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FOOD PROTECTION TRENDS

SCIENCE AND NEWS FROM THE INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

APRIL 2004

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FOOD PROTECTION TRENDS

SCIENCE AND NEWS
FROM THE INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

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"PRESIDENT'S" PERSPECTIVE

By **PAUL A. HALL**
PRESIDENT

"Grow beyond your work"

The great American novelist John Steinbeck wrote in his timeless book *The Grapes of Wrath* that "Man, unlike any other thing organic or inorganic in the universe, grows beyond his work, walks up the stairs of his concepts, emerges ahead of his accomplishments." It is human nature to take pride and satisfaction in those things that are most important to us. As food safety professionals, we take pride and gain much personal satisfaction in striving to make the world a safer place in which to live. I know I do!

Another great author and motivational speaker, Dale Carnegie, once said, "If your work is becoming uninteresting, so are you. Work is an inanimate thing and can be made lively and interesting only by injecting yourself into it. Your job is only as big as you are." Striving for excellence in what we do can even make mundane work more interesting. One way to help keep our work interesting and lively is to acknowledge and recognize the contributions of our co-workers, colleagues and others in our professional field. IAFP, your professional association, for years has acknowledged the importance of peer recognition. Every year, at the IAFP Annual Meeting, we hold an Awards Banquet on Wednesday evening. The purpose of the Awards Banquet is to recognize the contributions and achievements of our professional colleagues and institutions in the area of food safety. There are thirteen awards presented at the annual Awards Banquet that cover all segments of our profession including education, industry, government, international leadership and more. The list of past award recipients reads like the Hollywood Walk of Fame. Each of the past award recipients exemplifies the character and determination described by Steinbeck... emerging ahead of their accomplishments; each accolade bestowed was well deserved. If you would like to learn more about the various awards please visit the IAFP Web site at www.foodprotection.org. It is worth your time to get to know these awards and their history.

I would like to take this opportunity to also thank the various sponsors of our IAFP awards including Wilbur Feagan and F&H Food Equipment Company, Silliker, Inc., Nasco International, Inc., Nelson-Jameson, Inc., Ecolab, Inc., Weber Scientific, Unilever SEAC, The National Food Processors Association and the IAFP Foundation Fund. Please extend your appreciation to the representatives of these organizations for their role in sponsoring specific awards at the IAFP Annual Banquet.

I also want to invite each of you to attend IAFP 2004 in Phoenix, Arizona, August 8–11, to help congratulate and recognize this year's award recipients. By celebrating these individuals and institutions and their accomplishments, I hope it would energize you to "grow beyond your work," ultimately, "emerging ahead of your accomplishments." Even if you are not fortunate to receive a formal award from your peers, at least you will have the self-satisfaction of doing the best you can. By doing so, you are giving yourself a fair shake and you'll have your own place in the "Food Safety Walk of Fame!" As always, please share your thoughts with me at phall@kraft.com. Until next month...

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Sedona and Verde Valley Tour
Saturday, August 7
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Diamondbacks Baseball Game
Saturday, August 7
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Visit the Web site at **www.foodprotection.org** to sign up.

Announcing

The inaugural "John H. Silliker Lecture"

To be held at IAFP 2004 during a Plenary Session on Tuesday, August 10, 2004 in Phoenix, Arizona

Featured Speaker: R. Bruce Tompkin
Retired Vice President–Product Safety
ConAgra Refrigerated Foods

Presentation Title: "Guess Who's Come to Stay – The Resident Pathogen Issue"

Tuesday, August 10, 2004
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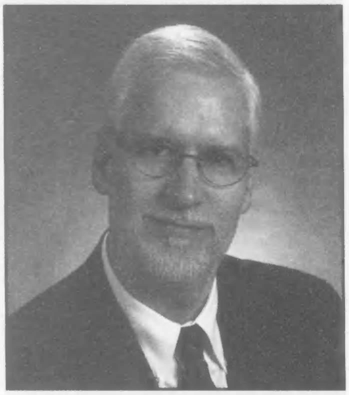
IAFP thanks Silliker, Inc. for their contribution to the IAFP Foundation in support of this Lecture.

"COMMENTARY"
FROM THE EXECUTIVE DIRECTOR



By **DAVID W. THARP, CAE**
EXECUTIVE DIRECTOR

"Thanks to everyone who is involved in the various journal functions"

The growth of IAFP is so evident when you look at our two journals. First let's review the journal you are reading, *Food Protection Trends*. You will notice that this month, we are publishing four peer-reviewed articles for the first time. This became necessary because the number of submissions to *Food Protection Trends* has steadily increased over the past few years and is now to a point where printing three articles will not keep up with the supply of completed articles that we have on hand. Just a few years ago, we were in short supply of articles for *FPT* (*Dairy, Food and Environmental Sanitation* at the time) and only printed two articles at that time. We think the name change for the journal has provided new interest in article submission along with a number of targeted efforts designed to increase submissions.

We are pleased with the growth of *FPT* and the new clean look of the journal. The redesign, effective with the inaugural January 2003 issue of *FPT*, has helped *Food Protection Trends* become more recognized as a leading journal of applied articles on protecting the food supply. The journal is packed with up-to-date information designed to help you perform your job functions more efficiently and effectively. When you compare page sizes of volume 23 (2003) at 1,068 to the 816 pages printed in volume 17 (1997), it is easy to see the growth we have enjoyed.

The *FPT* Management Committee is considering adding additional features to the journal. One feature currently under discussion is to have a point – counterpoint article four to six times per year. This would give an opportunity to Members to express opinion on issues affecting the world of food safety. Right now, "reader comments" is a feature area that goes unused. Currently, it is possible for readers to write to *FPT* and have their observations printed. So, if you are interested, start writing now!

The growth in the *Journal of Food Protection* is even more evident. In 1997, (volume 60) we printed 1,644 pages; this past year, in 2003 (volume 66) we printed 2,416 pages! Almost a 33% increase in page quantity! There were about 230 articles printed in *JFP* in 1997 compared to 345 in 2003. This shows incredible growth for our journal and secures its position as the leading journal covering food science and food protection issues.

If you are not yet receiving *JFP* Online, you might want to consider this enhanced delivery attribute. By adding *JFP* Online to your Membership, you have "early" access to articles published in the *Journal of Food Protection*. Each month, *JFP* is available at the first of the month of issue. For example, articles published in the April issue of *JFP* were available on the first day of April. Even though the journal mails at the same time (the first of each month), having *JFP* Online can provide articles to you between one week to three weeks (international delivery) earlier. In addition, you can search more than three years of *JFP* articles online by subject, title, and author to find the research you are looking for. You might want to consider *JFP* Online when renewing your IAFP Membership for faster access to research presented in *JFP*.

Both journals help the Association to fulfill its mission of "providing food safety professionals worldwide with a forum to exchange information on protecting the food supply." This could not be accomplished without the help of many dedicated professionals. Authors, Review Boards, Scientific Editors and our staff all work together to ensure the highest quality publications are produced. Thanks to everyone who is involved in the various journal functions. Your time and dedication is very much appreciated!

If you are interested in becoming more involved with either the *Journal of Food Protection* or *Food Protection Trends*, you may contact the journal Scientific Editors or me for more information. Lend your time to help ensure the continued growth of IAFP and our journals!

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International Association for Food Protection.

Overview of the FDA Juice HACCP Rule

FADWA AL-TAHER* and KATHY KNUTSON

The National Center for Food Safety and Technology, 6502 S. Archer Rd., Summit-Argo, IL 60501, USA

SUMMARY

The Juice HACCP regulation published January19, 2001 requires most juice processors to comply with safety standards through implementation of a HACCP program. This article is designed to help industry understand the events that led up to this regulation and the key points of the HACCP regulation. It is divided into three sections.The first addresses the outbreak history and microbial, physical and chemical hazards associated with juice. The Juice HACCP rule was enacted because of an increase in the number of foodborne illness outbreaks caused by consumption of fresh juices during the past decade. The second section discusses the development of juice regulations such as the HACCP rule and the requirement of a warning label on all unpasteurized or untreated packaged juice products, advising consumers of the potential risk of consuming these products. The last section deals with new or emerging processing technologies, such as ultraviolet radiation and high-pressure processing, and measures taken to ensure that juice processors abide by the Juice HACCP rule. One approach to help increase the safety of fresh juice products is to develop a standardized training curriculum for inspectors, which the National Center for Food Safety and Technology (NCFST) has developed. This is readily available at the Center's web site in pdf format or may be purchased in bound form from NCFST.

A peer-reviewed article

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INTRODUCTION

"Hazard Analysis Critical Control Point (HACCP); Procedures for the Safe and Sanitary Processing and Importing of Juice; Final Rule," the Food and Drug Administration's (FDA's) Juice HACCP regulation, was published, January 19, 2001. The regulation requires most juice processors to comply with safety standards through implementation of a HACCP safety program. Any juice sold as such or used as an ingredient in beverages must be manufactured according to this new regulation, which applies to processors of fruit or vegetable juices, purees and concentrates, and to importers of such products *(3, 38)*. The HACCP model is a preventive system designed to control or prevent food safety hazards in food processing operations. With the HACCP system, a firm is continuously preventing and solving problems within food processing, rather than relying on finished product testing regulatory agencies or consumer complaints *(2, 3)*.

This article is written in three sections. The first section addresses the outbreak history and hazards associated with juice, the second discusses juice regulations and the third deals with processing technologies and measures taken to ensure that juice processors abide by the Juice HACCP rule.

POTENTIAL JUICE HAZARDS

Microbial hazards

The Juice HACCP rule was enacted because of an increased number of foodborne illness outbreaks caused by consumption of fresh juices during the past decade *(2, 3)*. These outbreaks are listed in Table 1. In the 1990s, there were over 800 confirmed cases of illnesses from unpasteurized apple or orange juices with two deaths, in the United States *(7)*.

FDA estimates that between 16,000 and 48,000 cases of juice-related illnesses occur each year. Foodborne infections are particularly dangerous for young children, the elderly and those with weakened immune systems. It is estimated that the Juice HACCP rule will prevent at least 6,000 illnesses per year by improving the safety of fruit and vegetable juices and juice products *(35, 41)*.

Traditionally, unpasteurized juice or cider has been considered nonhazardous because of its high acidity. However, unpasteurized cider and juice, even at pH 3.6 to 4, can transmit pathogens *(30)*. Although apple cider and juice usually are acidic (pH of 3–4), both *Cryptosporidium* and *E. coli* O157:H7 are acid tolerant, and both organisms can survive in apple cider for up to four weeks. If pathogens are present in juice, their ability to survive or multiply depends on several factors: acidity, temperature, and the chemical composition of the product *(5, 33)*. Pertinent microorganisms of concern in juice are *Cryptosporidium parvum*, *Escherichia coli* O157:H7, *Salmonella*, and *Listeria monocytogenes* (Table 2). Sources of the pathogens include water, fruit, unsanitary processing conditions, and infected workers or food handlers *(3, 39)*.

The largest number of outbreaks caused by foodborne pathogens in juice occurred in 1996. In October 1996, an outbreak of disease caused by *Escherichia coli* O157:H7 in Connecticut was due to unpasteurized apple cider or juice. In the Western United States, *E. coli* O157:H7 intoxication caused illness in 66 persons and one death due to hemolytic uremic syndrome (HUS) from unpasteurized commercial apple juice. Apples used for juice production associated with the outbreak were from the end of the harvest season and were of unusually low quality *(6, 33)*. A similar outbreak in 1991 in southeast Massachusetts resulted in 43 people having either bloody diarrhea or HUS from drinking apple cider. The press operator also raised cattle, which grazed in a field adjacent to the mill. The source of *E. coli* may have been manure that contacted the apples, equipment or workers' hands *(6, 24, 30)*.

Because *E. coli* is usually of fecal origin, it may indicate the presence of pathogens. *E. coli* O157:H7 can cause severe damage to the lining of the intestine resulting in stomach cramps, vomiting, fever, and bloody diarrhea. The young and the elderly are particularly susceptible to this bacterium. Some people develop HUS, which is a disease caused by the organism attacking the kidneys. Patients need dialysis, and in extreme cases kidney failure may result in death. *E. coli* is readily destroyed by pasteurization *(15, 24, 40, 45)*. *E. coli* O157:H7 is resistant to acid, so it can survive in an acidic medium like orange or apple juice *(31)*; *E. coli* O157:H7 survives in apple juice for up to 24 days at 4°C. When dropped apples are used to produce cider, the pH of the cider increases because of mold growth and rot. *E. coli* O157:H7 will grow slowly at room temperature *(9)*.

When fallen fruit is used for making apple cider, apples may have become contaminated by contact with manure *(6, 33)*. Two documented *Cryptosporidium* outbreaks have been associated with apple cider. In 1993, 213 persons became ill in Maine during a school agricultural fair. Cider had been prepared by children from apples that had been dropped on the edge of a cow pasture. The protozoan was detected in the apple cider, on the cider press, and in the stool specimen of a calf on the farm that supplied the apples. Fruit can also become contaminated when rinsed with non-potable water. In October 1996, unpasteurized apple cider was associated with *C. parvum* infections in the Northeast, resulting in three outbreaks *(6)*.

Cryptosporidium is a protozoan parasite that causes severe diarrhea and life-threatening disease, especially in immunocompromised patients *(17, 40)*. Since there is no effective drug for the treatment of cryptosporidiosis, elimination of parasites in food and drink is highly desirable, especially for high-risk individuals *(10)*. Juice may be contaminated by fecally-contaminated water, fruit, or environmental surfaces. *C. parvum*, which can infect all animals and humans, is present on more than 90% of dairy farms. Calves are a source of human infection if the disease has been transmitted by drinking raw milk. Studies on the survival of *C. parvum* in beverages have shown that 85% of the oocysts, the infective stage of the organism, died in beers, sodas, and fruit juices stored for 24 hours at 4°C or 22°C *(17, 39)*.

In 1974, 296 persons in New Jersey were found to be infected with *Salmonella* Typhimurium after consuming unpasteurized apple cider. The cider was prepared from apples that had dropped onto a field fertilized with manure. In 1995, 63 reported cases of salmonellosis in visitors were linked to a theme park in Orlando, Florida. The serovars isolated from these patients were *S.* Hartford, *S.* Gaminara, and *S.* Rubislaw. Drinking unpasteurized orange juice at character breakfasts had caused the illness. One orange grove used surface water for irrigation. The oranges

TABLE 1. Disease outbreaks from consumption of apple and orange juices

Year	Disease Vehicle	Causative Microorganism	Cases/Death	Comments
1923	Sweet Cider	*S.* Typhimurium	?	Infected sweet cider
1944	Unpasteurized Orange juice (O.J.)	*S.* Typhimurium	18/1	Asymptomatic food handler, OH
1962	Reconstituted O.J.	Hepatitis virus	24/0	Asymptomatic food handler, MO
1966	Reconstituted O.J.	Gastroenteritis (causative agent unknown)	5200/0	Contaminated water, CA
1974	Unpasteurized Apple cider	*S.* Typhimurium	296/0 ?	Use of animal manure
1980	Unpasteurized Apple cider	Enterotoxigenic *E. coli*	?	?
1989	Reconstitute O.J.	*S.* Typhimurium	69/0	Asymptomatic food handler, NYC
1991	Orange Juice	Norwalk-like virus	?/?	Unidentified cause, Australia
1991	Apple Cider	*E. coli* O157:H7	43/0	Contaminated apples, MA
1992	Unpasteurized O.J.	Enterotoxigenic *E. coli*	?/?	Sanitation, India
1993	Reconstituted O.J.	Gastroenteritis? (causative agent yeast cause or some other unknown contaminant)	23/0	Unidentified cause, OH
1993	Apple cider	*Cryptosporidium*	213/0	Contaminated apples, Maine
1994	Reconstituted O.J.	Gastroenteritis? (causative agent unknown)	85/0	Unidentified cause, AL
1995	Unpasteurized O.J.	*S.* Hartford, *S.* Gaminara, *S.* Rubislaw	63/0	Sanitation, FL
1996	Unpasteurized O.J.	Gastroenteritis (causative agent unknown)	2/0	Symptomatic handler, CO
1996	Unpasteurized Apple Juice	*E. coli* O157:H7	?	CT
1996	Unpasteurized Apple Juice	*E. coli* O157:H7	66/1	Contaminated apples, western US
1996	Unpasteurized Apple Juice	*C. parvum*	3/0	Contaminated apples, Northeast US
1999	Unpasteurized O.J.	Salmonellosis (causative agent unknown)	>500/0	Contaminated culls? Australia
1999	Unpasteurized O.J.	Salmonellosis (causative agent unknown)	2/0	Sanitation? GMPs, FL
1999	Unpasteurized O.J.	*S.* Muenchen (causative agent unknown)	423/0	Ice? Sanitation, AZ/Mex
2000	Unpasteurized O.J.	Salmonellosis (causative agent unknown)	88/0	Unidentified cause, CA

(24) Parish, M.E. 1997. Public Health and Nonpasteurized Fruit Juices. Crit. Rev. Micr., 23(2):109–119.

Parish, M. E. 2002. Personal Communication. University of Florida, Lake Alfred, FL.

TABLE 2. Microorganisms important in fresh juices

Microorganism	Symptoms	Duration	Infectious Dose	Reasonably Likely to Occur In
E. coli O157:H7	Bloody diarrhea, nausea, abdominal pain, vomiting, fever Complications- HUS - kidney failure	5 – 10 days	10 – 100 cells	Apple cider, apple juice and citrus juice
Salmonella	Nausea, vomiting, abdominal cramps, diarrhea, fever, headache Complications- chronic arthritis	1 – 2 days or longer	15 – 20 cells	Citrus juice
Cryptosporidium parvum	Watery diarrhea, abdominal pain, vomiting, low-grade fever	4 days – 3 weeks	Less than 10 cells	Apple cider or juice

(40) US Food and Drug Administration. 2001. "The Bad Bug Book." Foodborne Pathogenic Microorganisms and Natural Toxins Handbook, Center for Food Safety and Applied Nutrition, [Internet, WWW], ADDRESS: http://www.cfsan.fda.gov/~mow/intro.html.

were often knocked from the trees onto the ground; later, cultures of both soil and the surfaces of oranges tested positive for *Salmonella (24, 30)*. Toads and frogs, which were in close proximity to the processing facility, were found to be infected with these same three serovars. Outbreaks from fresh orange juice have included symptoms of typhoid fever, hepatitis, gastroenteritis, salmonellosis and *E. coli* O157:H7 intoxication *(24)*.

Salmonella spp. are commonly found in the intestinal tract of humans and animals. Environmental sources of the organism include water, soil, insects, animal feces, raw meats, seafood, and poultry. The *Salmonella* infection that has been associated most often with juice outbreaks is the gastroenteritic syndrome caused by non-typhoid strains of *Salmonella* spp. The severity of this infection depends on the number of bacteria ingested and the susceptibility of the individual. Typical symptoms are diarrhea, fever, nausea, cramps, bloody stools and vomiting *(40)*. *Salmonella* is readily destroyed by pasteurization *(45)*.

Salmonella Typhimurium and *Salmonella* Enteritidis are the most common serotypes causing illness in the United States, and *Salmonella* Muenchen is a less common species of *Salmonella (40)*. In late June of 1999, *S.* Muenchen caused a total of 423 illnesses in 22 states and three Canadian provinces, an outbreak that resulted in a nationwide recall of unpasteurized juice. The probable cause was contaminated ice added to orange juice transported from Mexico *(7)*. A *S.* Enteritidis outbreak in 2000 was caused by unpasteurized orange juice and resulted in 88 illnesses in six western states *(35, 41)*.

Although there have been no reported illnesses from *Listeria monocytogenes* in juice, a series of outbreaks in the early 1980s in cole slaw, pasteurized milk and Mexican-style cheese caused this bacterium to be recognized as a foodborne pathogen. The detection of *L. monocytogenes* in the food-processing environment proves that the pathogen is likely to occur and therefore should be addressed in the hazard analysis plan *(28, 32)*. Unlike most bacteria, this ubiquitous pathogen can grow slowly at refrigerator temperatures and survive at a very low pH for days to weeks. It can also cause serious problems in pregnant women, newborns, people with weakened immune systems, and the elderly. This bacterium occurs widely in soil, sewage, and fresh-water sediments and is carried in the intestinal tract of animals and humans *(17, 32, 40)*.

FDA and the United States Department of Agriculture (USDA) established a "zero tolerance" policy for *L. monocytogenes* in ready-to-eat foods in 1986. This policy requires ready-to-eat foods to test negative for *L. monocytogenes* in two 25-gram samples of food product. Currently, in the US, a food product in which *L. monocytogenes* is detected is considered adulterated and the food company would be expected to conduct a recall of the product *(11, 28, 32)*. With a more complete understanding of the occurrence, transmission and control of *L. monocytogenes* as a foodborne pathogen, the International Commission on Microbiological Specifications for Foods (ICMSF) has recommended 100 *L. monocytogenes* per gram as an acceptable level of consumption in certain foods by low-risk populations *(11)*, but US regulators have not embraced this recommendation. Since high-risk populations consume juice, juice processors are prudent to include the control of *L. monocytogenes* in their hazard analysis.

Physical hazards

Glass fragments

Companies have recalled juice products that contained pieces of glass. Glass bottles breaking may be caused by transportation to the juice processing facility, mechanical handling (cleaning, filling and capping) of bottles, and thermal shock to the glass during hot filling or pasteurization. This can constitute a severe public health problem. Processors that package juice in glass must conduct a hazard analysis and establish controls, if necessary, for glass fragments *(2, 38)*.

Metal fragments

Metal hazards should be part of the hazard analysis if juice-processing equipment used to grind the fruit, extract juice from fruit, or blend juice, can sustain metal fatigue, wear of metal parts, or metal-to-metal contact. In this case, metal fragments are a hazard that is reasonably likely to occur in the juice, and controls need to be established in the HACCP plan for metal fragments *(45)*.

Chemical hazards

Patulin

Patulin is a mycotoxin produced primarily by *Penicillium expansum*, a mold that causes rot in apples and other fruits. Patulin occurs in many foods including apple juice, and in apples and pears with brown rot *(13)*. At this time, the FDA has identified patulin as a safety concern in apple juice. High levels of patulin can be produced in rotting or moldy apples. Fallen fruit and apples that have been damaged, for example, by insects or birds, or that have been bruised, have a greater-than-average chance of supporting the growth of patulin-producing molds. The rotten portions of most fruits and grains are usually removed before processing *(36, 38)*. Patulin is destroyed by fermentation, so it is not found in alcoholic fruit beverages or in vinegars produced from fruit juices *(36)*. Patulin is heat stable and can survive pasteurization *(13)*.

In March 1997, the FDA found that apple juice from a processor in Washington state contained high levels of patulin, a potential health hazard, especially for infants and young children, who most commonly drink apple juice. Patulin has been found to occur at high levels in some commercial apple juices in the US *(36, 42)*. A survey of apple juices purchased between 1994 and 2000 in the U.S. showed that 12.6% of juices had patulin levels in excess of 50 μg/L, and approximately 6% had levels over 100 μg/L *(26)*.

FDA officials believe that if apple juice processors do not implement controls for patulin, then long-term exposure to high levels of patulin from the consumption of apple juice may have adverse effects. Culling or trimming apples before juice production to eliminate damaged, bruised, moldy, and rotting apples will reduce patulin levels in the juice *(13, 45)*. Washing apples in dump tanks or with high-pressure water sprays may also be effective in reducing patulin levels *(1, 13)*. FDA has recently established a 50 μg/L action level for patulin in single strength apple juice and reconstituted apple juice *(36)*. Control of patulin is required in HACCP plans for apple juice, cider and concentrates *(45)*.

Lead

In 1992, an 18-month old child, in a routine physical exam, was found to have a blood lead level of 36 μg/dL. The child had consumed, per day, about three cans of imported fruit juices packed in 12-ounce, lead soldered cans. As a result of this incident, FDA announced an emergency action level of 80 ppb for lead in fruit beverages, such as juices and nectars packed in lead-soldered cans (58 FR 17233, April 1, 1993). The agency then banned the use of lead-soldered cans (60FR 33106, June 27, 1995) *(2)*.

Juice can become contaminated with lead if lead-contaminated fruit is used to make the juice. Lead contamination of fruit can occur in many ways because of the widespread past and present use of lead in agricultural and industrial settings. For example, lead arsenate was used as a pesticide in what were apple orchards. It is believed to have caused persistent lead contamination of the soil, causing carrots grown on these sites to contain elevated lead levels. Most recently, lead was found in baby food containing carrots and in carrots in frozen mixed vegetables because the soil where the carrots were grown had been contaminated with lead. This is a particular health problem for children. HACCP can address the problem of lead contamination. If the processor is importing carrots or other raw ingredients from an area known to have unacceptable levels of lead in soil, then lead should be identified as a hazard that is reasonably likely to occur in the HACCP plan *(3, 38)*.

Undeclared food allergens in juice

If a juice processor handles other foods containing allergenic food ingredients in the same facility, the processor must consider potential hazards from cross-contact of the juice by other food substances that can cause allergic reactions. A chemical hazard can occur when juice is processed on the same equipment that was used to process a potentially allergenic food without adequate cleaning prior to the juice run. For example, if juice were processed with the same equipment that was used to produce milk or a dairy beverage without adequate cleaning, milk protein could be inadvertently introduced. This could cause a health problem for those individuals who are allergic to milk *(45)*.

FDA believes the most effective way to prevent milk protein from becoming a component of juice is to carry out a multi-step cleaning procedure on the equipment, usually referred to as a clean-in-place (CIP), between a milk run and a juice run. The cleaning step can be carried out as a critical control point (CCP) or as a sanitation standard operating procedure (SSOP). An inspector will verify that the cleaning is being done by examining the processors' CCP or SSOP records to ensure the removal of any milk residue from equipment prior to a juice run.

According to FDA, the following foods can cause serious allergic reactions in some individuals and account for more than 90% of all food allergies: peanuts, soybeans, milk, eggs, fish, crustaceans, tree nuts, and wheat *(45)*. Some 100% juice products may also contain added ingredients, such as soy proteins, or preservatives, such as sulfites, that can cause allergic or food intolerance reactions in sensitive individuals. These products are subject to the HACCP regulation because they are juices with added ingredients, and not beverages that contain juice as an ingredient, such as a flavored bottled water or a dairy-based beverage with juice. If an ingredient is added to a 100% juice product, the presence of the ingredient should be declared on the label in accordance with the food labeling regulations in 21 CFR Part 101. Proper labels should be used as a control in the HACCP plan. Ingredients for which such controls should be implemented include the following:

1. Any of the 8 foods listed
2. Sulfites, in concentrations of 10 ppm or greater
3. FD&C Yellow No. 5 *(45)*

Pesticide residues

Pesticides are used for insect control on fruits, vegetables, grains, and other foods. Before a pesticide may be sold in the US, the Environmental Protection Agency (EPA) grants a registration that permits its sale and use. EPA also establishes a tolerance, the amount of residue legally allowed, for pesticides used on foods *(45)*.

FDA believes that pesticide residues "above tolerance" may be potential hazards, but that they are unlikely to be identified during a hazard analysis as hazards that must be included in the HACCP plan. This is because they do not occur frequently and the public health impact of infrequent exposure is not severe. If illegal pesticide residues are hazards that are reasonably likely to occur, it is appropriate for a processor to identify them in its hazard analysis and include them in its HACCP plan. If an agreement between a processor and a grower adequately ensures that illegal pesticide residues will not be a hazard that is reasonably likely to occur, then controls for that particular hazard need not be included in the HACCP plan *(3)*.

If a processor uses produce imported from a country where there is a high rate of compliance with US pesticide tolerances, and rarely any safety problems for pesticides in food exported to the US, then there is no need to include control in a HACCP plan. The situation in which a processor may have a greater likelihood of having to include pesticide controls in a HACCP plan would be if the produce is imported from a country that does not comply with US pesticide tolerances, or with documented safety problems for pesticides in food. In that case, the processor would have to give special attention in the hazard analysis to the likelihood of pesticides being a hazard in his juice. If the hazard is reasonably likely to occur, pesticide control measures should be in the HACCP plan, according to FDA.

Harvest environment

Good agricultural practices (GAPs) should followed. Contamination can occur from environmental sources during harvesting. Microorganisms may enter fruits and vegetables when natural defenses are damaged by punctures, wounds, cuts, splits or bruises. For example, manually picked fruits are subject to tearing of the peel around the stem; mechanical harvesting causes splits, punctures, and bruises. This provides an opportunity for pathogens to enter the fruits. With a HACCP program, culling (removing damaged or rotten fruit from the production process) is used to decrease the microbial load of fruit. Fallen fruit picked off the ground should not be used for juice production *(33)*. Fallen fruit is fruit that has fallen naturally from the tree to the ground in an orchard *(45)*. Diseased, rotten fruit, fruit with damaged skin and fruit with dirt or animal/bird excrement should be treated to decrease the microbial load. Washing fruit may reduce surface contamination. Fruit with broken skins and fruit that are badly bruised or worm damaged should be sorted and discarded *(33)*.

Pathogen control in the agriculture setting is difficult. Foodborne pathogens can be introduced into orchards via animal waste. Widespread use of animal manure as fertilizer is a growing concern, because pathogens spread to water, soil and crops. Contaminated water can also spread pathogens. Water used to dilute pesticides and irrigate orchards should be of an acceptable microbiological quality. This water can become contaminated if growers do not follow control practices to ensure that the water quality is sufficient for its intended use *(12)*.

Internalization of pathogens

High-pressure washing can split the fruit that has already been physically damaged if the fruit is placed in a dump truck or a hydrocooler. This will cause the internalization of pathogens from contaminated water *(3, 24)*.

When warm apples are submerged in colder water contaminated with *E. coli* O157:H7, as may happen in processing plants where unsanitary dump trucks or flumes are used, the pathogen is occasionally internalized. Six percent of warm apples immersed in a cold dye solution internalized dye through open channels leading from the blossom end into the core region of the fruit *(5)*. Studies of citrus fruit were conducted to evaluate the infiltration of dye and bacteria into the interior of oranges and the impact of this on achieving a 5-log reduction of bacteria during fresh juice processing. Microscopic observations showed the bacterial contaminants to be localized at or near the surface, where they may be reached by surface sanitizing treatments. Dye infiltration was not a reliable indicator of bacterial penetration in citrus fruit. However, dye still may be used in research to indicate the penetration capability of sanitizers in surface sanitizing treatments *(19)*.

Pathogens are not present in the interior of citrus fruits, such as oranges, with intact peels. Any contamination being introduced into the juice will come from the surface of the fruit or the food contact surfaces of the equipment. The contamination on the skin of the fruit can be introduced to the juice by piercing into the fruit to extract the juice. Fruits and vegetables should be washed, brushed or sanitized with organic acids or other antimicrobial agents before juice extraction *(18–23)*.

Surface treatments

Several studies show that surface treatments are ineffective in reducing microbial populations that have been internalized into the fruits. Common fruit washing in a packinghouse or juice extraction facility involves thorough wetting and brushing of the fruit's surface with a detergent over revolving brushes, followed by a water rinse. Washing the surface of inoculated oranges with various washing solutions for 30 s, followed by a potable water rinse, reduced *E. coli* by 1.9 to 3.5 log cycles. Prewetting fruit for 30 s before washing provided no significant benefit in most cases *(20)*.

Immersing inoculated oranges in hot water was shown by Pao and Davis to reduce *E. coli* by 5 logs. However, when various chemical solutions (200 ppm chlorine solution, 100 ppm chlorine dioxide solution, 200 ppm acid anionic sanitizer, 80 ppm peroxyacetic acid, or 2% trisodium phosphate) were used for surface treatments of oranges, *E. coli* was reduced by only 1.8–3.1 log cycles, except for the stem scar populations, which were reduced by 1.0 log *(21)*.

Waxes are currently used on fruits and vegetables, including citrus, apples, pears, tomatoes, eggplants and peppers, to reduce water vapor loss, increase surface shine and provide a vehicle for antimicrobial agents and/or dyes. A strong bacteriocidal effect was observed when a combination of high temperature and pH treatment was used on glass surface carrying *E. coli*. A 5-log reduction of *E. coli* was achieved by dipping the glass slides in heated alkali (50°C, pH 10) wax solutions for 4 min. At pH 11, dipping in 50°C wax for 2 min had a similar bacteriocidal effect when the wax procedure was applied to oranges. *E. coli* was reduced by 4.7 log at the mid-section, but by only 1.0 log at the stem scar area *(22)*.

In a 1997 survey of seven Florida packinghouses, no pathogenic bacteria of concern were found associated with the surface of citrus fruit. Also, no generic *E. coli* were found on fruit at the end of packinghouse procedures (dumping, washing, waxing, and hand picking), and no *Salmonella* was found at any point in the packinghouse procedure *(23)*.

The individual and combined effects of processing sanitation and fruit surface treatments on the microbial quality of fresh squeezed, unpasteurized orange juice were studied by Pao and Davis *(18)*. Initially, juice made with unsanitized juice extractors had total aerobic counts of about 4 log CFU/ml. The concentration was reduced to 2.5 log CFU/ml when the extractors were cleaned and sanitized with quaternary ammonium compounds. Initial yeast and mold counts of juice were 2.5 log CFU/ml when non-washed fruit was extracted by use of the sanitized extractor. Concentrations were lowered to less than 1 log CFU/ml when the fruit was washed prior to extraction. The best result was with treatment of both fruit and equipment surfaces with hot water (80°C), yielding less than 1 log CFU/ml for both aerobic plate counts and yeast and mold counts *(18)*.

FDA recommends that farmers and processors use the FDA's "Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables" to evaluate and modify their agricultural practices accordingly. This guide helps them to minimize microbial food safety hazards from the field to the distribution phase of fresh fruits and vegetables. The HACCP program ensures reduction of the risk of illness the application of controls for food safety hazards *(2, 3)*.

TWO NEW RULES PROPOSED TO INCREASE SAFETY OF JUICES

Public meeting

In December 1996, as a result of the October apple juice outbreak of disease caused by *E. coli* O157:H7, FDA held a two-day public meeting to review the science, technology, and manufacturing practices related to the safe production of juices. Comments were received from the public, industry and the National Advisory Committee on Microbiological Criteria for Foods (NACMCF) *(2)*. NACMCF decided that safety concerns needed to be addressed regarding juices, especially unpasteurized juices, and recommended that juice processors adopt HACCP programs. HACCP systems had already been developed for seafood processors, and meat and poultry processors *(30)*.

Two new rules were proposed by FDA on April 21, 1998 to increase the safety of fresh and processed fruit and vegetable juices. These proposals were intended to increase the protection of consumers from foodborne illnesses caused by contaminated juices *(31)*.

HACCP system

The first proposed regulation required juice processors to implement a HACCP system *(31)*. HACCP is a science-based system that identifies potential hazards, determines where the hazards or contamination are most likely to occur, implements control measures at points where hazards are likely to occur, and takes corrective action if a problem occurs during production or processing. The HACCP program developed must be appropriate for each processing facility and for each product made at that facility. The process and product-specific plan anticipates food hazards and identifies points in the process where a failed control would likely create a potential hazard in the system. Instead of relying on finished product testing, regulatory inspectors or consumer complaints, the processors will have their own continuous problem-solving system *(8)*.

Pillsbury Company pioneered the application of the HACCP concept to food production while supplying food to the US space program in the early 1960s. Pillsbury recognized that its quality control techniques weren't adequate against contamination during food production and it worried that end-product testing would be so extensive that little food would be available for space flights. Pillsbury believed that the only way to ensure safety would be to develop a preventive system that kept hazards from occurring during production. Since then, Pillsbury's system has been used worldwide to control food safety hazards. HACCP was formed at the 1971 National Conference on Food Protection. The first article on HACCP, published in 1973 by the Pillsbury Company, was used to train FDA inspectors in HACCP principles during the dissemination of the federal mandatory regulations for canned acidified and low-acid foods packed in hermetically sealed containers *(8, 14)*.

The National Academy of Science recommended in 1985 that the HACCP approach be adopted by all regulatory agencies and that it be mandatory for food processors. This recommendation led to the formation of the National Advisory Committee on Microbiological Criteria for Foods (NACMCF). NACMCF adopted seven principles for HACCP for the control of specific food hazards: (1) Conduct a hazard analysis, (2) Determine the critical control points (CCPs), (3) Establish critical limits, (4) Establish monitoring procedures, (5) Establish corrective actions, (6) Establish verification procedures, and (7) Establish record-keeping and documentation procedures *(8)*. A CCP is "a point, step, or procedure in a food process at which a control measure can be applied and at which control is essential to reduce an identified food hazard to an acceptable level." These HACCP principles are intended to help the food industry implement food safety management systems. HACCP enables FDA inspectors to inspect the facility more efficiently and to verify that the firm is operating in accordance with the firm's HACCP plan. It also ensures that any problems that have occurred have been identified and addressed. The HACCP system is designed to prevent contaminated food from entering the market by yielding high-quality products with minimal risk of causing foodborne illness *(8, 11)*.

Warning labels

The second proposed regulation required a warning label on all unpasteurized or untreated packaged juice products, advising consumers of the potential risk of consuming these products. The warning label reads, "Warning: This product has not been pasteurized and, therefore, may contain harmful bacteria that can cause serious illness in children, the elderly, and persons with weakened immune systems." This regulation was published as a final rule on July 8, 1998 under 21 CFR 101.17 (g).

FDA required that apple juice and apple cider have warning label statements by September 8, 1998 and for all other juice products by November 5, 1998. FDA requires labeling with a warning statement for the fruit and vegetable juice products (i.e., juices and beverages containing juice) that have not been pasteurized or treated in a way to prevent or eliminate harmful bacteria or reduce them by 100,000 fold (5-log reduction) *(43)*. "Guidance for Industry: Warning and Notice Statement: Labeling of Juice Products Small Entity Compliance Guide" was published September 18, 1998. Warning labels are not required for untreated juice products that are sold directly to consumers in retail establishments, such as restaurants, delis, grocery stores, and roadside stands, and that are intended for immediate consumption and are not pre-packaged *(38, 43)*.

On October 7, 2002, FDA issued a guidance document recommending ways for effectively achieving a 5-log pathogen reduction in juice. This guidance document, "Guidance for Industry: Exemptions from the Warning Label Requirement for Juice—Recommendations for Effectively Achieving a 5-Log Pathogen Reduction" encourages processors who are not subject to the juice HACCP rule and who are performing a 5-log pathogen reduction to be exempt from the warning label requirement to apply effective 5-log pathogen reduction treatments. Once processors are under the juice HACCP regulation (i.e., January 20, 2004 for very small processors), the warning label will not be allowed and juice must be treated to achieve a 5-log reduction of the pertinent microorganism of concern *(43)*.

Prerequisite programs

To be effective, HACCP must be built upon key prerequisite programs, such as Current Good Manufacturing Practices (CGMPs) (21 CFR Part 110) and Sanitation Standard Operating Procedures (SSOPs). The HACCP concept allows inspectors of food processors to focus their attention on parts of the process that are most likely to affect the safety of the product. The inspection of plants using HACCP methods differs from traditional inspection methods of food safety control. Traditional methods evaluated processing practices on the day or days of inspection. The HACCP approach allows regulators to look at what happens in the plant through time by examining the firm's monitoring and corrective action records. The inspector verifies the HACCP plan by determining that significant food safety hazards have been identified and potential hazards are constantly controlled *(8)*.

Current good manufacturing practices

Firms covered by the Juice HACCP regulation are still subject to the CGMPs in 21 CFR Part 110 *(38)*. One common misconception about HACCP is that some hazards that are reasonably likely to occur can be controlled under a firm's CGMP programs under 21 CFR Part 110. CGMP programs cannot be used to control a specific hazard that is reasonably likely to occur in a hazard analysis. HACCP controls must be used to control any such hazards *(45)*.

CGMPs encompass measures that prevent food from becoming adulterated due to unsanitary conditions. The CGMPs regulations cover personnel, plant and grounds, sanitary operations and facilities. The food plant and equipment must be sanitary, employees must practice good hygiene, and processes must eliminate or control potentially hazardous microorganisms. Food produced under the CGMPs regulation must not be adulterated and must be produced under sanitary conditions *(8)*. CGMPs are an essential foundation for a successful HACCP system *(38)*.

Sanitation standard operating procedures requirement

Sanitation Standard Operating Procedures (SSOPs) help maintain CGMPs in the production of food. SSOPs are written procedures that a food processor uses to maintain sanitary conditions and practices in a food plant. SSOPs are "key to the successful implementation of a HACCP system." If sanitation practices are not met, then corrective action must be taken. Unsanitary conditions can cause food hazards, and may have an effect on whether the HACCP plan can control food hazards. Unsanitary conditions can cause post-process contamination *(3, 8)*.

Some pathogens can be introduced during food handling and preparation by inadequate human sanitation or through cross-contamination by contact with raw foods. Water that is used in juice processing plants must be safe and sanitary. The final rule requires that juice processors have SSOPs that address the safety of the water that comes into contact with food or food contact surfaces or that is used for making ice. Processors must check the source of the water they use in their facilities for sanitary compliance. If hazards are found in the water, then a CCP must be established and included in the HACCP plan *(3, 8)*.

According to the Juice HACCP rule, SSOPs shall address the following: (1) Safety of the water that comes into contact with food or food contact surfaces or that is used in the manufacture of ice; (2) Condition and cleanliness of food contact surfaces, including utensils, gloves, and outer garments; (3) Prevention of cross contamination from unsanitary objects to food, food packaging material, and other food contact surfaces, including utensils, gloves, and outer garments, and from raw product to processed product; (4) Maintenance of hand washing, hand sanitizing, and toilet facilities; (5) Protection of food, food packaging material, and food contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitizing agents, condensate, and other chemical, physical, and biological contaminants; (6) Proper labeling, storage and use of toxic compounds; (7) Control of employee health conditions that could result in the microbiological contamination of food, food packaging materials, and food contact surfaces; and (8) Exclusion of pests from the food plant *(3)*.

The processor shall monitor the conditions and practices during processing to ensure compliance of the SSOPs with regard to the plant and the food being processed. The processor should correct those conditions and practices that are not met. Each processor is also required to maintain SSOP records that document the monitoring and any corrections made. SSOPs controls may be included in the HACCP plan *(3)*.

TRADITIONAL TECHNOLOGIES

HACCP rule

Large processors implemented the HACCP rule January 22, 2002. Small companies had to comply with the regulation by January 21, 2003. Very small companies had to comply by January 20, 2004 *(2, 3)*.

The HACCP regulation applies to domestic and imported juice and juice concentrates. Juice processors are required to evaluate their manufacturing process to determine whether there are any microbiological, chemical, or physical hazards that could contaminate their products. If a potential hazard is identified, processors must implement control measures to prevent, reduce or eliminate the hazard. Processors are also required to use methods that achieve a 5-log, or 100,000-fold, reduction in the numbers of the most pertinent pathogens of public health concern in their finished products. This pathogen may vary with the type of juice and the type of treatment used, though typically it would be *Salmonella* or *E. coli* O157:H7 for citrus juices and *E. coli* O157:H7 and *Cryptosporidium* for apple juice *(2, 3, 38)*.

Survival of pathogens

Pathogens of concern, such as *E. coli* O157:H7, *Salmonella*, *L. monocytogenes* and *Cryptosporidium*, can be reduced more than 5 log cycles by a heat treatment. Bacterial pathogens such as *Salmonella* and *E. coli* O157:H7 do not grow in fruit juices because of the low pH of these foods but can survive and become adapted to the acidic environment. This acid-adaptation also increases the heat resistance of these organisms. A study showed the average z-value for *L. monocytogenes* to be 6.1 ± 0.3°C, for *Salmonella* 5.8 ± 0.3°C, and for *E. coli* O157:H7 5.3 ± 0.4°C. Acid-adapted *E. coli* O157:H7 had greater heat resistance than *Salmonella* and *L. monocytogenes (16)*.

Refrigeration temperatures effectively reduce microbial metabolism, decreasing growth rates and reproduction. However, these temperatures are not necessarily lethal to pathogenic microorganisms. Pathogens in low pH systems die more rapidly at temperatures approaching room temperature than under very cold conditions *(24)*. At refrigeration temperatures, *E. coli* O157:H7 in different cultivars of ground apples survived 18 days before visible mold spoilage occurred. Survival of *E. coli* is increased when product is stored at refrigeration rather than room temperature *(9)*.

A 1997 study of *E. coli* O157:H7 behavior in apple juice and orange juice, refrigerated, showed that even in the acidic environment of these juices, this organism survives. The fact that *E. coli* O157:H7 survived in orange juice and that human illness from other pathogens, such as *S.* Muenchen and other *Salmonella* species, has been linked to orange juice shows that consumption of contaminated orange juice can result in human illness *(25)*.

There are two basic types of juice producers: those that treat the fruit or process the juice to reduce the risk of contamination with harmful microorganisms, and those that do not. About 98% of juices sold in the US are pasteurized. The remaining two percent may contain harmful bacteria if steps are not taken to control the hazard *(2, 3, 38)*.

Pasteurization

Pasteurization is the process of heat-treating liquids or semi-liquid food products at a specific temperature for the specific amount of time that is necessary to destroy certain disease-causing and food-spoilage bacteria. Pasteurization is a safe and effective method, proven to reduce pathogens to safe levels *(31)*.

FDA is aware of the benefits of pasteurizing as well as the reasons some processors choose not to pasteurize. Some processors believe that pasteurization alters the flavor of the product and reduces its nutritional value. FDA warns that children, the elderly, and people with weakened immune systems should drink only juices that have been pasteurized or otherwise treated to kill pathogenic bacteria *(31)*.

Thermal pasteurization conditions of fruit juices vary depending on the fruit, the type of juice, and the desired final result, such as retention of the nutrients, color, texture, and flavor of the juice, and the destruction of pathogenic bacteria *(24, 40)*. Temperatures can range from 76°C to 99°C, for time ranging from a minute to a few seconds. This heat treatment increases the shelf life of fruit juices, but also causes a loss of "fresh" flavor characteristics *(24)*.

Many experts recommend a minimum pasteurization temperature of 72.8°C for 15 s (Table 3). However, one study showed that a 5-log reduction of *E. coli* O157:H7 can be achieved at 68.1°C for 14 s and at 65.6°C for 14 s for *Salmonella*. *L. monocytogenes* survived at 68.1°C for 14 s, but died in cider within 24 hours at 4°C. The study concluded that 68.1°C for 14 s is adequate for the destruction of the three pathogens in apple cider *(15)*.

The National Food Processors Association recommends subjecting juices to 71.1°C (160°F) for three seconds to achieve a 5-log reduction of *E. coli* O157:H7, *Salmonella* and *L. monocytogenes* in fruit juices. This process is not recommended for apple juice, where *C. parvum* has been identified as a hazard that is reasonably likely to occur. *C. parvum* may be more resistant to thermal processing than the three acid-adapted bacterial pathogens *(16)*. A study done at the University of Wisconsin has shown that treatments of 68.1°C (155°F) for 14 s are capable of achieving a 5-log reduction of acid-adapted *E. coli* O157:H7 in apple cider, while New York's recommended conditions are 71.1°C (160°F) for six s *(15)*. FDA recommends 71.1°C (160°F) for six seconds to reduce levels of *C. parvum* and *E. coli* O157:H7 in apple juice *(16, 45)*.

Shelf-stable and concentrated juice

Flash pasteurization, which is used to destroy harmful organisms in juice, involves a high temperature, short-time treatment in which juices are heated above 90°C for 3 to 15 s. After heating, the juice is cooled and packaged. This method allows drink pouches to be safe and shelf stable *(37)*.

Shelf-stable, hot-filled juice products are processed at high temperatures in a single step to kill spoilage microorganisms. The National Food Processors Association states that a typical pasteurization process might be 90°C for 2 s, followed by filling at 85°C and holding at that temperature for 1 min before cooling. Shelf-stable, hot-filled juices receive lethality sufficient to achieve a 50,000-fold reduction of acid-adapted pathogens, such as *E. coli* O157:H7, *Salmonella*, and *L. monocytogenes (15, 45)*. These temperatures are much higher than what is needed to achieve the 5-log reduction in the specific pathogen. Therefore, FDA exempts a processor of shelf-stable juices from the 5-log process control requirements in their HACCP plan if a single thermal processing step is used. A copy of the thermal process validation must be attached to the HACCP plan. Chemical and physical hazards must still be considered in the HACCP plan development.

Single strength juice is often produced from reconstituted juice (concentrate with water added back to produce juice of the same content as typical juice extracted from fruit) and then pasteurized before packaging. Most single strength citrus juices are processed as shelf stable and exempt from the 5-log reduction regulation *41)*. However, a HACCP program is still required for each type of juice, process and packaging through the entire production with respect to physical and chemical hazards that may occur anywhere in the process. Single strength juice or juice from concentrate that is not shelf-stable (e.g., gable-topped container sold refrigerated) must comply with the Juice HACCP regulation *(2, 3, 38)*.

Juice manufacturers of thermally concentrated juice use treatments similar to those used for the production of shelf-stable juices. The concentration process consists of thermal treatment, followed by several evaporation steps. FDA exempts evaporative concentration processes as requiring verification of the 5-log performance standard *(38)*.

Citrus concentrate is commonly frozen in cans. A typical consumer-level concentrate in a can is "3+1"—adding three volumes of water to one volume of concentrate, producing nearly the same juice concentration as that extracted from fruit.

Shelf-stable and concentrated juices are very safe and exempt from the regulation with regard to microbial hazards. However, physical and chemical hazards are addressed in the hazard analysis. If there are no critical control points for chemical or physical hazards (e.g., no glass or metal, no patulin), then that processor is not required to have a HACCP plan. However, the processor must still demonstrate a thorough hazard analysis. It is expected that most processors of shelf-stable and juice concentrates will have a HACCP plan for chemical or physical hazards *(2, 3, 38)*.

SINGLE FACILITY RULE

The Juice HACCP regulation specifies that the entire 5-log reduction process must occur under one firm's control and in one processing facility. That is, all the steps included in the 5-log reduction, from receiving to processing and packaging, must be done at one facility. If steps are taken to reduce a microbial hazard at a previous site, those steps are not included in the 5-log reduction. If processors transport fruit or juice to another facility for extraction, processing or packaging, the 5-log reduction requirement must be satisfied at the second facility. If extracted juice is shipped in bulk tankers or bulk-packaged aseptically and repackaged at another facility, a 5-log reduction process must be performed on that juice before final fill and packaging *(3, 45)*.

TABLE 3. Pasteurization conditions for 5-log reductions of the most pertinent microorganism of concern

Microorganism	Temperature	Time	Beverage	Reference
E. coli O157:H7 *Salmonella* *L. monocytogenes*	71.7°C	15 s	milk	*(45)*
E. coli O157:H7 *Salmonella* *L. monocytogenes*	71.1°C (160°F)	3 s	fruit	NFPA, Mazzotta *(16, 45)*
E. coli O157:H7 *Salmonella* *L. monocytogenes*	68.1°C (155°F)	14 s	apple cider	University of Wisconsin *(15, 45)*
E. coli O157:H7 *Cryptosporidium parvum*	71.1°C (160°F)	6 s	apple cider	New York *(45)*

In a "Letter Concerning Single Facility Requirement," Daniel Troy of FDA stated on January 22, 2002, that FDA will consider amending the juice HACCP regulation to exempt processors of certain shelf-stable and certain concentrated juice products from the "single facility" requirement. FDA will consider exercising enforcement discretion if hazards potentially occurring during transportation are addressed as part of a processor's HACCP plan by making transportation a CCP. The exemption will not be applied to producers and users of high Brix juice concentrate that is diluted to single strength and repackaged *(4, 45)*.

To provide guidance on its discretionary policy, FDA released the document "Guidance on Bulk Transport of Juice Concentrates and Certain Shelf Stable Juices" on October 7, 2002. Control measures must be applied to the bulk transport of: (1) high Brix juice concentrate that is transported to a separate facility either for final packaging or for dilution to a consumer strength concentrate and final packaging, and (2) shelf stable single strength juice that is transported in aseptic packaging to a separate facility for final packaging *(44)*.

ALTERNATIVE TECHNOLOGIES

Demand for 'fresh' juice

Many juice processors oppose mandatory pasteurization of juices because the equipment is expensive, flavor is lost, and nutritional value is degraded from heat treatment *(2, 3, 11)*. The Juice HACCP regulation, states therefore, that juice processors may use alternative technologies as long as their process is validated to achieve a 5-log reduction of the "pertinent microorganism" *(2, 41, 45)*. The "pertinent microorganism means the pathogen that is likely to occur in juice and that is most resistant to the pathogen reduction technology used, and, if it occurs, is likely to be of public health significance" *(3)*. Consumer demand for foods that seem "fresher" has prompted the development of non-traditional processing techniques that do not use thermal pasteurization to control pathogens *(11)*.

Ultraviolet radiation processing

Ultraviolet (UV) radiation processing has been approved for juice products by FDA (21 CFR Part 179). The use of UV light for liquid disinfection is not new. It has been used in disinfecting wastewater for more than 10 years *(45)*. UV light is more efficient than chlorine because of its low cost, absence of toxic byproducts and effectiveness *(35)*. UV light is bacteriocidal in the 240–265 nm region. The sensitivity of bacteria to UV radiation varies with species and also among different strains of the same species *(37)*. UV has been used successfully to extend the shelf life of refrigerated apple cider without affecting its flavor. To achieve inactivation of most microorganisms, the UV radiant exposure must be uniform and at least 400 J/m^2 *(11, 34)*. A 5-log reduction was achieved when apple cider inoculated with *E. coli* O157:H7 was exposed to UV radiation *(37)*. *C. parvum* oocysts in fresh apple cider can be inactivated by UV radiation. A greater than 5-log reduction was obtained by exposing contaminated apple cider to 0.0143 J/cm^2 of UV irradiation for 1.2–1.9 s *(10)*.

Limitations for the use of UV radiation exist because of the problems presented by suspended solids in cider. Apple cider is juice extracted from apples that "may or may not be filtered to remove solids, and has a relatively short refrigerated shelf-life"

(10). The presence of small amounts of particulates in a liquid can greatly reduce UV penetration *(48)*. Some microorganisms (e.g., *E. coli* O157: H7) in apple cider tend to attach to the particles. When the cider is exposed to UV, the radiation photons cannot reach the microorganisms attached to the particles because of the shadowing effect. Thus, microbial inactivation is reduced *(2, 34, 45)*.

A commercial UV reactor from FPE, Inc. (Macedon, NY) was shown to be capable of more than a 5-log reduction after two passes of both apple cider from a Placerville, CA mill and Mott's dark apple juice *(35)*. The FPE UV unit is programmed to automatically compensate for total solids and color in the apple cider. Increased solids content and darker color caused by extended storage of apples decreases the UV penetration through the apple cider, but the unit ensures that all of the apple cider achieves the appropriate UV exposure to produce a 5-log reduction *(47)*.

In many cases, achieving a 5-log reduction through the use of UV light alone would be possible only for cider with very low levels of background microflora processed at extrememly slow rates *(45)*. At best, UV light can be used with other alternative processing technologies, including powerful oxidizing agents, such as ozone and hydrogen peroxide. UV systems are relatively inexpensive and appropriate for small processors. Investigation still needs to be done on the effect on nutrients and flavor during UV processing of juices *(2, 34, 37, 44)*.

High pressure processing

High pressure processing (HPP) is also gaining acceptance in the US as an alternative technology to pasteurization. Food is subjected to very high pressures (up to 130,000 psi) at a specified temperature and time. HPP is able to inactivate pathogenic microorganisms with minimal heat treatment *(27)*.

Basically two types of systems are used. One is a batch system in which pre-packaged juice is placed into a high-pressure vessel, pressurized for as little as two minutes and then removed. This system has been commercialized. Producers of ready-to-eat meats, fresh juices, prepared fruits and vegetables, and seafood are employing Avure Technologies' *Fresher Under Pressure*® high-pressure processing systems to ensure food safety and extend refrigerated shelf-life. Some of the commercially available foods treated with this technology in the United States include oysters, guacamole, orange juice, salsa and ham. The second system is a semi-continuous system where juice is pumped into a series of high-pressure vessels, treated with high pressure, then aseptically removed from the vessel and aseptically packaged.

One advantage of HPP is that pressure transmission is instantaneous and uniform. Other advantages include reduced process times; minimal heat damage problems; retention of freshness, flavor and color; no vitamin C loss; no undesirable changes in the food structure; and extended shelf life. The lack of extended exposure to high temperature, as with thermal pasteurization, results in products that better retain their nutritional values and flavor. The processing cost is slightly higher (approximately five cents a pound) than with conventional processes *(27, 37)*.

Juices treated with HPP have shown that food pathogens such as *Salmonella* and *E. coli* O157:H7 can be destroyed without changing the juice's fresh, natural characteristics. A 3–5 log reduction of the pathogens of concern can be achieved with a pressure exposure of 80,000 psi for 30 s. An example of a commercialized pressurized juice is orange juice by UltiFruit®, Pernod Richard Co., France *(27)*.

A variation of the continuous HPP system that uses a pressure and carbon dioxide (CO_2) combination was developed by the University of Florida and Praxair, Inc., Burr Ridge, IL. Praxair's *Better Than Fresh*™ is a continuous non-thermal process that uses CO_2 with low pressures (~5000 psi) compared with typical HPP systems. A juice product is mixed with liquid, food-grade CO_2, passed through a pressurization pump, and held under pressure for a specific period of time with the CO_2 in the juice. Afterwards, the pressure is reduced, and CO_2 is removed. The result is a 5-log kill for the target organisms in juice. HPP juices, including Praxair's pressure/CO_2 system, have better aroma and flavor than thermal pasteurized products while still providing an extended shelf life *(37)*.

Other alternative treatments

Other non-thermal food processing technologies that show promise as alternatives to pasteurization include extreme isostatic pressure, pulse-electric field pasteurization, ozone treatment, ohmic heating, modified atmosphere packaging, ultra filtration, high power microwave and ionizing irradiation (gamma, electron beam, and x-ray). The Juice HACCP regulation does not require thermal pasteurization of juice. A processor may use any of these alternative technologies to achieve a 5-log reduction for the "pertinent microorganism" *(2, 3)*.

JUICE HACCP CURRICULUM

Development of the juice HACCP alliance

The Juice HACCP Alliance was formed with the voluntary contribution of the food industry, government and academia that were interested in ensuring that the juice industry attains the greatest level of food safety using HACCP. The National Center for Food Safety and Technology (NCFST) at the Illinois Institute of Technology (IIT) led the Juice HACCP Alliance, which was created with the assignment of developing a juice HACCP training curriculum for juice processors during 2001. Representatives from the Food and Drug Administration (FDA) served as technical advisors *(14)*.

The major task of the Alliance was to produce a Juice HACCP training curriculum. Much of the Juice HACCP curriculum material was modeled on that of the Seafood HACCP training curriculum, "HACCP: Hazard Analysis Critical Control Point Training Curriculum." This document was developed by the Seafood HACCP Alliance for Education and Training, and the Juice HACCP Alliance was given permission to use the document as a starting point. Dr. Donn Ward of North Carolina University chaired the Seafood Editorial Committee made up of HACCP and seafood specialists from around the country. Dr. Peter Slade of NCFST/IIT chaired the juice Editorial Committee and led the work of the Juice HACCP Alliance *(14)*.

Extensive changes were made to the third edition of the seafood text to address the needs of juice processors and the Juice HACCP requirement for a 5-log reduction of the pertinent microorganism of concern in juice. Minor changes have also been made to reflect the requirement for documented and monitored prerequisite programs in the regulation *(14)*.

A first draft of the Juice HACCP curriculum was sent to FDA for review at the end of March 2002. FDA recognized the first edition of the Juice HACCP Training Curriculum: "Standardized Training Curriculum for Application to HACCP Principles to Juice Processing" as the standardized curriculum for Juice HACCP training on October 7, 2002 (www.cfsan.fda.gov/~dms/juicgui5.html). Other curricula may be used as long as the curriculum covers the following: (1) biological, chemical and physical hazards; (2) applicability of Current Good Manufacturing Practices and Sanitation Standard Operating Procedures; (3) the five preliminary steps of HACCP with application to juice processing; (4) the seven principles of HACCP with application to juice processing; and (5) FDA's Juice HACCP regulation (21 CFR Part 120) and related FDA guidance documents. The curriculum is available on the NCFST web site in pdf format for public access (www.ncfst.iit.edu) or may be ordered in bound copy from NCFST *(14)*.

Juice HACCP for HACCP experts

The Juice HACCP regulation states that anyone who develops and implements a juice HACCP plan must be a "HACCP-trained individual" according to the standardized curriculum or its equivalent. The rule states that such individuals "shall have successfully completed training in the application of HACCP principles to juice processing at least equivalent to that received under the standardized curriculum recognized as adequate" and allows someone to be qualified by job experience *(2, 3, 38)*. The traditional HACCP three-day workshops are designed for industry members and others needing to learn the HACCP principles as applied to juice. Participants learn basic HACCP principles and how to create a HACCP plan for juice. NCFST is working with trainers to encourage and facilitate the enrollment of state inspectors alongside their industry peers.

The "Juice HACCP for HACCP Experts" two-day workshops, held nationwide in major apple and citrus regions, prepared HACCP experts to deliver the three-day juice HACCP course. The first workshop was held in Orlando, Florida for a dozen attendees. Dr. Peter Slade leads the training, assisted by experts from academia, industry and government from regional sites. Participants include processors, federal and state field inspectors, academic experts, and consultants. Many processors want to be qualified to train their staff. Training is also available from other sources such as the Food Processors Institute (www.fpi-food.org).

A draft of the first edition of the FDA's "Juice HACCP Hazards and Controls (HC) Guidance" was released on September 12, 2002 *(45)*. The HC Guidance will help processors and inspectors assess hazards and develop/evaluate HACCP plans. The HC Guidance lists potential biological, chemical and physical hazards. The guidance also serves as a tool for federal and state regulatory officials in the evaluation of HACCP plans for juice products and identifies methods of controlling and preventing hazards. The Juice HACCP training curriculum was developed in cooperation with FDA technical advisors and reflects the hazards identified in the HC Guidance *(45)*.

Training of inspectors and inspections

In conjunction with the Office of Regulatory Affairs, the Center for Food Safety and Applied Nutrition (CFSAN) has developed and will conduct training of field investigators for juice HACCP inspections. Elements of the standardized curriculum have been a part of the investigators' training.

As with seafood, it is expected that both state and federal inspectors will attend training at the three-day Alliance and one-day regulatory course and then pass a juice HACCP exam for regulators. Inspectors in need of basic HACCP training can learn from three web-based courses offered through FDA's Office of Regulatory Affairs. On October 30, 2002, inspectors were trained through a downlink (http://www.fda.gov/ora/training/course_ora.html). The taped video is now available for viewing. In addition, a "Juice HACCP Regulator Training" document was released in September 2002 (www.cfsan.fda.gov/~comm/juiceman.html).

FDA inspections began in 2003 to verify that juice companies comply with HACCP regulations. Initially, educational inspections have been made with the aim of identifying areas where processors need to strengthen their HACCP plans to reduce hazards. If problems are discovered, it is expected that problem areas will be addressed by the second inspection. Additionally, these examinations will also provide the inspectors with hands-on experience in HACCP-based juice inspections *(46)*.

Future directions

Food safety management is an ongoing process. Understanding the microbiology of foodborne pathogens and identifying the mechanisms needed to improve the safety of the food supply are important. Although it is a very useful hazard management device, HACCP is not appropriate for all situations. A HACCP plan should not be mandated if a scientific analysis does not identify a point in the process that meets the CCP criteria. If HACCP is implemented, it should remain flexible to include science and data specifically for a certain product and process that best meets Food Safety Objectives (FSOs) in managing food safety. Over time, additional hazards may be identified and a HACCP plan revised to include the new hazards *(29)*.

A recently proposed risk management revolves around FSOs. ICMSF defines FSOs as "statement[s] of the maximum frequency and/or concentration of a microbiological hazard in a food at the time of consumption that provides the appropriate level of protection (ALOP)." FSOs can integrate with HACCP and GMPs into a framework that "achieves public health goals in a science-based, flexible manner" *(11)*.

ICMSF proposes to emphasize process control systems and validation to assess the efficacy of CCPs in HACCP systems and certain prerequisiste programs to: (1) control the initial level of a hazard, (2) control an increase in the level of a hazard and/or (3) reduce the level of a hazard. In the case of juice, a 5-log reduction is being required for control of enteric pathogens, such as *Salmonella* and *E. coli* O157:H7. If the initial level of *Salmonella* is as high as 100 CFU/ml of juice, then a 5-log reduction step would result in 0.1 CFU/100 ml of juice. At face value, this would not appear to be adequate to ensure safety of the juice, especially if those who are at high risk consume it on a daily basis. However, if the effects of exposure of survivors to low pH in the juice are factored in, it is assumed that there will be a slow progressive die-off of survivors, which will render the juice safe *(29)*.

The incoming juice should be controlled to maintain a lower initial pathogen level and/or apply a reduction step that would achieve a reductio greater than a 5-log reduction. For *Salmonella*, the National Advisory Committee on Microbiological Criteria for Foods recommends a level of less than or equal to 1 CFU per 10 L of juice to be adequate to provide an ALOP *(29)*.

Therefore, an FSO for fresh juice would be "the level of enteric pathogens, such as *Salmonella* and *E. coli* O157:H7, must not exceed 1 CFU/10 L of juice." This value should be considered when attempting to achieve a 5-log process and establishing control measures through the application of GMPs and HACCP *(29)*.

Regulatory agencies can use FSOs and "processing safety objectives" to control hazards in a food processing facility and then to evaluate the adequacy of a facility's control system. To learn more about the application of FSOs, read "IFT Expert Report on Emerging Microbiological Food Safety Issues: Implications for Control in the 21st Century" *(11)*.

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Iowa High School Students' Perceptions of Food Safety

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SUMMARY

Food safety perceptions and practices of adults have been researched extensively, yet little research exists about high school students' perceived foodborne illness risks or their food safety concerns. The goal of this study was to determine Iowa high school students' perceptions of food safety by measuring awareness of foodborne illness sources; determining perceived risk of foodborne illness from various foods; assessing food safety attitudes associated with home, restaurants, and school; and assessing demographic influences on perceptions. This research provides a basis for educational material and program development with potentially great impact on future adult consumers.

Students were familiar with *Salmonella* (90.7%), *E. coli* (88.9%), and Hepatitis A (83.7%), but few were aware of *Campylobacter* (4.8%), *Listeria* (12.8%), or *Clostridium* (14.2%). Students were more concerned about getting sick from eating meat and eggs than about getting sick from eating fruits and vegetables.

Food processors/manufacturers were considered the most likely source of food safety problems (75.8%), followed by restaurants (64.4%), transportation (58.1%), supermarkets (47.1%), home (40.5%), and farms (38.4%). Students were more confident of the safety of food eaten at home than of that eaten at school and were least confident of food from restaurants.

Nearly a third of students (32.5%) had foodservice work experience and 62.3% of students had received some food safety education in school. Nevertheless, students reported a limited awareness of common foodborne illness sources and perceived risk of foodborne illness.

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INTRODUCTION

In 1997, the National Food Safety Initiative focused on consumer food safety education *(20)*. The development of consumer food safety education programs and materials has been based on research on adult consumers' food safety knowledge *(8, 16, 19, 23)* and perceived risk *(1, 4, 7, 8, 13, 14, 22, 23)* associated with food handling.

Food-safety related behaviors that consumers believe to be risky could be different from behaviors that are actually associated with the greatest risk of causing illness or worse. Consumers have a tendency to overestimate certain risks, typically of low probability but severe consequences, while underestimating other risks *(19)*. Even though numerous studies and governmental agencies report that elderly people are more susceptible to foodborne illness than younger, healthy consumers *(10, 11, 15, 20)*, three times as many consumers age 18 to 39 said they had experienced a foodborne illness within the last year, compared with respondents 60 years and older *(8)*. Consumers who had experienced a foodborne illness believed that food safety and microbial contamination were a greater problem than those who had not experienced a foodborne illness *(8)*. If the percentage of consumers believing they had become ill from food increases when the illness source is not confirmed, then consumer confidence in the safety of the food supply may decrease because of false perceptions about the incidence of foodborne illness. In addition, consumers perceive that most foodborne illnesses are caused by food consumed outside the home *(8, 22)* while experts believe that illnesses caused by food prepared in the home are more common than is recognized *(12)*. This misperception can result in less motivation for consumers to change food handling practices in the home *(4)*.

Consumers are more likely to purchase, store, prepare, and serve safer foods if they understand what causes foodborne illness. Knowledge of the most common foodborne pathogens, the most dangerous foodborne pathogens, and food products with which these pathogens are associated allows consumers to make more educated food safety decisions. Reported information regarding consumers' awareness or knowledge of specific foodborne pathogens has been contradictory *(2, 6, 13, 15)*.

Consumers in general were most familiar with *Salmonella* (80.2%), botulism (74.8%), trichinosis (40.8%), and hepatitis (39.3%) *(2)*, whereas Tennessee health workers believed *Salmonella* (90%), *E. coli* (56%), *Staphylococcus* (36%) and *Shigella* (32%) were the four most common foodborne-illness-causing pathogens *(13)*. Mead et al. *(15)* reported that the five most common foodborne-illness-causing pathogens were Norwalk-like viruses (66.6%), *Campylobacter* spp. (14.2%), *Salmonella* (nontyphoidal) (9.7%), *Clostridium perfringens* (1.8%), and *Giardia lamblia* (1.4%). For meat products specifically, the most commonly associated foodborne pathogen is *E. coli* O157:H7 for ground beef; *Listeria* for processed meat products or ready-to-eat products; *Campylobacter* for poultry; and *Salmonella* with pork *(6)*.

Recent research into consumer perceptions has focused on consumers 18 years of age and older *(1–4, 8, 13, 14, 17, 18, 21, 23)*. Attitudes of high school students, who may soon be leaving home and becoming more responsible for their own food purchasing and preparation decisions, have not been reported in the literature. Further, there has been an increase in the number of high school students working in food service jobs *(5)*. Thus, the understanding of students' food safety practices and perceptions is important.

The goal of this study was to determine Iowa high school students' perceptions of food safety by measuring awareness of foodborne illness sources; assessing differences in food safety attitudes associated with home, restaurants, and school; determining perceived risk of foodborne illness from various food products; and determining demographic, education, and employment influences on perceived frequency of foodborne illness and concern about illness from foodborne illness sources.

MATERIALS AND METHODS

Seventeen schools were randomly selected from all of Iowa's public high schools. Biology teachers from the selected schools were utilized as on-site survey administrators. A biology teacher from each of the 17 schools was contacted by telephone between March and April 2002 to determine their willingness to participate. One biology section from each school received surveys, providing approximately 400 students for the study sample.

The survey instrument consisted of 16 questions that focused on knowledge, perceptions, and demographics. The knowledge questions evaluated familiarity with foodborne pathogens by asking whether or not students had heard of specific microorganisms. Microorganisms were chosen based on prevalence in food products. This section also had students identify segments in the food production and distribution system where they perceived that food safety problems were most likely to occur. Six specific segments were listed, and students chose all of the segments they believed to be a potential source of food safety problems.

Students' food safety perceptions were determined by measuring perceived illness frequency, food safety control, and illness risk at home, restaurants, and school, as well as by measuring concern about illness from specific food products. Students' concern about getting sick from specific food products was measured for four meat products (ground beef, pork,

TABLE 1. Demographic characteristics of Iowa high school students participating in the study (N=289)

Characteristic	No.[a]	%
Age		
14	5	1.7
15	125	43.3
16	87	30.1
17	56	19.4
18	13	4.5
Grade		
Freshman	6	2.1
Sophomore	199	68.9
Junior	29	10.0
Senior	54	18.7
Gender		
Male	135	46.7
Female	153	52.9

[a]Some students did not respond to demographic items, so totals may not equal total sample size.

poultry, and processed meats), eggs, fresh fruits, raw vegetables, and baked goods. Students' perceptions of how frequently consumers become ill from food handling were measured for home, school, and restaurants. The perceived level of food safety control for home, school, and restaurants was measured on a 7-point scale, using the statement "How much control do you have over the safety of food you eat at…". Scale anchors were "no control" and "complete control." A rank-order for perceived risk of foodborne illness at home, school, and restaurants was determined by comparing the locations in pairs—home versus restaurants; restaurants versus school; and school versus home. Students were asked to choose one location from each pair that best completed the statement "I am at greatest risk of getting a foodborne illness from food I eat at…".

Age, gender, and grade in school were determined for each student. Additional descriptive information collected from the students included whether they had ever been or were currently employed in a job that involved food handling, and if they had received any previous food safety education in school.

A majority of students who completed the survey were under 18 years old, so parental consent was required. The Iowa State University Human Subjects Research committee required that an informational letter be provided to all students for delivery to their parents or guardians. The letter provided information about the survey, its purpose, and its subject content. If a parent or legal guardian disapproved of a student's participation, the form was to be signed and returned to the teacher prior to survey administration. Students' completion of the survey provided their consent to participate.

An informational letter was also provided to the building administrators for each school, notifying them of the survey, its purpose, and the intended use of the data. Administrators were asked to sign the letter and have the teacher return it with the completed surveys.

The survey instrument was pilot tested to estimate completion time and to determine clarity. A biology class at a local high school was used for pilot testing. Pilot testing identified the need for revisions to the scale anchors for questions measuring concern. The terms "no opinion", "neutral", and "unsure" were removed from the mid-point of the 7-point scale because the students may not have opinions regarding food safety. Without a mid-point anchor, the scale's end anchors meant more to students. Frequencies, means, and standard deviations were calculated for the pilot data to determine if the variability associated with the responses was acceptable.

Participating teachers received the surveys, consent letters, administrator notification letter, survey administration instructions, and a self-addressed, postage-paid return envelope in October 2002. Surveys were administered at the beginning of the semester to minimize the potential influence of biology class material on students' responses. The survey administration date was selected at the teacher's discretion. All materials were to be returned by November 15, 2002. Reminder postcards were mailed to the non-responding teachers on November 15, 2002, and were followed by reminder telephone calls on November 22, 2002. Each completed survey was assigned an order number for data entry.

Data were analyzed using SPSS version 11 for Windows. Means, standard deviations, and frequencies were calculated for questions as appropriate. Significance was determined using an alpha (α) level of 0.05 for all tests. ANOVA was used to compare means. Bonferroni post hoc tests were used to identify which means were different when the ANOVA indicated a difference among means.

TABLE 2. Percentage of Iowa high school students identifying locations where food safety problems are most likely to occur (N=289)

Location	No.	%[a]
Food processors/manufacturing plants	219	75.8
Restaurants	186	64.4
Transportation	168	58.1
Supermarkets	136	47.1
Home	117	40.5
Farm	111	38.4

[a]Column totals more than 100% because students could select more than one location.

TABLE 3. Percentage of Iowa high school students who were aware of common foodborne pathogens (N=288)

Pathogen	No.	%[a]
Salmonella	262	90.7
E. coli O157:H7	257	88.9
Hepatitis A	242	83.7
Trichinella	70	24.3
Clostridium	41	14.2
Listeria	37	12.8
Campylobacter	14	4.8

[a] Column totals more than 100% because students were asked to choose all that apply.

A general linear model was used to determine influences on self-reported knowledge level, perceived likelihood of contracting a foodborne illness, and concern for illness from food products. Three separate binomial tests based on normal approximation were used to determine if a difference was present for the perceived risk of illness at home versus school, school versus restaurants, and restaurants versus home. An α of 0.05/3 (or 0.017) was used for each of the three separate binomial tests to achieve an α level of 0.05 for the overall ranking of the three locations.

RESULTS AND DISCUSSION

A total of 289 surveys were received from 12 schools. Demographic characteristics of the sample are presented in Table 1.

Participant ages ranged from 14 to 18, with a mean age of 15.8 ± .9. All four traditional high school grades, freshman through senior, were represented in the sample. A sample skewed toward sophomores (ages 15 and 16) was expected because of the way the high school curriculum is designed. However, it was not anticipated that seniors would represent such a large percentage (almost 19 percent) of the sample. Two of the 12 schools contributed 72.2% (n = 39) of the seniors, which may indicate that these were advanced biology classes. The sample was almost equally divided between male and female students.

The mean self-reported knowledge level was 3.9 ± 1.2 of a possible 7. Of the students surveyed, 62.3% (n = 180) had received some food safety education in school and 32.5% (n = 93) had worked or were currently working in a job that involved preparing or handling food.

A regression analysis showed that foodservice employment was the only factor affecting the self-reported knowledge level. Students with foodservice experience reported being more knowledgeable about food safety than students without any foodservice experience.

Foodborne illness sources

Students identified segments of the food production chain they thought might be a source of food safety problems (Table 2). More than 75% of the students reported food processors/manufacturing plants as the most common point for problems to occur. Restaurants were the second most common, with 64.4%, followed by transportation (58.1%). The segments that students thought were least likely to cause food safety problems were the farm (38.4%) and home (40.5%). These results are consistent with the consumer attitudes reported by the Food Marketing Institute (FMI) *(9)* in that food manufacturers/processors were the most commonly identified point for food safety problems, followed by restau-

TABLE 4. High school students' concern about foodborne illness from specific food products[a]

Food product	Mean score[b]	SD
Processed meats	3.2[a]	1.8
Ground beef	3.2[a]	1.6
Poultry	3.1[a]	1.6
Pork	3.0[a]	1.7
Eggs	3.0[a]	1.7
Raw vegetables	2.1[b]	1.4
Fresh fruits	1.9[b]	1.4
Baked goods	1.9[b]	1.3

[a]Concern was ranked on a 7-point scale with 1 = Not at all concerned and 7 = Very concerned

[b]Means with different letters were significant at $P < 0.05$.

rants. However, students in this study selected these two segments more frequently than consumers in the FMI study and ranked home fifth on the ordered list of likely locations for food safety problems, compared with third in the FMI study *(9)*.

A small portion of the students (5.5%) chose "other" and wrote in an additional location, most commonly the school (3.8%, n = 11). Because the target population for this survey was high school students, "school" should have been included in the list of segments in the food production system where food safety problems might occur.

Students' awareness of common foodborne pathogens is reported in Table 3. The pathogens most familiar to students were *Salmonella* (90.7%), *E. coli* O157:H7 (88.9%), Hepatitis A (83.7%), and *Trichinella* (24.3%). Of the four pathogens most familiar to students, *Salmonella* was the only one identified by Mead et al. *(15)* as one of the five most prevalent illness-causing pathogens. It was not expected that *Trichinella* would be familiar to students because of its low prevalence *(15)*.

Clostridium (14.2%), *Listeria* (12.8%), and *Campylobacter* (4.8%) completed the ranking as the least familiar pathogens. Students' low familiarity with *Listeria* and *Campylobacter* identifies a need for additional education about common foodborne pathogens, as these two pathogens have become prevalent *(6)*. If this study were conducted again, Norwalk and Norwalk-like viruses would be included because these are implicated in 66.6% of all foodborne illnesses *(15)*. Botulism also would be included to evaluate students' familiarity with this specific disease.

Concern about becoming ill from eating certain food products was determined. Mean scores for each food category evaluated are reported in Table 4. Ground beef, pork, poultry, and processed meats received the highest concern scores, which were similar to eggs. The mean concern scores were low for the entire list of products (max. = 3.2 on a 7-point scale).

Analysis of variance for the four meat product scores showed no difference among scores. There also was no difference between scores for fresh fruits and for raw vegetables. Because no difference was present among the meat products or the fruits and vegetables, each student's four meat product responses were averaged to provide a mean score for meat. An average of the scores for fruits and raw vegetables also was calculated.

Analysis of variance for meat, eggs, fruits/vegetables, and baked goods scores showed no difference between the mean scores for meat and eggs, or between fruits/vegetables and baked goods. Students were more concerned about becoming ill from eating meats and eggs than from eating fruits/vegetables or baked goods. Males were less concerned than females about getting ill from eating meat products. The concern about illness from meat products increased as self-reported food safety knowledge increased.

Results of pathogen awareness and specific product concern were not consistent. *Campylobacter*, the second most common cause of foodborne illness, is the most common pathogen found in meat products, specifically poultry, and was the least known to students. *Listeria*, one of the most common pathogens isolated from processed meat products, was the pathogen with which students were second least familiar. *E. coli* O157:H7, the pathogen second-most familiar to students, is becoming more prevalent in foodborne illness cases associated with raw vegetables and melons.

Perceptions of food safety at home, school, and restaurants

Students believe that they have the most control over the safety of food eaten at home, which they also believe is least likely to cause illness (Table 5). Students think that illness is less likely to be caused by food handled at school than by food handled in restaurants, but they feel they have more control over the safety of restaurant food than of school food. Responses related to the perceived level of control appear appropriate for the setting, as consumers have a

TABLE 5. Importance of location on Iowa high school students' perceptions of food safety

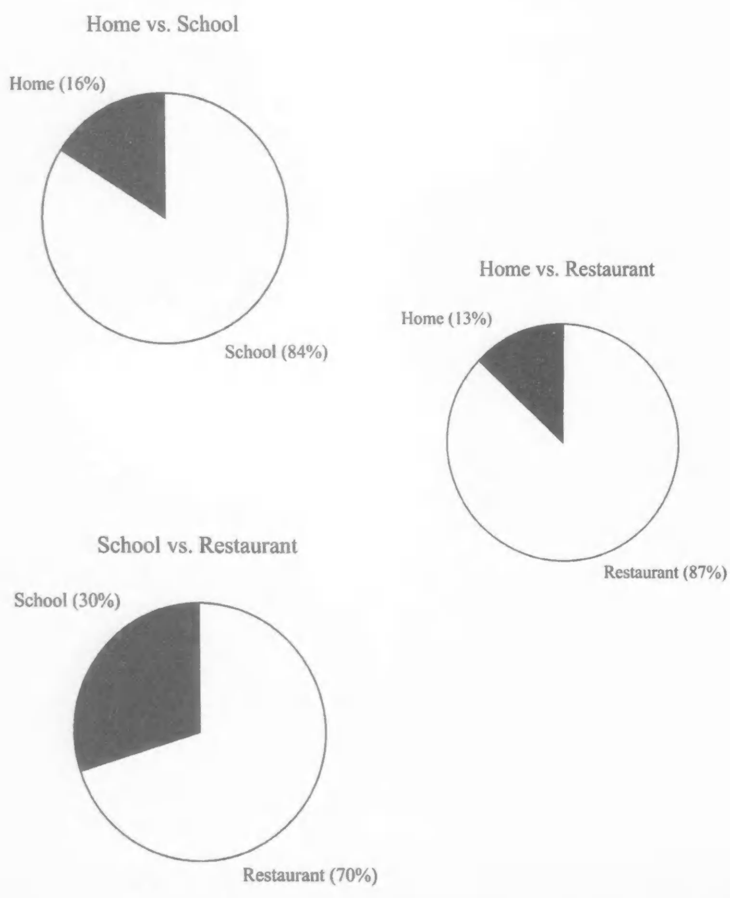
	Frequency of sickness from food handling		Control over food safety	
	Mean score[a,b]	SD	Mean score[a,c]	SD
Home	4.3[a]	1.5	5.8[a]	1.1
Restaurants	3.4[c]	1.3	2.7[b]	1.5
School	3.9[b]	1.5	2.3[c]	1.3

[a]Means within columns with different letters are significantly different at $P < 0.05$.

[b]A 7-point scale with 1 = Very common and 7 = Very Uncommon was used for the question, "How common is it for people to get sick because of how food was handled?"

[c]A 7-point scale with 1 = No control and 7 = Complete control was used for the question, "How much control do you have over the safety of the food you eat?"

FIGURE 1. Students' perceived risk of becoming ill from eating at home, restaurants, or schools



greater impact on food safety in the home than in restaurants as the result of greater food handling responsibility. Students can make more decisions about the food they eat in restaurants than about the food they eat at school, which may influence their perceptions about food safety control.

Students were presented with three pairs of locations (home versus restaurant, home versus school, and restaurant versus school) and asked to select the one location from each pair where they were at greater risk of contracting a foodborne illness. As shown in Fig. 1, home is perceived to be the least likely source of illness, followed by school and then restaurants.

A general linear model was used to determine if perceived control at each location, self-reported food safety knowledge, age, gender, prior food safety education, or foodservice employment affected the perceived frequency of illness from food handled in each of the three locations (home, school, and restaurants). Gender had an effect on perceived risk at home (β = .363, P = .041), school (β = .343, P = .047), and restaurants (β =.486, P = .003). More females than males reported that it was common to get sick from food, which is consistent with results of other studies *(3, 14, 18, 21)*. It has been reported that males are greater risk takers than females, resulting in lower perceived risk of illness by males than females.

Age affected perceived risk at school (β = .295, P = .002). As age increased, students said they were less likely to get sick from food handled at school. Age may affect perceived risk of illness because of more training at work, education, or personal experiences. However, this does not explain why age did not affect the perception of illness risk associated with home or restaurants.

The current study shows the locations with which students are most comfortable or confident in eating food. Additional research is needed to better understand why students place more confidence in food eaten at home than food from restaurants or school and how these factors influence students' food handling practices.

Similar to previous adult consumer research, this study indicates a need for additional education for high school students to increase awareness of common foodborne pathogens and dangerous foodborne pathogens. The results of this study serve as a guide for student food safety education and training program development. These data show a need for more food safety education at an earlier age. However, education alone will not reduce food safety problems. As shown by Albrecht (*1*), the PR/HACCP Rule Evaluation Report (*16*), and Shiferaw et al. (*18*), consumers often are knowledgeable about food safety, but still practice unsafe behaviors.

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Microbial Food Safety Considerations for Organic Produce Production: An Analysis of Canadian Organic Production Standards Compared with US FDA Guidelines for Microbial Food Safety

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SUMMARY

Increased attention has been focused on fresh fruits and vegetables, especially raw or minimally processed, as a significant source of foodborne illness. Outbreaks have been linked to both conventionally and organically grown produce. This paper outlines the risks associated with fresh produce, common pathways of contamination, and current trends in organic agriculture. The primary objective was to determine whether the Canadian General Standards Board (CGSB) organic standard is consistent with the production of microbiologically safe produce and to examine the potential for the CGSB organic standard to include considerations for microbial food safety. This objective was achieved by examining information gaps between the US Food and Drug Administration on-farm food safety guidelines and the organic standard developed by the CGSB. This examination showed a significant degree of commonality and, in some cases, it was demonstrated that microbial food safety standards are achieved indirectly under organic production. The main difference between the US guidelines and the CGSB standard is the focus on the process rather than the safety of the final product and the lack of discussion of microbial considerations in the CGSB standard. Specific omissions include worker hygiene and recommendations for safe use of processing and irrigation water. The production of safe food is the responsibility of everyone in the farm-to-fork chain. With established relationships between growers and regulatory infrastructure, the CGSB organic standard would be an ideal vehicle for providing organic growers with information and guidelines on identifying and controlling microbial hazards on their produce.

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INTRODUCTION

Organic agriculture has been described as the fastest growing sector in the Canadian agri-food system, primarily as a result of growing consumer demand *(6, 27, 32)*. This trend has also been seen in the United States and Europe *(7)*. Part of this growing consumer demand can be ascribed to the perception of organic produce as "healthier" and "safer" than conventionally produced fruits and vegetables *(8, 12)*, although there is little research to support the perception that organic products are safer or healthier than their conventional counterparts. Increasing numbers of outbreaks associated with fresh produce have led to a closer examination of fruit and vegetable production systems. The Institute of Food Technologists Expert Report *(13)* identified organic agriculture as one of the emerging issues in food safety. The use of manure as the primary source of fertilizer as well as a potential source of pathogens, along with the prohibition of bacteria-reducing chemicals, were identified as concerns for future food safety issues.

Gaps exist between current organic standards, such as the Canadian General Standards Board (CGSB) organic standard and specific on-farm food safety initiatives, such as the FDA on-farm food safety guidelines. The purpose of this paper was to outline the potential risks associated with fresh produce and common sources and causes of contamination, as well as to examine whether organic production standards such as the CGSB organic standard are consistent with the production of microbiologically-safe produce. Established organic standards have the potential to include food safety considerations. The current role of organic certifying bodies in standardizing food production processes may be further utilized to deliver food safety messages to the organic agriculture community. This paper includes a discussion of the potential of the CGSB organic standard to include microbial food safety considerations such as those outlined in the FDA on-farm food safety guidelines. The identification of gaps between organic production ideology and food safety standards will provide a framework for future safe food production initiatives in alternative food production systems.

ORGANIC AGRICULTURE IN CANADA

Organic retail sales in Canada in 1999 accounted for one per cent of total sales *(27)*. This is a direct result of growing consumer demand, estimated as increasing at a rate of 25 per cent per year in North America and 40 per cent per year in Europe *(7)*. The organic industry itself has ascribed this increase to growing consumer concern over the human health and environmental effects of genetic engineering and chemical pesticides associated with food production *(7)*.

Concern for environmental issues has increased dramatically since the 1980s, and Canadian consumers have consistently identified pesticides as one of their top food safety concerns *(6)*. Food has cultural and social overtones, and food choices have become more and more influenced by consumer values *(9)*.

A direct result of increasing consumer demand for organic food is that organic products are becoming more mainstream and more widely available in larger supermarkets rather than in specialty markets alone *(8)*. Loblaw's, a Canadian retailer, has introduced a line of President's Choice certified organic products *(14)*. The organic industry claims that their products, positioned as premium products, offer assurances of environmental quality, safety and nutritional value that conventional farmers cannot provide *(5)*.

Survey data have indicated that 18 percent of Canadians buy them on a regular basis and 22 per cent buy them occasionally *(8)*. Studies that examine why consumers buy organic produce have shown that the top reason for both North American and European consumers is that organic food is perceived as "healthier" *(8, 9, 11, 12)*. Other advantages of organic farming cited by consumers included better taste and quality, higher nutritional value, benefits for the environment, greater safety, and "more natural" *(6, 11, 12, 25)*. When asked which foods in the grocery store were the safest, US consumers rated "natural" and organic foods highest and irradiated foods lowest *(6)*. Studies by both CFM&Z *(6)* and Hutchins and Greenhalgh *(11)* found that consumers have little understanding of the term "organic." The use of terms such as "safer" and "healthier" are an indication of consumer oversimplification of agricultural food safety issues. These generalities are not separated to specify whether the consumer is referring to perceived microbial or chemical risks. This lack of understanding is further revealed in the survey by Hutchins and Greenhalgh *(11)*, in which all respondents stated that organic foods were "produced without chemicals." Another common reply was that organic foods were more "natural," indicating poor understanding of the complexity of both organic and traditional agriculture systems.

There is little research to support the perception that organic products are safer than their conventional counterparts *(10)*. However, increasing outbreaks associated with fresh produce have led to a closer examination of fruit and vegetable farming practices. In response to increased concern over the safety of fresh produce, regulators and several producer groups have developed on-farm food safety guidelines and programs for fresh fruit and vegetable production.

Among those with such plans are the, US Food and Drug Administration *(25)*, the Canadian Horticultural Council (CHC) *(4)*, and the Ontario Greenhouse Vegetable Growers (OGVG) *(15)*. The CHC and OGVG have based their programs on the FDA guidelines. The OGVG program also includes microbial sampling to validate the effectiveness of food safety processes. The FDA guidelines are comprehensive and focus on identifying broad microbial hazards in common areas of concern and recommending good agricultural and management practices for reducing risk of microbial contamination in fresh produce.

In Canada, the Canadian General Standards Board (CGSB) has published a set of guidelines for organic production *(3)*. The standard was written to establish a baseline amongst various organic certification groups and can be used during inspection to ensure that the certification of products as organic meets the same minimum standard across Canada. Through the creation of a national standard, a line of communication has been established between the CGSB and the organic farming community. The organic standards in their current form are not designed to convey food safety messages. The current structure of the CGSB may, however, provide a venue for bridging the gap between organic production methods and on-farm food safety standards.

RISKS ASSOCIATED WITH FRESH PRODUCE

The health benefits of a diet rich in fresh fruit and vegetables are well known *(19)* and Canadian produce has long been recognized for its safety and quality. This is evident by the increase in per capita consumption of fresh fruits and vegetables in Canada and the United States in the past decade *(20, 25)*. Major contributing factors to this increase include improvements in agronomic practices, processing, preservation and distribution, all of which have enabled the industry to supply high quality fresh fruits and vegetables all year long *(20)*. Public health efforts in the US and Canada have also focused on increasing consumption of fresh fruits and vegetables with their "five-a-day" campaigns *(4)*. This type of initiative reiterates national health officials' commitment to the promotion of fresh fruits and vegetables.

Traditionally, animal products have been identified as the most common vehicles of foodborne illness. However, the number of reported outbreaks associated with fresh fruits and vegetables, such as *E. coli* O157: H7 in leaf lettuce and *Salmonella* spp. in tomatoes and cantaloupe *(2)*, has increased dramatically over recent years *(2, 17, 22)*. As a result, increasing attention is now being focused on the fresh fruit and vegetable sector, especially raw or minimally processed vegetables, as a significant source of foodborne illness *(2, 23, 25)*. Media attention and consumer concern over foodborne illness associated with fresh produce are also increasing *(17)*. For fresh fruits and vegetables eaten raw, there is no treatment that can be relied on to substantially reduce the numbers of contaminating microorganisms; washing with antimicrobial compounds, while important, often brings about only a relatively small reduction *(18)*.

Along with changing patterns of consumption of fresh produce, the epidemiology of foodborne disease is also changing *(2)*. Industry changes that have improved consumer access to fresh produce have also increased the geographical distribution and incidence of foodborne illness. Food now reaches consumers through longer chains of production, increasing the number of potential points for contamination along the production chain *(2)*. A number of new pathogens has emerged over the past 20 years, most of which have animal reservoirs although they do not cause illness in animals. Many of these pathogens are relatively resistant to heat, acid, and antimicrobials, which, combined with low infective doses, makes the pathogens difficult to control *(22)*. Minimal cooking and processing methods common for fresh vegetables may be inadequate to reduce microbial contamination so as to prevent infection *(22)*.

PATHOGEN PATHWAYS

Investigations of outbreaks of foodborne disease associated with the consumption of fresh produce have indicated that contamination often occurs early in the production chain rather than just before consumption by the consumer *(1)*. Such outbreaks are caused by a number of different pathogens from a variety of sources. Pathogens such as *Listeria monocytogenes*, *Clostridium botulinum* and *Bacillus cereus* are present naturally in the soil and are common on fresh produce *(1)*. Produce becomes contaminated primarily through the use of raw or improperly composted manure or contaminated irrigation and wash water *(1, 22)*. Contact with domestic or wild mammals, reptiles, fowl, and/or insects that may enter the field is another potential source of contamination, as is contact with unpasteurized products of animal origin *(1, 13)*. Surfaces, including human hands that contact produce, represent potential points of contamination throughout the farm-to-fork system of growing, harvesting, packing, processing and shipping. Reduction in the risk of human illness can therefore be achieved only by controlling these points of contamination in the production chain, from the field through to the consumer.

Maintaining control over the entire farm-to-fork food production process is vital for avoiding the recall campaigns, adverse publicity and loss of sales that can result from an out-

TABLE 1. Summary of gaps between FDA food safety guidelines and CGSB organic standards

Main areas of concern for food safety	FDA Food Safety Guidelines	CGSB organic standards
Water	-Guidelines for irrigation and processing water (wash water)	-Guidelines for irrigation water only
Manure	-Recommends using only aged or composted manure in fall with cover crop	-Recommends composted manure only if not organic and 4 month preharvest interval
Worker Health and Hygiene	-Guidelines for training, monitoring and handling worker hygiene, health and illness	-Not addressed
Equipment sanitation	-Guidelines on sanitation procedures, monitoring and documentation	-Addressed indirectly with focus on chemical contamination
Transportation	-Guidelines for hygiene of transportation workers, sanitation of trucks and containers, proper handling to maintain integrity of packaging, and proper temperatures to prevent spoilage	-Addresses good sanitation practices but does not include specific practices for microbiological risks such as temperature control
Traceback	-Recommends identification and documentation of produce distribution pathways	-Extensive audit and tracking protocols

break of foodborne illness associated with a specific product *(15)*. A preventive approach by industry to control contamination of their product is a greater safeguard for the health and safety of consumers than the reactive measures regulatory agencies are forced to take after problems arise.

All sectors of the food industry have a responsibility in ensuring food safety. The stability of local, national and international markets depends on consumer confidence and buying patterns *(15)*. Processors and retailers are demanding food safety assurances from their suppliers, thus creating tremendous upstream demand for effective pathogen and chemical contamination control strategies. Food service and processing industries have been making significant advances through application of the Hazard Analysis Critical Control Point (HACCP) approach to food safety *(16)*. HACCP programs are now being used in various sectors of the food industry.

HACCP is a system of food safety control based on a systematic approach to the identification and assessment of hazards associated with food operations and the definition of means for their control *(21)*. The US Food and Drug Administration (US FDA) has suggested that because critical control points are, at this point, unachievable, a true HACCP system is too rigid for the farm *(26)*. However, HACCP principles have helped to guide the development of on-farm food safety programs by directing risk assessments and establishing points of control where good agricultural practices are applied.

In response to the increased risk of foodborne illness from fresh fruits and vegetables, the US FDA in 1998 *(25)* published a document on the safe production and processing of fresh produce. According to the FDA, this guide was intended to further enhance produce safety by providing farmers and processors with practical steps to reduce the possibility of microbial contamination in their crops. The FDA guidelines are voluntary and focus on five main areas of concern:

- water quality, including considerations for surface and ground water sources, irrigation water and guidelines for water testing;
- manure and municipal biosolids, which includes recommendations for the safe and proper handling of these materials to minimize microbial hazards;
- worker hygiene, including sources of contamination and guidelines for handwashing, training and sanitation;
- guidelines for field, facility and transport sanitation,

identification of potential hazards and considerations for their control; and,

- an examination of traceback systems.

IDENTIFYING THE GAPS BETWEEN THE CGSB ORGANIC STANDARDS AND FDA GUIDELINES

The CGSB organic standards are a comprehensive set of standards covering all aspects of the farm operation. Although the standards are mandatory for organic certification, there are several certifying bodies within Canada, and details on specific requirements for certification vary between bodies. The FDA guidelines which are voluntary, cover micobial considerations at every stage in the farm operation but do not cover other topics such as the safe use of agricultural chemicals. These topics are usually included under Good Agricultural Practices (GAP), and many on-farm food safety programs such as the CHC program include such GAPs. Both the FDA guidelines and CGSB standards are based on several guiding principles, but the principles themselves are significantly different. Organic principles are based upon minimizing impact to the environment and maintaining integrity of organic products. The FDA guidelines focus on preventing contamination through the use of good agricultural practices and appropriate management. Organic advocates claim that their rigorous standards indirectly control microbial contamination through strict adherence to good agricultural practices in order to prevent contamination from non-organic chemicals or products. The CGSB organic standard was assessed using the FDA's main areas of concern listed above. A summary of the comparison is provided in Table 1.

Water

The FDA guidelines cover use of both irrigation water and processing water such as wash water. In comparison, the CGSB organic standards address irrigation water only. Quality of irrigation water used in organic agriculture must be monitored; however, the focus is on prohibited substances such as chemicals rather than microbial pathogens. Processing and irrigation water can be a potential source of pathogens *(17)*. This gap between the FDA guidelines and CGSB standards has the potential to create an elevated level of risk if organic farmers are not aware of this food safety concern.

Manure and municipal biosolids

Animal manure and human fecal material represent a significant source of potential foodborne pathogens. The FDA guidelines provide recommendations and restrictions on the use, handling and application of raw and composted manure and biosolids to reduce the risk of contamination. The guidelines also provide considerations for nearby livestock.

The CGSB organic standard has similar recommendations on composting manure and safe timing for manure application. The CGSB standard prohibits the use of municipal biosolids and raw manure that is not from an organic source. However, recommendations for organically produced raw manure (produced by organic livestock ideally from the same farm) are not as strict as the raw manure recommendations by the FDA. More specifically, the CGSB standard recommends a preharvest interval of four months except when used on known nitrate accumulators. On such crops the CGSB organic standard states that manure should not be applied less than four months before planting. The FDA guidelines recommend against the use of raw manure on produce fields during the growing season prior to harvest and for fresh produce crops that are harvested throughout most of the year. Recommendations for use include post-harvest application and application with fall cover crop. The CGSB organic standard does not provide recommendations for locating livestock in relation to horticultural crops. Whereas the US National Organic Program *(24)* has requirements for manure application and composting, Canada has only recommendations.

The potential of manure to contain pathogens and contaminate a crop is a risk that exists for both organic and conventional agriculture. The FDA guidelines provide a reduced risk by minimizing the window of opportunity for contamination. By ascribing to the guidelines that are geared to improving food safety, the CGSB could reduce the potential for contamination on organic farms and better protect public health and the industry from the hardships that can accompany product recalls.

Worker health and hygiene

The FDA guidelines recognize the importance of farm workers as a vector for transmission of bacterial and viral pathogens. Guidelines are set for monitoring and handling worker health and illness, and for providing worker training programs, with additional considerations for customer-pick operations and road side stands. These issues are not addressed in the CGSB organic standards.

Sanitation: facilities, field, packing facilities

Both the US and Canada have laws regulating sanitation of facilities. The FDA guidelines provide further recommendations on providing accessible, adequate, and clean hand-washing and toilet facilities with adequate sewage disposal. The document addresses proper sanitation and use of all equipment, containers, areas and facility management as well as pest control and temperature control to prevent spoilage. The CGSB organic standards cover most of these issues indirectly. Sanitation of all containers and equipment is required; however, the main focus is on preventing contamination by prohibited substances such as chemical or non-organic residues. Good overall sanitation is recommended to prevent infestation by pests and maintain organic integrity.

The CGSB documentation does not fully address sanitation issues, but has the potential to incorporate the food safety initiative put forward by the FDA. Monitoring programs have been established for the Canadian Horticultural Council *(4)*, and the Ontario Greenhouse Vegetable Growers (OGVG), which provide checklists to ensure that proper worker sanitation facilities are present. Organic certifiers, already visiting farms, could incorporate these checks into their tasks. By using an existing relationship to communicate food safety issues the process is simplified and may improve the success of communicating on-farm food safety messages.

Transportation

FDA guidelines for transportation include hygiene of transportation workers, sanitation of trucks and containers, proper handling to maintain integrity of packaging, and proper temperatures to prevent spoilage. The CGSB organic standards state that transport facilities must be free of (pests vertebrate and invertebrate) and of non-organic produce residues through the use of appropriate maintenance and sanitation. As with sanitation, worker hygiene considerations are not included in the CGSB organic standards. Proper sanitation practices will achieve a reduction in microbial risk; however this is not a direct goal, as there is no mention of microbial hazards or contamination. The CGSB organic standards do not address temperature control, an important aspect of controlling bacterial growth. While addressing concerns regarding the sanitation of transport facilities, the opportunity exists for the CGSB standards to encourage microbiological food safety practices.

Traceback

The ability to identify and track product back to its source is described in the FDA guidelines as extremely useful in identifying and eliminating dangerous pathways. These guidelines provide an overview of the traceback process and recommendations for instituting an effective traceback system. Organic certifiers also require significant record keeping and an audit trail as part of their system. These systems are mandatory and rigorous.

CONCLUSIONS

Surveillance data show that fresh fruits and vegetables, produced either conventionally or organically, are common vehicles for the transmission of foodborne disease. Certification as organic does not require that the grower use production practices that will eliminate, reduce or control the presence of pathogenic microorganisms. The CGSB standard for organic agriculture is to become the minimum standard enforced by the various third-party organic certifiers. Comparison of the CGSB standards to FDA's on-farm food safety guidelines shows a significant degree of commonality. Manure management, water sources and other common sources of pathogens are routinely assessed and controlled through the organic inspection/certification process. In some cases, microbial food safety standards are obtained indirectly; however, the CGSB organic standards focus on the process rather than the safety of the final product, and microbial considerations are not discussed. Through the identification of gaps that exist between the two initiatives, efforts can be made to establish a coordinated on-farm food safety effort.

The production of safe fruits and vegetables can be achieved only through a coordinated effort at all points along the farm-to-fork chain. Since food production begins at the farm, it is the responsibility of all primary producers, organic and conventional, to take efforts to minimize microbial risks on their products. Because organic growers already have a certification and inspection system, the CGSB organic standards could be expanded to better incorporate food safety concerns. Specific additions could include ensuring adequate facilities and training to ensure worker hygiene and recommendations for processing and maintaining processing water quality. The documentation requirements and monitoring and regulation of high-risk inputs give organic growers a head start over conventional growers who may be trying to implement an on-farm food safety system. Because established relationships between growers and regulatory infrastructure are already in place, the CGSB organic standard would be an ideal vehicle for providing organic growers with direct information and guidelines on identifying and controlling microbial hazards on their produce.

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Manual Shaking as an Alternative to Mechanical Stomaching in Preparing Ground Meats for Microbiological Analysis

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SUMMARY

This study compared manual shaking with mechanical stomaching for preparing ground meats for microbiological analysis. Manual shaking is simple and inexpensive compared to use of a mechanical stomacher. However, it may not sufficiently homogenize a sample to allow for accurate detection (qualitative methods) or quantitation of particular microbes or microbial groups. Packages of ground beef (n = 38) and poultry (n = 37) were purchased from a local market. Using a split-plot experimental design, 25-g samples of each package were prepared by mechanical stomaching and manual shaking for enumeration of *Escherichia coli* by use of the Petrifilm *E. coli*/coliform count plate method. Statistical analysis using the Mixed procedure (SAS, version 8) showed that the two sample preparation methods were not interchangeable ($P = 0.0058$). In terms of *E. coli* recovery, ground beef and ground poultry were almost significantly different ($P = 0.085$), but there was no statistically significant interaction between sample preparation method and type of ground meat. Manual shaking cannot be used instead of mechanical stomaching for ground meat sample preparation.

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TABLE 1. Frequency distribution for presumptive *E. coli* counts (log CFU per g of sample homogenate) obtained for ground beef and poultry following preparation by mechanical stomaching and manual shaking

Number of presumptive *E. coli*	Ground Beef Prepared by		Ground Poultry Prepared by		Total Prepared by	
	Stomach	Shake	Stomach	Shake	Stomach	Shake
< DL*	25	25	14	19	39	44
DL – 0.9	5	6	7	7	12	13
1.0 – 1.9	8	7	13	8	21	15
2.0 – 2.9	0	0	1	2	1	2
≥ 3.0	0	0	2	1	2	1
n	38	38	37	37	75	75
Mean**	0.7	0.7	1.0	0.9	0.8	0.7
Std. Devn.	0.4	0.3	0.7	0.7	0.6	0.5

*Detection limit was 5 CFU per g of homogenate.

** When no colonies were detected, a value of 0.5 was assigned.

INTRODUCTION

To conduct accurate qualitative or quantitative analyses for bacteria in food, it is important to take representative samples and ensure that any sub-samples transferred to bacteriological media are representative. The sample may be rinsed with a diluent, which is then used to inoculate the detection/enumeration medium. However, rinsing the sample may not remove all of the bacteria from the food, resulting in underestimation of bacterial numbers or failure to determine that bacteria are present. This problem can be reduced by homogenizing the sample so that bacteria attached to small particles are transferred to the medium via pipet.

Common techniques for homogenizing food samples include mechanical blending and mechanical stomaching. Mechanical stomaching is a commonly recommended method *(1, 2)* that is often used instead of blending to avoid broken/leaking blender jars and heating of the sample as the result of blending. To stomach a sample, a plastic bag holding the sample and diluent is hung into the stomacher, the machine is closed, and piston-driven paddles then pummel the sample bag for a pre-determined time. Soft food samples such as ground meats are converted to a slurry. Some drawbacks of the stomaching method are the high cost of the stomacher and the danger of hard food particulates puncturing the sampling bag, resulting in a lost sample and, possibly, dangerous contamination of the laboratory. In situations in which there are several technicians, numerous samples to analyze, and only one stomacher, stomaching of samples can slow analyses.

Recently a meat processor who was confronted with this situation asked the corresponding author if manual shaking of ground meat samples was a valid way to prepare sample homogenates and thus improve analytical efficiency. In response to the processor's query, the present study evaluated the results of manual shaking of ground meat sample and diluent in a stomacher bag prior to microbiological analysis. Analysis of *E. coli* was chosen for the comparison with mechanical stomaching because this organism is not always present in ground meats (thus allowing a useful qualitative comparison) and because it is commonly used quantitatively as an indicator of meat processing hygiene (making quantitative comparison appropriate).

MATERIALS AND METHODS

Over a 5-month period, packages of ground meat were obtained from a local grocery store and transported within 15 minutes to the laboratory, where they were refrigerated at 5°C until analysis. The packages contained ground beef (n = 38) or ground chicken or turkey (n = 37). Analyses were done within one day of the sell by date.

Each package of ground meat was opened by sanitizing the outside

TABLE 2. Frequency distribution for difference in presumptive *E. coli* counts (log CFU per g of sample homogenate) obtained for ground beef and poultry following preparation by mechanical stomaching and manual shaking. Value for shaken sample was subtracted from value for stomached sample

Difference in presumptive *E. coli*	Ground Beef	Ground Poultry	Total
-1.0 – -0.5	1	0	1
-0.4 – -0.1	5	7	12
0	24	13	37
0.1 – 0.5	3	17	20
0.6 – 1.0	5	0	5
> 1.0	0	0	0
Total	38	37	75

of the packaging film with 70% (v/v) ethanol and then cutting the film with previously sanitized scissors. Two representative 25-gram samples were randomly taken from each package, using a sterile spatula. Each sample was placed into a sterile filter bag (Fisher Scientific, Itasca, IL) and 225 ml of Butterfield's Phosphate Diluent (BPD; International Bio Products, Redmond, WA) was added. The first sample from each product was homogenized for 2 minutes in a stomacher (Seward Stomacher 400 Model, Fisher Scientific) at normal speed, and the second sample was manually shaken in a 90° arc of approximately 30 cm for 2 minutes. Further dilutions of each sample were made in BPD. The initial and subsequent dilutions were plated in duplicate on Petrifilm *E. coli*/Coliform count plates (3M Microbiology Products, St. Paul, MN). Following incubation at 35°C for 48 hours, blue colonies with associated gas were counted and the log Colony-Forming Units (CFU) per gram was calculated for each sample. A representative colony of presumptive *E. coli* from each positive sample was streaked to purity on Brain Heart Infusion agar (Difco, Becton-Dickinson, Mansfield, MA) and incubated for 24 hours at 35°C. A resulting colony was tested for cell morphology, gram stain reaction, oxidase reaction, colony characteristics on Levine-EMB agar (Difco), and biochemical profile (API 20E, bioMérieux, Hazelwood, MO). Throughout the study, the isolate confirmation rate was 95.2% (94.8% for isolates from stomached samples and 95.7% for isolates from shaken samples).

STATISTICAL ANALYSIS

Data from the split-plot experimental design *(3)* were analyzed using the Mixed procedure of SAS (SAS version 8, SAS Institute, Inc., Cary, NC). The whole unit was the package and the factor was the type of product (beef or poultry). There were 38 packages of beef and 37 packages of poultry, resulting in one degree of freedom for product type and 73 degrees of freedom for the whole plot error due to variation among the packages. The subplot units were the two 25-gram samples per package and the treatment was the preparation method (stomached or shaken). Thus, there was one degree of freedom each for preparation method and the interaction of product type and preparation method, and 73 degrees of freedom for the subplot error due to variation among the samples within the packages. The response variable was on the log scale so that the distribution was approximately normal. When no presumptive *E. coli* were detected, a value of 0.5 log CFU/g was assigned. A significance level of 0.05 was used. Thus, a difference in results was considered statistically significant if the P value was < 0.05.

RESULTS AND DISCUSSION

Frequency distributions for log CFU/g of presumptive *E. coli* in ground beef and poultry are shown in Table 1, along with a frequency distribution for the difference in log CFU/g between the two sample preparation methods (Table 2). We found that 34% of ground beef samples contained presumptive *E. coli*, regardless of the sample preparation method, compared to 49% and 62% of ground poultry samples prepared by shaking and stomaching, respectively. These results suggest that direct or indirect fecal contamination of beef or poultry is fairly common during dressing, fabrication, grinding and/or packaging. If temperature abuse occurred during processing or distribution, growth of presumptive *E. coli* may also have occurred, thereby increasing the likelihood of detection. It also appears that presumptive *E. coli* is more likely to be present, and to be

TABLE 3. Statistical analysis (proc Mixed on SAS software) of data from analysis of ground beef and poultry for numbers of presumptive *E. coli* after sample preparation by manual shaking or mechanical stomaching

Effect	Numerator Degrees of Freedom	Denominator Degrees of Freedom	*F* value	*P* value
Product Type	1	73	3.04	0.085
Preparation Method	1	73	8.07	0.0058
Product type x Prep. method	1	73	0.03	0.86

present at higher levels, in ground poultry than in ground beef.

Qualitative results (presence/absence of presumptive *E. coli*) following the two sample preparation methods were the same for 78% of ground beef and 62% of ground poultry samples. For ground beef, the two sample preparation methods often yielded equivalent numbers of presumptive *E. coli* (24 of 38 samples, Table 2); larger numbers were obtained after stomaching for 8 samples and after shaking for 6 samples. The difference between the two methods exceeded 0.5 log CFU/g five times when stomaching yielded higher numbers, but only once when shaking yielded higher numbers. Differences between the two methods were more frequent for ground poultry. A total of 13 samples showed no difference between methods, while 17 samples yielded higher results after stomaching, compared to 7 samples yielding higher numbers after shaking. The difference between the two methods never exceeded 0.5 log CFU/g.

Statistical analysis (Table 3) showed a small but statistically significant difference between the two sample preparation methods ($P = 0.0058$). Greater numbers of presumptive *E. coli* were detected following stomaching than after shaking. Although presumptive *E. coli* were detected more often on ground poultry than on ground beef, there was only weak evidence of a difference when the two product types were directly compared ($P = 0.085$). There was no significant interaction between product type and sample preparation method ($P = 0.86$). That is, the difference between the sample preparation methods applied to both ground beef and ground poultry. Moreover, the variance components were 0.223 for the whole plots and 0.0337 for the subplots, indicating a larger variation among the packages than among the samples within the packages.

The results suggest that manual shaking either does not detach cells from meat particles or does not subdivide ground meat into particles small enough to be pipetted to the plating medium. Manual compression of the meat inside the sample bag after diluent addition may have increased the number of presumptive *E. coli* cells recovered, but this procedure is likely to vary greatly among technicians and would be difficult to standardize. Thus, it was not done in the present study. In summary, our results clearly show that manual shaking is not a valid substitute for mechanical stomaching in the preparation of raw ground meat samples for microbiological analysis.

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New Faces at Guelph Food Technology Centre

GFTC is very proud to announce the appointment of Dr. John Michaelides as its new technical director.

Dr. Michaelides holds a Ph.D. in biology with a specialization in mycology (fungi) from the University of Waterloo, and began his career at the University's Centre for Process Development working in the area of biotechnology. He then joined Robin Hood Multifoods where he worked for 18 years, including approximately ten managing the company's research program. He has served on numerous government advisory committees to establish programs in areas as varied as tax credits, and research in agriculture, food and biotechnology. He has unparalleled knowledge and experience in cereal science and the baking industry. From 1998 to 2001, he was a valued member of GFTC's board of directors.

Dr. Michaelides' responsibilities will include managing and overseeing the entire technical services area, which includes clients confidential projects in product development, process development, shelf-life evaluation and extension, packaging evaluation, pilot-scale trials, and equipment evaluation.

Frank Schreurs was promoted to director of food safety and quality services in addition to Iain Wright as audit services manager and Paul Medeiros as senior quality systems specialist. "Frank Schreurs is the ideal candidate to lead this group, having been with GFTC since October 1998 and led the auditing and consulting services division of GFTC to record sales. In addition to his ongoing responsibility for overseeing the auditing and consulting services, he will take on the overall management of the training component, including both public seminars and customized on-site training and will guide the efforts of Jennifer McCreary, Marlene Inglis and the whole training group as they develop and deliver GFTC's highly respected training programs," explains Terry Maurice, GFTC's president and CEO.

Also joining the Food Safety and Quality Services group is Iain Wright, GFTC's new audit services manager. "Iain has been working as a consultant with GFTC since December 1997 and has a broad range of experience in auditing, consulting and training. His expertise will be invaluable in managing GFTC's audit services, including ensuring the quality of our auditors, developing and implementing our new database software to add value to audits, and developing new, needed services," says Mr. Maurice.

Paul Medeiros was formerly quality manager with Burger King. "Paul will be working on the training and consulting side to help bring relevant training programs to the food service industry. He holds a diploma in adult education and is currently pursuing an M.Sc. in food science at the University of Guelph," remarks Maurice.

Dr. Pedro Valle-Vega Named Director of Silliker-American Quality Laboratory in Mexico

Silliker, Inc. announced the appointment of Dr. Pedro Valle-Vega as director of the Silliker, American Quality Lab in Mexico. He is responsible for managing scientific operations, quality systems, and staff at the organization's Mexico City and Queretaro City operations. Dr. Valle-Vega reports to general manager Agustin Girard. With 15 years of industry experience, Dr. Valle-Vega possesses extensive expertise in food processing, quality systems, and testing methodologies, and served as a quality assurance manager with Unilever-Best Foods prior to joining Silliker in December.

A graduate of North Carolina State University (Raleigh) with a Ph.D. in food science and technology, Dr. Valle-Vega is a food toxicology professor at the Facultad de Quimica, Unam. He is a member of the Institute of Food Technologists, American Chemical Society, International Federation of Fruit Juice Producers and several other industry and professional organizations.

Gainco, Inc. Makes New Sales and Engineering Appointments

Gainco, Inc. announces two new appointments in its sales management and engineering departments.

R. Scott Seabrook has been appointed as southeastern regional sales representative. In this position, Seabrook will be responsible for managing customer relationships with plants in the states of Georgia, Alabama, Kentucky, Tennessee, Mississippi, Louisiana and Florida. He will be based in Alabama. Seabrook has an extensive poultry industry background. Prior to joining Gainco, he held several supervisory and managerial positions with Gold Kist

Farms, Perdue Farms, and Marshall Durbin plants in Alabama, Mississippi and North Carolina. His positions at Gold Kist Farms in Boaz and Trussville, AL covered the full range of responsibilities for live receiving through evisceration, processing of chicken parts, packaging, shipping and sanitation. Seabrook holds a Bachelor's of Science degree in poultry science from Mississippi State University.

Gainco has also appointed Andrew Cremens to the position of applications engineer. Cremens comes to Gainco with a strong technical background plus a deep knowledge of USDA requirements for poultry processing plants and equipment. His prior employment includes ten years at Stork Gamco, where he was responsible for creating installation drawings, plus managing the installation and service of new equipment. Cremens holds a Bachelor of Architectural Engineering degree from Southern Polytechnic State University in Marietta, GA, and an MBA degree from Brenau University in Gainesville, GA.

David Kirk Joins Fristam Pumps

Fristam Pumps is pleased to announce David Kirk has joined the company as a product manager for their new shear blender and powder mixer lines.

David has six years of sanitary processing experience in the US and Europe and holds a mechanical Engineering HTC (higher technical certificate) from Coventry Technical College, UK.

New Staff at Institute of Food Technologists

The Institute of Food Technologists (IFT) recently filled two key staff positions within the not-for-profit scientific society, hiring an assistant editor for its flagship publication and a sales associate supporting its annual food exposition.

Karen Banasiak has been named assistant editor for *Food Technology* magazine, overseeing the production of regular industry, company and society news columns, as well as book reviews, other editorial content and special assignments. An experienced food scientist and writer, Banasiak received a master's degree in food science from University of Illinois, and a Master's of Arts degree in journalism from Michigan State University.

Bato Prostran has been promoted to sales associate in support of IFT Food Expo® booth sales. He is the first staff member to hold this position, which is new to IFT. Prostran has been with IFT since 2001, most recently in its information services department as customer service representative

Control Products, Inc. Extends Focus on Food Service Equipment Industry —Jerry Brown Joins Team

Control Products, Inc. welcomes Jerry Brown to its team as the director, food service industry. Jerry's focus will be to extend Control Products' growth within the food service industry working closely with major commercial appliance OEM's and directly with national restaurant chains to further advance its Intelli-Net™ communications technology and electronic control product offerings.

In recent years, Jerry was selected to be a member of a Major Quick Service Restaurant's Equipment Supplier Council. He is a NAFEM Certified Food Service Professional and a past president of the Southeast Chapter of the American Society of Gas Engineers.

3-A SSI Attains ANSI Accreditation

3-A Sanitary Standards Inc. (3-A SSI) reached a major milestone with formal notice of achieving accreditation as a Standards Developer Organization (SDO) by the American National Standards Institute (ANSI). The ANSI Executive Standards Council announced its action based on the 3-A SSI application for accreditation submitted last summer.

ANSI accreditation was granted for new "umbrella" procedures submitted by 3-A SSI for its standards development activities. Accreditation by ANSI signifies the procedures meet the Institute's essential requirements for openness, balance, consensus and due process. Formal accreditation provides the opportunity for 3-A SSI to submit new standards developed in accordance with ANSI requirements as American National Standards.

Last fall, 3-A SSI launched a project to develop new pharmaceutical equipment standards (P3-A) following procedures consistent with the essential requirements of ANSI. New procedures are now under development for existing 3-A Standards.

The attainment of ANSI accreditation represents a major mission objective for 3-A SSI. According to the 3-A SSI Chairman Steve Perry of the International Association of Food Industry Suppliers, "The founding members agreed years ago how important it was for 3-A SSI to be recognized as a modern standards development organization and to operate in line with the principles of ANSI. ANSI accreditation provides the recognition and the opportunity for us to modernize our entire standards development process."

FSIS Issues Alert on the Importance of Cooking and Handling Ground Beef

The US Department of Agriculture's Food Safety and Inspection Service is issuing a public health alert to remind consumers of the importance of following food safety guidelines when handling and preparing raw meat. FSIS has been informed by the Centers for Disease Control and Prevention (CDC) of an outbreak investigation involving 37 illnesses of *Salmonella* Typhimurium in Connecticut, Maine, Massachusetts, New Hampshire, New York and Vermont.

Many of the people who have become ill have reported eating ground beef. Some reported eating raw ground beef. FSIS is working with the CDC to determine the source of the contamination. Food contaminated with *Salmonella* can cause salmonellosis, one of the most common bacterial foodborne illnesses. *Salmonella* infections can be life-threatening, especially for infants, the frail or elderly and persons with chronic disease, with HIV infection, or taking 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. Anyone concerned about an illness should contact a physician.

In an effort to reduce incidences of foodborne illness, USDA works to educate consumers on the importance of following food safety guidelines. As a liaison to the Partnership for Food Safety Education, USDA is involved in the Fight BAC!™ campaign. The goal of this campaign is to educate consumers on the following four easy steps that they can take to decrease the risk of foodborne illness:

- *Cook* – Cook to a safe internal temperature. Ground beef should be heated to 160°F.
- *Separate* – Separate raw and cooked/ready-to-eat food to prevent cross-contamination.
- *Clean* – Clean your thermometer after using it. Be sure there are plenty of clean utensils and platters on hand. Wash your hands often.
- *Chill* – At home, store leftovers in the refrigerator or freezer within 2 hours of taking food off the grill. On hot days above 90°F refrigerate or freeze within 1 hour. Make sure the temperature in your refrigerator is 40°F or below and 0°F or below in the freezer. Check the temperature occasionally with a refrigerator/freezer thermometer.

Because color is not a reliable indication that meat and poultry products are thoroughly cooked, a food thermometer is the only way to tell if food has reached a high enough temperature to destroy bacteria. USDA recommends using a food thermometer to ensure that hamburgers made of ground beef are cooked to an internal temperature of 160°F; ground poultry to 165°F. Roasts, steaks, and chops of beef, veal, or lamb should be cooked to an internal temperature of 145°F for medium rare and 160°F for medium. Fresh pork should reach 160°F. Whole poultry should reach 180°F, as measured in the thigh.

Consumers with food safety questions can phone the toll-free USDA Meat and Poultry Hotline at 1.888.MPHOTLINE. The hotline is available in English and Spanish and can be reached from 10 a.m. to 4 p.m. (Eastern time), Monday through Friday. Recorded food safety messages are available 24 hours a day.

New Database Helps Monitor Food Pathogens

The world's largest online database of information on how pathogenic bacteria respond to different environmental conditions in food has been established by scientists with the Agricultural Research Service and the United Kingdom's Institute of Food Research.

The database, called ComBase, is designed to help make risk assessments and model development easier. ComBase software facilitates research cooperation among scientists studying predictive microbiology. This growing field estimates the behavior of microorganisms in response to environmental conditions, including food production and processing operations from the farm to the table.

Using the database, available at http://wyndmoor.arserrc.gov/combase/, scientists can enter data such as the temperature, acidity and available water, and then retrieve all records that match the search criteria. The database already contains about 25,000 growth and survival data records.

ComBase is a project of the Center of Excellence in Microbial Modeling and Informatics (CEMMI), a "virtual laboratory" available online at http://www.arserrc.gov/cemmi/. The ARS Eastern Regional Research Center (ERRC) in Wyndmoor, PA, unveiled CEMMI in February 2002 to help generate partnerships that advance the use of predictive models of microorganisms in food.

CEMMI links its members' expertise to researchers in the food industry, government and academia. According to CEMMI coordinator Mark L. Tamplin, ERRC hopes to enhance the way predictive models are developed and applied to various food processing situations, while ensuring that users interpret results properly. Predictive microbiology also benefits the risk assessment community by filling gaps in research data and enhancing uniformity in experimental designs.

ERRC's Pathogen Modeling Program software, a research and instructional tool for estimating the effects of multiple variables on the growth, inactivation or survival of foodborne pathogens, is available for download at the Web sites for CEMMI and ERRC's Microbial Food Safety Research Unit (www.arserrc.gov/mfs/pathogen.htm).

Read more about this research in the February 2004 issue of *Agricultural Research* magazine, available online at: http://www.ars.usda.gov/is/AR/archive/feb04/food0204.htm.

New CAST Paper Examines Food Safety Strategies: What Consumers, Regulators, and Researchers Want to Know about: Current and Future Intervention Strategies

The Council for Agricultural Science and Technology (CAST) has released a new issue paper that examines intervention strategies for the microbiological safety of foods of animal origin. Growing awareness of food safety issues — highlighted by recent events involving livestock in the United States — underscores the concerns felt by the public, government regulatory agencies, and the food industry about the safety of foods derived from animals.

"Current intervention strategies need to be examined as they are practiced at the farm, production, processing, and retail levels," says Michael P. Doyle, director of the Center for Food Safety and Quality Enhancement at the University of Georgia, and CAST Task Force chair. "And additional strategies need to be identified to decrease the incidence of foodborne illnesses associated with foods contaminated by animal wastes."

The new issue paper, Intervention Strategies for the Microbiological Safety of Foods of Animal Origin, (Issue Paper No. 25) was written by a task force of nine authors and reviewed by four subject experts. Major topics addressed in the paper include microbiological safety of foods of animal origin during production; food processing strategies for manufactured foods of animal origin, both ready-to-cook and ready-to-eat; food safety initiatives in retailing; consumer interventions to enhance food safety; and challenges to applying food safety controls uniformly across all sectors of the food service industry.

"Consumers have never had more choices in terms of variety, value, nutrition, convenience, and quality. Consumers are a significant force behind the current dramatic changes in the food-retailing business. But in order to make safe food consumption choices and to apply appropriate food-handling practices in their homes, consumers must have factual scientific information and must understand the potential negative consequences of mishandling food. CAST is striving to make that type of information more available," notes Teresa A. Gruber, CAST executive vice president.

This new paper identifies products and practices that could provide important food safety enhancements in the retail and food service areas. For example, certain equipment manufacturers are producing "e-kitchens," where equipment is monitored continually on-site and remotely and the staff is notified quickly of equipment failures.

According to Doyle, the task force authors worked to examine both existing and future intervention strategies in the areas of food production, food processing, retail food marketing, and food service. The paper concludes with a list of 12 recommendations for development and application of new intervention strategies to decrease human illnesses attributed to foods derived from animals. Among the recommendations are the following: A strategic approach, such as quantitative microbial risk assessments, is needed to identify critical points within the food continuum at which effective interventions will have the greatest impact on decreasing public health hazards.

Improving the safety of foods of animal origin needs to begin at the farm. New intervention strategies that decrease public health hazards should receive expedited review by regulatory agencies.

New strategies for educating consumers must be used, possibly including mass media campaigns that capture people's attention and encourage behavioral change.

The full text of the paper "Intervention Strategies for the Microbiological Safety of Foods of Animal Origin" (Issue Paper No. 25) may be accessed on the CAST Web site at <www.cast-science.org>, along with many of CAST's other scientific publications.

Freezing Process Seen as Emerging Food Safety Strategy

Freezing technology that has advanced food convenience and quality also could kill or reduce potentially harmful microbes more strategically, according to a report published January 15, 2004, in the *International Journal of Food Microbiology*. The article by Douglas L. Archer, Ph.D., concluded more research could help create a freezing battle plan to aid public health.

"It is clear that under certain conditions, freezing can be lethal for certain foodborne pathogens. It also seems clear that there are researchable areas that might lead to increased use of freezing as a barrier to foodborne pathogens. It seems that freezing may be an underutilized food safety technology that can be enhanced to become a major hurdle for pathogen survival," Archer wrote.

Archer is a past deputy director of the Center for Food Safety and Applied Nutrition of the US Food and Drug Administration. Currently, he is a professor in the Food Science and Human Nutrition Department of the University of Florida, Gainesville, FL.

The article notes the positive food safety track record of frozen food products, and synthesizes existing research on the effects of freezing on microorganisms. The significance of the paper is the identification of variables that could be researched to maximize freezing as a food safety technology. These variables include the temperatures and rates at which foods are frozen, storage times and temperatures, and the chemical makeup of the foods. Archer also notes the characteristics of specific microorganisms, and their unique interactions with various foods.

"Frozen foods have earned a reputation for safety. Advanced research could take this reputation for safety to a new level of reliability that redefines the possibilities of food safety. This is an opportunity and a call to action for the scientific community," said Leslie G. Sarasin, president and chief executive officer of the American Frozen Food Institute (AFFI).

Lock to Foodborne Pathogen Pathway May be Key to Vaccine

A previously unidentified protein on the surface of intestinal cells is giving Purdue University researchers clues on how to prevent disease. The scientists believe their results eventually could lead to a way to prevent foodborne *Listeria monocytogenes* infection, which has a 20 percent fatality rate, as well as other diseases. The study of the bacteria is reported in the February issue of the journal *Infection and Immunity*. "This research reveals a detailed mechanism that allows interaction of *Listeria* with a cell-surface protein, or receptor, on intestinal cells. Knowing the entryway into the cell will allow us in the future to develop a method to prevent that interaction," said Arun Bhunia, a Department of Food Science microbiologist.

Jennifer Wampler, a post-doctoral student and lead author of the study, said, "*Listeria* often is implicated in patients with weakened immune systems, so we think that this research could also give us clues as to how other diseases work. This receptor is not unique for *Listeria*, so it also could be used by other organisms to take advantage and get inside a host cell to cause disease."

Bacteria have proteins, called ligands, that bind with a protein molecule, or receptor, on cells in the body, which is like placing a key in a lock. This interaction opens the door that leads to a complicated series of biochemical reactions. These reactions allow the pathogen to enter cells, in this case in the intestine, and then move on into the liver, spleen, brain or placenta, causing illness and possibly death.

Listeria is responsible for about 2,500 recorded foodborne illnesses annually in the United States and is the deadliest foodborne disease, according to the Centers for Disease Control and Prevention. It is especially dangerous for pregnant women, the elderly and those with immunocomprised diseases such as HIV. The infection can cause meningitis, brain-stem encephalitis and spontaneous abortion.

The Purdue team placed a *Listeria* protein known to bind with human host cells in a laboratory dish with human intestinal cells. They found that the bacteria's ligand bound with an intestinal cell surface protein, which they identified as heat shock protein 60 (Hsp60).

Heat shock proteins are found in most cells. They are called chaperone proteins because they help other proteins stay organized when cells face any type of stress. Until recently, it was believed these proteins were only found in the mitochondria, the cells' engines.

Now that researchers know that these proteins also are found on cell surfaces and act as receptors, they will begin investigating how to control the infection process.

In the study published in *Infection and Immunity*, the Purdue researchers used an anti-Hsp60 antibody, a built-in disease-fighting antibody that reduced *Listeria's* ability to bind with intestinal cells by 74 percent. "If interaction of these two molecules is the beginning of the infection's intestinal phase pathway that leads to illness, then we need to block them. Our focus now is to determine when and under what conditions the bacterium moves from intestinal cells into the system. If we understand the mechanism of how bacteria interacts with cells before causing damage and producing systemic illness, this may allow us to formulate a vaccination strategy to prevent the infection," Bhunia said.

The Purdue researchers plan to study whether the Hsp60 is more abundant in the intestine and also in people most at risk for *Listeria*-caused foodborne disease, such as pregnant women or HIV patients, Wampler said. They also want to study what other diseases might use this or a similar pathway to enter the body.

Other researchers on this study were Kwang-Pyo Kim, a doctoral student, and Ziad Jaradat, a former postdoctoral student. Bhunia also is a researcher in the Purdue Center for Food Safety Engineering, a collaboration among the university's schools of Agriculture, Consumer and Family Sciences, Engineering, Veterinary Medicine and the US Department of Agriculture-Agricultural Research Service.

Memo to Working Americans: "Desktop Dining" Trend Demands New Office Eating Etiquette

For many working Americans, eating a meal is just another task to juggle during a busy workday of E-mails, phone calls, meetings and deadlines. And as more employees opt to multi-task their way through breakfast, lunch and even dinner, "desktop dining" has quickly become a mainstay of corporate culture.

According to a new survey by the American Dietetic Association and ConAgra Foods, a majority of Americans eat lunch (67 percent) and snack throughout the day (61 percent) at their desks, while more than one out of three typically find breakfast the first task on their workplace to-do list. And office demands are winning out over dining ambience for the small percentage (10 percent of men, seven percent of women) who dine desktop for dinner, as well. "In many cases, desktops have replaced kitchen tables as the primary place to eat meals, but that doesn't mean we should allow bacteria to work overtime," says Carolyn O'Neil, registered dietitian and national spokesperson for ADA/ConAgra Food's Home Food Safety… It's in Your Hands® program. "It's important that your mealtime multi-tasking also includes practicing proper food safety techniques."

The traditional lunch hour may be a thing of the past, but when it comes to protecting themselves against foodborne illnesses, many professionals are still "out to lunch."

According to the ADA/ConAgra Foods' survey, the most popular brown bag options for working Americans include meat and cheese sandwiches (69 percent), leftovers (64 percent) and salads (37 percent) — all of which can spoil if not properly refrigerated.

Yet, survey results show that nearly 30 percent of Americans who bring their lunches to work don't store them in the office refrigerator. And of those, more than four out of five typically leave their lunch unrefrigerated for more than three hours before eating —

which means foods may be spoiled even before the first bite. "Perishable foods should never sit out for more than two hours. At that point, bacteria begin to multiply rapidly, increasing your risk of food poisoning," says O'Neil.

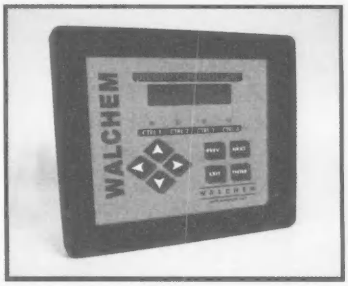
The same food safety rules also apply to shared foods. From staff birthday celebrations to post-meeting leftovers, these community treats are an office staple — but they can also be dangerous business if perishable foods are not properly refrigerated.

According to the ADA/ConAgra Foods survey, foods are left around the office to share at least once a week in nearly 70 percent of offices. In most of these cases (68 percent), shared foods sit out for more than two hours or until they're finished — with more than three out five Americans saying they feel comfortable eating it.

"Our hectic work schedules may have changed the way we eat, but the basic rules of food safety are still the same. As kitchens continue to extend beyond the home and into the office, Americans need to re-think their desktop dining habits and make sure proper office eating etiquette is on their daily to-do list," says O'Neil.

Give bacteria the pink slip by following proper food safety tips from ADA and ConAgra Foods:

- Wash hands before and after digging into your desktop dish. If you can't get to a restroom to wash hands with soap and water, keep moist towelettes or an anti-bacterial hand cleaner at your desk.
- From the time you make your lunch at home — assuming it contains perishable food items, as many brown bags do — don't let more than two hours pass before you put it in the refrigerator. Also, don't let lunchtime leftovers remain unrefrigerated for more than two hours.
- Keep perishable foods properly refrigerated below 40°F. Not sure what the temperature in the office fridge is? Do yourself and your co-workers a favor by bringing in a refrigerator thermometer from home to keep track.
- Thaw frozen foods in the refrigerator or microwave, not on the countertop.
- If you bring leftovers for lunch, re-heat them to the proper temperature of 165°F.
- Don't forget that the same food safety tips apply to carry-out and fast food, which also can be susceptible to bacteria if not handled properly.



Walchem Corporation

Walchem Panel Mount Controllers Provide Reliable, Flexible On-line Control

Walchem Corporation introduces the W305 single or dual input panel mount pH/ORP controllers. The W305 line has been designed for reliability, flexibility and ease-of-use, even in challenging industrial environments.

Walchem's W305 panel mount controllers provide significant cost and space savings by allowing you the flexibility to add a second sensor rather than a second controller. A simple sensor calibration process saves time, and digital inputs for each sensor input channel prevent control based on stagnant samples or empty tanks. Control output limit timers prevent runaway chemical addition. Manual output activation makes it easy to test outputs on installation or make chemical additions safely by hand. Other features demonstrating the W305 controllers' range, flexibility and ease-of-use include an optional calibration reminder, automatic probe wash and automatic buffer recognition.

Walchem's 1/2 DIN, NEMA 4X W305 pH/ORP controllers are UL/ CSA/CE certified and support one or two sensors in any combination of pH or ORP. Each sensor input channel has temperature measurement capability for automatic probe temperature compensation or process temperature monitoring. The W305 has five standard relays and supports a wide variety of control and alarming modes. Pulse proportional outputs allow for direct operation of electronic metering pumps without requiring signal converters.

Walchem Corporation
508.429.1110
www.walchem.com
Holliston, MA

BOC Technology Validated for Controlling *Listeria* on Ready-to-eat Meat and Poultry Products

BOC technology aimed at making food safer for consumers by controlling *Listeria* (*L. monocytogenes*) has been validated by Kansas State University and accepted by the US Department of Agriculture's Food Safety Inspection Service.

BOC's aqueous ozone technology provides a proven antimicrobial process for killing *Listeria*. This is especially key for makers of ready-to-eat foods (RTE) foods, since these foods eliminate the final, in-home cooking step that can kill any *Listeria* organisms that may remain on the food product. For these foods, *Listeria* organisms must be controlled in the food production environment to ensure consumer safety.

Mark DiMaggio, business manager, food safety markets, BOC, said, "Producers of RTE products can now have confidence that there is a proven effective, accepted and economical means of killing *Listeria* on food products and food contact surfaces."

A recent risk assessment conducted by the US Department of Agriculture's Food Safety Inspection Service (USDA FSIS), in conjunction with the Food and Drug Administration, ranks certain RTE meat and poultry products as having a very high potential for contamination. This is partly because the *L. monocytogenes* organism is capable of growing at refrigerated storage temperatures during the extended shelf life of the RTE meat and poultry products.

James Marsden, regent's distinguished professor at Kansas State University (KSU) says, "Meat and poultry processors can incorporate antimicrobial ingredients such as salts of organic acids to control *L. monocytogenes* growth. However, with RTE products, it is also necessary to incorporate a lethality step in the production process that will reduce the levels of this pathogen and leave surviving cells injured."

"While surface heat can be used to achieve the lethality required for surface *L. monocytogenes* contamination, it can result in undesirable changes in product quality and the capital investment costs can be restrictive. This aqueous ozone technology is very effective in helping processors achieve the desired lethality for surface *L. monocytogenes* contamination,

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at a lower cost and without negatively impacting the food product," Marsden said.

BOC submitted its proprietary aqueous ozone technology to KSU for testing and validation. BOC then submitted the KSU results to the USDA as evidence that the technology will reduce surface contamination of *L. monocytogenes* and reduce the risk of this pathogen in the RTE products.

Food processors look to BOC for its experience and expertise in delivering the engineered solutions they need. BOC helps customers address their atmosphere, microbe and temperature control requirements so they can deliver the highest quality food to their customers. BOC provides a range of offerings, such as ozone and UV light pathogen intervention systems, chilling and freezing technologies, modified atmosphere packaging, state-of-the-art food monitoring and control technologies, water management services and a precision-controlled, continuous grinding and blending system to help customers achieve total process control in their plants.

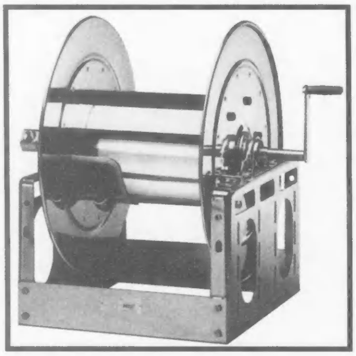
The BOC Group
908.771.1510
www.boc.com
Murray Hill, NJ

Scale Free International Offers Two Complete Non-chemical Water Treatment Systems

As a pioneer in the non-chemical water treatment industry for over 30 years, Scale Free International, LLC (SFI) has introduced the patented "Scale Defender" and "Tower Defender" systems.

SFI totally eliminates the need for chemicals in boilers, cooling towers, chillers and heat exchangers. Patented microprocessor controls, alter the positive nature of process water to a negative or neutral state eliminating scale formation and addresses microbial concerns without the use of magnets.

Scale Free International, LLC
636.305.0696
www.scalefreeintl.com
Fenton, MO



Hannay Reels Inc.

Hannay's Durable SS3000 Stainless Steel Reels Ideal for Sensitive and Harsh Environments

The SS3000 series of Hannay Reels stainless steel reels provide superior protection against corrosion. A paint-free surface eliminates the potential for rusting associated with chipping. The rugged stainless steel design makes SS3000 reels ideal for the food and beverage industry, chemical transfer applications, harsh environmental situations, off-shore use and cosmetics applications.

The SS3000 series, similarly to all of the Hannay stainless steel reels, is constructed of fine grade 304 stainless frames, discs and drums. It is designed for single hose with 3/4" or 1" I.D., and operates at a pressure of up to 1,000 PSI. The SS3000 features a direct crank rewind system, where the removable crank is attached to the reel axle.

Hannay Reels Inc.
1.877.GO.REELS
www.hannay.com
Westerlo, NY

Fluid Metering, Inc. Introduces the New IDS-2000ARH Industrial Dispense Pump

The IDS-2000ARH is CE approved and integrates FMI's patented CeramPump® valveless piston pumping principal with precision stepper control. FMI's patented CeramPump® valveless design has only one moving part, a single rotating and reciprocating piston made of dimensionally stable, chemically resistant ceramics. This unique pump design accomplishes all fluid control functions while eliminating valves which can clog, fatigue, and fail, causing accuracy drifting and pump failure over time. The electronics feature precision stepper motor control, multiple dispense and continuous modes, and will interface with a PC or PLC.

The IDS-2000ARH provides precision stroke adjustment using an easy-grip flow control ring graduated in 450 divisions resulting in an accuracy of 1% or better. The low dead volume pump head design ensures maximum bubble clearing and provides a typical stroke to stroke precision of 0.5% or better. It will dispense 0-100ul per stroke up to 50 ml/min. continuous metering at pressures up to 100 psig. It is ideal in applications which require both frequent and highly accurate changes in dispense volumes or flow rates.

The integrated pump and electronics are housed in a rugged stainless steel enclosure suitable for wall mounting in production and process areas. Typical applications include chemical and pharmaceutical processing, electronics and semiconductor manufacturing, metal finishing, food processing and packaging, and process instrumentation.

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

Optimize Your Use of Near IR Fiber Probes from Lambda Solutions

Lambda Solutions, Inc. has introduced 3 new models of its Near Infra-Red Vector Probes. These fiber optic probes are designed for diffuse reflectance spectroscopy requiring high sensitivity and dynamic range. They will interface with most existing FTIR, AOTF and dispersive spectrometers.

The Vector Probes are ideally suited for research, quality assurance and quality control applications in the chemical, agricultural, food and pharmaceutical industries. The design of the units allow for ease of use in repetitive testing environments.

The new models include the NIR-H which is a 10 cm probe with a gun-handle grip for ease of handling. The NIR-HT which includes the gun-handle grip also provides a built-in trigger, LEDs and a serial port interface to allow convenient connection to computer systems.

The third new model is the NIR-MB which is available with probe head lengths up to 30 cm and a versatile "torpedo-shaped" barrel grip. The NIR-MB is also supplied complete with mounting accessories for fixed-position operation.

A proprietary optic design allows for exceptionally low internal light reflection and high light collection efficiency ensuring high signal to noise characteristics.

All the new models are constructed of stainless steel with sapphire windows and solvent resistant fittings. The standard fiber length is 2 meters but models are available with custom fiber lengths. In addition, all models can be supplied with immersible probe heads.

Lambda Solutions, Inc.
781.478.0170
www.lambdasolutions.com
Waltham, MA

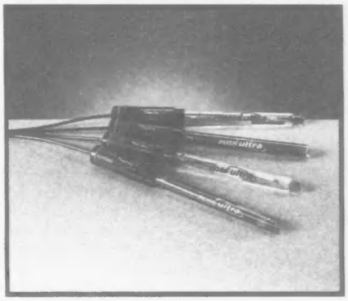
New Lifestor® Dunnage Racks with Microgard® from Eagle

Introducing Lifestor® dunnage racks from Eagle Foodservice featuring high strength polymer shelf panels with Microgard® antimicrobial protection. Microgard® provides protection from a broad range of bacteria, molds and mildew that can cause stains, odors and product degradation. The antimicrobial protection never washes out—even with dishwasher cleaning of polymer shelf sections.

Constructed of 16 gauge type 304 steel and featuring 1 5/8" diameter legs and 1 1/4" diameter crossbracing on all four sides, these racks provide the ultimate in corrosion- and rust-free storage. Stationary units have stainless steel bullet feet for maximum stability while mobile units feature four 5" heavy duty swivel casters, two with brakes for easy transport. The construction allows for storing heavy loads, while the ventilation slots allow air to circulate under stored goods. They are portable, easy to use and assemble without the use of tools.

Eagle's Lifestor® dunnage racks are available in six sizes, 18" and 23" widths and 32", 41" and 50" lengths. All units are 16" in height. The stationary units hold up to 1,000 lbs. each, while the mobile units hold up to 800 lbs.

Eagle Group
800.441.8440
www. eaglegrp.com
Clayton, DE



Thermo Orion

Thermo Orion Introduces New ROSS Ultra™ Groundbreaking pH Electrodes

Thermo Orion has announced the release of six ROSS Ultra state-of-the-art electrodes to add to an already impressive pH electrode line.

The Thermo Orion ROSS pH electrodes are now even better. They use a unique reference system developed by Thermo Orion that offers longer life, greater stability, and fast results, regardless of sample composition or temperature. ROSS Ultra pH electrodes are available in a rugged and standard glass bulb, flat surface, semi-micro and epoxy bodied styles to best determine the pH of a variety of sample types. A ROSS Ultra half-cell reference electrode is also available for applications where separate sensor and reference electrodes are preferred. ROSS Ultra electrodes will be offered under their own catalog numbers and are available as Thermo Orion meter and electrode packages. Due to the outstanding innovations and performance of these electrodes, the ROSS Ultra line has twice the warranty and greater stability than its predecessor.

The ROSS Ultra pH line includes the following new features:

- Virtually drift-free reference system
- Unparalleled pH response to temperature changes
- Designed for the most difficult samples
- Extended warranty to 24 months when typical pH electrode warranties are 3 to 12 months

Thermo Orion
978.232.6057
www.thermo.com/orion
Beverly, MA

Gainco's New Infiniti™ Programmable Weight Indicator Provides Optimal Protection against Washdown and Moisture Invasion

Gainco, Inc. introduces a breakthrough design in weight indicators. Its new Infiniti™ Programmable Weight Indicator provides the industry's best protection against washdown and moisture condensation. The new unit features a highly durable polymeric housing that performs equally well in cold work environments and during hot chemical washdowns and high pressure washing. The low thermal conductivity of the housing material virtually eliminates any internal condensation. In addition, it is impervious to the chemicals typically used in washdown procedures in the meat and poultry processing environments.

Jim Petersen, Gainco's director of sales and marketing, explained the importance of the Infiniti™ unit's rigorous protection against moisture. "In consulting with maintenance managers in processing plants across the country, the biggest challenge we found with weight indicators is moisture. Regular washdown procedures — along with condensate buildup from temperature fluctuations in the plant — too often result in weight indicators failing after only a short time," Petersen noted. "Our new product utilizes a completely new design that truly solves rather than simply curtails the problem."

Using a state-of-the-art bonding technique that chemically welds the housing together, all electronics of the Infiniti™ Programmable Weight Indicator are permanently encapsulated inside the front section of the dual-chamber housing. This results in the best protection offered against the daily onslaught of high-pressure chemical washing and condensate moisture. No longer will users need to wrap units in plastic or remove them from the plant floor before performing washdown activities, nor undertake other remedial measures such as double-boxing.

In addition to superior water- and moisture-resistant properties, new Infiniti™ Programmable Weight Indicators provide other important benefits to users. A larger, brighter LED display allows for easy, accurate viewing. The operator keypad utilizes special proximity sensors mounted behind the housing to detect touch. The result is protection from wear, puncture and moisture. Oversized buttons allow the operator to easily choose their desired selection, even when wearing gloves. Universal ID symbols make it easy for any operator to understand the weight indicator's basic operation, regardless of language proficiency.

The Infiniti™ Programmable Weight Indicator provides simple plug-and-play capabilities for most static weighing equipment; just attach the leads to the load cell and power up the weight indicator. For more sophisticated controllers, IR, RF and Ethernet programming options are available. In addition to their simplified set-up, Infiniti™ Programmable Weight Indicators are also very easy to service.

Gainco, Inc.
770.534.0703
www.gainco. com
Gainesville, GA

Be sure to mention, "you saw it in *Food Protection Trends*"!

Ivan Parkin Lecture

Sunday, August 8, 2004
7:00 p.m. – 8:00 p.m.

Presented by

Dr. Martin B. Cole

Chief Research Scientist
Food Science Australia
North Ryde, New South Wales, Australia

Dr. Martin B. Cole is the Deputy Chief Executive of Food Science Australia, Australia's premier food science organization. He has held a number of senior positions within the food industry, including Head of Microbiology for Unilever, located in UK and The Netherlands, as well as Group Director of Food Safety, Microbiology & Chemistry for Nabisco in the USA. He has presented and published over 80 papers on many aspects of food microbiology including predictive modeling, risk assessment and novel food preservation technology.

Dr. Cole has over 10 years experience within the CODEX Food Hygiene Committee where he has been a member of a number of different country delegations including the United States and more recently Australia. He is frequently asked to be a contributing expert to national and international consultations on a wide range of food safety issues. Within Australia, Dr. Cole is the Co-Director of the Australian Food Safety Centre of Excellence, a Fellow of Food Standards Australia and New Zealand (FSANZ) as well as a Visiting Research Professor at the University of Tasmania. Internationally, he is the Chairman of the International Commission for the Microbiological Specifications of Foods (ICMSF), a member of the Editorial Board of Innovative Food Science & Emerging Technologies and a member of the Editorial Advisory Board for *Food Safety Magazine*.

IAFP 2004
Preliminary Program

Sunday, August 8, 2004 – 7:00 p.m.

- Opening Session
- Ivan Parkin Lecturer — Martin B. Cole, Food Science, Australia

Monday, August 9, 2004

Morning – 8:30 a.m. – 12:00 p.m.

Symposium Topics

- Molecular Subtyping of Foodborne Pathogens: Tying It All Together
- Retail Food Safety Risks: Protecting Public Health and Changing Behaviors
- Validation and Verification of Pathogen Interventions in Meat and Poultry Processing
- Extending the Shelf Life of Fluid Dairy Products

Technical Session

- Don't be Sonoran (Antimicrobials and Produce)

Poster Session (9:00 a.m. – 1:00 p.m.)

- Antimicrobials and Foods of Animal Origin

Afternoon — 1:30 p.m. – 5:00 p.m.

Symposium Topics

- Postprocessing Intervention Technologies
- Water's Role in Food Contamination
- Recent Developments in *Listeria monocytogenes* Research
- Integrating Genomic Data in Quantitative Risk Assessments
- Sanitary and Hygienic Design, Construction and Fabrication of Dairy and Food Equipment

Technical Session

- General Microbiology and Sanitation

Poster Session (2:00 p.m. – 6:00 p.m.)

- Rattlesnake Roundup (General Microbiology and Sanitation, Methodology, and Toxicology)

Tuesday, August 10, 2004

Morning — 8:30 a.m. – 12:00 p.m.

Symposium Topics

- Food Safety for Immunocompromised Populations
- Chatterbugs: Quorum Sensing and Food Safety
- Transfer and Spread of Pathogens in Food Environments
- Indicator Organisms and Testing — Where's the Value?

Technical Session

- Foods of Animal Origin

Poster Session (9:00 a.m. – 1:00 p.m.)

- Saguaro Soiree (Risk Assessment, Education, and Pathogens)

Afternoon — 1:30 p.m. – 3:30 p.m.

Symposium Topics

- Update on Foodborne Disease Outbreaks
- Everything You Wanted to Know about Adopting New Methods… But Were Afraid to Ask!
- Food Toxicology 101: Basics for the Food Safety Professional
- *Salmonella* Control in Broiler Chickens: What Can We Learn from the Scandinavian Experience

Technical Session

- Education

Technical Session

- Risk Assessment

***Plenary Session* — 3:45 p.m. – 4:30 p.m.**

John H. Silliker Lecturer

- R. Bruce Tompkin, ConAgra Refrigerated Foods (Retired)

Business Meeting – 4:45 p.m. – 5:30 p.m.

Wednesday, August 11, 2004

Morning — 8:30 a.m. – 12:00 p.m.

Symposium Topics

- Credibility in Science
- Risk and Control of *Enterobacter sakazakii*
- Impact of Environmental Viral and Parasitic Contamination on Food Safety
- Safety of Raw Milk Cheeses — The State of the Science
- Packaging Innovations, Safety Concerns and Seafood
- Heat Resistant Spoilage Microorganisms in the Juice and Beverage Industry

Poster Session (8:00 a.m. – 12:00 p.m.)

- Pathogens

Afternoon — 1:30 p.m. – 5:00 p.m.

Symposium Topics

- Sanitation — Because You Have to be Clean to be Safe
- The Global Food Safety Initiative
- Optimizing Data and Minimizing Risk
- Biofilms and Their Impact on Food Safety

Technical Session

- Chips and Salsa (General Food Microbiology and Methods)

Technical Session

- Pathogens

Poster Session (1:00 p.m. – 5:00 p.m.)

- Prickly Pear Potpourri (Dairy, Produce, and Other Commodities)

Visit our Web site for updated information at **www.foodprotection.org**

IAFP 2004
Networking Opportunities

IAFP FUNCTIONS

NEW MEMBER RECEPTION
Saturday, August 7, 2004 • 4:30 p.m. – 5:30 p.m.
Sponsored by Kluwer Academic Publishers

If you recently joined the Association or if this is your first time attending an IAFP Annual Meeting, welcome! Attend this informal reception to learn how to get the most out of attending the Meeting and meet some of today's leaders.

AFFILIATE RECEPTION
Saturday, August 7, 2004 • 5:30 p.m. – 7:00 p.m.
Reception sponsored by Capitol Vial
Speakers sponsored by Weber Scientific

Affiliate officers and delegates plan to arrive in time to participate in this educational reception. Watch your mail for additional details.

COMMITTEE MEETINGS
Sunday, August 8, 2004 • 7:00 a.m. – 5:00 p.m.

Committees and Professional Development Groups (PDGs) plan, develop and institute many of the Association's projects, including workshops, publications, and educational sessions. Share your expertise by volunteering to serve on any number of committees or PDGs. All meetings are open.

STUDENT LUNCHEON
Sunday, August 8, 2004 • 12:00 p.m. – 1:30 p.m.
Sponsored by Nestlé USA, Inc.

The mission of the Student PDG is to provide students of food safety with a platform to enrich their experience as Members of IAFP. Sign up for the luncheon to help start building your professional network.

OPENING SESSION
Sunday, August 8, 2004 • 7:00 p.m. – 8:00 p.m.

Join us to kick off IAFP 2004 at the Opening Session. Listen to the prestigous Ivan Parkin Lecture delivered by Martin B. Cole, Chief Research Scientist, Food Science Australia, North Ryde, Australia.

CHEESE AND WINE RECEPTION
Sunday, August 8, 2004 • 8:00 p.m. – 10:00 p.m.
Sponsored by Kraft Foods, Inc.

An IAFP tradition for attendees and guests. The reception begins immediately following the Ivan Parkin Lecture on Sunday evening in the Exhibit Hall.

IAFP JOB FAIR
Sunday, August 8 through Wednesday, August 11, 2004

Employers, take advantage of recruiting the top food scientists in the world! Post your job announcements and interview candidates.

COMMITTEE AND PDG CHAIRPERSON BREAKFAST (By invitation)
Monday, August 9, 2004 • 7:00 a.m. – 9:00 a.m.

Chairpersons and Vice Chairpersons are invited to attend this breakfast to report on the activities of your committees.

EXHIBIT HALL RECEPTION
Monday, August 9, 2004 • 5:00 p.m. - 6:30 p.m.
Sponsored by DuPont Qualicon and Oxoid, Inc.

Join your colleagues in the exhibit hall to see the latest trends in food safety techniques and equipment. Discuss with exhibitors their latest products or use this time to view the poster presentations. Grab a drink and take advantage of this great networking reception.

JOHN H. SILLIKER LECTURE
Tuesday, August 10, 2004 • 3:45 p.m. – 4:30 p.m.

This plenary session will feature R. Bruce Tompkin, Retired Vice President — Product Safety, ConAgra Refrigerated Foods. He will deliver a presentation titled "Guess Who's Come to Stay — The Resident Pathogen Issue."

BUSINESS MEETING
Tuesday, August 10, 2004 • 4:45 p.m. – 5:30 p.m.

You are encouraged to attend the Business Meeting to keep informed of the actions of YOUR Association.

PRESIDENT'S RECEPTION (By invitation)
Tuesday, August 10, 2004 • 5:30 p.m. – 6:30 p.m.

This by invitation event is held each year to honor those who have contributed to the Association during the year.

PAST PRESIDENTS' DINNER (By invitation)
Tuesday, August 10, 2004 • 6:30 p.m. – 10:00 p.m.

Past Presidents and their guests are invited to this dinner to socialize and reminisce.

AWARDS BANQUET
Wednesday, August 11, 2004 • 7:00 p.m. – 9:30 p.m.

Bring IAFP 2004 to a close at the Awards Banquet. Award recipients will be recognized for their outstanding achievements and the gavel will be passed from Dr. Paul Hall to Incoming President Dr. Kathy Glass.

IAFP 2004 Event Information

91ST ANNUAL MEETING IAFP 2004 Phoenix, Arizona • August 8-11, 2004

EVENTS

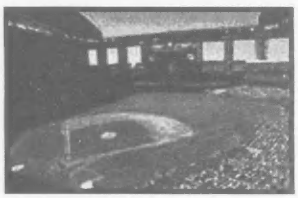
MONDAY NIGHT SOCIAL AT RAWHIDE WESTERN TOWN

Monday, August 9, 2004 • 6:30 p.m. – 10:00 p.m.

Step back in time to the days when the West ran wild! This is the Wild West of good guys, bad guys, balladeers, shoot-outs, saloon girls, and delightfully crooked card dealers. Upon arrival at Rawhide, you will have the opportunity to stroll down Main Street, browse in the numerous shops and boutiques, witness a blacksmith at work and watch Rawhide's street entertainers. Satisfy your appetite by stopping in the Steakhouse and Saloon for a "Chuckwagon Feast". Grab your partners, jump on the bus and get ready for a rip-roarin good time — YEE HA!

DIAMONDBACKS BASEBALL GAME

Saturday, August 7, 2004 • 12:00 p.m. – 4:00 p.m.



Enjoy a night at the ballpark as the Arizona Diamondbacks take on the Atlanta Braves at Bank One Ballpark. From its signature swimming pool to its retractable roof, Bank One Ballpark has become one of the game's most recognizable landmarks. Since the air-conditioned facility first opened its doors, fans have enjoyed the opportunity to watch the Arizona Diamondbacks without worrying about Phoenix's summer heat. Ticket price includes admission to the game and transportation to and from the JW Marriott Desert Ridge Resort.

GOLF TOURNAMENT

GOLF TOURNAMENT – Arnold Palmer Signature Course at Wildfire Golf Club

Saturday, August 7, 2004 • 6:00 a.m. – 11:00 a.m.

Everyone is invited to play in this best-ball golf tournament on the Arnold Palmer Signature Course at Wildfire Golf Club. A desert-style course of championship length, with generous fairways and large, bent-grass greens, the Palmer Course is challenging to all levels of golf skill. Begin IAFP 2004 with a round of golf playing before a backdrop of the Camelback Mountains!

Arnold Palmer SIGNATURE COURSE

DAYTIME TOURS

SEDONA AND VERDE VALLEY TOUR

Saturday, August 7, 2004 • 8:00 a.m. – 4:00 p.m.

Known worldwide for its brilliant red rock mountains, breathtaking scenery and quaint artisan shops, Sedona is a "must see"destination for visitors to Arizona. During the drive north, you will travel through the diverse terrain of the Sonoran Desert, Verde Valley and Camp Verde. Along the way, the guide will provide interesting narration about the area and answer questions.

Prior to reaching Sedona, we will stop at Montezuma's Castle, a twelfth century cliff dwelling built by the Sinagua Indians. This is considered one of the best-preserved cliff dwellings in the Southwest. Upon arrival in Sedona, your guide will point out the numerous red rock formations for which Sedona is famous — Snoopy Rock, Bell Rock, Chapel Rock, Submarine Rock and others. Lunch will be served at a quaint local eatery. Guests will have time to explore the galleries and shops of Main Street and Tlaquepaque.

CITY TOUR AND OLD TOWN SCOTTSDALE

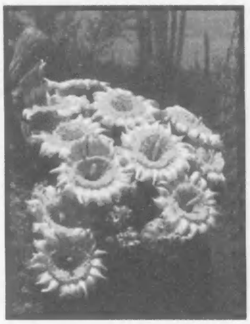
Sunday, August 8, 2004 • 10:00 a.m. – 3:00 p.m.

With amazing sunsets and spectacular mountain views, Arizona is a site to behold! The City Tour meanders through the amazing aspects of the valley. Each tour is unique in that the guide will stop along the way at several of the most beautiful sites and private homes in the valley.

The Wrigley Mansion is well known for its unique architecture, the Biltmore Resort has had the pleasure of Frank Lloyd Wright's touch and the State Capitol is majestic against the blue sky backdrop of the city. This tour provides an opportunity to stop and enjoy the unique shopping experiences of Old Town Scottsdale as well as a delicious lunch. Old Town encompasses over a square mile of themed shopping streets. Walking the sidewalks of this section of Scottsdale, one can find everything from Native American jewelry and artwork to western clothing.

DESERT BOTANICAL GARDEN AND HEARD MUSEUM TOUR

Monday, August 9, 2004 • 8:00 a.m. – 1:00 p.m.



Two of the Southwest's most unique visitor attractions, The Desert Botanical Garden and Heard Museum, have teamed up to present an unbeatable tour designed to acquaint visitors with the diversity of the region and the resourcefulness of its Native American people. This tour includes visits to both attractions plus lunch at the Heard Museum Cafe. Your visit begins at the Desert Botanical Garden which displays more than 10,000 desert plants in a spectacular outdoor setting. Plants and People of the Sonoran Desert, a three-acre permanent exhibit with authentic historic and prehistoric structures, shows how Sonoran Desert dwellers have used native plants for thousands of years for food, construction, fiber, and medicines. Continuing on you will visit the amazing Heard Museum, a museum of Native American cultures and art. The Heard Museum is internationally recognized for its collections of Native American artifacts and contemporary fine art.

FRANK LLOYD WRIGHT – TALIESIN WEST TOUR

Tuesday, August 10, 2004 • 8:00 a.m. – 12:00 p.m.

Taliesin West in Scottsdale is considered one of Frank Lloyd Wright's greatest architectural masterpieces. From its inception, the buildings at Taliesin West astounded architectural critics with their beauty and unusual form. Taliesin West still serves as a living, working educational facility with an on-site architectural firm. By touring Taliesin West visitors are able to broaden their appreciation of architecture and Wright's continuing contribution to it through his theories of organic design.

If you're interested in an in-depth, intimate look at Taliesin West, this exclusive experience is a must! Visit the Cabaret Cinema, Music Pavilion, Seminar Theater and Wright's private office — all linked by dramatic terraces, gardens and walkways overlooking the rugged Sonoran Desert and Valley below. You'll have the chance to talk to a Wright associate, have leisurely mid-morning refreshments in the colorful Taliesin Fellowship dining room and explore the dramatic Taliesin West living room — called the "Garden Room" by Wright. You'll sit in Wright-designed furniture and experience firsthand the drama of being a guest in Wright's famous Garden Room.

SOUTHWESTERN COOKING CLASS

Wednesday, August 11, 2004 • 10:30 a.m. – 1:00 p.m.

This hands-on class explores the magic and mysteries of tamales, one of the great culinary traditions of the America's. While making tamales you will learn the secrets of choosing a filling and flavoring them with different types of wrappers, from cornhusks to banana leaves. You will also learn how to choose and make a complementary salsa to create a more satisfying and dynamic taste experience. This class is a total emersion into tamales and salsas that provides you with all the knowledge and skills to create your own tamales at home! Following the class you will enjoy lunch at Blue Sage.

HOSPITALITY ROOM

Register your spouse/companion and they will have access to the hospitality room where a continental breakfast and afternoon snacks are provided Sunday through Wednesday.

91ST ANNUAL MEETING
IAFP 2004
Phoenix, Arizona • August 8-11, 2004

IMPORTANT! Please read this information before completing your registration form.

MEETING INFORMATION

Register to attend the world's leading food safety conference.

Registration includes:

- Technical Sessions
- Symposia
- Poster Presentations
- Ivan Parkin Lecture
- Exhibit Hall Admittance
- Cheese and Wine Reception
- Exhibit Hall Reception
- Program and Abstract Book

4 EASY WAYS TO REGISTER

Complete the Attendee Registration Form and submit it to the International Association for Food Protection by:

Online: www.foodprotection.org

Fax: 515.276.8655

Mail: 6200 Aurora Avenue, Suite 200W, Des Moines, IA 50322-2864, USA

Phone: 800.369.6337; 515.276.3344

The early registration deadline is July 7, 2004. After this date, late registration fees are in effect.

REFUND/CANCELLATION POLICY

Registration fees, less a $50 administration fee and any applicable bank charges, will be refunded for written cancellations received by July 23, 2004. No refunds will be made after July 23, 2004; however, the registration may be transferred to a colleague with written notification. Refunds will be processed after August 16, 2004. **Event and tour tickets purchased are nonrefundable.**

International Association for Food Protection®

EXHIBIT HOURS

Sunday, August 8, 2004	8:00 p.m. – 10:00 p.m.
Monday, August 9, 2004	9:30 a.m. – 1:30 p.m. 3:00 p.m. – 6:30 p.m.
Tuesday, August 10, 2004	9:30 a.m. – 1:30 p.m.

DAYTIME TOURS

Saturday, August 7, 2004

Sedona and Verde Valley Tour (Lunch included) — 8:00 a.m. – 4:00 p.m.

Sunday, August 8, 2004

City Tour and Old Town Scottsdale (Lunch included) — 10:00 a.m. – 3:00 p.m.

Monday, August 9, 2004

Desert Botanical Garden and Heard Museum Tour (Lunch included) — 8:00 a.m. – 1:00 p.m.

Tuesday, August 10, 2004

Frank Lloyd Wright – Taliesin West Tour — 8:00 a.m. – 12:00 p.m.

Wednesday, August 11, 2004

Southwestern Cooking Class (Lunch included) — 10:30 a.m. – 1:00 p.m.

EVENTS

Saturday, August 7, 2004

Diamondbacks Baseball Game — 12:00 p.m. – 4:00 p.m.

Sunday, August 8, 2004

Opening Session — 7:00 p.m. – 8:00 p.m.

Cheese and Wine Reception — 8:00 p.m. – 10:00 p.m.
Sponsored by Kraft Foods North America

Monday, August 9, 2004

Exhibit Hall Reception — 5:00 p.m. – 6:30 p.m.
Sponsored by DuPont Qualicon and Oxoid, Inc.

Monday Night Social at Rawhide Western Town — 6:30 p.m. – 10:00 p.m.

Wednesday, August 11, 2004

Awards Banquet Reception — 6:00 p.m. – 7:00 p.m.

Awards Banquet — 7:00 p.m. – 9:30 p.m.

GOLF TOURNAMENT

Saturday, August 7, 2004

Golf Tournament — 6:00 a.m. – 11:00 a.m.
Nick Faldo-designed Championship Golf at Wildfire Golf Club

HOTEL INFORMATION

For reservations, contact the hotel directly and identify yourself as an IAFP 2004 attendee to receive a special rate of $139 per night, single/double or make your reservations online. This special rate is available only until July 7, 2004.

JW Marriott Desert Ridge Resort
5350 E. Marriott Dr.
Phoenix, Arizona 85054
Phone: 800.228.9290 • Fax: 480.293.3738
Web site: www.marriott.com/phxdr
(Group Code INTINTA)

Attendee Registration Form

91ST ANNUAL MEETING
IAFP 2004
Phoenix, Arizona • August 8-11, 2004

International Association for
Food Protection®
6200 Aurora Avenue, Suite 200W
Des Moines, IA 50322-2864, USA
Phone: 800.369.6337 • 515.276.3344
Fax: 515.276.8655
E-mail: info@foodprotection.org
Web site: www.foodprotection.org

Name (Print or type your name as you wish it to appear on name badge) ____ Member Number: ____

Employer ____ Title ____

Mailing Address (Please specify: ❒ Home ❒ Work) ____

City ____ State/Province ____ Country ____ Postal/Zip Code ____

Telephone ____ Fax ____ E-mail ____

❒ ♿ Regarding the ADA, please attach a brief description of special requirements you may have. Member since: ____

❒ IAFP occasionally provides Attendees' addresses (excluding phone and E-mail) to vendors and exhibitors supplying products and services for the food safety industry. If you prefer NOT to be included in these lists, please check the box.

PAYMENT MUST BE RECEIVED BY JULY 7, 2004 TO AVOID LATE REGISTRATION FEES

REGISTRATION FEES:	MEMBERS	NONMEMBERS	TOTAL
Registration (Awards Banquet included)	$ 365 ($415 late)	$ 555 ($605 late)	____
Association Student Member (Awards Banquet included)	$ 75 ($ 85 late)	Not Available	____
Retired Association Member (Awards Banquet included)	$ 75 ($ 85 late)	Not Available	____
One Day Registration:* ❒ Mon. ❒ Tues. ❒ Wed.	$ 200 ($225 late)	$ 305 ($330 late)	____
Spouse/Companion* (Name): ____	$ 55 ($ 55 late)	$ 55 ($ 55 late)	____
Children 15 & Over* (Names): ____	$ 25 ($ 25 late)	$ 25 ($ 25 late)	____
Children 14 & Under* (Names): ____	FREE	FREE	____
*Awards Banquet not included			
EVENTS:		**# OF TICKETS**	
Golf Tournament – Arnold Palmer Signature Course (Saturday, 8/7)	$ 105($115 late)	____	____
Diamondbacks Baseball Game (Saturday, 8/7)	$ 26 ($ 36 late)	____	____
Student Luncheon (Sunday, 8/8)	$ 5 ($ 15 late)	____	____
Monday Night Social at Rawhide Western Town (Monday, 8/9)	$ 42 ($ 52 late)	____	____
Children 14 and under	$ 37 ($ 47 late)	____	____
Awards Banquet (Wednesday, 8/11)	$ 50 ($ 60 late)	____	____
DAYTIME TOURS: (Lunch included in daytime tours except on Tuesday)			
Sedona and Verde Valley Tour (Saturday, 8/7)	$ 90 ($100 late)	____	____
City Tour and Old Town Scottsdale (Sunday, 8/8)	$ 55 ($ 65 late)	____	____
Desert Botanical Garden and Heard Museum Tour (Monday, 8/9)	$ 78 ($ 88 late)	____	____
Frank Lloyd Wright – Taliesin West Tour (Tuesday, 8/10)	$ 70 ($ 80 late)	____	____
Southwestern Cooking Class (Wednesday, 8/11)	$ 65 ($ 75 late)	____	____

PAYMENT OPTIONS: ❒ VISA ❒ MasterCard ❒ American Express

TOTAL AMOUNT ENCLOSED $ ____
US FUNDS on US BANK

❒ Check Enclosed

Credit Card # ____

Expiration Date ____

Name on Card ____

JOIN TODAY AND SAVE!!!
(Attach a completed Membership application)

Signature ____

❒ Check box if you are a technical, poster, or symposium speaker.

EXHIBITORS DO NOT USE THIS FORM

IAFP 2004 Workshops

91st Annual Meeting IAFP 2004 Phoenix, Arizona • August 8-11, 2004

Sponsored by International Association for Food Protection.

Workshop I — August 6–7
Your Data, Your Job: Quality Systems for Microbial Food Analysis

This workshop will present principals for understanding and implementing microbial control in a food production environment by providing skills to address limitations in your current laboratory testing and documentation. You will learn, in an interactive environment, how to perform effectively sound food and environmental sample and microbial testing that can be implemented into your standard operating procedures and will conform to today's QA and ISO requirements. Workshop participants will review and discuss material from practical case studies and present their findings to the group in an informal presentation that will facilitate open discussion. Workshop includes a binder of tools and reference materials to reinforce the practical experience gained from the workshop.

Workshop Topics

- Microbial control: where and how raw ingredient and finished product testing fit into the big picture
- Microbial control: where and how environmental/investigational sampling fit into the big picture
- Outsourcing/Auditing: What should you expect from an outside food-testing laboratory relative to quality systems and capabilities
- Using data management and trend analysis techniques to drive continuous improvement
- Practical approaches to incorporating rapid methods into the laboratory
- Food Safety Testing in the 21st Century by PCR
- Laboratory quality assurance and preparing your laboratory to address ISO 17025

Instructors

Jay Ellingson, Ph.D., Marshfield Clinic Laboratories, Marshfield, WI

W. Payton Pruett, Jr., Ph.D., ConAgra Refrigerated Prepared Foods, Omaha, NE

Cindy Ryan, Nestlé USA, Dublin, OH

Michael Sole, Canadian Food Inspection Agency, Ottawa, Ontario, Canada

Organizers and Instructors

Jeff Kornacki, Ph.D., Kornacki Food Safety Associates LLC, McFarland, WI

Patricia Rule, bioMérieux, Inc., Hazelwood, MO

Who Should Attend?

Laboratory managers, supervisors, scientists and technicians responsible for product sampling, as well as performing and documenting microbial tests in a food production environment and quality control laboratories.

Hours for Workshop

Friday August 6, 2004	Saturday August 7, 2004
Registration – 7:30 a.m. Continental Breakfast	7:30 a.m. Continental Breakfast
Workshop – 8:00 a.m. – 5:00 p.m. (Lunch Provided)	**Workshop –** 8:00 a.m. – 4:00 p.m. (Lunch Provided)

Workshop II — August 7
Best Practices for Safe and High Quality Aquaculture Products

Aquacultured seafoods are an increasingly important component of global trade in seafoods. Overexploitation of natural harvests has created a growing interest in aquaculture to provide seafoods to a demanding public. Because aquaculture is a controlled enterprise, inventory control, quality, and safety issues are very different than wild catch products. This workshop is designed to give attendees an overview of practices necessary to deliver high quality and safe aquacultured products to today's discriminating consumer. The afternoon session will include an interactive field trip to Desert Sweet Shrimp Farm in Gila Bend, AZ.

Workshop Topics

- Shellfish (Crustacean and Mollusks)
- Finfish warm water
- Finfish cold water
- What works for the industry
- Interactive field trip

Instructors

Linda Andrews, Mississippi State University, Biloxi, MS

Lisbeth Truelstrup Hansen, Canadian Institute of Fisheries Technology, Dalhousie University, Halifax, Nova Scotia, Canada

Organizer and Instructor

Douglas L. Marshall, Mississippi State University, Mississippi State, MS

Who Should Attend?

Seafood processors, seafood retailers, and food service.

Hours for Workshop

Saturday, August 7, 2004

Registration –
7:30 a.m. Continental Breakfast

Workshop –
8:00 a.m. – 5:30 p.m.
(Lunch Provided)

Workshop III — August 7

Converting to the NCIMS Voluntary HACCP System from Traditional Dairy Inspection

Take advantage of the new Grade A HACCP program for dairy plants that was adopted by the 2003 National Conference on Interstate Milk Shipments (NCIMS) and became effective on January 1, 2004. The guidelines for this new Grade A HACCP program are outlined in Appendix K of the Pasteurized Milk Ordinance (PMO). NCIMS HACCP is an alternative to the traditional inspection/rating program for Grade A Dairy Processors that allows dairy plants to develop their own "PMO".

This workshop will give an overview of the NCIMS Voluntary HACCP Program with emphasis on the differences with the traditional PMO-based regulatory inspection system. Participants will hear perspectives of industry and regulatory participants involved in the 4 year pilot studies used to develop the program. Hands-on exercises will be provided to give participants a better understanding of what is required to document Prerequisite Programs, conduct a Hazard Analysis, develop a HACCP Plan and build a HACCP records system. An FDA presentation on state and FDA HACCP audits with comparisons to traditional inspections will conclude the program.

Workshop Topics

- Transition to the NCIMS Voluntary HACCP Program
- NCIMS HACCP implementation perspectives
- Hands-on HACCP program development for dairy plants
- Prerequisite Program, Hazard Analysis and HACCP Plan
- Practical recommendations for State and Federal NCIMS oversight of dairy plant HACCP
- Auditing of dairy plant HACCP Systems
- Hands-on HACCP dairy plant auditing

Instructors

Kristin Phillips, Publix Super Markets, Lakeland, FL

Greg Lockwood, Vermont Department of Agriculture, Montpelier, VT

Bill Sveum, Kraft Foods NA, Madison, WI

Lloyd Kinzel, FDA, North Wales, PA

Steve Sims, FDA, College Park, MD

Stephanie Olmsted, Safeway Foods, Bellevue, WA

Doug Pearson, Utah Department of Agriculture, Salt Lake City, UT

Organizers and Instructors

Steven Murphy, Cornell University, Ithaca, NY

Allen Sayler, International Dairy Foods Association, Washington, D.C.

Who Should Attend?

Grade "A" Dairy Processors, State and Federal Regulatory Personnel, Dairy Plant Suppliers, and Academicians.

Hours for Workshop

Saturday, August 7, 2004

Registration –
7:30 a.m. Continental Breakfast

Workshop –
8:00 a.m. – 5:30 p.m.
(Lunch Provided)

Workshop Registration Form

91ST ANNUAL MEETING IAFP 2004 Phoenix, Arizona • August 8-11, 2004

Friday–Saturday, August 6–7, 2004

Workshop 1: Your Data, Your Job: Quality Systems for Microbial Food Analysis

Saturday, August 7, 2004

Workshop 2: Best Practices for Safe and High Quality Aquaculture Products

Workshop 3: Converting to the NCIMS Voluntary HACCP System from Traditional Dairy Inspection

First Name (will appear on badge)

Last Name

Company | Job Title

Address | City

State/Province | Country | Postal Code/Zip + 4

Area Code & Telephone | Fax

E-mail | Member #

❐ Check Enclosed ❐ VISA ❐ ❐ MasterCard

Total Amount Enclosed (US Funds on US Bank) $ ______

Account Number ______

Signature ______ **Expiration date** ______

Register by July 16, 2004 to avoid late registration fees

• Registration •

WORKSHOP I: Your Data, Your Job: Quality Systems for Microbial Food Analysis

	Early Rate	Late Rate
IAFP Member	$450.00	$525.00
NonMember	$550.00	$625.00

WORKSHOP II: Best Practices for Safe and High Quality Aquaculture Products

	Early Rate	Late Rate
IAFP Member	$375.00	$450.00
NonMember	$475.00	$550.00

WORKSHOP III: Converting to the NCIMS Voluntary HACCP System from Traditional Dairy Inspection

	Early Rate	Late Rate
IAFP Member	$320.00	$395.00
NonMember	$420.00	$495.00

GROUP DISCOUNT:
Register 3 or more people from your company and receive a 15% discount. Registrations must be received as a group.

Refund/Cancellation Policy

Registration fees, less a $50 administrative charge, will be refunded for written cancellations received by July 23, 2004. No refunds will be made after that date; however, the registration may be transferred to a colleague with written notification. Refunds will be processed after August 16, 2004. The workshop may be cancelled if sufficient enrollment is not received by July 16, 2004.

For further information, please contact the Association office at 800.369.6337; 515.276.3344; Fax: 515.276.8655; E-mail: jcattanach@foodprotection.org.

• 4 Easy Ways to Register •

To register, complete the Workshop Registration Form and submit it to the International Association for Food Protection by:

Online: www.foodprotection.org

Phone: 800.369.6337; 515.276.3344

Fax: 515.276.8655

Mail: 6200 Aurora Avenue, Suite 200W, Des Moines, IA 50322-2864

91ST ANNUAL MEETING
IAFP 2004
Phoenix, Arizona • August 8-11, 2004

Contribute to the Seventh Annual Foundation Fund Silent Auction Today!

The Foundation of the International Association for Food Protection will hold its Annual Silent Auction during IAFP 2004, the Association's 91st Annual Meeting in Phoenix, Arizona, August 8–11, 2004. The Foundation Fund supports:

- Ivan Parkin Lecture
- Travel support for exceptional speakers at the Annual Meeting
- Audiovisual Library
- Developing Scientist Competition
- Shipment of volumes of surplus *JFP* and *FPT* journals to developing countries through FAO in Rome

Support the Foundation by donating an item today. A sample of items donated last year included:

- Waterford Crystal Bowl
- Food Safety Handbook
- Walt Disney World Theme Park Tickets
- United States Flag
- Lionel Electric Train
- Oscar Mayer Remote Controlled Wiener Mobile
- Freshwater Stick Pearl Necklace
- Wine
- "Taste of Chicago" Gift Certificates
- Ultimate Garden State Gift Basket

Complete the form and send it in today.

Description of Auction Items ______________________

Estimated Value ______________________

Name of Donor ______________________

Company (if relevant) ______________________

Mailing Address ______________________
(Please specify: ❐ Home ❐ Work)

City ______________________ State or Province ______________________

Postal Code/Zip + 4 ______________________ Country ______________________

Telephone # ______________________ Fax # ______________________

E-mail ______________________

Return to:

Donna Gronstal
International Association for Food Protection
6200 Aurora Avenue, Suite 200W
Des Moines, IA 50322-2864, USA
800.369.6337; 515.276.3344
Fax: 515.276.8655
E-mail: dgronstal@foodprotection.org

International Association for Food Protection®

Promotional Opportunities

We invite you to participate as a sponsor for IAFP 2004. Sponsorship participation provides an excellent opportunity to position your company or organization as a supporter of the Association.

Please review the event listing to select the one that will best position your organization. Reservations will be taken in order received for any open sponsorship events. A waiting list for events with a right of first option will be established.

Sponsorship Event List

Amount	Event
$17,000	Monday Evening Social
$16,000 Sponsored	Opening Reception Kraft Foods North America
$15,000	Exhibit Hall Reception DuPont Qualicon (1/2 sponsor)
$12,000 Sponsored	Conference Program Bag bioMèrieux, Inc.
$10,000	President's Reception
$8,000 Sponsored	Badge Holders w/Lanyards Strategic Diagnostics, Inc.
$6,000 Sponsored	Exhibit Hall Pastries and Coffee Deibel Laboratories, Inc. *(Monday Morning)*
$6,000 Sponsored	Exhibit Hall Pastries and Coffee Nice-Pak Products, Inc. *(Tuesday Morning)*
$3,500 Sponsored	Exhibit Hall Coffee Break NSF International *(Monday Afternoon)*
$3,500 Sponsored	Coffee Break BD Diagnostic Systems *(Tuesday Afternoon)*
$3,500	Coffee Break *(Wednesday Morning)*
$3,000	Coffee Break *(Wednesday Afternoon)*
$3,750 Sponsored	Notepads with Sponsor's Logo Bio-Rad Laboratories
$3,500	Spouse/Companion Hospitality Room
$3,500 Sponsored	Student PDG Luncheon Nestlé USA, Inc.
$3,000 Sponsored	Affiliate Educational Reception Capitol Vial, Weber Scientific
$2,500 Sponsored	IAFP New Member Orientation Kluwer Academic Publishers
$2,000 Sponsored	Awards Banquet Flowers PepsiCo
$1,750	Committee Day Refreshments
$1,500	Exhibitor Move-in Refreshments
$1,000	Speaker Travel Support Warren Analytical Laboratory

Partial sponsorship for the above events is available.

Contact David Larson for details.
Phone: 515.440.2810
Fax: 515.440.2809
E-mail: larson6@earthlink.net

Sponsorship Participant

Name ______

Company ______

Address ______

City ______ State or Province ______

Country ______ Postal Code/Zip + 4 ______

Phone ______ Fax ______

E-mail ______

Desired Event to Sponsor ______

Amount Paid $ ______
U.S. Funds on U.S. Bank

Return form to:
IAFP
6200 Aurora Ave., Suite 200W
Des Moines, IA 50322-2864
Phone: 515.276.3344
Fax: 515.276.8655
E-mail: info@foodprotection.org

Payment: ❑ Check ❑ VISA ❑ Mastercard ❑ American Express

Account Number ______

Expiration Date ______

Cardholder Signature ______

COMING EVENTS

MAY

- **2–4, United 2004 Produce Expo and Conference,** McCormick Place, Chicago, IL. For more information, call 202.303.3400; Web site: www.uffva.org.
- **3–7, Diploma in Food Hygiene and Safety,** GFTC, Guelph, Ontario, Canada. For more information, contact Marlene Inglis at 519.821.1246; E-mail: minglis@gftc.ca.
- **4–5, Plant Operations Conference,** Hilton Chicago Hotel and Tower, Chicago, IL. For more information, call 202.737.4332; or go to www.idfa.org.
- **4–6 HACCP for Juice Processors,** Atlanta, GA. For more information, call 800.355.0983; E-mail: fpi@nfpa-food.org.
- **4–6 South Dakota Environmental Health Association Annual Educational Conference,** Holiday Inn City Center, Sioux Falls, SD. For more information, contact Mark Schuttloffel at 605.367.8783; E-mail: mschuttlof@siouxfalls.org.
- **9–12, NEHA Annual Educational Conference and Exhibition,** Anchorage, Alaska. For more information, call 303.756.9090; E-mail: staff@neha.org.
- **12, Ontario Food Protection Association Annual Spring Meeting,** Mississauga Convention Centre, Mississauga, Ontario, Canada. For more information, contact Gail Evans Seed at 519.463.5674; E-mail: seed@golden.net.
- **13–14, HACCP II: Developing Your HACCP Plan,** GFTC, Guelph, Ontario, Canada. For more information, contact Marlene Inglis at 519.821.1246; E-mail: minglis@gftc.ca.
- **13–14, ISO 9001 Internal QMS Auditor,** Long Beach, CA. For more information, call 800.466.9953; E-mail: esales@Bizmanualz.com.
- **15–20, IFFA Delicat**, Frankfurt, Germany. For more information, contact Dirk Ebener at 770.984.8016; E-mail: info@usa.messefrankfurt.com.
- **17–21, 3-A Sanitary Standards Inc. Annual Meeting,** Four Points Sheraton Milwaukee Airport, Milwaukee, WI. For more information, call 703.790.0295; Web site: www.3-a.org.
- **18–19, Cultured Dairy Products Conference,** Hyatt Regency, Minneapolis, MN. For more information, call 202.737.4332; or go to www.idfa.org.
- **18–19, Pennsylvania Association of Milk, Food and Environmental Sanitarians Annual Meeting,** Nittany Lion Inn, State College, PA. For more information, contact Gene Frey at 717.397.0719.
- **18–20, Ingredients & Ingredient Functionality Workshop,** University of Nebraska Food Processing Center, Lincoln, NE. For more information, contact Pauline Galloway at 402.472.9751; E-mail: pgalloway2@unl.edu.
- **19, Dairy HACCP Workshop,** University of Wisconsin-Madison, Madison, WI. For more information, contact Marianne Smukowski at 608.265.6346 or go to www.wisc.edu/foodsci/.
- **25–26, Dairy Cost Accounting Workshop,** Sofitel Chicago O'Hare, Rosemont, IL. For more information, call 202.737.4332; or go to www.idfa.org.
- **26, Metropolitan Association for Food Protection Annual Spring Meeting,** Rutgers, Cook College, New Brunswick, NJ. For more information, contact Carol Schwar at 908.689.6693; E-mail: cschwar@entermail.net.
- **31, Microbiology VI: *Salmonella* Control,** GFTC, Guelph, Ontario, Canada. For more information, contact Marlene Inglis at 519.821.1246; E-mail: minglis@gftc.ca.

JUNE

- **7–11, 5th World Congress Foodborne Infections and Intoxications,** Berlin, Germany. For more information, call 49.30.8412.1939; E-mail: officewk5@bfr.bund.de.
- **8–9, Wisconsin Cheese Grading Short Course,** University of Wisconsin-Madison, Madison, WI. For more information, contact Scott Rankin at 608.263.2008 or go to www.wisc.edu/foodsci/.
- **18–20, Food Allergens: Issues and Solutions for the Food Product Manufacturer,** Hotel Sofitel, O'Hare, Chicago, IL. For more information, contact Pauline Galloway at 402.472.9751; E-mail: pgalloway2@unl.edu.
- **18–25, International Workshop/Symposium on Rapid Methods and Automation in Microbiology XXIV,** Kansas State University, Manhattan, KS. For more information, contact Debbie Hagenmaier at 800.432.8222; E-mail: debbieh@ksu.edu; outside USA call 785.532.5575.
- **23–24, IDFA's Washington Conference,** Washington Court Hotel, Washington, D.C. For more information, call 202.737.4332; or go to www.idfa.org.

JULY

- **14–15, 10th Annual Hawaii Lodging, Hospitality and Foodservice Expo,** Neal Blaisdell Center, Honolulu, HI. For more information, call 800.525.5275; E-mail: kanter@lava.net.

AUGUST

IAFP 2004 Workshops, JW Marriott Desert Ridge Resort, Phoenix, AZ.

- **6–7,** Workshop 1 – Your Data, Your Job: Quality Systems for Microbial Food Analysis
- **7,** Workshop 2 – Converting to the NCIMS Voluntary HACCP System from Traditional Dairy Inspection
- **7,** Workshop 3 – Best Practices for Quality Aquacultural Products

See page 278 of this issue for additional information.

IAFP UPCOMING MEETINGS

AUGUST 8-11, 2004
Phoenix, Arizona

AUGUST 14-17, 2005
Baltimore, Maryland

AUGUST 13-16, 2006
Calgary, Alberta, Canada

COMING EVENTS

- **8–11, IAFP 2004, the Association's 91st Annual Meeting,** JW Marriott Desert Ridge Resort, Phoenix, AZ. For more information, see page 277 of this issue for additional information or contact Julie Cattanach at 800.369.6337; E-mail: jcattanach@foodprotection.org.

SEPTEMBER

- **1–3, Food Safety and HACCP in the 21st Centry: From Theory to Practice,** Conrad Hotel, Bangkok, Thailand. Co-sponsored by IAFP. For more information, contact Chris Jones at 44.161.736.9172; E-mail: www.who.int/en.
- **22–23, Fifth Annual Illinois Food Safety Symposium,** Hotel Pere Marquette, Peoria, Il. For more information, contact Jayne Nosari at 217.785.2439; E-mail: jnosari@idph.state.il.us.
- **28, Washington Association for Food Protection Annual Conference,** Campbell's Resort, Chelan, WA. For more information, contact Bill Brewer at 206.363.5411; E-mail: billbrewer1@juno.com.
- **28–29, Wisconsin Association for Food Protection Annual Meeting,** Ho-Chunk Casino & Hotel Convention Center, Wisconsin Dells, WI. For more information, contact Randy Daggs at 608.837.2087; E-mail: rdaggs@juno.com.
- **29–Oct. 1, Wyoming Environmental Health Association Annual Educational Conference,** Great Divide Lodge, Breckenridge, CO. For more information, contact Roy Kroeger at 307.633.4090; E-mail: roykehs@laramiecounty.com.

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* Asterisk indicates author for correspondence.

ERRATUM

In the article "A Comparison of Hand Washing Techniques To Remove *Escherichia coli* and Caliciviruses under Natural and Artificial Fingernails," by Lin et al., *Journal of Food Protection* 66(12):2296–2301, last column (soap plus nailbrush) of Table 3 on page 2299, the log reduction in FCV for artificial nails should be 2.41 ± 0.79 A, not 0.41 ± 0.79 A.

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