Prevention (CDC) *(5)*. In recent years, bagged spinach, green onions, hot peppers and tomatoes were recalled because of hepatitis A, *Escherichia coli* O157:H7, and *Salmonella* contamination. At the beginning of the year, *Salmonella*-tainted peanut butter products manufactured by the Peanut Corporation of America (PCA) in Georgia killed nine people, sickened an estimated 22,000 and forced manufacturers to recall over 3,000 products *(4, 6, 13)*.

The current food safety system, with a patchwork of surveillance systems and over 15 agencies in charge of food safety *(2)*, was designed for a much simpler and local food supply chain and is overwhelmed in this new environment. Four major federal agencies (FDA, USDA, EPA and DHS) and a myriad of state agencies are in charge of inspections, standards, regulation and certification of the US food supply chain. This makes for a very complex system in which the different agencies act independently and with potentially overlapping mandates. Parts of the food supply chain can fall through the cracks of those agencies and go unmonitored and unregulated. Furthermore, the agencies, both at the state and federal levels, are underfunded and do not have sufficient resources to conduct health inspections of local plants, much less inspect foreign production plants. New regulation and new funding are long overdue to help protect the health of the American public. The existing system is outdated, puts the public at risk, and goes against the long-term financial interests of food manufacturers *(16)*.

Similarly, the monitoring system in charge of detecting foodborne illnesses is very slow to react and is not designed to properly handle food contamination at the national or international level. Foodborne illness can spread all across the country—the peanut butter *Salmonella* contamination affected people in 43 different states and in Canada *(15)*. It can originate either from within the country or from abroad—in 2008, a *Salmonella* outbreak resulted from contaminated jalapeño peppers from Mexico *(3)*. It typically takes two weeks between the time someone is diagnosed with an illness and the time the test result is submitted to federal officials. At the same time, the food supply chain is so complex that it is often hard to trace the problem back to the contamination source. The Minnesota Department of Health, known as one of the best in the nation, followed several wrong leads before being able to track down the peanut butter problem, thanks to jars of peanut butter found in a nursing home *(8)*.

Clearly something needs to be done to fix these problems, but the question is, What? A recent report provided nineteen recommendations for strengthening the system *(18)*. Sometimes, however, intervening in complex systems leads to similar or even worse problems through unintended consequences. Standard risk management engineering techniques include building and analyzing models to understand the sources of risk and to evaluate potential changes meant to reduce risk; however, those techniques have had limited applicability to these types of problems because the tools were created for man-made engineering artifacts in which the assumptions do not match those of more complex, socio-technical systems like the food and public health systems.

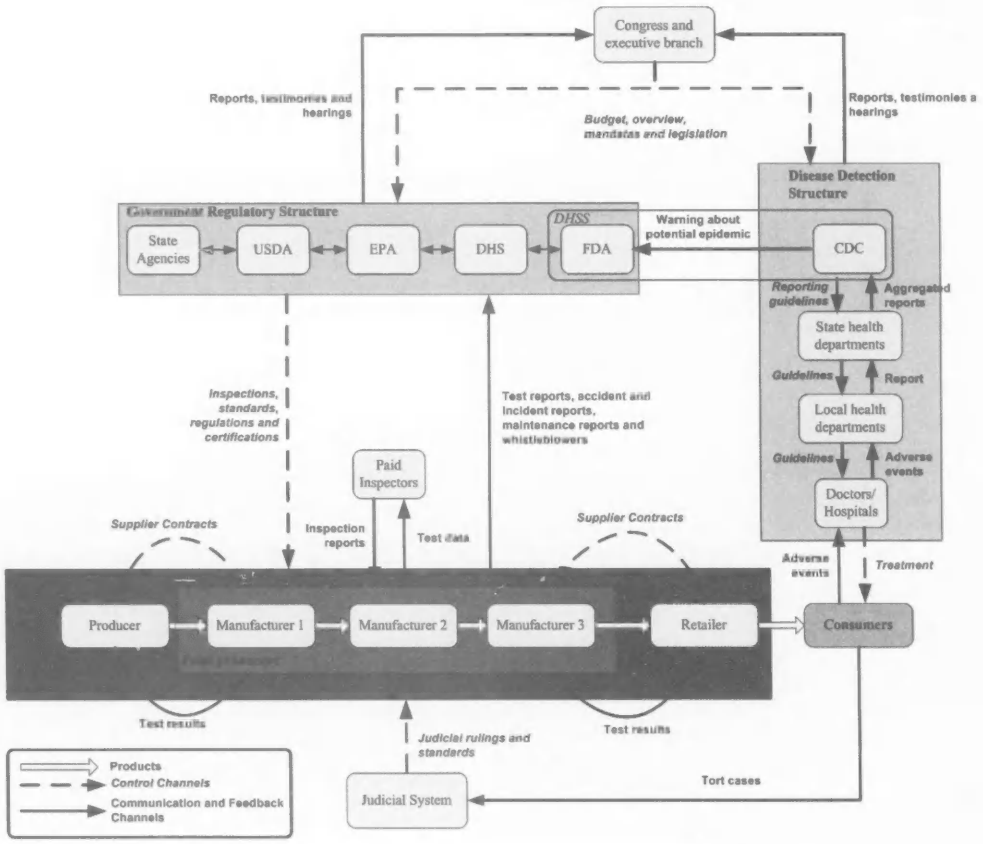
New engineering risk management approaches that do work on complex social systems, however, are applicable. In this article, we describe a new approach to risk management that can potentially support re-engineering the US food safety system.

The first step in the reengineering process is to model and analyze the current safety control structure. The models can then be used to generate and evaluate potential changes and improvements.

MODELING THE CURRENT US FOOD SAFETY SYSTEM

Traditionally, engineering safety and loss techniques are based on a model of causality that assumes that losses occur because of chains of directly-related failure events. For example, the owner of a peanut factory ships peanuts that have failed tests for contamination, the peanuts are used in commercial products, and customers get sick. A root cause is assessed, which is usually some event along the chain. In the example, the root cause assessed might be the actions of

FIGURE 1. Simplified safety control structure of the US food supply chain



the factory owner. While other events could be added to the chain, including events occurring before the owner's actions, a root cause event is always identified. The selection of this event is somewhat arbitrary, but often the chain is propagated back to some human operator in the system or some physical failure of a system subcomponent.

This chain-of-events causality model has been very effective in relatively simple, engineered systems. It has much less ability to understand the cause of accidents in more complex, socio-technical systems, however. Although it provides information for assessing blame, particularly in legal cases, it does not provide the type of understanding needed to re-engineer the system and eliminate future losses. For example, by simply tracing the current food safety problems to a rogue and unethical president of a food processor (such as in the PCA and melamine cases), the solution appears to be to punish the person responsible. However, that does not lead to the changes in the system necessary to ensure that such events do not recur in the future. A more comprehensive model of loss causality can do the latter. By using such a model, all the causal factors can potentially be identified and fixed, even those that are only indirectly related to the events that occurred.

In such a causality model, instead of treating safety as the result of a chain of system component failures, safety is instead treated as a control problem. One such model, called STAMP (System-Theoretic Accident Model and Processes) *(9–11)*, is based on systems theory and systems thinking rather than traditional reliability theory. In STAMP, safety is treated as an emergent property that results from the enforcement (through system design and operation) of safety-related constraints on the behavior of the system components. Accidents or losses result from unsafe interactions among humans, machines or physical devices, and the environment. Losses are the result of complex processes, including indirect and feedback relationships, rather than simply chains of directly-related failure events.

Safety then can be treated as a dynamic control problem rather than an individual component reliability problem. Many accidents result from dysfunctional interactions among components that have not failed; that is, they are operating as expected but the overall system design is unsafe. Each component of the food chain works to optimize its own goals, but the overall operation of these components, given the controls in place, is not adequately protecting public health.

Safety constraints and requirements

For the US food safety system, the hazard to be prevented is foodborne illness. The overall system safety constraints are: (1) to ensure that food reaching consumers is safe for consumption while not unnecessarily

diminishing or interrupting the food supply (which has its own public health implications), and (2) to provide for fast and effective recall of dangerous products should the first constraint somehow be violated. Using these constraints, general requirements can be derived for the "engineered" system, such as (1) health regulation standards must be established, (2) food producing and processing facilities must be certified and inspected for compliance with the standards, and (3) a system must exist for identifying, tracking, and recalling dangerous products, etc.

The goal for engineering our food safety system is to design a control structure that will implement the identified requirements. Figure 1 shows a simplified control structure for the US food safety system. Each component of this structure has its own responsibilities with respect to the overall system responsibility (safety constraints).

For example, the official responsibiliies of the FDA *(1)* are to:

- regulate all food and food-related products, except for a few items that fall under the jurisdiction of the USDA (e.g., processed egg products, meat and poultry products).
- ensure the safety of the production, processing, packaging, storing and holding of all domestics and imported foods, except for those products that are under the jurisdiction of the USDA.
- approve new food additives and monitor ingredients and foods to see that they are contaminant free.
- inspect plants and keep track of what each plant manufactures.

As another example, the responsibilities of paid inspectors are to:

- inspect food manufacturing plants to ensure they meet the standards provided by the appropriate regulatory agencies.
- provide inspection reports to the plant owners indicating any compliance issues related to the appropriate regulatory standards.

When losses occur, either some or all of the food safety system components did not fulfill their responsibilities, or the overall design of the system (the design of the components and their responsibilities) does not adequately fulfill the system goals and needs to be redesigned.

Controls

Each component of the food safety system has potential controls and control actions it can use to execute its responsibilities. Reengineering requires understanding the controls currently in place and, if necessary, designing more effective ones. The FDA, for example, can impose standards, conduct inspections, etc. A limitation of the potential FDA controls is that the agency does not have the power to initiate a food recall. Note that controls need not be draconian, external measures. In engineering, component failures and unsafe interactions may be "controlled" through system and component design (e.g., redundancy, interlocks, fail-safe design) or through process (manufacturing processes and procedures, maintenance processes, operations), or through social controls. Social controls, in turn, need not necessarily be governmental or regulatory; they may also be cultural, policy, or individual (self-interest). As an example of the latter in our current financial crisis, when investment banks went public, individual controls to reduce personal risk and long-term profits were eliminated and risk shifted to shareholders and others who had few and weak controls over those taking the risks. Food producers and manufacturers, who have the most actual control over the safety of the food supply, may be motivated by the need to maintain their customers and thus stay in business or simply through moral considerations. Some controls may be more or less effective than others, and their effectiveness can change over time.

Controls must be designed and implemented throughout the whole system, not just on some of the components, and the communication channels for information and feedback must be in place and operational. Losses occur when the controls are inadequately designed or they degrade over time.

Influences, pressures, and changes over time

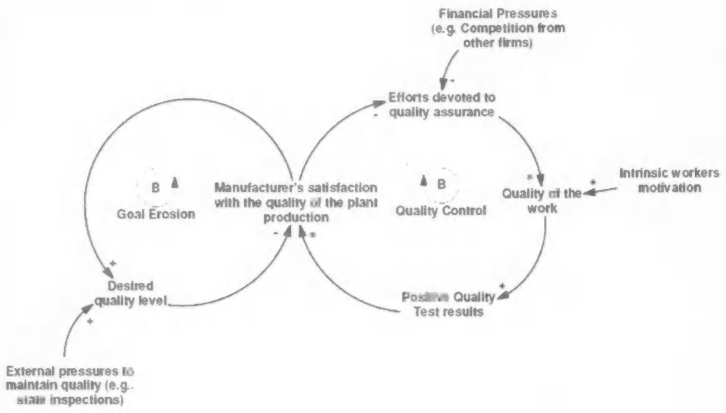
An underlying assumption of STAMP is that most people do not act with malevolent intent but instead are operating under pressures and perhaps with inadequate knowledge that can lead to actions that are contrary to public health. Major accidents often result from a slow migration of the system due to competitive and economic pressures *(10, 14)* that result in a state of unacceptable risk. Usually nobody intends to harm other people, but these pressures can lead to taking larger risks or inadequately executing responsibilities.

Because of various contextual and stress factors, the behavior of the enforcers of regulatory and other controls over food safety will tend to change over time. In addition, structural changes may be made to the system without adequate consideration of the implications of the change on the various system components' ability to oversee and control safety. One factor in the *E. coli* O157:H7 contamination of the water supply of a small town in Ontario, Canada, was the privatization of the government water testing laboratory without establishing feedback loops from the private labs to the government overseers of the water system to detect when operating conditions were degrading *(11)*. This flaw in the altered water system safety control structure is similar to limitations in the US food safety control structure in that the FDA does not have access to data provided by inspectors hired by the manufacturers. This flaw becomes clear once the system is viewed as a control structure, as illustrated in Figure 1.

It is the responsibility of the safety control system to prevent migration to unacceptably high states of risk (i.e., unacceptable safety system component behavior) or to detect when it is occurring and respond appropriately. So, re-engineering the food safety system (or any socio-technical system) requires understanding the context in which decision making takes place, particularly those factors that militate against a controller providing the control necessary to successfully fulfill its responsibilities.

For example, food safety has to compete with other governmental priorities (e.g., healthcare, the environment, national defense, education) when Congress determines funding levels for the government food regulatory agencies and the disease detection structure. Food safety is only one of the FDA's responsibilities, which can lead to difficult decision-making about allocation of resources within the agency. As another example, while plant safety inspections are typically required by the companies that purchase raw products, external inspectors are typically paid by the owners of the plants they are inspecting, and there is no standard procedure the auditors have to follow when inspecting a plant. In addition, plant inspection is a competitive business. For-hire inspectors can lose business when they provide a poor grade to a plant or a negative test result, or plant managers can switch companies to get the results they want. In return, the food industry is competitive, which leads to cost cutting pressures, and food producers are for-profit companies. The number of food producers is very large, making it difficult to provide much state or federal oversight.

FIGURE 2. Quality assurance model, adapted from Business Dynamics: Systems Thinking and Modeling for a Complex World



The interactions among the contextual factors and pressures in this very large and complex food safety control structure can themselves be complex, and changes meant to fix one problem may be less effective than intended or may create unintended consequences. Computational and simulation models can be constructed to assist in understanding these interactions and to redesign the system to mitigate some of these contextual pressures. To accomplish this goal we use system dynamics *(17)*.

The field of system dynamics, created at MIT in the 1950s by computer pioneer Jay Forrester, is designed to help decision-makers learn about the structure and dynamics of complex systems, to design high leverage policies for sustained improvement, and to catalyze successful implementation and change. System dynamics provides a framework for dealing with dynamic complexity, where cause and effect are not obviously related. It is grounded in the theory of non-linear dynamics and feedback control, but also draws on cognitive and social psychology, organization theory, economics, and other social sciences.

"All too often, well-intentioned efforts to solve pressing problems create unanticipated 'side effects.' Our decisions provoke reactions we did not foresee. Today's solutions become tomorrow's problems. The result is policy resistance, the tendency for interventions to be defeated by the response of the system to the intervention itself. From California's failed electricity reforms, to road building programs that create suburban sprawl and actually increase traffic congestion, to pathogens that evolve resistance to antibiotics, our best efforts to solve problems often make them worse. At the root of this phenomenon lies the narrow, event-oriented, reductionist worldview most people live by. We have been trained to see the world as a series of events, to view our situation as the result of forces outside ourselves, forces largely unpredictable and uncontrollable… System dynamics helps us expand the boundaries of our mental models so that we become aware of and take responsibility for the feedbacks created by our decisions." – John Sterman *(17)*.

In system dynamics models, behavior over time (the dynamics of the system) can be explained by the interaction of positive and negative feedback loops. Figure 2 shows a simple example of a causal loop diagram modeling the quality assurance process within a manufacturing firm.

In Fig. 2 there are two main control loops, both of them balancing loops: Quality Control and Goal Erosion. An arrow denotes a variable that influences another variable. The "+" means the two variables connected by the arrow move in the same direction, while "–" denotes the values of the variables move in opposite directions. For example, as financial pressures increase, efforts devoted to quality assurance can degrade.

Process models

The *process model* is an important component of STAMP-based modeling. A basic theorem in control theory is that in order to provide effective control, a controller must have an accurate and complete model of the system it is controlling. The model is used to determine what control actions are necessary to provide to keep the system operating effectively (see Fig. 3). This process model includes assumptions about how the controlled process operates and the current state of the controlled process.

Losses often occur when the controller's process model becomes inconsistent with the true state of the process and inadequate control is therefore applied. For example, the FDA thinks that the food manufacturers themselves or state and local authorities are adequately monitoring operations and does not impose additional monitoring or inspection activities. Process models are kept updated and kept accurate through information provided by feedback or other communication channels.

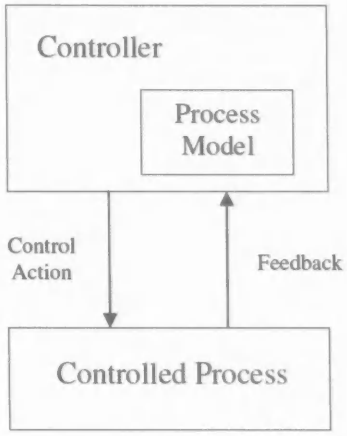
A potential cause of inadequate control (and system hazards) is missing or defective feedback channels. For example, the government usually does not have access to test results provided by plant managers, by private inspectors, or sometimes even by state inspectors. The FDA has a hard time keeping track of all the manufacturers and what they produce. Process models (and thus control actions based on these models) may be deficient simply because of inadequate scientific knowledge; for example, *Salmonella* has not commonly been considered a risk associated with peanut butter, and therefore inspectors may not test for it. Time lags can be an issue in process model accuracy. Test results, for example, may come back after products have already been distributed.

Coordination among controllers

Another common causal factor in accidents is inadequately coordinated controls exercised by multiple controllers. When a system or system component is controlled in multiple ways, it is easy to assume that the other controller is operating effectively (and thus not to feel it necessary to exercise one's own controls) or for two controllers to conflict in the control actions they take, thus inadvertently leading to inadequate overall control and a loss event. As an example, in the recent peanut events, both the federal government regulatory agency (the FDA) and the Georgia food safety regulatory agency had responsibility for inspecting PCA. The FDA relied on the Georgia Department of Agriculture and therefore had not inspected the plant in over 8 years *(7)*. However, the state did not have the budget to properly conduct those inspections because of rising needs and falling budgets: Georgia has only 60 agents to monitor over 16,000 plants *(12)*, which means that each inspector has to take care of more than 260 plants.

In general, no federal or state agency is mandated to take care of food safety exclusively. Different agencies have food safety responsibilities, usually on top of other competing responsibilities.

FIGURE 3. A General Control Loop showing the Process Model



The agency mandates are disjoint and overlapping, with some agencies having overlapping responsibilities while other potential causes of food hazards are unregulated. In general, the responsibilities are as follows:

- *Food and Drug Administration (FDA):* Ensures the safety of the production, processing, packaging, storing and holding of all domestic and imported foods, except for those products that are under the jurisdiction of the USDA; is responsible for safeguarding all ingredients used in food products, approving new food additives and monitoring ingredients and foods to see that they are contaminant free; sponsors the Hazard Analysis Critical Control Point (HACCP) plan.
- *Department of Homeland Security (DHS)*: Works with the FDA to assess threats to the food supply; trains workers on how to respond to a crisis and develops bioterrorism regulations.
- *Environment Protection Agency (EPA):* Regulates pesticide usage and sets water quality standards.
- *US Department of Agriculture (USDA)*: Regulates and monitors soil, water and wildlife on private property; monitors drinking water for rural Americans and meat, poultry and egg products for all Americans.
- *State agencies*: Fill in the gaps left by the federal agencies or exercise the responsibility delegated to them by the federal agencies.

In addition, there is very little communication and information sharing amongst the different agencies. Modeling and understanding the overlapping responsibilities as well as the communication channels is an important step in redesigning this system.

USING THE SAFETY CONTROL STRUCTURE MODEL TO RE-ENGINEER A SAFER SYSTEM

Some flaws in the safety control structure can be seen simply by examining it once the model is created. For example, whenever there are multiple controllers (as is true in the US food safety system), there is potential for overlaps and gaps in control responsibilities. In addition, various types of analysis techniques (called *hazard analysis* in engineering) can be applied to the model, both formal (based on mathematical analysis) and informal (based on heuristics and expert knowledge).

STAMP, the safety modeling technique used in this paper, has associated with it a technique called STPA (STamP Analysis). Basically, STPA is a rigorous method for examining the control loops in the safety control structure to find potential flaws and the potential for (and causes of) inadequate control actions. STPA is much more powerful than HACCP because it is based on a more general model of how losses are caused.

Flaws in the safety control structure identified by STPA can be used to redesign or re-engineer the safety controls. In turn, the model and analysis techniques can be used to evaluate proposed changes. Changes may involve adding or strengthening communication and feedback channels in order to ensure accurate process models and thus improved decision making. Other changes may require redistributing responsibilities, coordinating or consolidating oversight, or simply clarifying the assumptions and rules under which the system operates.

The models are useful for one other objective. Safety control systems tend to degrade over time as the result of conflicting pressures and goals. Detecting examples of this degradation, such as, changes in the way people in the system are performing their roles over time, before a serious loss occurs is clearly better than waiting for a loss to occur and then making necessary changes. The models provide a starting point for identifying metrics and leading indicators of increasingly risky behavior that should be collected and examined for increasing risk.

CONCLUSIONS

A new approach to system safety engineering has been described that treats safety and loss as a control problem. Accidents and losses are considered to be dynamic processes rather than just a chain of events started because of a single or a few isolated events or failures. Instead of focusing only on the *events* that occur prior to a loss in order to determine why it occurred and how to prevent future occurrences, the entire dynamic accident or loss process is investigated, i.e., why the overall safety control structure did not enforce constraints on the behavior of the system components that would have prevented the loss. In STAMP, violation of constraints may result from environmental disturbances or conditions, system component failures, or unsafe interactions among the system components. Inadequate control actions can be traced to:

- A lack of designed controls
- Inadequate operation of the existing controls, perhaps due to:
  - Controller process models that do not match the state of the process being controlled because of missing or inadequate feedback and communication channels
  - Social and political contextual factors

- Degradation of the safety-control structure over time
- Inadequate coordination of safety-control actions among multiple controllers

Using this approach, it is possible to model and understand the dysfunctionalities and interactions that lead to food safety problems in the US, to evaluate potential changes for both their intended and unintended consequences, and to identify potential leading indicators and metrics to detect migration of the food safety system toward states of higher risk. There is no perfect solution to food safety problems, simply a continuum of interventions and changes that have overlapping but sometimes different benefits and drawbacks. New system engineering approaches can provide more scientific evaluation and comparison of these solutions.

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Call for Nominations 2010 Secretary

A representative from the education sector will be elected in March of 2010 to serve as IAFP Secretary for the year 2010–2011.

Send letters of nomination along with a biographical sketch to the Nominations Chairperson:

David A. Golden, Ph.D.
University of Tennessee
Dept. of Food Science and Technology
2605 River Dr.
Knoxville, Tennessee 37996-4591
Phone: 865.974.7247
E-mail: david.golden@tennessee.edu

The Secretary-Elect is determined by a majority of votes cast through a vote taken in March of 2010. Official Secretary duties begin at the conclusion of IAFP 2010. The elected Secretary serves as a Member of the Executive Board for a total of five years, succeeding to President, then serving as Past President.

For information regarding requirements of the position, contact David Tharp, Executive Director, at 800.369.6337 or 515.276.3344; Fax: 515.276.8655; E-mail: dtharp@foodprotection.org.

Nominations Close October 30, 2009

NEW MEMBERS

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Gabriela L. Stancanelli
3M Argentina
Buenos Aires

AUSTRALIA

Graeme Richardson
DTS Food Laboratories
Kensington

BRAZIL

Paula Martins Freitas
Carapicuiba, Sao Pãulo

Adriana R. Tassinari
3M Do Brasil Ltda
Jundiai, Sao Pãulo

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Mark Feduke
VLM Food Trading International Inc.
Kirkland, Quebec

Brian Fones
3M Canada Company
London, Ontario

Lerrin French
3M Canada Company
London, Ontario

Yuncai Gao
Neova Technologies, Inc.
Abbotsford, British Columbia

Beverley Hale
University of Guelph
Guelph, Ontario

Lauren Jung
Canadian Food Inspection Agency
Victoria, British Columbia

John Kukoly
BRC
Fenwick, Ontario

Didier Leroux
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Marcel Lessard
VLM Food Trading International Inc.
Kirkland, Quebec

Moustapha Oke
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Saputo Dairy Products Canada G.P.
Montreal, Quebec

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bioMérieux
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Kallithea

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Goody's – Hellenic Catering
Sindos

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Bogor

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Kanagawa

Takahiro Ohya
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Russell Cross
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Mary Cuervo
Texas A&M University
College Station

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Grand Prairie

Sueann Kagel
Spartan BioScience, Inc.
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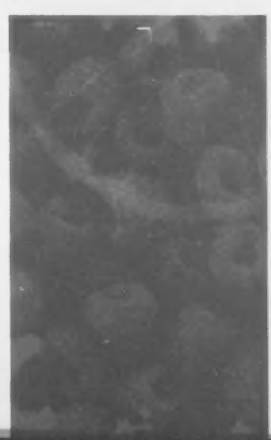



WHAT'S HAPPENING IN FOOD SAFETY

USDA and HHS Praise Guidelines for Foodborne Disease Outbreak Response

Agriculture Secretary Tom Vilsack and Health and Human Services (HHS) Secretary Kathleen Sebelius have commended the Council to Improve Foodborne Outbreak Response (CIFOR) for the new Guidelines for Foodborne Disease Outbreak Response. These guidelines assist local, state and federal agencies in preventing and managing foodborne disease outbreaks through planning, detection, investigation, control and prevention.

"Improving food safety is at the forefront of President Obama's agenda, and these Guidelines will help local, state and federal agencies to prioritize prevention, strengthen surveillance and enforcement, and improve response and recovery. Last week the Obama Administration took an important step forward by introducing tougher standards to reduce *Salmonella* contamination and *E. coli* outbreaks, and the Guidelines announced will help government agencies further that goal," said Tom Vilsack.

On March 14, 2009, the President created the Food Safety Working Group, co-chaired by Secretaries Vilsack and Sebelius. The Working Group is charged with enhancing our food safety system by building collaborative partnerships with consumers, industry and our regulatory partners.

"I would like to thank CIFOR for their hard work and for this vital contribution toward food safety reform. The Guidelines show that by working together, we can all dramatically improve our food safety system and further protect the public health. We hope to further this collaborative effort through the Food Safety Working Group," said Secretary Sebelius.

CIFOR is a multidisciplinary working group that includes representatives of local, state and federal agencies with expertise in the fields of epidemiology, environmental health, and laboratory science. This working group, chaired by the Council of State and Territorial Epidemiologists and the National Association of County and City Health Officials, was organized to reduce the burden of foodborne illness in the United States. USDA and HHS' agencies, the Food and Drug Administration and the Centers for Disease Control and Prevention, are the federal representatives to CIFOR.

The working group released a draft version of these Guidelines in June 2008, which then went through a public review and comment process.

To access the Guidelines and more information about CIFOR, please visit www.cifor.us.

Colorado Firm Recalls Ground Beef Products Due to Possible *Salmonella* Contamination

King Soopers, Inc., a Denver, CO, establishment, is recalling approximately 466,236 pounds of ground beef products that may be linked to an outbreak of salmonellosis, the US Department of Agriculture's Food Safety and Inspection Service (FSIS) has announced.

The products subject to recall are listed at http://www.fsis.usda.gov/News_&_Events/Recall_039_2009_Release/index.asp. The ground beef products were produced on various dates ranging from May 23, 2009 through June 13, 2009 and bear the establishment number "EST. 6250" within the USDA Mark of Inspection, which is printed on the front of the packages. The ground beef products were distributed to retail establishments in CO, KS, MO, NE, NM, UT and WY.

FSIS has no reason to believe that these products are still available for sale in commerce. However, consumers who may have purchased these fresh ground beef products between May 23 and June 23, 2009, and have stored them in the freezer should look for and discard or destroy these products.

As a result of an ongoing investigation into an outbreak of *Salmonella* Typhimurium DT104 associated with ground beef products, the Colorado Dept. of Public Health and Environment (CDPHE) notified FSIS of the problem. Epidemiological investigations and a case control study conducted by CDPHE and the Centers for Disease Control and Prevention (CDC) determined that there is an association between the fresh ground beef products and 14 illnesses reported in Colorado. The illnesses were linked through the epidemiological investigation by their less common pulsed-field gel electrophoresis (PFGE) pattern found in PulseNet, a national network of public health and food regulatory agency laboratories coordinated by the CDC.

FSIS would like to remind consumers of the importance of following food safety guidelines when handling and preparing raw meat. Ground beef should be cooked to a safe minimum internal temperature of 160°F.

This particular strain of *Salmonella*, *Salmonella* Typhimurium DT104, is resistant to many commonly prescribed drugs, which can increase the risk of hospitalization or possible treatment failure in infected individuals.

Consumption of food contaminated with *Salmonella* can cause salmonellosis, one of the most common bacterial foodborne illnesses. *Salmonella* infections can be life-threatening, especially to those with weak immune systems, such as infants, the elderly, and persons with HIV infection or undergoing chemotherapy. The most common manifestations of salmonellosis are diarrhea, abdominal cramps, and fever within eight to 72 hours. Additional symptoms may be chills, headache, nausea and vomiting that can last up to seven days.

3-A SSI Announces 2009 Volunteer Service Awards and Progress Report

3-A Sanitary Standards, Inc. (3-A SSI) announced the recipients of its 2009 Volunteer Service Awards and the release of a special progress report, *The Symbol of Assurance*, at the 3-A SSI Annual Meeting in Milwaukee, WI.

Introduced in 2008, the new 3-A SSI Volunteer Service Awards recognize the extraordinary dedication and commitment of individuals who contribute to the development of voluntary standards and the mission of 3-A SSI. Nominations for the awards are made by fellow volunteers among the three stakeholder groups in 3-A SSI regulatory sanitarians, fabricators, and processors and others.

Winners of the 3-A SSI Volunteer Service Awards for 2009 announced at the meeting included:

- Mr. Donald Wilding (Dairy Equipment Specialist, Illinois Dept. of Public Health, Div. of Food, Drugs and Dairies) received the *Leadership Service Award* for outstanding service to 3-A SSI voluntary standards development and significant contributions to the mission of 3-A SSI.
- Mr. J. Mel Jolly (Consultant) received the *Advancement Award* for outstanding accomplishments on behalf of 3-A SSI.
- Mr. Stuart Salvador (Paul Mueller Co.) received the *Next Generation Award*, made to an individual who has been engaged in 3-A SSI standards development activities for less than five years and has demonstrated leadership, dedication and significant contributions to the development of 3-A Sanitary Standards or 3-A Accepted Practices.

Highlights of 3-A SSI progress in the latest year are now available in the 2009 Annual Report, *The Symbol of Assurance*. The report is available at the 3-A SSI Web site under News & Events at http://www.3-a.org.news/2009annualreport.pdf or upon request from 3-A SSI.

FDA Egg Safety Final Rule

The US Food and Drug Administration has announced a regulation expected to prevent each year approximately 79,000 cases of foodborne illness and 30 deaths caused by consumption of eggs contaminated with the bacterium *Salmonella* Enteritidis.

The regulation requires preventive measures during the production of eggs in poultry houses and requires subsequent refrigeration during storage and transportation.

Egg-associated illness caused by *Salmonella* is a serious public health problem. Infected individuals may suffer mild to severe gastrointestinal illness, short term or chronic arthritis, or even death. Implementing the preventive measures would reduce the number of *Salmonella* Enteritidis infections from eggs by nearly 60 percent.

The rule requires that measures designed to prevent *Salmonella* Enteritidis be adopted by virtually all egg producers with 3,000 or more laying hens whose shell eggs are not processed with a treatment, such as pasteurization, to ensure their safety.

Details about the regulation can be found at www.fda.gov.

Jim Gorny, Jenny Scott, and Kathy Gombas Join FDA as Senior Advisors

Longtime produce industry safety expert Jim Gorny recently joined the Food and Drug Administration.

Sebastian Cianci, spokesman for the FDA, confirmed that Mr. Gorny started his new position as an advisor in mid-July.

Jenny Scott, of the Washington, D.C.-based Grocery Manufacturers Association, also joined FDA in early August. "Jenny has served the members of GMA for nearly 30 years," Mr. Cianci said.

Kathy Gombas has also joined the agency. She worked at Dean Foods and has previously worked for FDA.

"All three join the agency as senior advisors in the FDA's Center for Food Safety and Applied Nutrition's Office of Food Safety," Mr. Cianci said.

Agriculture Secretary Tom Vilsack Names Jerold R. Mande as Deputy Under Secretary for Food Safety

Agriculture Secretary Tom Vilsack has announced the appointment of Jerold R.

Mande, M.P.H., as deputy under secretary for food safety at the US Dept. of Agriculture (USDA). In this position, Mande will have responsibility for the Food Safety and Inspection Service, the USDA agency which protects public health through food safety and defense by ensuring that the nation's supply of meat, poultry and processed egg products are safe and wholesome.

"Jerold Mande brings years of experience in health, nutrition and epidemiology, food safety, and public policy in both government and academia that will greatly serve USDA and the public as we continue to work to protect public health," said Mr. Vilsack.

Most recently, as associate director for public policy at the Yale Cancer Center, Yale University School of Medicine, Mr. Mande developed a national model to increase support for cancer prevention and control, including diet, exercise, and obesity. He also initiated and helped manage the cancer center disparities program, to improve cancer control and care in underserved populations. He was also a lecturer in public health, and helped train select groups of physicians for careers in public policy.

Prior to this, Mr. Mande served on the White House staff as a health policy advisor where he helped lead key food safety, tobacco control and cancer initiatives, including expansion of FoodNet and PulseNet. He was Deputy Assistant Secretary for Occupational Health at the US Dept. of Labor. He also served as Senior Advisor and Executive Assistant to the Commissioner of the Food and Drug and Administration, where he led design of the Nutrition Facts food label, for which he received the Presidential Award for Design Excellence. Mr. Mande began his distinguished career in the US Congress where he was first hired to work on food safety legislation.

Mr. Mande holds a masters degree in Public Health (M.P.H. Nutrition and Epidemiology) from the University of North Carolina at Chapel Hill and a bachelor of science degree, magna cum laude (B.S. with Distinction in Nutritional Sciences) from the University of Connecticut at Storrs. He also attended the John F. Kennedy School of Government, Harvard University, completing a program for senior managers in government.

FMI and GMA Heads Join GSI US Board

Pamela G. Bailey, president and chief executive officer of the Grocery Manufacturers Association (GMA), and Leslie G. Sarasin, president and chief executive officer of the Food Marketing Institute (FMI), have been elected to the Board of Governors of GSI US, the supply-chain standards organization.

Ms. Bailey joined GMA in January 2009 after serving as president and CEO of the Personal Care Products Council. She has also served as president and CEO of the Advanced Medical Technology Association, and was founding CEO and president of the Healthcare Leadership Council (HLC), an organization of more than 50 healthcare industry chief executives. In the 1970s and '80s, Ms. Bailey served in the White House for three US presidents.

Ms. Bailey is currently a director of Greatbatch Technologies, Inc., and of the MedCath Corporation and is vice chair of the Partnership for Food Safety Education.

Ms. Sarasin joined FMI in November 2008. Previously, Ms. Sarasin served as president and chief executive officer of American Frozen Food Institute (AFFI). She also served as president of the National Yogurt Association, an association that AFFI managed, and had oversight responsibility for the National Frozen Pizza Institute, the Frozen Potato Products Institute, the International Frozen Food Association, the Texas-Mexico Frozen Food Council and the Food Processing Environmental Conference. She has also worked for the National Food Brokers Association, Crest International Corporation, Salomon Brothers Investment Bankers and Senator Wendell H. Ford.

Ms. Sarasin is a member of the Committee of 100 of the US Chamber of Commerce, which is comprised of the top 100 association executives within the Chamber's membership, and serves on the Board of Directors of the National Chamber Foundation. She serves on the Board of Directors of the Produce for Better Health Foundation and as a Board member of the US Former Members of Congress Auxiliary.

New Director-General for Campden BRI

Dr. Steven Walker has formally taken up the role of director-general of Campden BRI, succeeding Prof. Colin Dennis who retired in June. Steven joined the business in 1986 and was appointed director of research in 1995 – a role he held for 10 years. From 2005 until 2009 he was director of the division of cereals and cereal processing. During his 22 years of service, Steven has played a major role in both the scientific and commercial aspects of the business, has worked closely with our members, government and trade bodies on many issues, and has been actively involved in the evaluation of other research organizations in the UK and overseas.

Steven comments, "Industry faces major challenges – both com-

mercial and in terms of broader concerns such as food security and sustainable production. Science and technology offers many solutions, and as a major provider – with well-established networks throughout industry, government, universities and other research organizations – we are ideally placed to partner our members and other clients in meeting these challenges."

Bob Clarke, chairman of Campden BRI commented, "I am very much looking forward to working with Steven in the further development and strengthening of Campden BRI. These are exciting times as we begin to consolidate the benefits of the merger between the former Campden & Chorleywood Food Research Association (CCFRA) and Brewing Research International (BRI), including the increasingly international outlook of the business."

Erin Crowley Named AOAC Study Director of the Year

Q Laboratories, Inc. Microbiology R&D Laboratory Supervisor Erin Crowley has been named Study Director of the Year by AOAC International. Q Laboratories, Inc. is a Cincinnati-based company providing microbiology, analytical chemistry and research and development laboratory services to companies worldwide in the food, pharmaceutical, cosmetic, health and beauty care and dietary supplement industries.

The Study Director of the Year Award recognizes consistently outstanding performance by a Study Director over a period of years. Awardees will be honored during the Keynote Address and Awards Ceremony at the AOAC International Annual Meeting, September 14 in Philadelphia.

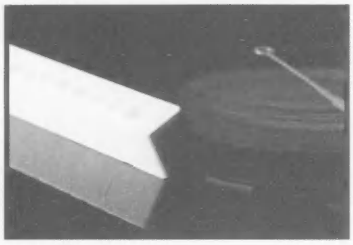
Study Directors design and conduct collaborative studies, work with General Referees and Committee Statisticians, enlist and assist collaborators, and write up the collaborative studies for the AOAC Official Methods Program.

The AOAC Official Methods Program is designed to provide fully validated methods that can be used with confidence by regulatory agencies, regulated industry, product testing laboratories, and academic institutions. They are subjected to an eight or more laboratory collaborative study according to internationally recognized standards and receive rigorous scientific review of performance results. Adoption of a method is based on the demonstration of its reliability and practicality by completion of a successful collaborative study.

AOAC International is committed to being a proactive, worldwide provider and facilitator in the development, use, and harmonization of validated analytical methods and laboratory quality assurance programs and services.

AOAC also provides a number of key publications, hosts technical meetings and conferences, and offers training courses in the areas of laboratory management, quality assurance, accreditation, statistics, and measurement uncertainty. Publications include the Official Methods of Analysis of AOAC International (OMA), the compendium of methods adopted by AOAC International, which contains over 3,000 methods, is distributed throughout the world, and is considered the most authoritative volume in its field.

INDUSTRY PRODUCTS



Hardy Diagnostics

Hardy Diagnostics Listeria-ID Panel

The Listeria-ID Panel from Microgen® is an AOAC-RI approved, *Listeria* identification panel, which is ideal for food, environmental, clinical, and pharmaceutical laboratories. Listeria-ID is a complete identification system for identifying all *Listeria* spp. from culture, with no additional materials required. The Listeria-ID system employs 12 standardized micro-well substrates and provides results in as little as 24 hours. Each panel has a built-in haemolysis test which is a key reaction when identifying *Listeria*. Easy-to-use identification software is included within the kit at no extra charge. This *Listeria* identification panel aids in the identification of the *Listeria monocytogenes*, *Listeria innocua*, *Listeria welshimeri*, *Listeria grayi*, and *Listeria ivanovii*.

Hardy Diagnostics is an FDA-licensed and ISO 13485-certified manufacturer of medical devices for microbiological procedures in both clinical and industrial laboratories. Over 6,000 laboratories are serviced by Hardy Diagnostics throughout the nation

Hardy Diagnostics
800.266.2222
Santa Maria, CA
www.hardydiagnostics.com

New Dust and Fume Collector from Farr Air Pollution Control

Farr Air Pollution Control has introduced a new Gold Series® GS4M Mini dust collector that controls emissions from small airflow applications up to 2,000 cfm. It incorporates the best features of Farr's premium Gold Series cartridge collectors – rugged construction, durability, high filtration efficiency and ease of service – into a compact and competitively priced unit ideal for capture of dust and fumes from laser cutting tables, welding stations and many other small airflow processes in the full range of manufacturing industries. The collector's extremely quiet performance and small footprint make it ideal for indoor applications, especially where noise and/or space constraints are a concern.

The collector is a fully assembled and pre-wired unit complete with a low-noise fan (< 70dB), controls, motor starter, filters and cleaning system. It contains four HemiPleat® flame-retardant filter cartridges with 788 total sq. ft. of media rated at 99.99 percent efficiency on 0.5 micron particles (MERV 12). HemiPleat technology has won multiple industry awards for its innovative "open-pleat" design that delivers longer cartridge service life at reduced pressure drop. The automatic, reverse pulse cleaning system is activated by an on-demand control panel that ensures more efficient cleaning and optimizes cartridge life. A safety monitoring filter is also included to allow recirculation of the filtered air downstream of the collector for energy savings.

The Gold Series GS4M collector uses a 3 horsepower fan motor designed to handle 1,000 cfm at 9" w.c. or 2,000 cfm at 5" w.c. static pressure. The footprint of the collector is approximately 38" square with a height of less than 8 ft. Maintenance features include a spark trap inlet for fire prevention, easy-to-remove aluminum dust drawers, and a cam-lock system that allows fast and easy cartridge removal with no tools required. An optional explosion vent is available for combustible dust applications. Different filter media, inlet configurations, a dust hopper and leg support structure, aluminum and stainless steel flex ducts, and a spark-resistant flex hose are among the many other available options.

Farr Air Pollution Control
800.479.6801
Jonesboro, AR
www.farrapc.com

Strategic Diagnostics' RapidChek® SELECT™ *Salmonella* System Awarded AOAC Emergency Response Validation Program Certification for Peanut Butter

Strategic Diagnostics Inc., a provider of biotechnology-based detection solutions for food safety and life science applications has announced that it has been issued a Certificate of Validation for its RapidChek® SELECT™ *Salmonella* system by the AOAC Research Institute Emergency Response Validation (ERV) program.

Be sure to mention, "I read about it in *Food Protection Trends*"!

The publishers do not warrant, either expressly or by implication, the factual accuracy of the products or descriptions herein, nor do they so warrant any views or opinions offered by the manufacturer of said articles and products.

INDUSTRY PRODUCTS

The AOAC Research Institute, a subsidiary of AOAC International, launched the ERV program in response to the second *Salmonella* recall linked to peanut butter in February 2009, the largest food recall in US history. This program is designed to respond immediately to emerging food contamination crises by rapidly evaluating detection methods of several candidates once a crisis is identified. The ERV program employs the Performance-Tested Methods℠ program operated by the AOAC Research Institute. The AOAC Research Institute awarded the RapidChek® SELECT™ *Salmonella* system Performance-Tested Methods status in 2006. The recently awarded Certificate of Validation extends the validation of the RapidChek® SELECT™ *Salmonella* system previously certified for the identification of *Salmonella* in various foods to now include detection of *Salmonella* in peanut butter.

Scott Coates, AOAC Research Institute senior managing director, commented, "Food processors and the President's Administration are responding to increasing pressure to protect the health of consumers. The AOAC's new Emergency Response Validation program supports these enhanced expectations by independently evaluating and validating the technologies that most effectively address *Salmonella* and other food safety outbreaks."

SDI offers a simple, accurate and reliable *Salmonella* testing solution to companies that manufacture peanut butter or use peanut butter in their manufactured products. SDI believes the RapidChek® SELECT™ *Salmonella* test method is unlike any other rapid or conventional method on the market. SDI's method delivers the industry's lowest rate of false results while still offering low start-up and operational costs including reduced sample preparation, transfer and incubation steps and no investment into capital equipment. Given the President's recent Food Safety Working Group recommendations, SDI believes there will be increased pressure on food companies to meet safety requirements while also meeting financial demands requiring them to employ technologies such as RapidChek® SELECT™ that are accurate, fast and cost effective.

Strategic Diagnostics Inc.
800.544.8881
Newark, DE
www.sdix.com

Fluid Metering, Inc. New Valveless PulseFree Dispensing and Metering System

Fluid Metering, Inc. has introduced its new Smooth-flo PDS100 System. The Smooth-flo is a unique valveless dispensing and metering system which utilizes dual Fluid Metering pumps precisely synchronized to eliminate pulsation typically present in other piston pump designs.

Pump heads are integrally mounted to the control unit, which includes stepper motors, drivers and programmable electronics housed in a rugged anodized aluminum enclosure.

The Smooth-flo is intuitive, menu-driven and uses convenient front-panel membrane switches and a large LCD display for programming.

The system features Pulse-Free fluid delivery down to 15 uL/min continuous flow. The precision dual stepper controlled pumpheads are factory calibrated to the users flow range.

The Smooth-flo PDS100 System offers RS485, 4-20 mA, 0-5V and 0-10V electronic control interface for connection to process sensors, PLC and PC control systems.

The rugged anodized aluminum enclosure is suitable for wall mounting or bench top installation in the laboratory or production areas.

The system includes tubing, fittings and configuration instructions for Smooth-flo PDS100 System operation. Universal Power Input operates on 100-240 VAC 50/60 Hz.

Fluid Metering, Inc.
800.223.3388
Syosset, NY
www.fmipump.com

KD Scientific New Syringe Pump Delivers Picoliters Flowrates

The new Pico Syringe Pump from KD Scientific has both infusion and withdrawl capabilities with accurate delivery of picoliter, nanoliter, microliter and milliliter flow rates.

The Pico Pump is designed to hold two syringes from 0.5 µl up to 10 ml and combines smoother flow and updated features to create a high performance pump at affordable prices.

The flow range of this unit is from 1.3 picoliters/min up to 0.8788 ml/min depending on the syringes selected.

The bright two line display, easy-to-use interface, and 6 membrane keys require only two entries to start pumping.

The flow rate can be changed while the pump is running.

KD Scientific
508.429.6809
Holliston, MA
www.kdscientific.com

INDUSTRY PRODUCTS

Onset Announces Kilowatt Hour Transducers

Onset Computer Corporation has announced a family of kilowatt hour (kWh) transducers for use with HOBO® data loggers.

The WattNode® transducers – manufactured by Continental Control Systems and sold directly through Onset – provide high-accuracy measurements of 1, 2, or 3-phase power in 2, 3, or 4 wire configurations. They connect directly to Onset's web-based HOBO U30 monitoring systems and standalone HOBO Energy Logger Pro™ data loggers, and are easy to install in service panels and junction boxes. Typical applications include energy monitoring, sub-metering, and phase-load monitoring.

For plotting and analyzing kWh data, Onset offers HOBOware® Pro software, an intuitive graphing and analysis software package for PC and Mac computers. HOBOware Pro provides a user-friendly graphical user interface that enables users to quickly and easily graph, analyze and print data files, as well as export the data to Microsoft Excel and other spreadsheet programs for further analysis.

Onset Computer Corporation
800.564.4377
Bourne, MA
www.onsetcomp.com

WLD-TEC New Model of AutoloopPRO

WLD-TEC has introduced the AutoloopPRO, a fully automatic carrousel for flame sterilizing inoculation loops.

The stable housing of the AutoloopPRO enables comfortable and easy access to inoculation loops. Removal positions on both sides make the carousel equally suitable for right and left handers. Suitable for up to 4 inoculation loops. Keep all functions in view with the fully graphic display. Flaming and cooling time can be adjusted to the second. The carousel rotates and controls flaming automatically.

No unintentional use of hot inoculation loops: When flaming is completed, the display shows the remaining cooling time and the removal positions of cool inoculation loops. Additionally, an intelligent sensor of the AutoloopPRO monitors safe sterilization.

Continuous working during the flaming and the cooling phases of the inoculation loops saves a great deal of time and makes it possible to work efficiently.

The AutoloopPRO is fabricated entirely of stainless steel, anodized aluminum and a display, protected by heat-resistant glass. The AutoloopPRO can withstand extreme laboratory conditions and is suitable for use with all Fuego safety laboratory gas burners from WLD-TEC.

WLD-TEC
310.589.3709
Chicago, IL
www.WLD-TEC.com

Harvard Apparatus New Smooth, Accurate and Precise Syringe Pump

Harvard Apparatus has introduced the new PHD ULTRA™ Syringe Pump. The PHD ULTRA sets a new performance standard in syringe pumps for smooth, accurate and precise flow.

The PHD ULTRA™ is designed to meet today's most demanding standards in fluidics applications.

The new EZ Pro™ Software functions like a PC and contains an advanced methods architecture for pre-programmed quick-start or advanced methods templates.

A new easy-to-use GUI on an advanced color display allows alpha/numeric reporting capability and advanced connectivity at the touch of the screen.

This unit also provides maximum versatility of Configuration and Application. It can handle flow rates from picoliter to 220 ml/min with the highest accuracy, precision and smoothness of flow.

The PHD ULTRA™ can control remote units 30 ft. away, accommodates 2 to 10 syringes for multi-channel or larger reservoir capacities, and contains advanced pre-programmed operational modes. With the push of a button alternate between auto-fill continuous-flow, pulsatile, bolus, concentration mode, daisy chain, gradients and flow programming modes.

The functional balance of these features makes the PHD ULTRA™ the ultimate problem solver for your lab or work place in MS, drug infusion, nanofluidics, electro-spinning, aerosol generation, reaction chamber dosing and more.

Solve your most demanding fluidics applications with PHD ULTRA™ fluidics from Harvard Apparatus.

Harvard Apparatus
800.272.2775
Holliston, MA
www.harvardapparatus.com

INDUSTRY PRODUCTS

Charm Sciences Receives 5-Year USDA Contract for Antibiotic Test

Charm Sciences, Inc. has announced a 5-year renewable contract by the US Department of Agriculture's Food Safety and Inspection Service (FSIS) to provide Charm KIS™ (Kidney Inhibition Swab) tests to USDA inspectors at slaughter facilities to screen for sulfonamides and antibiotic drugs under the National Residue Program.

FSIS will begin implementing the Charm KIS Test in phases starting with cattle (FSIS notice 50-09) <http://www.fsis.usda.gov/OPPDE/rdad/FSISNotices/50-09.pdf>, and eventually implement it for all livestock.

Fusing simplicity, speed, and sensitivity, the Charm KIS test rapidly screens broad spectrum antimicrobial drugs in both fresh and thawed tissue. The KIS test detects close to kidney tolerances for sulfonamides, beta-lactams, tetracyclines, aminoglycosides, macrolides, and lincosamides. The KIS test has been successfully applied to beef and pork kidney, poultry serum, water, feed extracts, and live animal urine samples.

"The USDA contract provides an important diagnostic and prevention program for the quality of US beef and pork, and affirms Charm Sciences' resolute commitment to a safe food supply," said Dr. Stanley Charm, president of Charm Sciences.

KIS reagents are self-contained, solvent-free, and pre-measured in a single-use, disposable swab. Testing can be performed in a farm, slaughter house or laboratory setting. The KIS test requires no sample preparation or extraction and is performed in four easy steps:

1. Cut tissue with KIS housing
2. Absorb sample on the KIS swab
3. Re-insert swab into housing and twist to activate test
4. Incubate for 3 hours and observe color change.

KIS incubators are available for low, medium, and high sample throughput.

Charm Sciences, Inc.
978.687.9200
Lawrence, MA
www.charm.com

Eriez® Model T Ferrous Traps for Removal of Damaging Tramp Metal from Paper Pulp Slurries

Eriez® offers its powerful Model T Permanent Magnetic Ferrous Traps to efficiently remove contamination in 6–36 inch (152–914 mm) pipelines. The rugged welded pipe and reinforced plate construction withstands working pressures up to 75 PSI (5.3 kg/sq cm). Pressure drop through the unit is normally no more than that of a 90° elbow.

These units significantly reduce damage and maintenance costs to filters, pumps, refiners and other processing machinery handling paper pulp slurries, chemical slurries and other liquid products. Standard units are constructed of mild steel enclosures with stainless magnetic tubes. Internal surfaces can be epoxy resin coated for corrosion resistance. Eriez also offers all stainless steel Model T Trap units.

Model T traps are built with *Xtreme*™ Rare Earth (RE) magnets made from Erium® 3000, which has up to 25 times the strength of conventional ceramic or Alnico magnet materials.

The bottom of the Model T Trap body provides sump for trapping heavy nonmagnetic tramp metals, stones, etc. A bottom plug allows simple drainage of sump.

Model T Traps are specifically designed for removal of tramp metal contaminants from paper stock. These units are primarily for upright installation in horizontal lines, but may also be mounted sideways, or in inclined or vertical lines.

Eriez
800.345.4946
Erie, PA
http://en-us.eriez.com

COMING EVENTS

OCTOBER

- **1–2, Advanced *Listeria monocytogenes* Control Measures in RTE Meats and Poultry,** Toronto, Canada. For more information, contact Blaise Ouattara, Canadian Meat Council at 613.729.3911 ext. 23; or go to www.cmc-cvc.com.
- **5–7, Process Expo 2009,** Las Vegas Convention Center, Las Vegas, NV. For more information, go to www.fpsa.org/processExpo/.
- **5–8, HACCP Prerequisite Programs.** For more information, E-mail Debby Newslow at Debby@newslow.com.
- **5–9, ASM Conference on *Salmonella*: Biology, Pathogenesis and Prevention,** Aix-en-Provence, France. For more information, call American Society for Microbiology at 202.737.3600 or go to www.asm.org.
- **6–7, Advancing Your HACCP Program,** University of Georgia, Athens, GA. For more information, call 706.542.2574; E-mail: EFS@uga.edu.
- **6–7, Iowa Association for Food Protection Annual Conference,** Quality Inn & Suites, Ames, IA. For more information, contact Lynn Melchert at lynn.melchert@swissvalley.com.
- **7–8, Associated Illinois Milk, Food and Environmental Sanitarians Fall Conference,** Stoney Creek Inn, East Peoria, IL. For more information, contact Steve DiVincenzo at Steve.DiVincenzo@illinois.gov.
- **7–9, IAFP European Symposium on Food Safety,** Berlin, Germany. For more information, call 515.276.3344 or go to www.foodprotection.org/events/european-symposia/.
- **12–13, Advanced HACCP Training Course,** Greensboro, NC. For more information, contact Tatiana Lorca at tatiana.lorca@ecolab.com.
- **13, Good Food Manufacturing Practices,** New Brunswick, NJ. For more information, contact Jenna Kimock at ocpe@njaes.rutgers.edu.
- **13–16, 2009 ASTHO Annual Meeting,** Vienna (Tysons Corner), VA. For more information, go to www.astho.org.
- **14–15, GlobalGap Tour 2009,** Kuala Lumpur, Malaysia. For more information, go to www.globalgap.org.
- **14–15, Implementing SQF 2000 Systems Training Course,** Greensboro, NC. For more information, contact Tatiana Lorca at tatiana.lorca@ecolab.com.
- **17–20, National Frozen & Refrigerated Foods Convention,** Washington, D.C. For more information, call 717.657.8601 or go to www.nfraweb.org.
- **18–21, Food Microbiology Symposium – Current Concepts in Foodborne Pathogens and Rapid and Automated Methods in Food Microbiology,** University of Wisconsin–River Falls, River Falls, WI. For more information, go to www.uwrf.edu/afs-all/institutes/foodmicro/.
- **19–21, Foodservice Distribution Conference & Expo,** Baltimore, MD. For more information, call 703.532.9400 or go to www.ifdaonline.org.
- **21–22, British Columbia Food Protection Association 10th Anniversary Fall Technical Session and Conference,** Delta Vancouver Airport Hotel, Richmond, BC. For more information, contact Terry Peters at 604.666.1080; E-mail: terry_peters@telus.net.
- **26–27, Food Plant Sanitation Workshop Course,** Guelph, Ontario, Canada. For more information, call 519.821.1246 or go to www.gftc.ca.
- **26–29, North Dakota Environmental Health Association Annual Conference,** Doublewood Inn, Fargo, ND. For more information, go to www.ndeha.org.
- **28–31, Worldwide Food Expo,** McCormick Place, Chicago, IL. For more information, go to www.worldwidefood.com.
- **29, GlobalGap Tour 2009,** Washington, D.C. For more information, go to www.globalgap.org.

NOVEMBER

- **2–4, Sweets Middle East,** Dubai International Convention and Exhibition Centre, Dubai, U.A.E. For more information, phone 971.4.308.6748; E-mail: sweetsmiddleeast@dwtc.com.
- **5–7, Mexico Association for Food Protection Annual Meeting,** NH Krystal Hotel, Puerto Vallarta, Mexico. For more information, E-mail Alex Castillo at a-Castillo@tamu.edu or go to inocuidad.cucei.udg.mx.
- **7–11, 137th APHA Annual Meeting and Exposition,** Philadelphia, PA. For more information, go to www.apha.org/meetings.
- **9–10, Advanced HACCP Training Course,** Ecolab Inc., Eagan, MN. For more information, contact Tatiana Lorca at tatiana.lorca@ecolab.com.
- **9–11, 3rd Halal Expo,** Dubai, U.A.E. For more information, go to www.worldhalalexpos.com.
- **10–12, Sanitation Workshop,** Randolph Associates, Inc., Birmingham, AL. For more information, call 205.595.6455; E-mail: kristy.clark@raiconsult.com.
- **11–12, GlobalGap Tour 2009,** Athens, Greece. For more information, go to www.globalgap.org.
- **11–12, Implementing SQF 2000 Systems Training Course,** Ecolab Inc., Eagan, MN. For more information, go to foodsafety@ecolab.com.
- **11–13, 2009 EFFoST Annual Conference,** Budapest Hungary. For more information, go to www.effostconference.com.

COMING EVENTS

- **11–13, IAFP Asia Pacific Symposium on Food Safety,** Seoul KyoYuk MunHwa HoeKwan Hotel, Seoul, South Korea. For more information, go to www.iafpkorea.co.kr/main.asp.
- **18–20, HACCP: A Basic Concept for Food Protection,** New Brunswick, NJ. For more information, contact Jenna Kimock at ocpe@njaes.rutgers.edu.
- **24–27, VIII Workshop on Rapid Methods and Automation in Food Microbiology,** Barcelona, Spain. For more information, go to http://quiro.uab.cat/workshopMRAMA.

DECEMBER

- **7–10, Pasteurization Workshop,** Murfreesboro, TN. For more information, call 205.595.6455; E-mail: kristy.clark@raiconsult.com.
- **8–9, BRC Global Food Safety Standard Training Course,** San Antonio, TX. For more information, contact Wendy Harmon at 888.525.9788 ext. 262 or go to www.food-safetynet.com.
- **14–15, Advanced HACCP Training Course,** Ecolab Inc., Eagan, MN. For more information, contact Tatiana Lorca at tatiana.lorca@ecolab.com.
- **16–17, Implementing SQF 2000 Systems Training Course,** Eagan, MN. For more information, contact Tatiana Lorca at tatiana.lorca@ecolab.com.

IAFP UPCOMING MEETINGS

AUGUST 1-4, 2010
Anaheim, California

JULY 31-AUGUST 1, 2011
Milwaukee, Wisconsin

JULY 22-25, 2012
Providence, Rhode Island

ADVERTISING INDEX

Food Safety Thrives When You Focus on Five!

NATIONAL RESTAURANT ASSOCIATION®

1 Avoid Purchasing Food from Unsafe Sources

You can't make unsafe food safe. That's why it is important to check all food when it arrives. Always make sure the food you receive is in good condition, and at the right temperature.

2 Clean and Sanitize Correctly

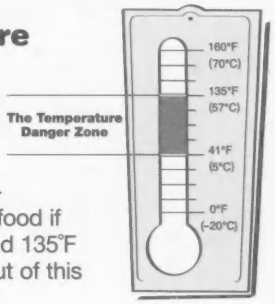
Dirty equipment and utensils can contaminate food with disease-causing pathogens. To keep food safe, clean and sanitize all food-contact surfaces. Cleaning a surface removes food and other dirt, and sanitizing a surface reduces pathogens to safe levels.

3 Prevent Cross-Contamination

Disease-causing pathogens can spread from dirty hands, equipment, and utensils to food. If this happens, the food might make someone sick. You can help prevent this by ensuring workstations, cutting boards, and utensils are cleaned and sanitized before using them.

4 Prevent Time-Temperature Abuse

Some food, like meat and dairy, requires time and temperature control to keep it safe. It's called TCS food (**T**ime and **T**emperature **C**ontrol for **S**afety). Disease-causing pathogens will grow well in TCS food if it's kept at temperatures between 41°F and 135°F (5°C to 57°C). You must keep TCS food out of this temperature danger zone to keep it safe.

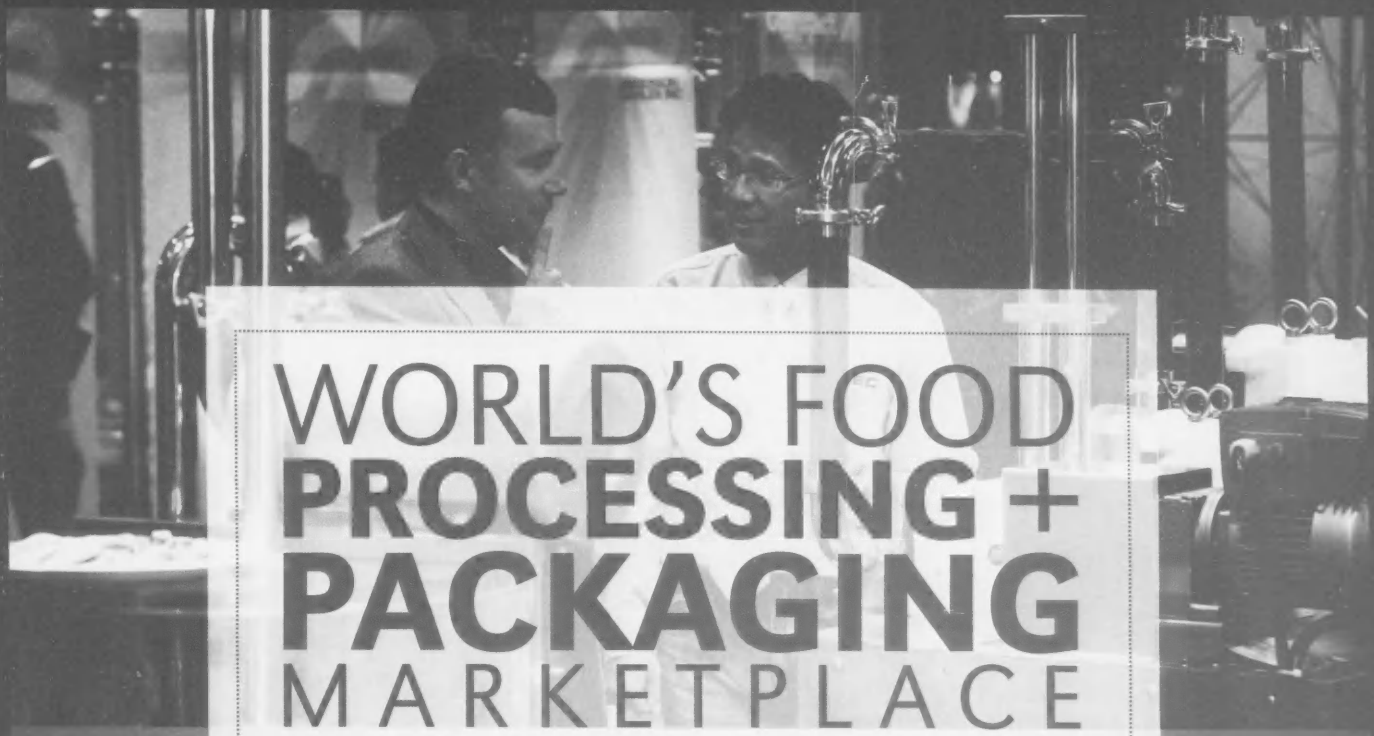


5 Practice Personal Hygiene

Touching food with dirty hands can make people sick. That's because disease-causing pathogens can be transferred from hands to food. Always wash your hands after using the restroom, or any time they get dirty.

nfsem

National Food Safety Education Month®



WORLD'S FOOD PROCESSING + PACKAGING MARKETPLACE

WORLDWIDE FOOD EXPO 2009

In a market like this, you need to operate at peak performance. Food processors need every advantage they can get. Today, your biggest opportunity lies in innovation. At the Worldwide Food Expo, you'll see how new technologies can address today's hot topics – from trends and ingredients to food safety, sustainability and how to "green" your operations and packaging. Co-located with the AMI Meat, Poultry & Seafood Expo, the Worldwide Food Expo is also an ideal venue for exploring "crossover" ideas between industries.

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WHERE THE DAIRY AND FOOD INDUSTRY COME TOGETHER

OCTOBER 28–31, 2009 **CHICAGO, ILLINOIS** McCORMICK PLACE

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Milk Industry Foundation
National Cheese Institute
International Ice Cream Association

IAFP
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from
The Dairy Practices Council®

This newly expanded Five-volume set consists of 82 guidelines. Now Available on CD

1 Planning Dairy Freestall Barns
2 Effective Installation, Cleaning, and Sanitizing of Milking Systems
3 Selected Personnel in Milk Sanitation
4 Installation, Cleaning, & Sanitizing of Large Parlor Milking Systems
5 Directory of Dairy Farm Building & Milking System Resource People
6 Natural Ventilation for Dairy Tie Stall Barns
7 Sampling Fluid Milk
8 Good Manufacturing Practices for Dairy Processing Plants
9 Fundamentals of Cleaning & Sanitizing Farm Milk Handling Equipment
10 Maintaining & Testing Fluid Milk Shelf-Life
11 Sediment Testing & Producing Clean Milk
12 Tunnel Ventilation for Dairy Tie Stall Barns
13 Environmental Air Control and Quality for Dairy Food Plants
14 Clean Room Technology
15 Milking Center Wastewater
16 Handling Dairy Products from Processing to Consumption
17 Prevention of & Testing for Added Water in Milk
18 Fieldperson's Guide to High Somatic Cell Counts
21 Raw Milk Quality Tests
22 Control of Antibacterial Drugs & Growth Inhibitors in Milk and Milk Products
24 Troubleshooting High Bacteria Counts of Raw Milk
25 Cleaning & Sanitation Responsibilities for Bulk Pickup & Transport Tankers
27 Dairy Manure Management From Barn to Storage
28 Troubleshooting Residual Films on Dairy Farm Milk Handling Equipment
29 Cleaning & Sanitizing in Fluid Milk Processing Plants
30 Potable Water on Dairy Farms
31 Composition & Nutritive Value of Dairy Products
32 Fat Test Variations in Raw Milk
33 Brucellosis & Some Other Milkborne Diseases
34 Butterfat Determinations of Various Dairy Products
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37 Planning Dairy Stall Barns
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40 Controlling Fluid Milk Volume and Fat Losses
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50 Farm Bulk Milk Collection Procedures
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53 Vitamin Fortification of Fluid Milk Products
54 Selection of Elevated Milking Parlors
54S Construction Materials for Milking Parlors
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70 Design, Installation & Cleaning of Small Ruminant Milking Systems
71 Farmers Guide To Somatic Cell Counts In Sheep
72 Farmers Guide To Somatic Cell Counts In Goats
73 Layout of Dairy Milk Houses for Small Ruminant Operations
75 Direct Microscopic Exam of Milk from Small Ruminants (training CD)
78 Biosecurity for Sheep and Goat Dairies
80 Food Allergen Awareness In Dairy Plant Operations
83 Bottling Water in Fluid Milk Plants
85 Six Steps to Success - Production of Low SCC Milk (training CD)
90 On-Farm & Small-Scale Dairy Products Processing
91 HACCP - SSOP's and Prerequisites
92 HACCP - Principle Number One: Hazard Analysis
93 HACCP - Principles 2 & 3 Critical Control Points & Critical Limits
97 Direct Loading of Milk from Parlor into Bulk Tankers
98 Milking Procedures for Dairy Cattle
100 Food Safety in Farmstead Cheesemaking
101 Farmers Guide To Somatic Cell Counts In Cattle
102 Effective Installation, Cleaning & Sanitizing of Tie Barn Milking Systems
103 Approving Milk and Milk Product Plants for Extended Runs
105 Sealing Bulk Milk Truck Tanks
106 On Farm Anaerobic Digesters "100+ Questions to Ask

IAFP has agreed with The Dairy Practices Council to distribute their guidelines. DPC is a non-profit organization of education, industry and regulatory personnel concerned with milk quality and sanitation throughout the United States. In addition, its membership roster lists individuals and organizations throughout the world.

For the past 38 years, DPC's primary mission has been the development and distribution of educational guidelines directed to proper and improved sanitation practices in the production, processing, and distribution of high quality milk and milk products.

The DPC Guidelines are written by professionals who comprise six permanent task forces. Prior to distribution, every guideline is submitted for approval to the state regulatory agencies in each member state. Should any official have an exception to a section of a proposed guideline, that exception is noted in the final document.

The guidelines are renown for their common sense and useful approach to proper and improved sanitation practices. We think they will be a valuable addition to your professional reference library.

If purchased individually, the entire set would cost $442.00. We are offering the set, packaged in five looseleaf binders for $330.00.

IF PURCHASED ON CD, take a 10% discount plus FREE shipping world wide.

To purchase this important source of information, complete the order form below and mail or fax (515-276-8655) to IAFP.

Please enclose $330.00 plus $17.00 shipping and handling for each set of guidelines within the U.S. Outside U.S., shipping will depend on existing rates. Payment in U.S. $ drawn on a U.S. bank or by credit card.

I would like to order: Hard Copy☐ CD☐

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Research Notes

Reviews

* Asterisk indicates author for correspondence.

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- ❒ D1010 The Bulk Milk Hauler: Protocol & Procedures
- ❒ D1031 Dairy Plant
- ❒ D1050 Food Safety: Dairy Details
- ❒ D1060 Frozen Dairy Products
- ❒ D1080 High-Temperature, Short-Time Pasteurizer
- ❒ D1100 Mastitis Prevention and Control
- ❒ D1105 Milk Hauling Training
- ❒ D1120 Milk Processing Plant Inspection Procedures
- ❒ D1130 Pasteurizer: Design and Regulation
- ❒ D1140 Pasteurizer: Operation
- ❒ D1180 10 Points to Dairy Quality

ENVIRONMENTAL

- ❒ E3031 Allergy Beware
- ❒ E3040 Asbestos Awareness
- ❒ E3055 Effective Handwashing – Preventing Cross Contamination in the Food Service Industry
- ❒ E3125 Good Pest Exclusion Practices
- ❒ E3128 Integrated Pest Management (IPM)
- ❒ E3131 Key Pests of the Food Industry
- ❒ E3133 Physical Pest Management Practices
- ❒ E3235 Regulatory and Good Manufacturing Practices
- ❒ E3236 Rodent Control Strategies
- ❒ E3240 Sink a Germ
- ❒ E3245 Wash Your Hands
- ❒ E3251 Would Your Restaurant Kitchen Pass Inspection?
- ❒ E3260 Swabbing Techniques for Sampling the Environment and Equipment

FOOD

- ❒ F2005 A Lot on the Line
- ❒ F2007 The Amazing World of Microorganisms
- ❒ F2008 A Recipe for Food Safety Success
- ❒ F2009 Basic Personnel Practices
- ❒ F2011 Available Post Harvest Processing Technologies for Oysters
- ❒ F2012 Control of *Listeria monocytogenes* in Retail Establishments
- ❒ F2013 Control of *Listeria monocytogenes* in Small Meat and Poultry Establishments
- ❒ F2014 Controlling Food Allergens in the Plant
- ❒ F2015 Controlling *Listeria*: A Team Approach
- ❒ F2016 Bloodborne Pathogens: What Employees Must
- ❒ F2017 Building a Better Burger – Improving Food Safety in the Food Supply Chain
- ❒ F2021 Egg Production
- ❒ F2025 The Special of the Day: The Eggceptional Egg
- ❒ F2030 "Egg Games" Foodservice Egg Handling & Safety
- ❒ F2036 Emerging Pathogens and Grinding and Cooking Comminuted Beef
- ❒ F2037 Cooking and Cooling of Meat and Poultry Products
- ❒ F2039 Food for Thought – The GMP Quiz Show
- ❒ F2040 Food Irradiation
- ❒ F2045 Food Microbiological Control
- ❒ F2050 Food Safe-Food Smart – HACCP and Its Application to the Food Industry (Part 1 & 2)
- ❒ F2060 Food Safe Series I (4 videos)
- ❒ F2070 Food Safe Series II (4 videos)
- ❒ F2080 Food Safe Series III (4 videos)
- ❒ F2081 Food Safety Begins on the Farm
- ❒ F2090 Food Safety: An Educational Video for Institutional Food Service Workers
  Food Safety for Food Service Series I
- ❒ F2095 Now You're Cooking
- ❒ F2101 Tape 1 – Food Safety for Food Service: HACCP
- ❒ F2103 Tape 2 – Food Safety for Food Service: Time and Temperature Controls Food Safety for Food Service Series II
- ❒ F2104 Tape 1 – Basic Microbiology and Foodborne Illness
- ❒ F2105 Tape 2 – Handling Knives, Cuts, and Burns
- ❒ F2106 Tape 3 – Working Safely to Prevent Injury
- ❒ F2107 Tape 4 – Sanitation
- ❒ F2110 Food Safety is No Mystery
- ❒ F2111 Controlling *Salmonella*: Strategies That Work
- ❒ F2121 Food Safety the HACCP Way Food Safety Zone Video Series
- ❒ F2125 Tape 1 – Food Safety Zone: Basic Microbiology
- ❒ F2126 Tape 2 – Food Safety Zone: Cross Contamination
- ❒ F2127 Tape 3 – Food Safety Zone: Personal Hygiene
- ❒ F2128 Tape 4 – Food Safety Zone: Sanitation
- ❒ F2129 Food Technology: Irradiation
- ❒ F2130 Food Safety: You Make the Difference
- ❒ F2131 Fruits, Vegetables, and Food Safety: Health and Hygiene on the Farm
- ❒ F2133 Food Safety First
- ❒ F2134 Food Safety: Fish and Shellfish Safety
- ❒ F2136 GLP Basics: Safety in the Food Micro Lab
- ❒ F2137 GMP Basics: Avoiding Microbial Cross-Contamination
- ❒ F2140 GMP Basics: Employee Hygiene Practices
- ❒ F2143 GMP Basics: Guidelines for Maintenance Personnel
- ❒ F2147 GMP Basics: Process Control Practices
- ❒ F2148 GMP – GSP Employee
- ❒ F2150 GMP: Personal Hygiene and Practices in Food Manufacturing
  GMP Food Safety Video Series
- ❒ F2151 Tape 1 – Definitions
- ❒ F2152 Tape 2 – Personnel and Personnel Facilities
- ❒ F2153 Tape 3 – Building and Facilities
- ❒ F2154 Tape 4 – Equipment and Utensils
- ❒ F2155 Tape 5 – Production and Process Controls
- ❒ F2160 GMP: Sources and Control of Contamination during Processing
  GMPs for Food Plant Employees
- ❒ F2161 Tape 1 – Definitions
- ❒ F2162 Tape 2 – Personnel and Personnel Practices
- ❒ F2163 Tape 3 – Building and Facilities
- ❒ F2164 Tape 4 – Equipment and Utensils
- ❒ F2165 Tape 5 – Production/Process Controls
- ❒ F2168 HACCP Advantage – Good Manufacturing Practices
- ❒ F2169 HACCP: Training for Employees – USDA Awareness
- ❒ F2170 The Heart of HACCP
- ❒ F2172 HACCP: Training for Managers
- ❒ F2173 Inside HACCP: Principles, Practices and Results
- ❒ F2180 HACCP: Safe Food Handling Techniques
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- ❒ F2220 Proper Handling of Peracidic Acid
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- ❒ F2250 On the Line
- ❒ F2260 100 Degrees of Doom…The Time and Temperature Caper
- ❒ F2265 A Day in the Deli: Service, Selection, and Good Safety
- ❒ F2266 HACCP: A Basic Understanding
- ❒ F2271 Preventing Foodborne Illness
- ❒ F2280 Principles of Warehouse Sanitation
- ❒ F2290 Product Safety and Shelf Life
- ❒ F2320 Safe Handwashing
- ❒ F2321 All Hands on Deck
- ❒ F2322 The Why, The When, and The How Video
- ❒ F2325 Safe Practices for Sausage Production
- ❒ F2340 Sanitizing for Safety
- ❒ F2342 Seafood HACCP Alliance Internet Training Course
- ❒ F2350 ServSafe Steps to Food Safety
- ❒ F2350–1 Step One: Starting Out with Food Safety
- ❒ F2350–2 Step Two: Ensuring Proper Personal Hygiene
- ❒ F2350–3 Step Three: Purchasing, Receiving and Storage
- ❒ F2350–4 Step Four: Preparing, Cooking and Serving
- ❒ F2350–5 Step Five: Cleaning and Sanitizing
- ❒ F2350–6 Step Six: Take the Food Safety Challenge: Good Practices, Bad Practices – You Make the Call
- ❒ F2391 Understanding Foodborne Pathogens
- ❒ F2430 Smart Sanitation: Principles and Practices for Effectively Cleaning Your Food Plant
- ❒ F2440 Cleaning and Sanitizing in Vegetable Processing Plants: Do It Well, Do It Safely!
- ❒ F2450 A Guide to Making Safe Smoked Fish
- ❒ F2451 A HACCP-based Plan Ensuring Food Safety in Retail Establishments
- ❒ F2460 Safer Processing of Sprouts
  Fast Track Restaurant Video Kit
- ❒ F2500 Tape 1 – Food Safety Essentials
- ❒ F2501 Tape 2 – Receiving and Storage
- ❒ F2502 Tape 3 – Service
- ❒ F2503 Tape 4 – Food Production
- ❒ F2504 Tape 5 – Warewashing
  Worker Health and Hygiene Program for the Produce Industry
- ❒ F2505 Manager Guide to Worker Health and Hygiene Your Company's Success May Depend on It!
- ❒ F2506 Worker Health and Hygiene: Your Job Depends on It!
- ❒ F2600 Food Industry Security Awareness: The First Line of Defense

OTHER

- ❒ M4030 Ice: The Forgotten Food
- ❒ M4050 Personal Hygiene and Sanitation for Food Processing Employees
- ❒ M4060 Psychiatric Aspects of Product Tampering
- ❒ M4070 Tampering: The Issue Examined

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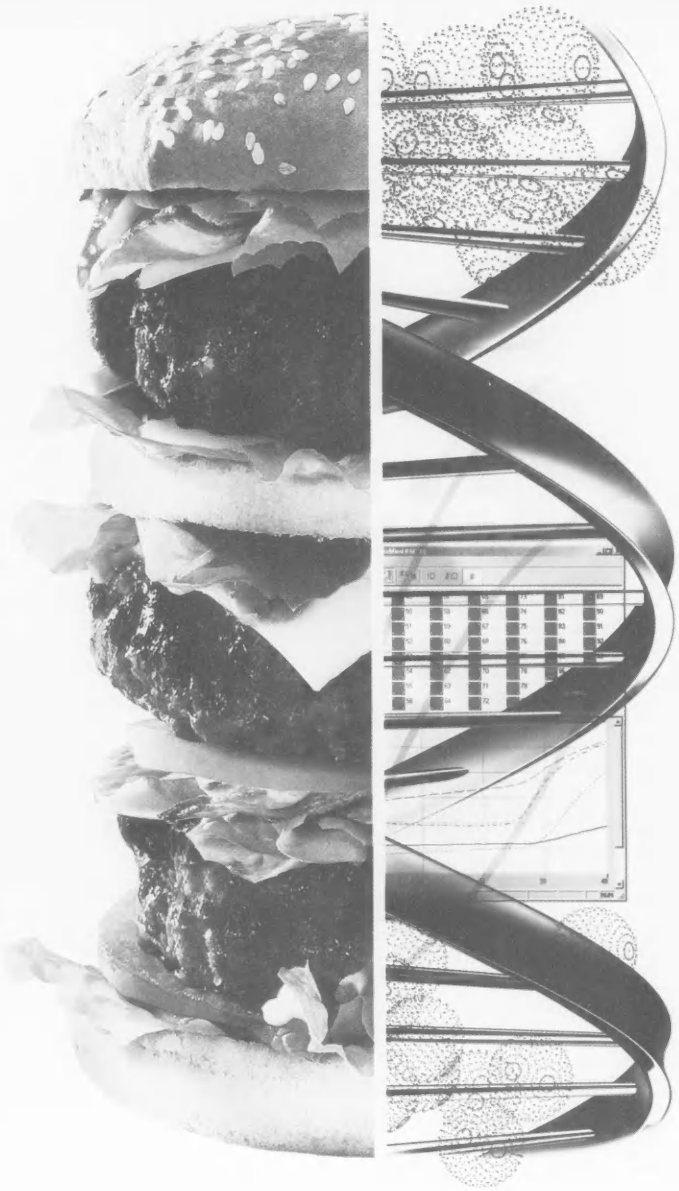

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