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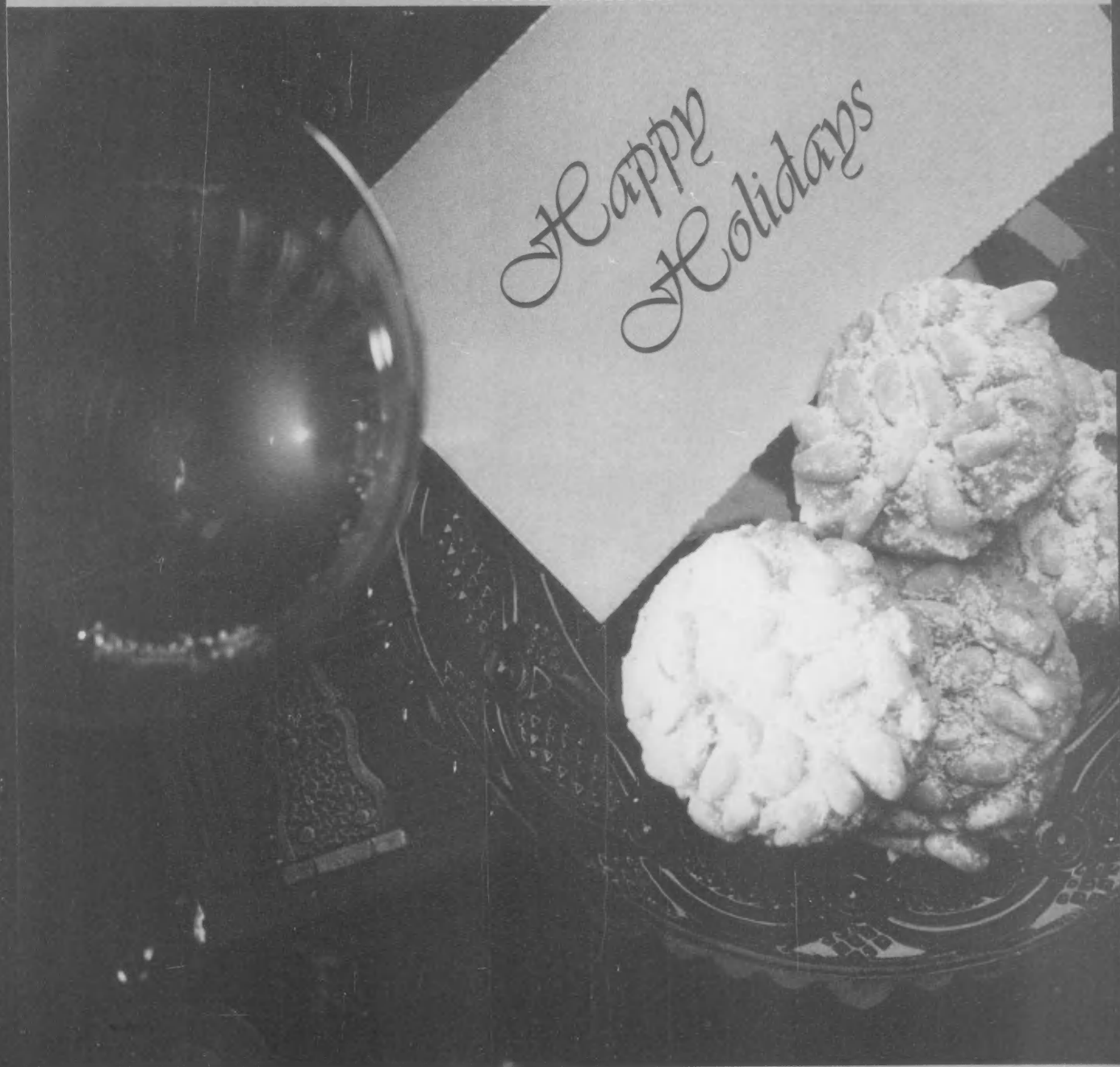
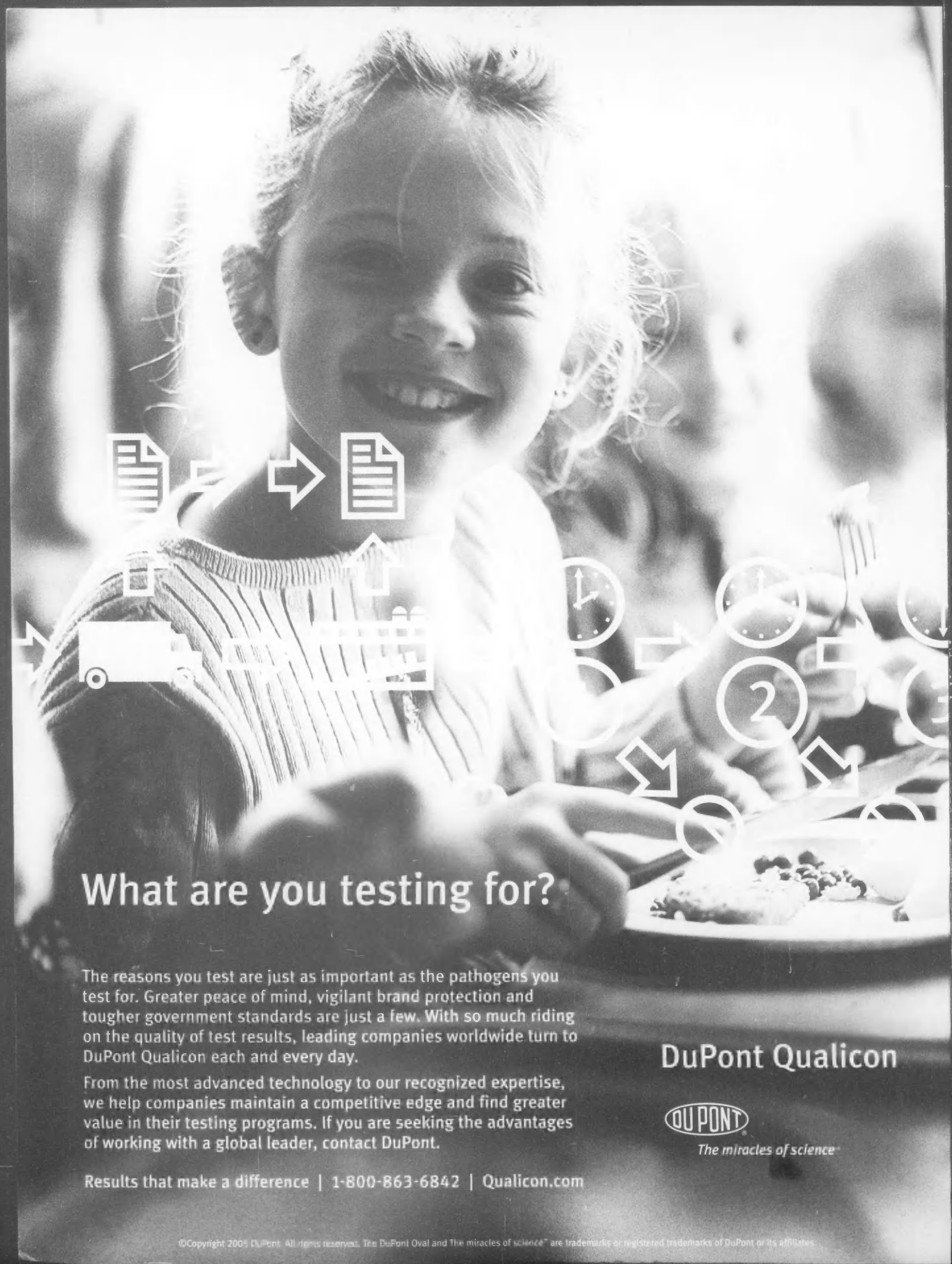
FOOD PROTECTION TRENDS

SCIENCE AND NEWS FROM THE INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

DECEMBER 2005

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International Association for Food Protection

FOOD PROTECTION TRENDS

VOLUME 25, NO. 12

ARTICLES

ASSOCIATION NEWS

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EXTRAS

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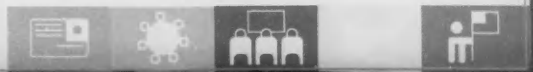

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FOOD PROTECTION TRENDS
SCIENCE AND NEWS
FROM THE INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

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IAFP 2006

AUGUST 13-16

Telus Convention Centre
Calgary, Alberta, Canada

IAFP 2007

JULY 8-11

Disney's Contemporary Resort
Lake Buena Vista, Florida

IAFP 2008

AUGUST 3-6

Hyatt Regency Columbus
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International Association for Food Protection

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"PERSPECTIVES FROM NORTH OF THE 49TH"

By JEFFREY FARBER
PRESIDENT

"Our meeting in Prague, the first ever IAFP meeting outside of North America was a smashing success!"

I have just returned from Prague and wanted to let you in on the news right away! Our meeting in Prague, the first ever IAFP meeting outside of North America was a smashing success! It truly was a historic moment for IAFP. Our first early indicator of this was when people came up to us and asked us where the meeting will be next year, and that they are really looking forward to seeing these meetings on a regular basis! This was music to our ears. The Executive Board had been thinking about putting on a meeting outside of North America for some time and to see it come to fruition and end on a successful note was just fantastic. The meeting was held at the Dorint Novotel Hotel and Conference Centre which was outside the old town of Prague, an excellent location. The meeting room was very spacious and we had very good help and cooperation from the AV people at the hotel. The only glitch we had was actually with the mail system! We had sent out boxes of IAFP folders and material two weeks before the meeting and they arrived a day after the meeting! Such is life! We were still able to distribute the IAFP promotional material to the many people who stayed after our meeting to attend an ILSI-Europe workshop.

A meeting such as this does not go off so smoothly without a lot of dedicated hard work and effort. I just wanted to take this opportunity to personally thank everyone involved! The whole event was truly a team effort! Lisa helped keep things organized along with David (printed materials, etc.). Julie and Farrah processed registrations. Bev helped with posting information on the Web site. Tamara, our newest employee, worked on posting the presentations and pictures on our Web site. Everyone at the IAFP office helped with a couple of mailing projects! We even put Connie Tharp and Barbara Farber to work the morning of the meeting! Nancy did an outstanding job both before and at the meeting, keeping everything running smoothly! A big thank you to our bronze sponsors and exhibitors, BD Diagnostics and DuPont Qualicon, our sponsor and exhibitor bioMérieux as well our additional exhibitors, the British Food Journal, International Food Hygiene, Matrix Microsciences and ILSI-Europe. We also had a very good presence from our IAFP Past Presidents as Jenny Scott (presenter), Anna Lammerding (chairperson) and Paul Hall (participant), were present and involved with the meeting.

I also wanted to acknowledge the whole organizing committee: Laurentina Pedroso, Leon Gorris, Lone Gram, Gordon Hayburn, Anna Lammerding, David Tharp, Bruce Tompkin, and Sandra Tuijtelaars. In addition, David Lloyd very kindly took over as Co-chair from Gordon Hayburn and did a great job. I also would like to personally thank Leon Gorris, who really helped us tremendously with all the scientific aspects of the meeting. As briefly mentioned above, the abstracts, as well as the slides from each of the talks are available on the IAFP Web site, so that our Members, as well as the scientific community, can benefit from the outstanding presentations that were given by all the speakers. So please visit our Web site and take advantage of this!

To continue on with the excitement, right after our meeting, IAFP was also involved as a co-sponsor of a risk assessment workshop that was put on by ILSI-Europe. The whole ILSI-Europe team (Sandra Tuijtelaars, Toula Aslanidis, Nico van Belzen, and Ruth Marquet) was fantastic to work with. As many of you know, we have had a great association with ILSI North America for a number of years. Our new connections to ILSI-Europe could really open a number of new avenues to us, as we continue our strategic goal of truly becoming an international association. A number of IAFP Members also participated

in the ILSI-Europe risk assessment workshop. The workshop began on Wednesday afternoon and went until Friday afternoon. At the beginning of the workshop, David Tharp gave a talk to all participants about the goals of our Association (I did a similar thing at the start of our IAFP symposium), and IAFP was acknowledged throughout the meeting. Both of these meetings gave IAFP excellent visibility in the international food safety community, and I think you will see us reaping tremendous benefits from our active participation and involvement in these two meetings. Some of you may know that we also co-sponsored the ICMSF two-day meeting which was held in Washington, D.C. the first of November. More about this at a later date!

As always, I can be reached by E-mail at jeff_farber@hc-sc.gc.ca and would love to hear from you!

Quote of the month:

By believing passionately in something that still does not exist, we create it. The nonexistent is whatever we have not sufficiently desired.

Franz Kafka

For you literary buffs, Franz Kafka, born in 1883, was a novelist and also a lawyer, who was born and lived in Prague, which was then part of the Austro-Hungarian Empire. He published only a few short stories during his lifetime, and so his writing did not attract much attention until after he died in 1924. Before dying, he had told his friend and literary executor Max Brod, to destroy all of his manuscripts. His girlfriend, Dora Dymant, faithfully destroyed all the manuscripts that she had. However, Max did not follow Kafka's instructions, and actually oversaw the publication of most of his work, which soon began to attract attention and critical regard.

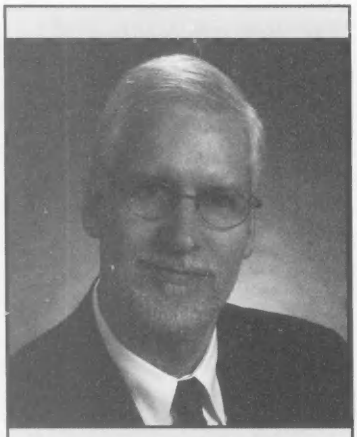
Have a great month!

"COMMENTARY"
FROM THE EXECUTIVE DIRECTOR

With December's arrival, it is a good time to look back over the past year to see what we have accomplished. This year has many highlights; too many to cover in detail in this column, but allow me to mention a few. IAFP chartered an Affiliate organization in New Zealand; we began an effort to improve the visibility of the IAFP Foundation and conducted filming at IAFP 2005 to forward this effort; we held our first Symposium outside of North America; we have increased Membership over the year, we set attendance records at IAFP 2005 in Baltimore, and we had a record-breaking financial performance for the year ending August 31, 2005!

President Jeffrey Farber covered the IAFP Symposium and our co-sponsorship of the ILSI-Europe Workshop held in Prague, Czech Republic so I won't go into detail about these events. What I do want to say is a hearty "thank you" to everyone who helped make these events possible. Specifically, thanks to ILSI-Europe for their help in organizing these events; thanks to our Symposium organizing committee and the speakers; and thanks to everyone who was able to attend. We had a great educational event in Prague and met many new food safety professionals to expand our worldwide network. The attendee surveys reported satisfaction, enthusiasm and support for future IAFP endeavors in Europe. We must start planning now for the future!

The topic I want to spend most of the time on this month is the financial condition of the Association. It brings me great pleasure to report to you that for the third year straight, IAFP will have a positive fund balance in the General Fund! Above, I mentioned that we had a record-breaking financial year and that is indeed true. For the year ending August 31, 2005, IAFP posted net revenues in excess of net expense in the amount of $312,000 (see page 1036). This is the result of an exceptional year in which we were able to reduce operating expenses while finding additional sources of revenue. In addition, a 12% increase in Annual Meeting attendance improved our net results from IAFP 2005 in Baltimore.



By DAVID W. THARP, CAE
EXECUTIVE DIRECTOR

"This year has many highlights"

We were fortunate to have a full exhibit hall, excellent participation from our sponsors and keen interest in this year's workshops. Each of these contributed in a positive way to our banner year. Also during the year, we saw increased Membership including an increase in Sustaining Memberships, which really helps to provide support to IAFP. Our subscription revenue, mostly related to the *Journal of Food Protection* and *JFP* Online also increased significantly. Each of these factors helped to boost the net financial results for the Association.

As of the end of August, our General Fund balance was just more than $500,000. As I stated last year in my financial summary report, it is the financial goal of IAFP to reach at least a 50% level of our annual operating budget. We are about half way to our goal as our operating budget is now $2 million!

We have made great progress over the past three or four years in eliminating the negative fund balance that once hindered our Association's flexibility. Operating the Association with a positive General Fund balance is much more comfortable. It is appropriate to thank our many Members, our Annual Meeting attendees, our exhibitors and especially our Annual Meeting sponsors who have given freely of their support for the betterment of the Association. This is what it takes to have a truly successful organization — many individuals, corporate supporters and people who are willing to work together to help the Association progress! Thank you to everyone who provided this much needed support over the years.

Looking towards next year, I want to let you know that soon we will be working to establish a new, online submission program for *Journal of Food Protection* manuscripts where authors and reviewers will be able to access up-to-date information about their manuscripts via the IAFP Web site. This will allow for faster processing of manuscripts, which will allow quicker time to publication. In addition, the Executive Board will review the results of our First European Symposium in Prague and make a decision on when our Second European Symposium will be held! Keep watching this column and *Food Protection Trends* for the announcement.

To wrap up for this year, we want to wish everyone a very happy holiday season and best wishes for a prosperous New Year from all of us at IAFP!

ARTICLES

Food Protection Trends, Vol. 25, No. 12, Pages 974–980

6200 Aurora Ave., Suite 200W, Des Moines, IA 50322-2864

International Association for Food Protection

The Microbiological Status of Non/Food Contact Surfaces in Domestic Kitchens and the Growth of *Staphylococcus aureus* in Domestic Refrigerators

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SUMMARY

The objectives of this study were to investigate the incidence/levels of bacterial contamination at key sites in domestic kitchens and to assess the potential for *Staphylococcus aureus* growth during domestic chilled storage. Domestic kitchen surfaces and dishcloths were examined for total viable count (TVC), total *Enterobacteriaceae* count (TEC), total coliform count (TCC) and the presence/absence of *Salmonella* spp., *Campylobacter* spp., *Listeria monocytogenes*, *Yersinia enterocolitica*, *Staphylococcus aureus* and *Escherichia coli* O157:H7. The patterns of fluctuation in refrigeration air temperatures over 7 days were recorded and used to model the potential growth of *S. aureus* in broth. On the kitchen surfaces the TVCs varied between 1.8 $\log_{10}$ CFU cm^{-2} (microwave) and 5.8 $\log_{10}$ CFU cm^{-2} (refrigerator). TECs varied between 0 $\log_{10}$ CFU cm^{-2} (microwave) and 2.1 $\log_{10}$ CFU cm^{-2} (sink). TCCs ranged from 0.9 $\log_{10}$ CFU cm^{-2} (microwave) to 3.0 $\log_{10}$ CFU cm^{-2} (sink). The dishcloths contained higher total counts than any surface examined and were also a source of *E. coli*, *L. monocytogenes* and *S. aureus*. The average air temperature in domestic refrigerators varied from 4.6°C to 6.4°C, while in the refrigerator with the highest temperature profile, the temperature varied from 11.4°C to 12.2°C. Growth studies indicated that *S. aureus* numbers increased by approximately 3.7 $\log_{10}$ CFU cm^{-2} during storage for 7 days at the observed highest temperature profile. Modelling this data by use of the Monod equation suggested a generation time of approximately 10 h during the exponential growth phase at these temperatures, suggesting that microgram levels of toxin may be present after 7 days. This study reinforces the need for information regarding adequate cleaning, prevention of cross contamination and effective cold storage to prevent acquisition and transmission of infection in the home.

A peer-reviewed article

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INTRODUCTION

The recent renewed focus on promotion of hygiene practice in the home has come about because of recognition that even with the most effective hazard analysis and critical control point (HACCP) plans during food production, processing and retail, the ultimate safety of food cannot be guaranteed. Consumers often fail to store, handle and prepare food in a hygienic manner *(15)* and as a result many food poisoning cases are associated with domestic food preparation *(17)*. It has been estimated that private homes account for more outbreaks of foodborne illness than the sum of all other sources *(4, 33)*. Such illness thus represents a major socioeconomic cost in terms of discomfort, lost working days and medical expenses. Furthermore, contrary to consumer beliefs that most food poisoning is acquired in restaurants, current evidence would suggest that the proportion of food-associated illness acquired at home is increasing *(4)*.

Bacterial contaminants can enter the domestic kitchen by a variety of means, including water, people, pets, pests and raw foods. Once in the kitchen, pathogens are easily spread by cross-contamination throughout the domestic kitchen, e.g., onto knives, cutting boards, worktops, draining boards, sinks, dishcloths, etc. *(4, 16, 18)*, leading to many cases of domestic food poisoning *(29, 31)*. *S. aureus* is among the most common pathogenic bacteria found in domestic kitchens *(22)* and is capable of surviving on domestic kitchen surfaces for several days *(4)*. It is a significant cause of food poisoning *(2)*, being the second or third most common cause of food-associated illness in a number of countries *(2, 30)*. Symptoms are associated with the effects of enterotoxin(s), produced when the *S. aureus* population exceeds 5 $\log_{10}$ CFU ml^{-1} *(1, 34, 38)*. Most consumers rely on their refrigerator to prevent the growth and toxin production by this pathogenic organism. However, previous studies, such as one reported by Flynn et al. *(14)*, would suggest that domestic refrigerators operate over a range of temperatures and that the air temperature in the refrigerator may be as high as 12.6°C, i.e., temperatures at which toxin production occurs.

Based in Dublin, this study investigates the incidence/levels of contamination at key sites in domestic kitchens and reports on the operational temperatures of the refrigerators in these kitchens. This study also investigates the effect of the operational domestic refrigerator temperatures on the growth of *S. aureus*.

METHODS AND MATERIALS

Microbiological survey

Ten participants were randomly selected and asked to allow microbiological swabs to be taken at unspecified sites in their kitchens. Participants were asked to make no changes in their cleaning, refrigerator usage or other domestic kitchen activities during the period of the study. Cellulose sponge swabs (10 × 10 cm × 100 mm) supplied by Sydney Heath and Son (Stoke-on-Trent, Staffordshire, UK) were sterilized in plastic bags with 5 ml Maximum Recovery Diluent (MRD; Oxoid, Unipath Ltd., Basingstoke, UK). The inner sides and base (approx. 2076 cm) of the refrigerator were swabbed, using the inverted bag technique *(23)*. Swabs were then transported to the laboratory in a cool box and examined to determine total viable count (TVC), total coliform count (TCC), total enteric count (TEC) and the presence/absence of *E. coli*, *Salmonella* Enterica, *Campylobacter*, *L. monocytogenes*, *Y. enterocolitica*, *S. aureus* and *E. coli* O157:H7.

Swabs were stomached for 2 min with 250 ml Buffered Peptone Water (BPW; Oxoid) in a sterile stomacher bag (Stomacher 400; Seward Medical, London,UK), using a Colworth Stomacher (Model BA 6021; A.J. Seward and Company Ltd., London, UK). Serial dilutions of the resultant bacterial suspensions were prepared in MRD and plated onto (a) Plate Count Agar (PCA; Oxoid), incubated at 25°C for 48 h and examined to estimate TVCs; (b) Chromocult Coliform Agar (Chromocult; Merck), incubated at 37°C for 24 h and examined to estimate TCCs; (c) Violet Red Bile Glucose Agar (VRBGA; Oxoid), incubated at 32°C for 24–48 h and examined to estimate TECs.

Presumptive *E. coli* (dark blue/violet colonies on the Chromocult coliform agar) were confirmed by plating onto Levine's Eosin Methylene Blue agar (EMB; Oxoid) and, Phenol Red Sorbitol Agar (Oxoid), and by completion of the range of biochemical tests described by Finney et al. 2003 *(13)*. Colonies exhibiting the biochemical profile of *E. coli* (a green metallic sheen on EMB, no fluorescence on UV illuminated Phenol Red Sorbitol agar with 4-methylumbelliferyl-B-D-Glucuronide, Gram negative, indole positive, oxidase negative, no citrate utilization, and acid production using Methyl Red and Vogues Proskauer (MRVP) broth) were analyzed further by immunomagnetic separation as described by Cagney et al. *(7)*.

Salmonella spp. were isolated and confirmed as described by Pearce et al. *(27)*. Each sample was supplemented with double strength BPW and incubated at 37°C for 24 h. A 0.1-ml aliquot of each enriched culture was then transferred into 10 ml of Rappaport–Vassiliadis (Oxoid) medium and incubated at 42°C for another 24 h. The enrichment cultures were streaked out onto Brilliant Green Agar (BGA; Oxoid), incubated at 37°C for 24 h, and examined for red colonies. The enrichment cultures were also streaked out onto Mannitol Lysine Crystal Violet Brilliant Green Agar (MLCB; Oxoid), incubated at 37°C for 24 h, and examined for large black colonies. Presumptive *Salmonella* from both the BGA and MLCB were recovered, purified and cultured on non-selective media (Tryptone Soya Agar, TSA; Oxoid) at 37°C for 24 h. Colonies exhibiting the biochemical profile of *Salmonella* spp. (Gram negative; motile; positive for dextrose, mannitol and lysine decarboxylase; negative for urease, sucrose/salicin, ONPG, indole and the production of hydrogen sulphide) were maintained on TSA slants at 2°C.

Campylobacter spp. were isolated and confirmed as described by Cloak et al. *(8)*. Each sample was enriched in *Campylobacter* Enrichment Broth (CEB; Oxoid) and incubated at 37°C for 4 h, followed by further incubation at 42°C for 44 h. Following this enrichment, a loopful of the culture was streaked out onto *Campylobacter* blood free medium, Charcoal-Cefoperazone-Deoxycholate Agar (CCDA; Oxoid) plates and incubated at 37°C for 48 h under microaerophilic conditions, using gas generating kits in anaerobic jars (Oxoid) to create an atmosphere of 6% oxygen and 10% carbon dioxide. Colonies exhibiting the biochemical profile of *Campylobacter* spp. (Gram negative, catalase and oxidase positive, motile, hydrolysis of hippurate, production of hydrogen sulphide and sensitivity to nalidixic acid) were maintained on TSA slants at 2°C.

Y. enterocolitica were isolated and confirmed as described by Logue et al. *(24)*. Initial *Yersinia* numbers were determined from samples by direct plating on *Yersinia* Selective Medium (CIN; Oxoid). All plates were incubated at 37°C for 24 h. Suspect colonies of typical 'bulls-eye' appearance were counted as *Yersinia*. Presumptive *Yersinia* isolates were streaked onto TSA plates and incubated at 37°C for 24 h. Colonies exhibiting the

FIGURE 1. The average temperature (n = 9) and highest temperature (n = 1) profiles recorded at 6-hour intervals in the domestic refrigerators in this study

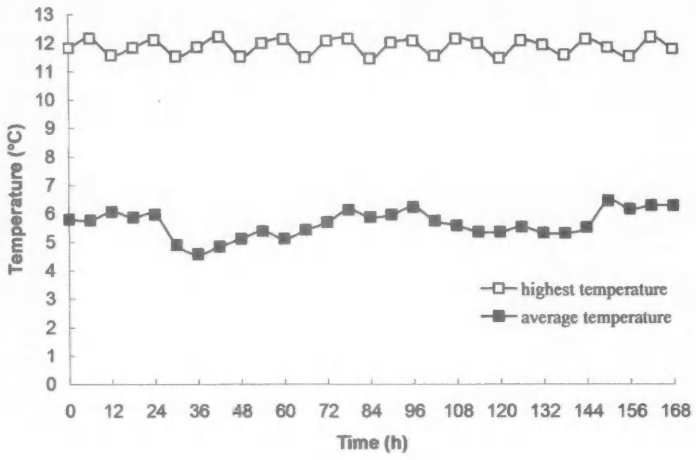
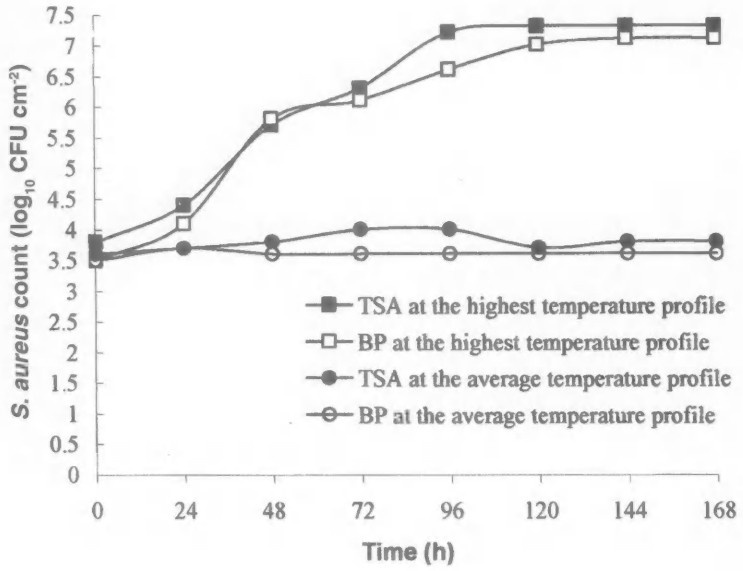


FIGURE 2. The average growth curves for 5 cocktails of 5 *S. aureus* domestic refrigerator isolates at the highest and average recorded temperature profiles on TSA and BP. Each experiment was carried out in duplicate and repeated 3 times



biochemical profile of *Yersinia* (acid slope and butt on TSI; urease positive; lactose positive/negative colonies on MAC; lysine decarboxylase negative; ornithine decarboxylase positive; motile at 25°C but not at 37°C in sulphide indole motility medium (SIM); acetoin production using MRVP broth; fermentation of sucrose, rhamnose, melibiose, raffinose, and a-methyl-D-glucoside; Simmons citrate utilization and indole production) were maintained on TSA slopes at 2°C.

L. monocytogenes were isolated and confirmed as described by McClain et al. *(26)*. Each sample was enriched in buffered *Listeria* Enrichment Broth containing *Listeria*-selective enrichment supplement (Oxoid) and incubated at 30°C for 24 h. After incubation, a loopful of each enriched culture was transferred onto Oxford agar (*Listeria*-selective base plus *Listeria*-selective supplement, Oxoid). Colonies exhibiting the biochemical profile of *L. monocytogenes* (Gram positive; motile; catalyse positive; oxidase; hydrogen sulphide and indole negative; acid production using MRVP broth; no reduction of nitrate; growth enhanced near the *S. aureus* streak for the CAMP test; no hydrolysis of urea; ß-haemolysis on blood agar; acid production from L-rhamnose; no acid production from D-xylose or mannitol, and hydrolysis of hippurate and esculin) were maintained on TSA slants at 2°C.

S. aureus were isolated by plating onto Baird Parker Agar Base with Egg Yolk tellurite emulsion (BP; Oxoid). The plates were incubated at 37°C for 48 h. Colonies of *S. aureus* were tested using the Gram stain procedure and tested for the production of coagulase, catalase, and DNAse; for the fermentation of mannitol; and for the non-utilization of oxidase. Primary identification involved subculturing of typical *S. aureus* colonies onto DNase plates (Oxoid) and Blood agar plates (Columbia Base Agar and 5% Lysed Horse Blood; Oxoid) and incubating at 37°C for 24 h. Colonies exhibiting the biochemical profile of *S. aureus* (positive for all the aforementioned tests) were maintained on TSA and confirmed by testing for the clumping factor (Staphylase Test Kit; Oxoid).

Temperature survey

The in-use air temperature profiles of the 10 domestic refrigerators were recorded with Testo 175™ temperature data loggers (Testo Ltd., Alton, Hampshire, UK). The temperature loggers were placed in the center of the middle shelf in each refrigerator. The temperature was recorded every 6 h over a 168 h (1 week) period. The recorded temperatures were downloaded onto a PC. The refrigerator with the highest temperature profile was separated out and the remaining profiles (n = 9) were averaged (Fig. 1) for use in the modelling study.

MODELLING STUDY

Strain selection

Twenty-five *S. aureus* isolates from BP plates (5 typical colonies from 5 positive refrigerators) were confirmed as previously described and maintained on Protect™ Stock Culture Beads (Protect, Technical Consultants Limited, UK) at -18°C.

Inoculum preparation

One bead of each strain was resuscitated in 30 ml sterile TSB (Tryptone Soya Broth; Oxoid) at 37°C for 24 h. Following incubation, a 1 ml aliquot from each cul-

TABLE 1. Bacterial counts at different sites in the domestic kitchen

Bacteria	Site					
	Refrigerator	Cutting Board	Sink	Worktops	Microwave	Dishcloth
	$n = 10$	$n = 10$	$n = 10$	$n = 10$	$n = 10$	$n = 10$
	Bacterial count					
	($\log_{10}$ CFU cm^{-2})					$\log_{10}$ CFU ml^{-1}
TVC	5.8	2.8	5.5	3.9	1.8	6.2
TEC	1.2	0.9	2.1	1.2	ND	2.3
TCC	1.7	1.3	3	2	0.9	3.2

ND = not detected, TVC = Total viable count, TEC = Total *Enterobacteriaceae* count, TCC = Total coliform count

TABLE 2. The incidence of bacteria and bacterial pathogens in the domestic kitchen

Bacteria	Site					
	Refrigerator	Cutting Board	Sink	Worktops	Microwave	Dishcloth
	$n = 10$	$n = 10$	$n = 10$	$n = 10$	$n = 10$	$n = 10$
	Incidence (%)					
E. coli	10	0	10	0	0	10
Salmonella spp.	0	10	0	0	0	0
Campylobacter spp.	0	0	0	0	0	0
L. monocytogenes	10	0	10	0	0	10
Y. enterocolitica	0	0	0	0	0	0
S. aureus	50	30	50	30	10	50
E. coli O157:H7	0	0	0	0	0	0

ture was transferred to 99 ml sterile TSB and incubated for another 18 h at 37°C. Aliquots of 30 ml TSB from 5 suspensions (× 5) were combined in sterile containers (Sterilin, Staffordshire, UK) and mixed, using a vortex mixer. Amounts of 30 ml of the resultant mixture were centrifuged (Eppendorf AG, Hamburg) at 4,800 × g for 10 min at 4°C. The recovered pellet was washed three times with, and re-suspended in, MRD. The numbers of *S. aureus* cells per ml of the cocktail suspension were estimated by use of the Acridine Orange method *(37)* and diluted in TSB to contain approximately 5.0 $\log_{10}$ CFU ml^{-1}.

Medium equilibration

100 ml amounts of sterile TSB in screw cap bottles (Duran Schott, Mainz, Germany) were equilibrated to 5.8°C (average 'start' refrigerator air temperature) or 11.6°C (highest 'start' refrigerator temperature) by immersion in a Louda™ polyethelene glycol bath (LAUDA DR.R. Wobser, GMBH & Co. KG) programmed as per the temperature profile in Figure 1. The temperatures of the water baths were monitored and adjusted, using thermocouples inserted into 'blank' samples attached to a temperature microprocessor (Ellab A/S, Oslo, Norway).

Inoculation and incubation

As soon as the medium had reached the target temperature, each bottle was inoculated with 1 ml of *S. aureus* cocktail. The contents of the bottle were mixed with a sterile loop and a sample (1 ml) was withdrawn immediately, and then every 24 h for 1 week, from each bottle. These samples were serially diluted and plated in duplicate onto BP and TSA. BP plates were incubated at 37°C for 48 h, and examined. The TSA plates were incubated at 25°C for 2 h, over-laid with BP, incubated at 37°C for an additional 48 h and examined. The 2-h delay in overlaying the TSA plates with BP was to allow injured cells to recover.

Modelling

The data generated were analyzed by use of the Monod model ($N = N_0 2^{t/g}$) or $g = 0.69 / \ln (N_0/N)$ where N is the number of cells at time = t, N_0 is the initial number of cells and g is the generation time (time for the population to double).

RESULTS

The bacterial counts (TVC, TEC and TCC) for the different kitchen sites (refrigerators, cutting boards, sinks, worktops, microwave ovens and dishcloths) are shown in Table 1.

The highest surface TVC, 5.8 $\log_{10}$ CFU cm^{-2} was obtained on the inside of the refrigerators, followed by the sink (5.5 $\log_{10}$ CFU cm^{-2}), worktops (3.9 $\log_{10}$ CFU cm^{-2}), cutting boards (2.8 $\log_{10}$ CFU cm^{-2}) and microwave ovens (1.8 $\log_{10}$ CFU cm^{-2}). Both the highest surface TEC (2.1 $\log_{10}$ CFU cm^{-2}) and the highest surface TCC (3.0 $\log_{10}$ CFU cm^{-2}) were obtained from the sink.

The dish cloths were heavily contaminated. The TVC (average 6.2 $\log_{10}$ CFU ml^{-1}) varied between 8 $\log_{10}$ CFU ml^{-1} and 4.3 $\log_{10}$ CFU ml^{-1}. The TEC (average 2.3 $\log_{10}$ CFU ml^{-1}) varied between 3.8 $\log_{10}$ CFU ml^{-1} and 1.4 $\log_{10}$ CFU ml^{-1}. The TCC (average 3.2 $\log_{10}$ CFU ml^{-1}) and it varied between 5.2 $\log_{10}$ CFU ml^{-1} and 1.5 $\log_{10}$ CFU ml^{-1}.

The frequencies of detection of bacterial pathogens (*E. coli*, *Salmonella* spp., *Campylobacter* spp., *L. monocytogenes*, *Y. enterocolitica*, *S. aureus* and *E. coli* O157:H7) are presented in Table 2. *S. aureus* was the most prevalent bacterial pathogen, being detected on 50% of refrigerator surfaces, on 30% of cutting boards, on 50% of sinks, on 30% of worktops, on 10% of microwave ovens and in 50% of dishcloths (Table 2). The next most frequently detected pathogens were *E. coli* and *L. monocytogenes*, both of which were found on the surfaces of one refrigerator, on one sink and in one dishcloth. The only other pathogen detected was *Salmonella*, which was detected on one cutting board.

The temperature of the 'average' profile (n = 9) ranged between 4.6°C and 6.4°C, with an overall average of 5.6°C. The temperatures of the 'highest' profile ranged between 11.4°C and 12.2°C, with an overall average of 11.8°C (see Fig. 1). The average temperature profile did not support the growth of *S. aureus* but maintained the bacterial population at approximately 3.5 $\log_{10}$ CFU ml^{-1} to 4.0 $\log_{10}$ CFU ml^{-1} (see Fig. 2). In contrast, the highest temperature profile supported a 3.7 $\log_{10}$ CFU ml^{-1} increase as determined on TSA and a 3.6 $\log_{10}$ CFU ml^{-1} increase as determined by use of BP. Using the Monod model, the generation times (g) calculated for 0–24 h (early lag and early exponential phase) was 12 hours for TSA and BP; for 24–120 h (exponential phase) was 10.3 h for TSA and 9.9 h for BP and for 120–168 h (late lag phase) was 144 h for both TSA and BP.

DISCUSSION

Factors that may affect the detection of bacteria from surfaces include sensitivity of the bacteria to drying *(10, 19)*, attachment characteristics of the bacteria *(25)*, surface structures *(28)*, a clump structure *(36)*, presence of food residues and ability to form spores *(4)*. *S. aureus* was detected on worktops (30%), chopping boards (30%), sinks (50%), refrigerators (50%) and dishcloths (50%) (see Table 2). This incidence of *S. aureus* may be due, in part at least, to its clump-like structure, which can allow detachment of more cells during sampling and protect the innermost cells against drying *(36)*. Conversely, the absence of *Campylobacter* in this study may be attributed to the sensitivity of this organism to drying *(4)*. The lack of detectable *Salmonella* in the domestic kitchen environment was an unexplained observation reported by other authors *(5, 6, 18)*; however, *Salmonella* was found in the kitchen environment of this study and also in a study by Humphrey et al. *(20)*.

It should not be assumed that the refrigerator is a secure line of defense. In this study, *E. coli* (10%), *L. monocytogenes* (10%) and *S. aureus* (50%) were detected. Previously, *E. coli (35)*, *L. monocytogenes (3, 9, 32)* and *S. aureus (11)* have also been readily found in domestic refrigerators *(22)*. The refrigerators contained an average TVC of 5.8 $\log_{10}$ CFU cm^{-2}, TEC of 1.2 $\log_{10}$ CFU cm^{-2} and TCC of 1.7 $\log_{10}$ CFU cm^{-2}. A previous study reported an average TVC and TCC in Irish refrigerators of 7.1 $\log_{10}$ CFU cm^{-2} and 4.0 $\log_{10}$ CFU cm^{-2}, respectively *(22)*. These total counts and the presence of potential pathogens in refrigerators are particularly important when the operating temperature of consumers' refrigerators is high enough to support the persistence and growth of bacteria (Fig. 1).

The dishcloth was shown to be a potential vehicle for cross contamination. It was a heavily contaminated site in the domestic kitchen, with TVC, TEC and TCC of 6.2 $\log_{10}$ CFU ml^{-1}, 2.3 $\log_{10}$ CFU ml^{-1} and 3.2 $\log_{10}$ CFU ml^{-1}, respectively. This may be due to the presence of food residues and the moist environment. Similarly, Hilton and Austin *(18)* found an average TVC on dishcloths of 7.9 $\log_{10}$ CFU ml^{-1}. Higher *Enterobacteriaceae* and coliform counts on dishcloths were reported by Josephson et al. *(21)*, who reported an average TEC and TCC of 7.3 $\log_{10}$ CFU ml^{-1} and 6.7 $\log_{10}$ CFU ml^{-1}, respectively. This study found that 90% of dishcloths had a TVC greater than 5 $\log_{10}$ CFU ml^{-1}. Similarly, Gorman et al. *(16)* found that 72% of domestic dishcloths had bacterial counts in excess of 5 $\log_{10}$ CFU ml^{-1}.

The average TVC on sinks was 5.5 $\log_{10}$ CFU ml^{-1}, with a maximum of 7.8 $\log_{10}$ CFU cm^{-2}. The average TEC on sinks was 2.1 $\log_{10}$ CFU ml^{-1}, with a maximum of 4.6 $\log_{10}$ CFU cm^{-2}. The average TCC was 3.0 $\log_{10}$ CFU ml^{-1}, with a maximum of 5.6 $\log_{10}$ CFU cm^{-2}. Other studies *(12, 21)* have also found that the surfaces of domestic sinks harbor bacterial populations and have reported TCC as high as 6.04 $\log_{10}$ CFU cm^{-2}.

The 'highest' refrigerator temperature profile observed varied between 11.4°C and 12.2°C, which supported a 3.7 $\log_{10}$ CFU ml^{-1} increase in *S. aureus* (the most prevalent pathogen in the kitchens visited as part of this study) during one week in broth. This finding supports Angelotti et al. *(1)*, who first suggested that *S. aureus* could grow at temperatures as low as 6.7°C. From a consumer viewpoint, such increases will result primarily in decreased food storage time. However, storage at such temperatures may also increase the risk of growth of food-poisoning organisms such as *Listeria*, *Salmonella* spp. and *S. aureus (14)*. In this study, the exponential generation time of approximately 10 h would achieve 17 generations (time to increase from 1 cell to 10^5 or higher) in 170 h, or 7.1 days. This is significant in light of the fact that microgram levels of toxin may be produced and illness may occur when the *S. aureus* population reaches this level *(1, 34, 38)*.

A domestic refrigerator, even if capable of maintaining a 'safe' working temperature, is only as effective as consumer adjustment dictates. To preserve food effectively and minimize/prevent the growth of many foodborne pathogens, the refrigerator must operate within a suitable temperature range and the food it contains must be correctly positioned. If these practices are not adhered to, instead of aiding food preservation, a refrigerator can greatly increase the likelihood of food spoilage during typical storage times, supplying conditions suitable for the contami-

nation of food and the growth of microorganisms.

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Factors Impacting Food Workers' and Managers' Safe Food Preparation Practices: A Qualitative Study

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SUMMARY

This study collected data on food workers' self-reported food safety practices and beliefs about factors that impacted their ability to prepare food safely. Eleven focus groups were conducted with food service workers and managers in which they discussed their current implementation of seven food preparation practices (handwashing, hot holding, etc.), and the factors they believed impacted their safe implementation of those practices. Some participants reported unsafe food preparation practices, such as inappropriate glove use and not checking the temperatures of cooked, reheated, and cooled foods. Most participants, however, reported safe practices (e.g., washing their hands after preparing raw meat). Participants identified a number of factors that impacted their ability to prepare food safely, including time pressure; structural environments, equipment, and resources; management and coworker emphasis on food safety; worker characteristics; negative consequences for those who do not prepare food safely; food safety education and training; restaurant procedures; and glove and sanitizer use. Results suggest that food safety programs need to address the full range of factors that impact food preparation behaviors.

INTRODUCTION

Epidemiological research has indicated that the majority of reported foodborne illness outbreaks originate in food service establishments *(15, 23)*, and case control studies have shown that eating meals outside the home is a risk factor for obtaining a foodborne illness *(11, 16, 17, 19, 27)*. In addition, research on foodborne illness risk factors has indicated that most outbreaks associated with food service establishments can be attributed to food workers' improper food preparation practices *(1)*, and observation studies have revealed that food workers frequently engage in unsafe food preparation practices *(4, 14, 20)*. These findings indicate that improvement of restaurant workers' food preparation practices is needed to reduce the incidence of foodborne illness. Food worker intervention programs are needed to effect this improvement. However, health researchers have argued that an understanding of current practices and factors affecting those practices is necessary before behavior change efforts can be successful *(7, 10)*.

In an effort to contribute to our understanding of food workers' food preparation behavior, the Environmental Health Specialists Network (EHS-Net) conducted this study on food workers' and managers' food safety practices. EHS-Net is a

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TABLE 1. Recommended food preparation practices discussed by participants[1]

Food Preparation Practice	Recommendation
Handwashing	Food handlers should wash their hands frequently. For example, they should wash their hands after they use the restroom, before preparing food, and after they have handled raw meat or poultry.
Cross contamination prevention	Cross contamination from raw meat and poultry to other types of food should be prevented. Table tops, equipment, and utensils should be washed, rinsed, and sanitized after they have come into contact with raw meat and before they are used for anything else.
Glove use	To minimize hand-food contact, gloves should be worn when handling ready-to-eat food or raw food with your hands.
Determining food doneness	When cooking raw meat or poultry, a thermometer should be used to check that these foods have reached recommended temperatures at the end of the cooking process.
Holding	Hot foods should be held at 140 degrees or above, and cold foods should be held at 41 degrees or below. Additionally, the temperatures of held food should be checked periodically to ensure that the foods are being held at safe temperatures.
Cooling	Hot foods should be cooled from 140 degrees to 70 degrees within two hours and from 70 degrees to 41 degrees within four hours. The temperatures of cooling food should be checked periodically to ensure that the foods are being held at safe temperatures.
Reheating	Reheated food (food that has been previously cooked in the establishment and is being reheated for service) should be reheated to 165 degrees or higher. The temperature of reheated food should be checked at the end of the reheating process to ensure that the food reaches 165 degrees.

[1]Participants were asked to discuss the factors impacting their ability to implement these recommended food preparation practices.

network of epidemiologists and environmental health specialists from the Centers for Disease Control and Prevention (CDC), the US Food and Drug Administration (FDA), the US Department of Agriculture (USDA), and eight state public health agencies (in California, Colorado, Connecticut, Georgia, Minnesota, New York, Oregon, and Tennessee) that focuses on the investigation of environmental antecedents of foodborne illness. In this study, data were collected from food workers on their food safety practices and beliefs about the factors that impact their ability to prepare food safely. Focus groups were used to collect the data because they supply descriptive, qualitative data that can be difficult to acquire through other research methods.

MATERIALS AND METHODS

Eleven focus groups were conducted with food service workers and managers from restaurants in the eight EHS-Net states. Five groups were conducted with English-speaking food workers, four groups were conducted with English-speaking managers, and two groups were conducted in Spanish with workers whose primary language was Spanish. Twenty-six managers and 30 workers participated in the English-speaking focus groups; 14 workers participated in the Spanish-speaking groups. The focus groups were conducted through telephone conference calls, as they have been found to be effective in collecting information from participants who are difficult to recruit or who are scattered geographically *(12, 26)*, as the participants of this study were. Evidence suggests that, compared with face-to-face focus groups, telephone focus groups generate as much information and provide more anonymity for participants *(26)*.

To obtain participants, recruiters called restaurants randomly selected from purchased business lists to request participation from a kitchen worker or manager. To be eligible for participation, workers had to have worked in a restaurant kitchen for at least three months and managers had to have worked as a kitchen manager for at least three months. Because of initial difficulty in recruiting Spanish-speaking participants, recruitment for Spanish-speaking participants was limited to areas within the EHS-Net states with relatively high proportions of Hispanic populations. Study participants received an incentive of 60 dollars for their participation.

Each focus group consisted of 4 to 8 participants who responded to questions posed by a group moderator. Participants discussed seven food preparation practices—handwashing, prevention of cross contamination, glove use, determining food doneness, hot and cold holding, cooling, and reheating. These practices were chosen for discussion because their improper implementation has been associated with foodborne illness in food service establishments *(1, 9)*. In the worker

TABLE 2. Practices described by worker participants

Practice	Number of groups[a]
Handwashing	**7**
Wash hands after visiting restroom	7
Wash hands before preparing food	7
Wash hands before preparing raw meat/poultry	7
Wash hands when changing tasks	7
Wash hands periodically	7
Wash hands before putting on gloves/when changing gloves	4
Wash hands after handling money	4
Wash hands after sneezing/coughing	4
Wash hands after eating/drinking	3
Wash hands after taking a break	3
Wash hands after touching face, hair, or clothes	3
Use sanitizer	5
Cross contamination prevention	**7**
Clean and sanitize work surfaces, utensils, equipment	7
Sanitize (but not clean and rinse) work surfaces, utensils, equipment	3
Use gloves or utensils to prevent bare hand contact	6
Keep raw meat/poultry separate from other foods with separate storage areas	6
Keep raw meat/poultry separate from other foods during preparation with separate work areas/surfaces	5
Wash hands after preparing raw meat/poultry	5
Use stainless steel equipment	2
Work only with raw meat/poultry until task is complete	2
Flip cutting boards after using one side	1
Glove use	**7**
Wear gloves when in the kitchen or preparing food	6
Wear gloves when preparing raw meat/poultry	6
Wear gloves when hands have cuts or scratches	2
Wear gloves when preparing food don't want to touch directly	2
Wash hands with every glove change	5
Change gloves when changing tasks or products	5
Change gloves after preparing raw meat/poultry	3
Change gloves when damaged or dirty	2
Change gloves periodically	2
Do not wear gloves	5
Do not wear gloves when cutting food	2
Use gloves improperly	2

Practice	Number of groups[a]
Determining food doneness	**6**
Use thermometer	6
Use length of time cooking	6
Use appearance of food	3
Use feel of food	3
Use thermometer with certain foods	2
Use thermometer when inexperienced/working with new food	2
Holding	**5**
Use steam tables	4
Use walk-in coolers	4
Use sandwich/preparation tables	3
Use salad bars	2
Check temperatures of held foods	3
Record temperatures in temperature logs	3
Managers check/record temperatures	2
Set shelf life for held food	3
Throw away foods held at improper time/temperature	3
Stir held foods	2
Cover held foods	2
Cooling	**5**
Place cooling food in walk-in coolers	5
Place cooling food in shallow or small pans	4
Use ice baths	4
Use cooling wands/paddles	2
Use blast chiller	1
Check temperatures of cooling food	5
Do not check temperatures of cooling food	5
Record temperatures in temperature logs	2
Follow improper cooling practices	4
Reheating	**3**
Reheat food prior to placing in holding	2
Do not reheat prior to placing in holding	2
Discard foods rather than reheat/Reheat only once	2
Check the temperatures of reheated foods	3
Record temperatures in temperature logs	1
Have only experienced workers reheat	1

[a] The numbers in bold in this column (column entitled 'Number of Groups') represent the number of groups in which participants were asked to discuss the topic (e.g., Handwashing, Glove Use). The non-bolded numbers in this column represent the number of groups in which the practice was mentioned by at least one participant.

groups, participants first discussed their current implementation of these seven practices and then discussed the factors that influenced their ability to engage in these practices according to recommendations. (These recommendations are based on FDA's 2001 Food Code [9] and are presented in Table 1). For example, participants were asked to describe when they washed their hands while at work. After this discussion, the moderator read the recommendations concerning handwashing, and participants were then asked to discuss what made it easier or more difficult for them to wash their hands according to the recommendations. In the manager groups, participants were not asked to discuss their current food preparation practices because of concerns about their willingness to discuss unsafe practices. Thus, managers discussed only factors that influenced their and their workers' ability to implement recommended practices. The focus group questions and recommendations were derived in part from questions developed by Kendall, Melcher, and Paul *(18)*.

Each focus group discussion was taped and transcribed. We systematically reviewed these transcripts and identified and categorized common themes among the responses.

This study was approved by CDC's Institutional Review Board (protocol # 3773).

RESULTS

Described in this section are the themes identified in the workers' discussions of their current food preparation practices and in the workers' and managers' discussions of the factors that influenced their ability to engage in these practices according to recommendations. These themes are also presented in Tables 2 and 3 along with the number of groups that discussed each theme. The findings for all groups (English and Spanish-speaking worker groups and manager groups) are discussed together. The practices of determining food doneness, holding, reheating, and cooling were not discussed in every focus group, either because time constraints prevented a topic from being discussed or because participants were unfamiliar with the practice (e.g., participants did not work in a restaurant that engaged in the practice or did not have responsibilities pertaining to the practice).

Handwashing practices

When asked to describe when they washed their hands at work, some workers in every group said they washed their hands after visiting the restroom, before preparing food in general and raw meat or poultry specifically, and when they changed tasks, work stations, or items they were handling (e.g., changing from handling money to food) (Table 2). Some workers in every group also said they washed their hands periodically, either because their hands felt dirty, or because

TABLE 3. Factors impacting food preparation practices discussed by worker and manager participants

Factors impacting:	Number of groups[1] Workers	Managers	Total
Handwashing	**7**	**4**	**11**
Sink accessibility	5	4	9
Time pressure/high volume of business/staffing	4	4	8
Management emphasis	4	4	8
Negative consequences	5	2	7
Sanitizer use	3	3	6
Glove use	2	3	5
Restaurant procedures	3	2	5
Worker motivation/experience/age	2	2	4
Expectations of reciprocal treatment	3	1	4
Personal preferences	3	0	3
Food safety education and training	1	2	3
Coworker emphasis	2	1	3
Concern with sanitary appearance	1	1	2
Effect on hands	0	2	2
Adequate resources (e.g., soap)	1	0	1
Cross contamination prevention	**7**	**4**	**11**
Multiple, color-coded cutting boards	5	3	8
Glove and utensil use	6	2	8
Sanitizer use	4	2	6
Separation of work areas/tasks	3	3	6
Management emphasis	3	2	5
Food safety education and training	2	2	4
Time pressure/high volume of business/staffing	1	3	4
Pre-cooked or prepared meat	3	1	3
Negative consequences	2	1	3
Coworker emphasis	1	0	1
Language differences	0	1	1
Glove use	**7**	**4**	**11**
Manager emphasis/requirement	5	2	7
Negative consequences	4	2	6
Comfort and fit of gloves	4	2	6
Type of work	2	3	5
Personal preferences	4	1	5
Allergies to glove materials	2	3	5
Concern about sanitary appearance	3	0	2

Factors impacting:	Number of groups[1] Workers	Managers	Total
Glove use (Continued)	**7**	**4**	**11**
Adequate resources (e.g., gloves)	1	1	2
Time pressure/high volume of business/staffing	1	1	2
Worker motivation/experience/age	1	0	1
Coworker emphasis	1	0	1
Use of thermometer for food doneness	**7**	**4**	**11**
Time pressure/high volume of business/staffing	4	3	7
Type of meat	3	3	6
Restaurant procedures	3	2	5
Worker motivation/experience/age	3	1	4
Health regulations and inspections	0	3	3
Thermometer sanitation	2	1	3
Thermometer type	0	2	2
Holding	**5**	**4**	**9**
Equipment/thermometers	3	4	7
Management emphasis	3	2	5
Food safety education and training	2	2	4
Time pressure/high volume of business/staffing	2	2	4
Restaurant procedures	0	3	3
Negative consequences	0	2	2
Worker motivation/experience/age	1	0	1
Space	0	1	1
Hours of operation	0	1	1
Quality of food	0	1	1
Cooling	**5**	**3**	**8**
Time at which cooling occurs	2	2	4
Worker motivation/experience/age	2	0	2
Equipment/thermometers	2	0	2
Management emphasis	0	2	2
Space	0	2	2
Time pressure/high volume of business/staffing	1	0	1
Reheating	**3**	**3**	**6**
Food safety education and training	2	1	3
Thermometers	2	0	2
Time pressure/high volume of business/staffing	0	1	1

[1]The numbers in bold in this column ('Number of Groups') represent the number of groups in which participants were asked to discuss the topic (e.g., Handwashing, Glove Use). The non-bolded numbers in this column represent the number of groups in which the factor was mentioned by at least one participant.

of a restaurant process that required handwashing (e.g., a bell rings every hour signifying that workers must wash their hands). To a lesser extent, workers also said they washed their hands before putting on gloves or when changing their gloves, and after handling money, sneezing or coughing, eating or drinking, taking a break, or touching their face, hair, or clothes. Workers also said they cleaned their hands with bottled hand sanitizer or cloths stored in sanitizer buckets.

Factors impacting handwashing practices

Workers and managers most frequently identified sink accessibility as a factor that impacted the ability to wash hands as recommended (Table 3). Some participants in all groups said that having too few sinks or sinks inconvenient to the work area were barriers to handwashing, particularly when workers were experiencing time pressure. Time pressure, because of high volumes of business or inadequate staffing, was also frequently mentioned as a factor that negatively impacted proper handwashing. Participants indicated that they were not able to take the time to wash their hands when they had a large number of orders to prepare (e.g., "When your place is booming…only thing they're worried about is those customers getting their food").

Participants identified several factors they believed impacted handwashing positively. They said management and coworker emphasis on and attention to proper handwashing was a facilitator of handwashing (e.g., "If I forget to wash my hands, my supervisor speaks up."). Negative consequences for improper handwashing was also discussed as a handwashing facilitator (e.g., workers getting reprimanded or fired; customers getting sick). Other positive factors included restaurant procedures that encouraged handwashing (e.g., a bell rings every hour signifying that workers must wash their hands; logs in which workers were required to record every handwashing); worker motivation and food preparation experience (often associated with age, according to participants); expectations of reciprocal treatment from other food workers (e.g., "If I expect that of somebody else, I expect that of myself"); personal preferences for clean hands; food safety education and training on proper handwashing practices and their importance; concerns about appearing sanitary to customers (particularly in kitchens where workers can be seen by customers); and adequate re-

sources (e.g., soap). A few participants indicated that frequent handwashing sometimes made hands chapped and raw, which they believed could be a barrier to handwashing.

Some participants discussed sanitizer as a facilitator of clean hands. These participants said they sometimes used sanitizer in situations in which they did not feel they had the time to stop and wash their hands. Some workers said the use of sanitizer in place of handwashing was acceptable only in some situations (e.g., acceptable after making a sandwich but not after preparing raw meat). Even though these participants typically discussed sanitizer positively, comments suggested that sanitizer may actually negatively impact handwashing, as some participants seemed to be using sanitizer instead of washing their hands. Similarly, some participants said they used gloves to ensure the cleanliness of their hands. However, other participants expressed concern that glove use was a barrier to handwashing. These participants said that compared to workers who did not use gloves, some workers who used gloves washed their hands less, perhaps because they assumed that they did not need to wash their hands if they wore gloves.

Cross-contamination prevention practices

When asked to describe how they handled raw meat or poultry, participants described several different cross-contamination prevention practices (Table 2). Workers in all groups said they cleaned and/or sanitized their work surfaces, utensils, *and* equipment after preparing raw meat or poultry. Some said they cleaned and sanitized; however, some participants' comments indicated that although they wiped their work surfaces with a sanitizer, they did not clean and rinse those surfaces first (e.g., "Every time you put raw meat on there [your work surface], you should wipe it down with a clean towel [from your sanitizer bucket]").

Workers said they used gloves and utensils to prevent bare hand contact with raw meat and poultry and kept raw meat and poultry separate from other foods or from other types of raw meat and poultry during storage and preparation. Workers mentioned two methods for keeping these foods separate during preparation: separate work areas (e.g., meat is cut in the cooler, vegetables are cut elsewhere); and separate work surfaces, examples of which typically included color-coded cutting boards for use with different kinds of food (e.g., green boards for vegetables, yellow boards for chicken). Workers also said they washed their hands after preparing raw meat or poultry. Some workers reported using stainless steel bowls and work surfaces when working with raw meat or poultry, and a few said that when working with raw meat or poultry, they did nothing else until they completed the task. Finally, a few workers said that after getting one side of the cutting board dirty, they flipped the board over to its other side rather than cleaning it or getting a new one.

Factors impacting cross-contamination prevention practices

When asked what factors impacted their ability to engage in practices to prevent cross contamination from raw meat and poultry to other foods, participants most frequently identified multiple color-coded cutting boards as a positive factor (Table 3). Multiple boards helped ensure that workers could get clean boards when they needed them, as opposed to re-using dirty boards, and color-coded boards helped ensure that workers used different boards for foods that needed to be kept separated. The use of gloves and utensils with raw meat or poultry was also mentioned as a facilitator of cross-contamination prevention. However, as with handwashing, some participants expressed concern that glove use could act as a barrier to cross-contamination prevention because glove wearers may not wash their hands as often as they should. Participants in most groups also said that using sanitizer (e.g., "bleach water") was a facilitator of cross-contamination prevention because it allowed them to sanitize their equipment (e.g., knives, cutting boards) quickly.

Other identified facilitators of cross-contamination prevention included: separation of work areas and tasks, to ensure that raw meat or poultry and other foods are kept apart; management and coworker emphasis on and attention to cross-contamination prevention (e.g., "We look out for each other, and we say things to each other if it's not being done"); food safety education and training on cross-contamination prevention and its importance (e.g., "If they don't know the reason why, they'll keep doing it"); pre-cooked or prepared meat, which allows minimal meat preparation; and negative consequences for lack of cross-contamination prevention (e.g., restaurant receiving violations; employee getting fined). Time pressure and language differences between managers and workers (e.g., "Sometimes it's just really hard to relay the facts") were identified by some participants as barriers to cross-contamination prevention.

Glove use practicess

When asked when they used and changed gloves at work, workers in six groups said they wore gloves when in the kitchen or preparing food and when they worked with raw meat or poultry (Table 2). To a lesser extent, workers also said they wore gloves when they had cuts on their hands and when preparing food that they did not want to touch directly (e.g., food to which they had allergies or would make their hands smell). Some workers said they washed their hands with every glove change, and changed their gloves when they changed tasks or products (e.g., changing from making one sandwich to another), after preparing raw meat or poultry, and when their gloves were damaged or dirty. Several workers made comments that suggested their glove changing was not necessarily based on their food preparation activity; rather, they simply changed their gloves periodically throughout their shift. A few workers said they did not wear gloves at all (some of these said they used tongs or tissue paper when preparing some foods), and several workers said they did not use gloves when cutting food because gloves made the task more difficult. A few workers described unsafe glove practices, such as changing gloves without washing hands and washing hands with gloves on.

Factors impacting glove use practices

Workers and managers identified several factors that positively impacted glove use when handling raw or ready-to-eat food (Table 3). These factors included management and coworker emphasis on and attention to glove use (including glove use requirements and managers wearing gloves appropriately as a model for proper glove use); negative consequences for not wearing gloves (e.g., workers getting suspended from work); personal preferences; allergies to glove materials; concerns about appearing sanitary to customers; adequate resources (e.g., gloves); and worker motivation and experience.

Participants said gloves were often uncomfortable or did not fit well, which they believed negatively impacted glove use. The type of work was also mentioned

as a factor that impacted glove use, as participants believed that gloves made some work more difficult. For example, participants said gloves interfered with cutting foods (because the gloves got in the way of the knife) and checking the doneness of meat with a finger. Time pressure was also mentioned as a barrier to glove use.

Determining food doneness practices

Although some workers in all six groups that discussed determining food doneness practices said they sometimes used thermometers to check the temperatures of some cooked foods, many felt they did not need to use a thermometer because they had learned through experience to determine doneness by how long food cooked, the appearance of the food, and/or the feel of the food (Table 2). Workers were more likely to say they used thermometers with some types of food than with others (e.g., seafood versus steak; larger pieces of meat versus smaller pieces). Comments also suggested that those employees working with new foods, who were inexperienced, or who were training inexperienced workers were more likely to use thermometers.

Factors impacting determining food doneness practices

When asked what factors impacted their use of thermometers to determine the doneness of cooked meat and poultry, workers and managers most frequently mentioned time pressure (Table 3). Participants said taking the temperature of every piece of meat would be too time consuming and possible only with additional staff. Participants also said the type of meat impacted the difficulty of checking temperatures with a thermometer; they believed it was easier and took less time to check the temperatures of some foods (e.g., large pieces of meat) than others (e.g., hamburgers). Restaurant processes such as temperature logs were seen as facilitators of using a thermometer to check temperatures, as were health regulations and inspections, as temperature logs were kept as documentation for health inspections. Worker experience was also identified as a factor that impacted thermometer use—participants said experienced staff did not need to check temperatures because their experience allowed them to use other factors (e.g., appearance and feel of food; length of cooking time) to determine when food was done. One participant said that checking temperatures may be more likely with "fast" thermometers (e.g., infrared thermometers) than with other thermometers. Finally, a few workers said having to sanitize the thermometer between each use was a barrier to temperature checking.

Holding practices

Participants indicated that holding of hot foods occurred in steam tables, and holding of cold foods occurred in walk-in coolers, in sandwich or preparation tables where food is kept in stainless steel inserts in the top of a table and cooled from below, or in salad bars where food items are set in ice that is kept cool from below (Table 2). Most workers said they periodically checked the temperatures of held food, although there was variation in how often temperatures were checked (from "every half-hour to hour" to every shift change). Temperatures were checked with probe thermometers or with thermometers built in to equipment that display the temperature continuously. Several workers said their restaurants used temperature logs to record temperatures of held food every time they were checked. Comments from participants suggested that managers were more likely to check and record temperatures than were workers. Some workers mentioned that they had "shelf lives" for products that were being held (e.g., two or three hours), particularly during busy times when holding lids were likely to be open for long periods of time. Others said they threw away food that had not been held at appropriate temperatures or was held too long. Some workers also indicated that they periodically stirred foods that were being held hot to ensure even temperatures, and kept held foods covered as much as possible.

Factors impacting holding practices

Equipment was the most frequently mentioned factor impacting managers' and workers' ability to hold food at the proper temperatures and to check those temperatures periodically (Table 3). Workers and managers said that equipment problems, such as malfunctioning refrigerator blowers and heating elements, were barriers to proper holding, while properly maintained equipment and special kinds of equipment were facilitators of proper holding. Such equipment included hot-holding equipment that notified workers whenever the temperature drops below a set point and "ice blankets" that are placed on top of cold-held food during busy times when lids were open. Participants also said having an adequate number of thermometers for checking temperatures was important. Other factors believed to positively impact proper holding included: management emphasis on and attention to proper holding (e.g., "[when it's busy], "...the manager has got to remember to come back and grab them [temperatures]"; food safety education and training; restaurant procedures (e.g., temperature logs); negative consequences for improper holding (e.g., being required by health inspector to throw out costly food because it was held improperly); worker motivation and experience; adequate space for all foods that need to be held (e.g., "He's got limited space in his steam table, he will start jockeying things...to put something that he feels is more important to have hot"); and hours of operation that allow restaurants to close between lunch and dinner to check holding temperatures. Identified barriers to proper holding included time pressure and high volumes of business, which cause frequent opening of lids and doors of the holding equipment, and concerns regarding reduced quality of food (e.g., a small amount of hot-held cream soup easily burns).

Cooling practices

Workers in most groups that discussed cooling described the following practices: placing cooling food in walk-in coolers; transferring cooling food to shallow or smaller pans; and using ice baths (Table 2). A few workers indicated that they used cooling wands or paddles to cool food, and one worker indicated that his establishment used a blast chiller to cool food. Some workers said they checked the temperatures of cooling foods and recorded them in a temperature log. However, at least some workers in each group said they did not take the temperatures of cooling foods, and some workers reported other unsafe practices, such as leaving cooling food out on counters and only checking the temperature of cooling food the morning after the food had been placed in a walk-in cooler.

Factors impacting cooling practices

Workers and managers most frequently said the time at which cooling occurs, usually closing, was a barrier to proper cooling, as workers often did not take the time to cool properly (Table 3).

TABLE 4. Factors impacting safe food preparation practices discussed by worker and manager participants

Factor	Hand-washing	Cross contam.	Glove use	Food doneness	Holding	Cooling	Reheating
Time pressure/high volume of business/staffing	√	√	√	√	√	√	√
Structural environment, equipment, resources	√	√	√	√	√	√	√
Management/coworker emphasis	√	√	√		√	√	
Worker characteristics	√		√	√	√	√	
Negative consequences	√	√	√		√		
Education and training	√	√			√		√
Restaurant procedures	√			√	√		
Gloves and sanitizers	√	√					

Note: A check mark indicates that the factor was mentioned by participants in discussions of that practice.

Similarly, a few participants said that time pressure caused by high volumes of business was a barrier to proper cooling. One worker believed that additional staff that could be responsible for cooling during busy times would help alleviate this problem. Facilitators of proper cooling described by participants included worker motivation, availability of thermometers and equipment such as cooling wands, management emphasis on and attention to proper cooling, and adequate space for cooling equipment, (e.g., space for multiple, shallow containers and quick chill equipment).

Reheating practices

Several workers said they reheated food prior to placing it in hot holding, although one participant said workers in his establishment sometimes place food directly on the steam table without first reheating it to the proper temperature on the stove. Some participants indicated that their practice was to discard left-over food rather than reheat it or to reheat left-over food only once. Most, but not all, workers said they checked the temperatures of reheated food (Table 2), and some said they recorded temperatures of reheated food in temperature logs. One worker indicated that inexperienced workers were not responsible for reheating—only he and his manager reheated food.

Factors impacting reheating practices

Workers and managers identified few factors during the discussions on reheating (Table 3). However, participants did say that food safety education and training were important for safe reheating practices, as were thermometers. A few also said time pressure could be a barrier because reheating can be time consuming and workers may take shortcuts.

Consistencies in factors impacting practices

There are a number of consistencies in the factors participants identified as impacting their safe food preparation practices. Eight factors were mentioned in the context of two or more food preparation practices, and these factors are discussed below and presented in Table 4.

- *Time pressure/high volume of business/staffing.* The issue of time pressure was mentioned in the discussions of all seven food preparation practices. Participants said time pressure caused by high volumes of business and/or inadequate staffing made it difficult for them to wash their hands, change their gloves, clean their cutting boards, check the temperatures of cooked and held food, and cool and reheat foods properly.
- *Structural environment, equipment, and resources.* Issues associated with the structural environment of the restaurant kitchen, equipment, and resources arose in the discussions of all seven practices. Participants said accessible sinks and adequate resources, such as soap and gloves, facilitated handwashing and glove use; multiple color-coded cutting boards and separate work areas for different types of food helped prevent cross contamination; and multiple thermometers, well-maintained equipment, and certain kinds of equipment (e.g., blast chillers and infrared thermometers) facilitated temperature control. Not having enough workspace, however, made cooling and holding foods at proper temperatures difficult.
- *Management/coworker emphasis.* Management and coworker emphasis on safe food preparation practices was discussed in relation to five food preparation practices. Participants said having managers and coworkers who emphasized safe food preparation and who paid at-

tention to others' food preparation practices facilitated food safety.

- *Worker characteristics.* Participants identified several characteristics of food workers that positively impacted five practices. These included experience, motivation, age, preferences for clean hands, concerns about appearing sanitary to customers, and expectations of reciprocal treatment from other food workers. A few said allergies to glove materials negatively impacted glove use practices.
- *Negative consequences.* In discussions of four practices, participants said workers were more likely to engage in safe practices when they knew there would be negative consequences if they did not. These negative consequences could be for workers, for the restaurants, or for the restaurants' customers.
- *Education and training.* Participants indicated in the discussions of four practices that they thought food safety education and training was important to safe food preparation. Several participants emphasized that workers should be taught *why* engaging in safe food preparation practices was important, not just how to engage in those practices.
- *Restaurant procedures.* In discussions of three practices, participants' comments suggested that some restaurant procedures facilitated safe food preparation. For example, some restaurants required workers to record handwashing activities and food temperatures in logs.
- *Gloves and sanitizers.* Some participants believed that gloves and sanitizers facilitated food safety because their use helped to prevent cross contamination and keep hands clean. However, comments indicated that use of these sanitary supplements may sometimes have a negative impact on food safety. For example, some participants said they sanitized their cutting boards without first cleaning them and used sanitizer instead of washing their hands, and some participants expressed concern that glove use actually lowered handwashing rates because some workers used gloves incorrectly.

DISCUSSION

Some food workers in this study reported unsafe food preparation practices. A few workers reported unsafe hand hygiene practices, such as not washing their hands when changing gloves and using sanitizers instead of washing their hands. Several workers said they sanitized but did not wash and rinse their equipment after working with raw meat and did not check the temperature of all the meat they cooked because they believed they could determine food doneness through other methods (e.g., appearance and feel of the food). Others said they did not check the temperature of food being reheated or cooled. Most workers, however, reported safe food preparation practices. For example, workers described a variety of situations in which they washed their hands and changed their gloves, and said they cleaned their work surfaces and equipment after preparing raw meat or poultry and checked the temperatures of held food. These findings indicate that our participants were aware of and engaged in multiple food safety practices.

Previous research, however, suggests that food workers (and consumers) report engaging in food safety practices more frequently than they actually engage in those practices *(20, 24, 25)*. This phenomenon is likely the result of the social desirability bias, which is the tendency for people to report greater levels of socially desirable behavior (such as safe food preparation practices) than they actually engage in, or to report their best behavior rather than their typical or worst behavior. Although it is not possible to determine the extent to which our participants over-reported their safe food preparation practices, it is likely that they do not engage in these practices as frequently as they have reported.

Participants in this study identified a number of factors that impacted their ability to engage in safe food preparation practices. Time pressure and structural environments, including equipment and resources, were the two most consistently identified factors. Participants said time pressure had a negative impact on safe food preparation while structural environments, equipment, and resources supportive of food safety (e.g., accessible sinks, sufficient space for food safety procedures, multiple cutting boards, equipment that facilitated food safety, availability of soap and gloves) had a positive impact on safe food preparation. Other factors consistently identified by workers as having positive impacts on safe food preparation included managers and coworkers who emphasized food safety; worker characteristics, such as age, experience, and preferences for clean hands; negative consequences for those who do not handle food safely; food safety education and training; and restaurant procedures that encouraged food safety. Participants also identified glove and sanitizer use as factors influencing safe food preparation practices. Although some participants believed that these sanitary supplements had a positive influence, other participants indicated that these supplements could have a negative influence if used incorrectly.

The few other studies on this topic have reported similar findings. Kendall, Melcher, and Paul's *(18)* and Clayton and Griffith's *(3)* studies with food workers identified several of the same barriers and facilitators reported here, including time shortages, inadequate staffing, education and training, sink accessibility, availability of properly working equipment, and management concern for and attention to food safety.

Many of these factors are heavily influenced by management. For example, although managers may not be able to control the customer "rushes" that often result in time pressure, managers can emphasize the importance of food safety over speed and attempt to ensure that staffing is adequate to meet the demand. Additionally, managers often directly impact whether: workers have the equipment needed to prepare food safely; there are negative consequences for workers for unsafe food preparation practices; food safety training is provided to workers; and restaurant procedures support food safety. The findings reported here suggest that management plays a significant role in the extent to which food workers engage in safe food preparation practices. The findings also support FDA's contention that active managerial control – implementation and supervision of food safety practices by the person-in-charge — is important to food safety *(8)* and suggest that future food safety initiatives should ensure a significant focus on management and active managerial control.

Although the findings presented here suggest that a variety of factors impact safe food preparation practices, many of the current efforts in food safety are fo-

cused primarily on one factor—education. The findings from this study and others *(5, 21)* indicate that education is important for food safety. However, our results also suggest that providing food safety education to food workers is not enough to ensure that they will handle food safely, as a number of factors may impact their ability to implement that education. Other research supports this implication. Several studies have found that even when food workers demonstrate knowledge of safe food preparation practices, they do not always engage in those practices *(2, 3, 14, 20)*. In order to be successful, food safety intervention programs must do more than provide food safety training; they must also address the full range of factors that impact food preparation behaviors. Other researchers have made similar arguments; for example, Clayton and Griffith *(3)* argued that programs designed to increase safe food -preparation practices will be effective only if the resources and management systems are in place to enable and encourage food workers to implement those practices. Ehiri and Morris argued that food safety training would be more effective if it were founded on "principles which take into account employee motivations and other resource and environmental constraints..." *(6)*.

Participants' mixed beliefs concerning the influence of glove use on food safety reflects the ongoing glove use debate among food safety regulators, researchers, and industry representatives. Research indicates that proper glove use can decrease the transfer of pathogens from hands to food *(22)*. However, there is also evidence that glove use may promote poor handwashing practices *(12)*. More research is needed to determine the relationship between glove use, contamination, and handwashing.

The results presented here are qualitative and should not be generalized to a larger population in any statistical sense. However, these results can be useful for guiding future work in food safety. For example, future research might focus on determining which of the factors identified in this study have the greatest impact on food preparation practices.

The findings in this study have implications for food safety programs. Programs may wish to evaluate and modify their food safety activities in light of the findings provided here. For example, they could develop and implement activities that would contribute to a fuller understanding of the factors that impact food safety in food service establishments in their jurisdiction. They could then develop and test strategies designed to address those factors and eventually incorporate successful strategies into their regular food safety activities. Such activities should improve the effectiveness of these food safety programs as well as contribute to our broader understanding of effective food safety strategies.

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Color of Low Dose-Irradiated Ground Beef Before and After Cooking to 60°C or 71°C and Survival of *E. coli* O157:H7 in Irradiated Patties

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SUMMARY

The effects of electron beam irradiation (1.5 or 2 kGy), vacuum packaging, and end-point temperature (60°C or 71°C) on color of fresh and frozen ground beef were examined. The effect of irradiation on survival of *Escherichia coli* O157:H7 was also examined. Irradiation caused aerobically packaged ground beef to become permanently less red, but irradiated vacuum-packaged fresh ground beef suffered only temporary browning and regained its original redness when exposed to air. Average HunterLab 'a' and 'b' values were lower for meat patties cooked to 71°C than for meat cooked to 60°C. In cooked patties, the fresh-frozen, vacuum-aerobic, treatment group combinations could not be consistently separated by HunterLab colorimetry. A sensory panel found that patties made from frozen irradiated ground beef appeared fully cooked at only 60°C, but that patties of fresh vacuum-packaged irradiated ground beef appeared similar to non-irradiated patties. In vacuum-packed fresh patties, irradiation (1.1 kGy) killed ≤ 2.9 $\log_{10}$ CFU/g of *E. coli* O157:H7.

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INTRODUCTION

Despite the increasingly strict safety programs being implemented by food manufacturers and regulatory agencies, food recalls are frequent and bacteria in foods continue to make people ill. *Escherichia coli* O157:H7 is estimated to cause between 60,000 and 75,000 causes of human illness in the United States each year *(14)*. *E. coli* O157:H7-related illness and mortality could be effectively eliminated if these bacteria were killed by an end-of-line processing step, such as irradiation. Since being endorsed by the United States Food and Drug Administration *(8)* and an expert committee of the World Health Organization *(2)*, food irradiation has gained credibility as an acceptable safety measure. The major advantages of irradiation are that it kills undesirable bacteria (usually without changing the appearance of the food) and that it can be applied while the food is sealed in ready-to-purchase packages, which means that the food can be delivered to consumers without risk of recontamination. For these reasons, the Government of Canada may soon approve irradiation of ground beef *(12)*.

First offered in the United States at retail in 2000, irradiated ground beef has grown in popularity following large recalls of product contaminated with *E. coli* O157:H7 *(3)*. At least 9 major supermarket chains and three national food service companies sell irradiated ground beef in over 30 states. For one company, irradiated product represents 10% of all ground beef sales. Irradiated ground beef is sold fresh in trays or ≤ 5-kg chubs or frozen as patties. Fat content of the meat ranges from 7 to 20%. At present, irradiated ground beef is available in about 8,000 supermarkets and 2,500 restaurants in the United States *(6)*. In addition, irradiated frozen patties are being served voluntarily by 200 schools in the United States through the national school lunch program (NSLP; 7). Although irradiation of ground beef is an alternative that has growing support, its effects on sensory quality at low absorbed doses are not well characterized. Consumers may judge whether hamburger is fully cooked on the basis of the color of the patties, although research indicates that use of a food thermometer is the only reliable way to determine doneness *(13)*. If irradiated ground beef becomes gray earlier or remains red longer during cooking than regular ground beef, consumers may undercook or overcook patties. The experiments that follow investigate this possibility and the survival of *E. coli* O157:H7 in ground beef irradiated at the low level of 1.1 kGy.

METHODS

All experiments used lean (17% fat) ground beef prepared by a centralized processing and packaging facility in Winnipeg, Manitoba, and purchased at retail in the same city. Each retail package consisted of 1 kg of ground beef in a high-density plastic polymer tray over wrapped with oxygen-barrier film to maintain a high oxygen atmosphere (80% O_2 + 20% CO_2).

Changes in the color of fresh or frozen packaged (aerobic, vacuum) ground beef before and after irradiation, with or without cooking, were measured instrumentally. A sensory panel also evaluated color after cooking. For each of two trials, sixteen 1-kg packages of lean ground beef were purchased. Eight were immediately opened and the contents transferred to oxygen-barrier bags (Deli*1; WinPak Ltd., Winnipeg, MB). Oxygen transmission of the film was 2.3 $cm^3/m^2/d$ at 23°C. The beef was formed into a layer ≤ 4 cm thick; the air was removed and the bag was sealed using a Bizerba Model GM2002 vacuum-packaging machine (Bizerba Canada, Mississauga, ON). Packages intended for irradiation were prepared with 1 kg of ground beef, but some of the control (non-irradiated) packages contained slightly less. The remaining 8 retail packages were opened and their contents distributed among the 16 plastic retail trays, 500 g per container in a layer ≤ 3 cm thick. These containers were then over wrapped with an oxygen permeable (O_2 transmission 8000 $cm^3/m^2/d$ at 23°C and 70% RH) but moisture impermeable film (Vitafilm; Huntsman Film Products, Toronto, Ontario). Half of each packaging group was stored at 2 ± 2°C for 36–48 h and half at -40°C. Then the samples were packed in ice, transported (within 1.5 h) and irradiated by a 10 MeV linear electron beam accelerator (MB 10–4, Acsion Industries, Pinawa, MB). In total, four dosimeters (radiochromic thin film, FWT-60, Far West Technology Inc., Goleta, CA) were placed on two packs of fresh and frozen meat. Acsion Industries measured the doses by change in optical absorption of the dosimeters at 600 nm. Frozen samples were irradiated to a target dose of 2.0 ± 0.1 kGy (actual surface dose: 2.05–2.07 kGy) and fresh samples to a target of 1.5 ± 0.1 kGy (actual surface dose: 1.50–1.53). Thus there were 8 treatment groups (before cooking) in each trial, corresponding to all combinations of packaging system (aerobic or vacuum), state (fresh or frozen) and dose (irradiated or not irradiated).

Preparation of patties and instrumental color measurement

Fresh ground beef samples were formed into patties the day after irradiation; frozen samples were formed into patties on the second or third day after irradiation, having been thawed overnight at 2 ± 2°C. To make patties, all packages of a given treatment were mixed thoroughly in a stainless steel bowl. Samples of 100 g were weighed on squares of waxed paper and shaped by being pressed into the bottom of a standard (8.5 cm) Petri dish. HunterLab color measurements were taken with a Miniscan Colorimeter (Reston, VA), immediately after each patty was formed. Patties were placed on large cooking sheets, over-wrapped with Vitafilm and stored for up to 4 hours at 2 ± 2°C.

Six patties at a time were cooked on an electric grill (Hamilton Beach model 3600). Patties were seared on one side and flipped; then a type T thermocouple was inserted through the edge of each. Temperatures were monitored with a digital thermometer (model DP 460-TS; Omega Engineering, Stamford, CT). The target internal temperatures were 60°C and 71°C. Patties were cooked on one side until the measured temperature approached the target temperature. They were then flipped, which shifted the thermocouple slightly and changed the measured temperature. When flipping a patty no longer caused the measured temperature to drop below the target temperature, the patty was removed from the grill, allowed to cool slightly, and then cut in half horizontally to yield two circular pieces, each with the full diameter (8.5 cm) of the original patty. HunterLab color measurements or sensory panel measurements were then obtained.

Sensory panel color measurement

The sensory panel consisted of 6 trained panelists from the staff and students of the Department of Food Science, University of Manitoba. Panelists were provided with ballots consisting of two 15 cm unstructured lines, anchored at the ends. One of the lines was labeled 'color' and the other 'evenness'. During the training session, panelists were asked to examine a series of patties which had been cooked to internal temperatures of 50, 55, 60, 65, 70, and 75°C and to agree on appropriate end-point descriptors for the two lines. The labels chosen were 'not even', 'very even', 'brown-pink' and 'brown-grey'. Each panelist was given a patty that had been cooked to 60°C and rated its color and evenness by placing a mark on each of the two unstructured lines. Then the panelists discussed their ratings and reached a consensus.

For the test session, the 6 panelists were divided into two groups of three. For each packaging, state, and cooking temperature, three patty halves made from irradiated ground beef and three made from non-irradiated ground beef were assigned three-digit random numbers and placed in 6 sensory analysis booths. The patty halves were presented singly on 15- cm diameter white plates. Panelists were permitted to move among booths to complete all observations in each treatment. The light source was cool white fluorescent and intensity at the tabletop was 370 lux, as measured with an LI-1000 data logger light meter (LI-Cor Inc., Lincoln, NE). The sensory analysis was carried out on only one of the trials.

Effect of irradiation on *E. coli* O157:H7 in lean ground beef patties

Each of five flasks containing 500 ml of sterile tryptic soy broth (Difco, Becton Dickinson, Sparks, MD) was inoculated

TABLE 1. *E. coli* O157:H7 strains used for ground beef inoculation

Strain[a]	Location	Source	Toxin Genotype	Phage Type
LCDC 7110	Alberta	Human	VT1, VT2	8
LCDC 7236	Manitoba	Human	VT1, VT2, Va	23
LCDC 7267	Ontario	Human	VT1, VT2	32
LCDC 7282	Quebec	Hamburger Steak	VT1, VT2	4
LCDC 7283	Quebec	Hamburger Steak	VT1, VT2	1

[a]All strains were obtained from the Laboratory Centre for Disease Control, Tunney's Pasture, Ottawa, Ontario, Canada.

with one of 5 strains of *E. coli* O157:H7 (Table 1). After 48 h at 35°C, the contents of the flasks were poured into 250-ml bottles and centrifuged (10,000 × g for 10 min). Three 1-kg packages of unfrozen lean ground beef were opened on the day of retail purchase and the contents aseptically transferred to an aluminum tray. The pooled bacterial cells were resuspended in < 100 ml 0.86% NaCl and mixed manually into the ground beef, which was then passed through a sterile hand-powered meat grinder (equipped with a plate having 9 mm diameter perforations) and then manually mixed again. After mixing, 100-g portions were weighed and formed into patties as previously described. Each patty was placed on a square of waxed paper and covered with a second square. Four stacks of 7 patties each were vacuum-packaged in 4 Deli*1 bags. Similar procedures were used to prepare control samples, except that no bacterial cells were added to the meat.

Five stacks of 7 patties were prepared: 3 stacks of inoculated-irradiated patties and 1 stack each of uninoculated-irradiated and inoculated-unirradiated patties. In addition, 3 control patties were neither inoculated nor irradiated. Two FWT-60 dosimeters were placed on each patty in the uninoculated-irradiated stack, as well as at the bottom of the stack.

The stacks were irradiated (target surface dose 1.1 kGy) from one end, turned, and irradiated at the same dose from the other end. Following irradiation, the inoculated-irradiated stacks were immediately placed on ice. The package of the non-inoculated stack was cut open, the dosimeters were removed for analysis at Acsion, and the patties were aseptically transferred to sterile bags and placed on ice. At the University microbiology laboratory, 10-g portions were cut from the center of each patty from each stack plus the three untreated control patties and homogenized in 90-ml sterile 0.86% NaCl. Serial dilutions were made in 0.86% NaCl and cells were spread-plated on standard methods agar (SMA, BBL, Becton Dickinson, Cockeysville, Maryland) and sorbitol MacConkey agar (BBL) containing cefixime-tellurite (CT-SMAC); *(25)* (Dynal Inc., Lake Success, New York). Dilutions > 10^5 were plated by use of an Autoplate 4000 (Spiral Biotech, Norwood, MA). Colonies were counted after 36 h at 35°C.

Statistical analysis

Means and standard deviations of bacterial populations were determined by use of Microsoft Excel. For color measurements, *t*-tests and analysis of variance were performed with SAS version 8.1 (The SAS Institute, Cary, NC).

RESULTS

Dosimeters recorded that irradiation doses of 1.50–1.53 and 2.05–2.07 kGy were delivered to fresh and frozen ground beef, respectively. Following irradiation, all samples of raw ground beef were grey or brown. The ground beef was mixed in a bowl and formed into patties before color was measured. Aerobically-irradiated samples retained the gray or brown color while being formed into patties, but the vacuum-packaged fresh irradiated samples regained much of their original pink color upon exposure to air. Table 2 shows the HunterLab color values of the raw patties. On the HunterLab scale, higher values of L indicate greater brightness, higher values of 'a' indicate greater redness, and higher values of 'b' indicate greater yellowness. HunterLab 'a' and 'b' values (which represent redness and yellowness, respectively) were significantly affected by interactions of irradiation, type of packaging, and fresh/frozen state ($P < 0.0001$). Other statistically significant effects occurred ('b' values varied by trial ($P < 0.0001$)), but these effects were small. Irradiation reduced both 'a' and 'b' values in all samples except the fresh vacuum-packaged ground beef and had little effect on 'L' (lightness) values (Table 2).

The HunterLab measurements were relatively unsuccessful in distinguishing well-cooked from undercooked control patties. Although 'a' and 'b' values for the 71°C treatments tended to be lower than those for the corresponding 60°C treatments, there was considerable overlap (Table 3). Nevertheless, there were statistically significant differences related to end-point temperature ($P < 0.001$), packaging ($P < 0.001$), and fresh/frozen state ($P < 0.05$). Cooked patties made from irradiated beef were more red if the ground beef had been vacuum-packaged and less red if it had been aerobically packaged ($P < 0.001$; ANOVA), but *t*-tests could not detect a significant difference between either set of irradiated samples and the corresponding non-irradiated control.

Panelist measurements of cooked patty color and evenness

The panelists' color measurements indicated that cooking temperature and fresh/frozen state were the main factors affecting color ($P < 0.0001$), while irradiation had no overall effect. There were significant interactions, however, between irradiation and package type ($P = 0.0031$), irradiation and fresh/frozen state ($P < 0.0001$), and irradiation and final cooking temperature ($P = 0.0437$). For evenness, fresh/frozen state and temperature were again the major factors ($P < 0.0001$) and there were inter-

TABLE 2. Color of raw ground lean beef patties

Hunter Lab	Packaging Type	Physical State	Irradiated[a]	Control
L[b]	Aerobic	Fresh	38.1	37.7
		Frozen	37.1	37.2
	Vacuum	Fresh	37.8	36.9
		Frozen	36.9	37.0
a[c]	Aerobic	Fresh	5.7	10.8
		Frozen	6.5	14.2
	Vacuum	Fresh	12.3	11.9
		Frozen	6.5	14.1
b[d]	Aerobic	Fresh	8.5	9.4
		Frozen	8.7	10.7
	Vacuum	Fresh	10.3	10.1
		Frozen	9.0	10.8

[a]For irradiated samples, n = 38; for control samples, n=32.
[b]The least significant difference (LSD) is 0.5 for comparisons of 'L'.
[c]The LSD for comparisons of 'a' is 0.4.
[d]The LSD for comparisons of 'b' is 0.2 for comparisons between two irradiated samples, or between one irradiated and one control sample; it is 0.3 for comparisons between two control samples.

actions between irradiation and fresh/frozen state ($P < 0.0001$) as well as irradiation, fresh/frozen state, and temperature ($P = 0.0004$). In general, patties cooked to 60°C were more pink and less even in color than those cooked to 71°C, and patties made from fresh meat were more pink than those from frozen meat (Figs. 1 and 2). Irradiation increased the pinkness and color unevenness of patties prepared from fresh vacuum-packaged meat but also increased the grayness and color evenness of patties prepared from frozen aerobically packaged meat. Panelists could not distinguish frozen irradiated ground beef cooked to 60°C from non-irradiated ground beef (whether fresh or frozen) cooked to 71°C (Figs. 1 and 2).

Irradiation of ground beef patties containing *E. coli* O157:H7

The patties prepared in the Petri dish template were 1.5 ± 0.2 cm thick, and thus a stack of 7 patties was 10.5 cm high. Because the 10 MeV double-sided electron beam treatment used was unlikely to have evenly penetrated more than 4.5 cm from each end of the stack (J. Bernard, Acsion Industries; personal communication), and because the vacuum-packaging process distorted alignment of the stacks of patties slightly, the irradiation dose delivered at the center of the stack was more variable than desired (Table 4).

As shown in Fig. 3, 1 kGy reduced total numbers of naturally present bacteria by 4.0 ± 0.5 $\log_{10}$ CFU/g. There were also some naturally occurring organisms that grew on CT-SMAC with colony morphologies atypical of *E. coli* O157:H7, and 1-kGy reduced the number of these organisms from 4.9 ± 0.3 $\log_{10}$ CFU/g to below the detection limit (3.3 $\log_{10}$ CFU/g; data not shown). This reduction did not occur in patties toward the center of the stack, where the irradiation dose was more variable.

Numbers of bacteria recovered from patties inoculated with *E. coli* O157:H7 were 8.4 ± 0.6 $\log_{10}$ CFU/g (Fig. 4a) on CT-SMAC and were 8.9 ± 0.2 $\log_{10}$ CFU/g (Fig. 4b) on SMA. A 1-kGy dose reduced numbers on CT-SMAC by 2.9 $\log_{10}$ CFU/g (Fig. 4a) and on SMA by 2.6 $\log_{10}$ CFU/g (Fig. 4b). In the innermost patties, however, bacterial numbers on both media dropped by only 1–1.5 $\log_{10}$ CFU/g with irradiation, reflecting the lower penetration of the electron beam into these patties (Figs. 4a and b).

DISCUSSION

Color of irradiated ground beef before cooking

Irradiation has been reported to change the color of meat products. Irradiated turkey breasts tended to be pinker than controls, mostly because of the formation of carboxymyoglobin *(19)*. Irradiated beef steaks, however, generally become brown because of metmyoglobin formation *(20)*. Only a few studies have considered the effect of irradiation on color of ground beef. Chirinos and others *(4)* found that a trained panel could detect some differences in appearance between irradiated and non-irradiated raw hamburger patties. On the other hand, in studies by Fu and others *(9)* and Kusmider and others *(15)*, panelists did not distinguish between the colors of irradiated and control raw patties despite significant differences in HunterLab 'a' values. In the present study, the interaction of irradiation dose, type of packaging, and fresh/frozen state produced changes in 'a' values of raw ground beef that were significant and visually unmistakable. Raw ground beef irradiated aerobically was significantly less red and browner than non-irradiated ground beef. Giroux and others *(11)* reported similar findings with fresh ground beef aerobically packed, irradiated at 2 or 4 kGy and stored up to 7 days at 4°C; although CIE Lab L* values were unchanged following irradiation, a* and b* values were lowered, an effect prevented by adding 0.5% ascorbic acid to the meat before irradiation. The authors suggested that the affinity of ascorbic acid for free radicals may have been involved in meat pigment stabilization; citric acid at similar concentrations did not prevent color changes, so they concluded

TABLE 3. Color of cooked ground lean beef patties

Hunter Lab	Packaging Type	Physical State	Cooking Temperature	Irradiated	Control
L[c]	Aerobic	Fresh	60	38.9[a]	39.0[b]
			71	37.9	38.5[b]
		Frozen	60	36.4	37.8
			71	36.5	36.0
	Vacuum	Fresh	60	40.5	39.5
			71	39.0	38.0
		Frozen	60	37.0	38.3
			71	36.9	36.6
a[d]	Aerobic	Fresh	60	4.6	4.7[d]
			71	4.0	4.5[d]
		Frozen	60	4.9	5.1
			71	4.5	4.7
	Vacuum	Fresh	60	6.1	5.7
			71	4.7	4.7
		Frozen	60	5.7	5.0
			71	4.9	5.0
b[e]	Aerobic	Fresh	60	9.9	9.4[d]
			71	9.1	9.5[d]
		Frozen	60	9.4	9.7
			71	9.2	9.3
	Vacuum	Fresh	60	10.7	10.3
			71	10.1	9.7
		Frozen	60	9.7	9.8
			71	9.4	9.6

[a]Random replicates were removed from some treatment groups to standardize n = 16 (except where indicated), in order to calculate a single least significant difference (LSD) applicable to all comparisons.
[b]n = 13. LSD values used for comparisons where n = 16 may also be used for comparisons involving these data, without error.
[c]LSD for comparisons of 'L' is 1.3.
[d]LSD for comparisons of 'a' is 0.6.
[e]LSD for comparisons of 'b' is 0.4.

that pH reduction was not responsible for ascorbate action. Our results confirm that aerobic irradiation of fresh raw ground beef produces large color changes that might discourage consumers from purchasing the product.

The color of fresh vacuum-packaged ground beef was not affected by irradiation, but the corresponding frozen product became less red in appearance (lower 'a' value). In this study, fresh ground beef was irradiated at 1.5-kGy and frozen ground beef at 2.0-kGy, because these were the minimum doses originally proposed for approval in Canada *(12)*. Although these proposed levels may be revised downward because of some reports of color defects at low irradiation doses *(4, 18)*, it appears that irradiation in the presence of air (oxygen) contributes to reduced redness following irradiation. During storage at -20°C for up to 21 days, these color differences became less pronounced *(17)*.

In the United States, the Agriculture Marketing Service (AMS) specifies for procurement that ground beef containing up to 15% fat supplied to the national school lunch program be irradiated frozen at 1.35 to 3.9-kGy and remain frozen through storage and distribution *(1)*. Although in our work lipid oxidation was not studied, Luchsinger and others *(17)* noted that ground beef with 22.5% fat underwent greater lipid oxidation in aerobic packages. Under vacuum, ground beef with 10% fat had thiobarbituric acid reactive substances (TBARS) lower than detectable by sensory analysis after storage for 21 days at -20°C. Meat with higher fat content irradiated at 3.5-kGy had TBARS levels above the sensory threshold at 21 days.

Reduced redness of vacuum-packaged frozen ground beef following irradiation in the present study is in contrast to HunterLab color results found by Murano and others *(18)*. In tests reported here, retail-ready product that had been gas flushed with an 80% oxygen and 20% nitrogen mixture was used to provide meat of consistent quality. It is possible that, following repackaging under vacuum, not enough time was allowed for oxygen depleting reactions to take place before the meat was frozen and irradiated two days later. It should also be noted that in the present study meat was thawed before color was measured. Murano and others *(18)* and Luchsinger and others *(17)* monitored the color of frozen irradiated meat

FIGURE 1. Color of cooked ground beef patties prepared from untreated or irradiated meat, as perceived by panelists. Vertical lines indicate standard error of the mean

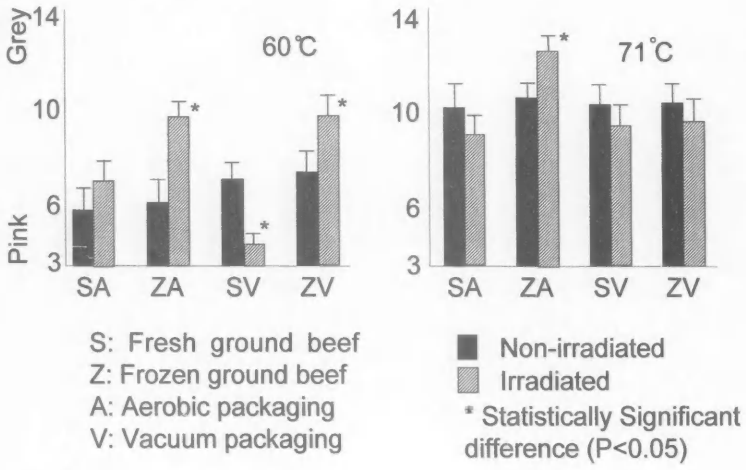
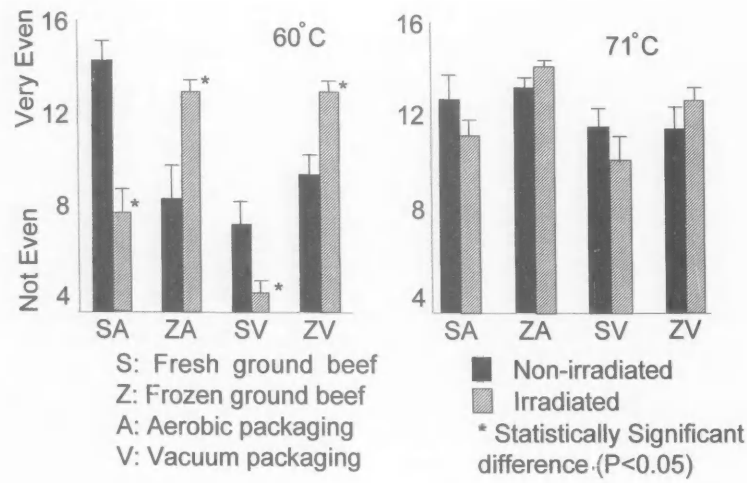


FIGURE 2. Evenness of color of cooked ground beef patties prepared from untreated or irradiated meat, as perceived by panelists. Vertical lines indicate standard error of the mean



during display. These differences in procedures may have affected experimental outcomes.

Color of irradiated patties after cooking

In raw meat, irradiation induces chemical changes that can lead to color differences after cooking. If meat is irradiated aerobically, metmyoglobin forms *(20)*, and thus Chirinos and others *(4)* observed that irradiated patties appeared browner before cooking and darker after cooking than control patties. On the other hand, irradiation can produce a stable red carbon monoxide-heme pigment *(19)* that persists even after cooking. Accordingly, Lorenzen and Heymann *(16)* found that patties irradiated at 1.0 kGy while frozen and vacuum-packaged were redder after cooking than non-irradiated patties. Luchsinger and others *(17)* found that when patties cooked to 71.1°C were vacuum packed, irradiated at up to 3.5-kGy and displayed at -20°C for up to 21 days, vacuum-packed samples had more vivid red color than aerobically packed samples. The latter authors concluded that marketing of precooked frozen irradiated beef patties might be possible only in the foodservice industry, because cooked patties were too pink in vacuum packages and were discolored (low a* and b* values) when aerobically packed and irradiated.

In the present study, instrumental measurement distinguished between irradiated and non-irradiated raw ground beef on the basis of differences in 'a' and 'b' values. However, when irradiated meats were cooked to either 60 or 71°C, the technique failed to detect irradiated samples. This may have been due in part to color unevenness in treated meat. Panelists were able to distinguish irradiated from non-irradiated meat cooked to 60°C, since the irradiated was less pink than the non-irradiated product. Thus patties made from frozen packaged (aerobic or vacuum) or those from fresh aerobically packaged, irradiated ground beef may appear well cooked at lower temperatures than non-irradiated ground beef. This would be a safety concern were it not for the fact that these same raw meat treatments were the least red in the raw state and therefore are unlikely to be widely marketed other than through foodservice. The main commercial approach is to irradiate frozen patties rather than ground beef and market these frozen. In tests here, vacuum-packaged, irradiated fresh ground beef tended to be redder than controls, which might lead a careful consumer to overcook it slightly, but this is not a safety concern.

Effect of irradiation on *E. coli* O157:H7 viability in patties

Since our results indicated that irradiation at doses that have been proposed *(12)* could cause discoloration, we tested the effect of a lower dose (1.1 kGy) on survival of *E. coli* O157:H7 in stacked patties of lean ground beef. Very little bacterial survival (Figs. 3 and 4) should have occurred at 3-cm depth from each end of the stack (J. Borsa, personal communication), and thus patties #3 and #5 should have had the lowest number of bacteria.

FIGURE 3. Total plate count (SMA) of non-inoculated raw ground beef patties without irradiation (C) or following 1.1-kGy irradiation (numbers). Column C represents results from duplicate spread plates from each of three non-irradiated patties; each of the numbered columns represents duplicate spread plates from a single patty

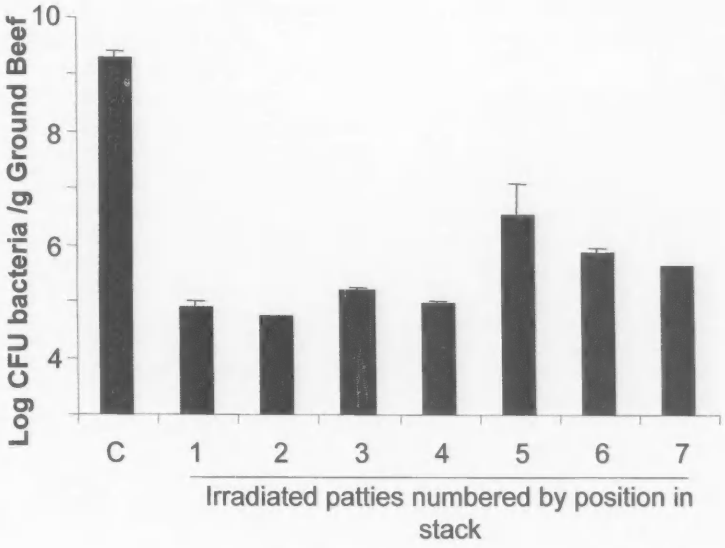
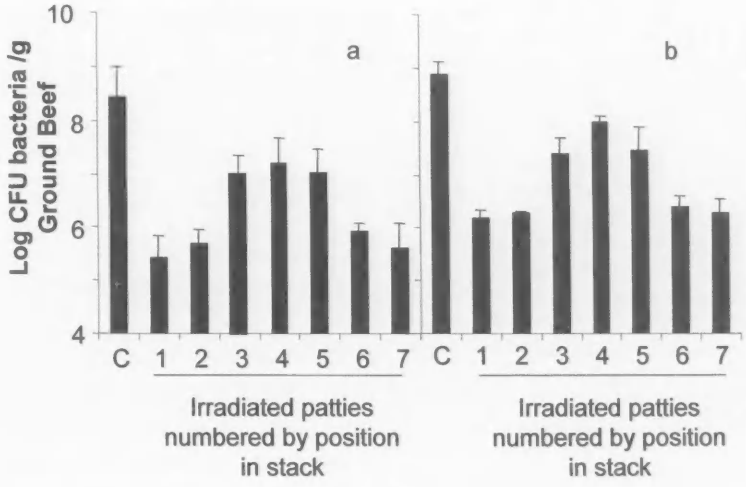


FIGURE 4. CT-SMAC (a) and SMA (b) plate counts of raw ground beef patties containing *E. coli* O157:H7 without irradiation (C) or following 1.1-kGy irradiation (numbers). Each of the numbered columns represents results from 6 measurements. Column C represents results from 14 measurements



This did not occur, perhaps because the thickness of the patties (1.5 ± 0.2 cm) obscured detection of the minima. Our results, however, confirm the general observation that irradiation kills several $\log_{10}$ CFU/g of *E. coli* and naturally occurring bacteria in ground beef. The initial level of bacteria found in this study was high (9.3 ± 0.1 $\log_{10}$ CFU/g), but not beyond the range found in high-oxygen packaged ground beef *(10)*. In patties that received 1-kGy, the number of *E. coli* O157:H7 capable of growing on CT-SMAC agar dropped by about 2.8 $\log_{10}$ CFU/g, which agrees with results reported by Fu and others *(9)* but is less than the 4 $\log_{10}$ reduction reported by Clavero and others *(5)* and Thayer and Boyd *(21)*.

Irradiation did not increase the proportion of sub-lethally injured *E. coli* O157:H7 cells. Comparing Fig. 3 with Fig 4b, it is obvious that the surviving cells on nonselective medium (SMA) were mainly *E. coli* O157:H7. Following irradiation at 1-kGy, there was a 2.6 $\log_{10}$ CFU/g reduction in the number detectable on the nonselective medium, roughly equal to the 2.8 $\log_{10}$ CFU/g reduction seen on the selective medium. Given that the level of *E. coli* typically encountered on carcasses *(22, 23)* or ground beef *(24)* at the production level is significantly lower than 2 $\log_{10}$ CFU/g, treatment with irradiation before distribution should effectively eliminate the risk of *E. coli*-related illness, provided temperature control is maintained.

CONCLUSION

Ground beef purchased at retail on different days was used in color and microbiological tests. Some of the color instability reported here may have been influenced by the use of fresh meat near the end of its shelf life. However, bacterial analyses were conducted only on samples evaluated for bacterial survival following irradiation and relevant controls.

The results presented here showing reduced redness of frozen ground beef following low-dose irradiation suggest that if oxygenated meat is irradiated, even though vacuum packaged, there may be adverse effects on meat color. Should this occur, it would be difficult to use meat color to determine a safe cooking end point. In commercial practice, it is unlikely that oxygenated ground beef would be irradiated.

As with cooking all meat, a thermometer should be utilized to determine the "doneness" of irradiated ground beef. The

TABLE 4. Electron beam irradiation doses received at different depths in the stack of beef patties[a]

	Dosimeter response (kGy)	
Distance (cm) through stack	1	2
(top) 0	1.15	1.15
1.5	1.22	1.29
3.0	1.07	0.89
4.5	1.31	0.15
6.0	1.80	0.42
7.5	1.20	1.78
9.0	1.21	1.40
(bottom) 10.5	1.21	1.16

[a]Two dosimeters were placed side by side on top of each patty and at the bottom of the stack. The dose sensitivity range of the dosimeters was 0.5 – 200-kGy.

results also confirm that electron beam irradiation is an effective means of killing *E. coli* O157:H7 in thin layers of ground beef and will not cause color changes that will lead consumers to undercook the meat. While the use of irradiation can make a very significant contribution to product safety, it does not replace existing good manufacturing practices.

ACKNOWLEDGMENT

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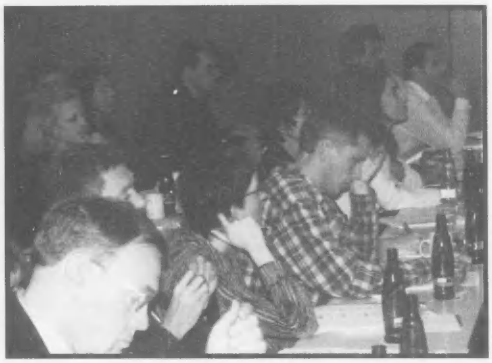
First IAFP European Symposium a Success!



Seventy-one scientists from 20 countries gathered on 11–12 October 2005 in Prague, Czech Republic for *Recontamination Issues in the Food Industry*, the first European Symposium sponsored by the International Association for Food Protection.

The organizing committee coordinated a program consisting of nine presentations on the recontamination issues. Presenters were:

- Jean-Louis Cordier, Nestlé Nutrition Operations, Switzerland
- Christopher Griffith, University of Wales, Cardiff, United Kingdom
- John Holah, Campden & Chorleywood Food Research Association, United Kingdom
- Maarten Nauta, National Institute for Public Health and the Environment, The Netherlands
- Laurentina Pedroso, Egas Moniz, CRL, Portugal
- Don Schaffner, Rutgers University, United States
- Jenny Scott, Food Products Association, United States
- Bruce Tompkin, Retired – ConAgra Refrigerated Foods, United States
- Esther van Asselt, National Institute for Public Health and the Environment, The Netherlands

The Symposium ended with questions from the audience for a panel comprised of all presenters.

Jenny Scott giving her presentation to the assembly.

Exhibits and poster presentations played a large role in this symposium. BD Diagnostics and DuPont Qualicon were Bronze Sponsors as well as exhibitors. An additional sponsor and exhibitor was bioMérieux. Also exhibiting were the *British Food Journal*, *International Food Hygiene*, ILSI-Europe, and Matrix Microsciences.

Esther van Asselt sharing her insights on modeling recontamination in an industrial setting.

Paul Hall, Kraft Foods Global, Inc. visits with exhibitors Adrian Patron and Tony Pasquale, representing Matrix Microsciences.

A total of 12 poster presentations were submitted and accepted from persons affiliated with:

- Agence Francaise de Securite Sanitaire des Aliments
- bioMérieux
- Danish Institute for Fisheries Research
- University of Birmingham
- University of Limerick
- University of Wales

Stephen Bulteau, bioMérieux, France explains the finer points of his poster presentation to Leon Gorris, Unilever, SEAC.

Subsequent to the Symposium, all participants were asked to complete a survey. Some comments received were:

Fabulous exchange of information on the issue of recontamination in the food industry. Some of the world's foremost experts in the area of food safety provided their insights into addressing the issue of recontamination. Excellent location for the meeting and tremendous attendance! – Paul Hall, Kraft Foods Global, Inc., United States

I thought that the conference focused some of the world's leading players in this field to cross pollinate ideas and for somebody like myself not directly associated with some of the subject matter it proved a very educational two days. I thought it was one of the best conferences that I had attended for quality and content of presentations. – David Lloyd, University of Wales Institute, Cardiff, United Kingdom

IAFP thanks the organizers of this Symposium for their hard work and dedication to this successful event. The organizers were:

- Jeff Farber, Health Canada
- Leon Gorris, Unilever, SEAC, UK
- Lone Gram, Danish Institute for Fisheries Research
- Gordon Hayburn, University of Wales Institute, UK
- Anna Lammerding, Public Health Agency of Canada
- Laurentina Pedroso, Egas Moniz, CRL, Portugal
- David Tharp, IAFP, US
- Bruce Tompkin, Retired, ConAgra Refrigerated Foods, US
- Sandra Tuijtelaars, ILSI Europe, Belgium

Panelist (from the left) Maarten Nauta, third from the left, answers a question posed by a Symposium attendee. Other panelists are, (from the left) Jean-Louis Cordier, John Holah, Esther van Asselt, Jenny Scott, and Bruce Tompkin.

Abstracts and presentations may be found on the IAFP Web site at www.foodprotection.org.

Watch for information on future European symposia through the International Association for Food Protection!

International Association for Food Protection

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Nominations deadline is March 13, 2006. You may make multiple nominations. All nominations must be received at the IAFP office by **March 13, 2006.**

- Persons nominated for individual awards must be current IAFP Members. Black Pearl Award nominees must be companies employing current IAFP Members. FPA Food Safety Award nominees do not have to be IAFP Members.
- Previous award winners are not eligible for the same award.
- Executive Board Members and Awards Committee Members are not eligible for nomination.
- Presentation of awards will be during the Awards Banquet at IAFP 2006 – the Association's 93rd Annual Meeting in Calgary, Alberta, Canada on August 16, 2006.



Nominations will be accepted for the following Awards:

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Harry Haverland Citation Award — Plaque and $1,000 Honorarium

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Harold Barnum Industry Award — Plaque and $1,000 Honorarium

Presented to an individual for dedication and exceptional service to IAFP, the public, and the food industry.

Sponsored by Nasco International, Inc.

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Presented to an individual for dedicated and exceptional service to the profession of Sanitarian, serving the public and the food industry.

Sponsored by Ecolab, Inc., Food and Beverage Division

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IAFP 2006

The Association's 93rd Annual Meeting
August 13–16, 2006
Calgary, Alberta, Canada

General Information

1. Complete the Abstract Submission Form.
2. All presenters must register for the Annual Meeting and assume responsibility for their own transportation, lodging, and registration fees.
3. There is no limit on the number of abstracts registrants may submit. However, presenters must present their presentations.
4. Accepted abstracts will be published in the Program and Abstract Book. Editorial changes will be made to accepted abstracts at the discretion of the Program Committee.
5. Photocopies of the abstract form may be used.
6. Membership in the Association is not required for presenting a paper at IAFP 2006.

Presentation Format

1. Technical – Oral presentations will be scheduled with a maximum of 15 minutes, including a two to four minute discussion. LCD projectors will be available and computers will be supplied by the convenors.
2. Poster – Freestanding boards will be provided for presenting posters. Poster presentation surface area is 4′ high by 8′ wide. Handouts may be used, but audiovisual equipment will not be available. The presenter will be responsible for bringing pins and velcro.

Note: The Program Committee will make the final decision on presentation format.

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1. Title – The title should be short but descriptive. The first letter in each word in the title and proper nouns should be capitalized.
2. Authors – List all authors using the following style: first name followed by the surname.
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Abstract Submission

Abstracts submitted for IAFP 2006 will be evaluated for acceptance by the Program Committee. Please be sure to follow the format instructions above carefully; failure to do so may result in rejection. Information in the abstract data must not have been previously published in a copyrighted journal.

Abstracts must be received no later than February 8, 2006. Return the completed abstract form through one of the following methods:

1. Online: Use the online abstract submission form located at www.foodprotection.org. You will receive an E-mail confirming receipt of your submission.
2. E-mail: Submit via E-mail as an attached text or MS Word™ document to abstracts@foodprotection.org.

Selection Criteria

1. Abstracts must accurately and briefly describe:
   (a) the problem studied and/or objectives;
   (b) methodology;
   (c) essential results, including statistical significance when applicable; and
   (d) conclusions and/or significant implications.
2. Abstracts must report the results of original research pertinent to the subject matter. Papers should report the results of new, applied research on: safety and microbial quality of foods (dairy, meat and poultry, seafood, produce, water); foodborne viruses and parasites, retail food safety, epidemiology and public health; non-microbiology food safety issues (food toxicology; allergens; chemial contaminants); advances in sanitation, laboratory methods, quality assurance, and food safety systems. Papers may also report subject matter of an educational and/or non-technical nature.
3. Research must be based on accepted scientific practices.
4. Research should not have been previously presented nor intended for presentation at another scientific meeting. Papers should not appear in print prior to the Annual Meeting.
5. Results should be summarized. Do not use tables or graphs.

Rejection Reasons

1. Abstract was not prepared according to the "Instructions for Preparing Abstracts."
2. Abstract does not contain essential elements as described in "Selection Criteria 1a–1d."
3. Abstract reports inappropriate or unacceptable subject matter.
4. Abstract is not based on accepted scientific practices, the quality of the research or scientific approach is inadequate, data does not support conclusions, or potential for approach to be practically used to enhance food safety is not justified.
5. Work reported appears to be incomplete and/or data and statistical validity are not presented (percentages alone are not acceptable unless sample sizes are reported). Indication that data will be presented is not acceptable.
6. Abstract was poorly written or prepared. This includes spelling and grammatical errors.
7. Results have been presented/published previously.
8. Abstract was received after the deadline for submission.
9. Abstract contains information that is in violation of the International Association for Food Protection Policy on Commercialism.
10. Abstract subject is similar to other(s) submitted by same author. (The committee reserves the right to combine such abstracts.)
11. Abstracts that report research that is confirmatory of previous studies and without justification of relevance and originality will be given low priority for acceptance.

Projected Deadlines/Notification

Abstract Submission Deadline: February 8, 2006. Submission Confirmations: On or before February 9, 2006. Acceptance/Rejection Notification: March 10, 2006.

Contact Information

Questions regarding abstract submission can be directed to Tamara P. Ford, 515.276.3344 or 800.369.6337; E-mail: tford@foodprotection.org.

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Abstract Form

DEADLINE: Must be Received
by February 8, 2006

(1) Title of Paper _____

_____

(2) Authors _____

_____

(3) Full Name and Title of Presenter _____

_____

(4) Institution and Address of Presenter _____

_____

(5) Phone Number _____

(6) Fax Number _____

(7) E-mail _____

(8) Format preferred: ☐ Oral ☐ Poster ☐ No Preference

The Program Committee will make the final decision on presentation format.

(9) Category: ☐ Produce ☐ Meat and Poultry ☐ Seafood ☐ Dairy and Other Food Commodities

☐ Risk Assessment and Epidemiology ☐ Education/ Other Non-Technical ☐ General Microbiology and Sanitation

☐ Pathogens and Antimicrobials ☐ Advances in Applied Laboratory Methods

☐ Food Toxicology/Non-Microbial Food Safety

(10) Developing Scientist Awards Competition ☐ Yes Graduation date _____

☐ Full-time student ☐ Part-time student

Major Professor/Department Head approval (signature and date) _____

(11) TYPE abstract, DOUBLE-SPACED, in the space provided or on a separate sheet of paper, using a 12-point font size. Use no more than 300 words.

Call for Entrants in the Developing Scientist Awards Competitions

Supported by the International Association for Food Protection Foundation

The International Association for Food Protection Foundation is pleased to announce the continuation of its program to encourage and recognize the work of students and recent graduates in the field of food safety research. Qualified individuals may enter either the oral or poster competition.

Purpose

1. To encourage students and recent graduates to present their original research at the Annual Meeting.
2. To foster professionalism in students and recent graduates through contact with peers and professional Members of the Association.
3. To encourage participation by students and recent graduates in the Association and the Annual Meeting.

Presentation Format

Oral Competition – The Developing Scientist Oral Awards Competition is open to graduate students (enrolled or recent graduates) from M.S. or Ph.D. programs or undergraduate students at accredited universities or colleges. Presentations are limited to 15 minutes, which includes two to four minutes for discussion.

Poster Competition – The Developing Scientist Poster Awards Competition is open to students (enrolled or recent graduates) from undergraduate or graduate programs at accredited universities or colleges. The presenter must be present to answer questions for a specified time (approximately two hours) during the assigned session. Specific requirements for presentations will be provided at a later date.

General Information

1. Competition entrants cannot have graduated more than a year prior to the deadline for submitting abstracts.
2. Accredited universities or colleges must deal with environmental, food or dairy sanitation, protection or safety research.
3. The work must represent original research completed and presented by the entrant.
4. Entrants may enter only one paper in either the oral or poster competition.
5. All entrants must register for the Annual Meeting and assume responsibility for their own transportation, lodging, and registration fees.
6. Acceptance of your abstract for presentation is independent of acceptance as a competition finalist. Competition entrants who are chosen as finalists will be notified of their status by the chairperson by May 29, 2006.
7. Entrants who are full time students, with accepted abstracts will receive a complimentary, one-year Student Membership with *JFP* Online.
8. In addition to adhering to the instruction in the "Call for Abstracts," competition entrants must check the box to indicate if the paper is to be presented by a student in this competition. A signature and date is required from the major professor or department head.
9. You must also specify full-time student or part-time student.

Judging Criteria

A panel of judges will evaluate abstracts and presentations. Selection of up to ten finalists for each competition will be based on evaluations of the abstracts and the scientific quality of the work. All entrants will be advised of the results by May 29, 2006. Only competition finalists will be judged at the Annual Meeting and will be eligible for the awards.

All other entrants with accepted abstracts will be expected to be present as part of the regular Annual Meeting. Their presentations will not be judged and they will not be eligible for the awards.

Judging criteria will be based on the following:

1. Abstract – clarity, comprehensiveness and conciseness.
2. Scientific Quality – Adequacy of experimental design (methodology, replication, controls), extent to which objectives were met, difficulty and thoroughness of research, validity of conclusions based upon data, technical merit and contribution to science.
3. Presentation – Organization (clarity of introduction, objectives, methods, results and conclusions), quality of visuals, quality and poise of presentation, answering questions, and knowledge of subject.

Finalists

Awards will be presented at the International Association for Food Protection Annual Meeting Awards Banquet to the top three presenters (first, second and third places) in both the oral and poster competitions. All finalists are expected to be present at the banquet where the awards winners will be announced and recognized.

Awards

First Place – $500 and an engraved plaque
Second Place – $300 and a framed certificate
Third Place – $100 and a framed certificate

Award winners will receive a complimentary, one-year Membership including *Food Protection Trends, Journal of Food Protection,* and *JFP* Online.

Policy on Commercialism

for Annual Meeting Presentations

1. INTRODUCTION

No printed media, technical sessions, symposia, posters, seminars, short courses, and/or other related types of forums and discussions offered under the auspices of the International Association for Food Protection (hereafter referred to as to Association forums) are to be used as platforms for commercial sales or presentations by authors and/or presenters (hereafter referred to as authors) without the express permission of the staff or Executive Board. The Association enforces this policy in order to restrict commercialism in technical manuscripts, graphics, oral presentations, poster presentations, panel discussions, symposia papers, and all other type submissions and presentations (hereafter referred to as submissions and presentations), so that scientific merit is not diluted by proprietary secrecy.

Excessive use of brand names, product names or logos, failure to substantiate performance claims, and failure to objectively discuss alternative methods, processes, and equipment are indicators of sales pitches. Restricting commercialism benefits both the authors and recipients of submissions and presentations.

This policy has been written to serve as the basis for identifying commercialism in submissions and presentations prepared for the Association forums.

2. TECHNICAL CONTENT OF SUBMISSIONS AND PRESENTATIONS

2.1 Original Work

The presentation of new technical information is to be encouraged. In addition to the commercialism evaluation, all submissions and presentations will be individually evaluated by the Program Committee chairperson, technical reviewers selected by the Program Committee chairperson, session convenor, and/or staff on the basis of originality before inclusion in the program.

2.2 Substantiating Data

Submissions and presentations should present technical conclusions derived from technical data. If products or services are described, all reported capabilities, features or benefits, and performance parameters must be substantiated by data or by an acceptable explanation as to why the data are unavailable (e.g., incomplete, not collected, etc.) and, if it will become available, when. The explanation for unavailable data will be considered by the Program Committee chairperson and/or technical reviewers selected by the Program Committee chairperson to ascertain if the presentation is acceptable without the data. Serious consideration should be given to withholding submissions and presentations until the data are available, as only those conclusions that might be reasonably drawn from the data may be presented. Claims of benefit and/or technical conclusions not supported by the presented data are prohibited.

2.3 Trade Names

Excessive use of brand names, product names, trade names, and/or trademarks is forbidden. A general guideline is to use proprietary names once and thereafter to use generic descriptors or neutral designations. Where this would make the submission or presentation significantly more difficult to understand, the Program Committee chairperson, technical reviewers selected by the Program Committee chairperson, session convenor, and/or staff, will judge whether the use of trade names, etc., is necessary and acceptable.

2.4 "Industry Practice" Statements

It may be useful to report the extent of application of technologies, products, or services; however, such statements should review the extent of application of all generically similar technologies, products, or services in the field. Specific commercial installations may be cited to the extent that their data are discussed in the submission or presentation.

2.5 Ranking

Although general comparisons of products and services are prohibited, specific generic comparisons that are substantiated by the reported data are allowed.

2.6 Proprietary Information (See also 2.2.)

Some information about products or services may not be publishable because it is proprietary to the author's agency or company or to the user. However, the scientific principles and validation of performance parameters must be described for such products or services. Conclusions and/or comparisons may be made only on the basis of reported data.

2.7 Capabilities

Discussion of corporate capabilities or experiences are prohibited unless they pertain to the specific presented data.

3. GRAPHICS

3.1 Purpose

Slides, photographs, videos, illustrations, art work, and any other type visual aids appearing with the printed text in submissions or used in presentations (hereafter referred to as graphics) should be included only to clarify technical points. Graphics which primarily promote a product or service will not be allowed. (See also 4.6.)

3.2 Source

Graphics should relate specifically to the technical presentation. General graphics regularly shown in, or intended for, sales presentations cannot be used.

3.3 Company Identification

Names or logos of agencies or companies supplying goods or services must not be the focal point of the slide. Names or logos may be shown on each slide so long as they are not distracting from the overall presentation.

3.4 Copies

Graphics that are not included in the preprint may be shown during the presentation only if they have been reviewed in advance by the Program Committee chairperson, session convenor, and/or staff, and have been determined to comply with this policy. Copies of these additional graphics must be available from the author on request by individual attendees. It is the responsibility of the session convenor to verify that all graphics to be shown have been cleared by Program Committee chairperson, session convenor, staff, or other reviewers designated by the Program Committee chairperson.

4. INTERPRETATION AND ENFORCEMENT

4.1 Distribution

This policy will be sent to all authors of submissions and presentations in the Association forums.

4.2 Assessment Process

Reviewers of submissions and presentations will accept only those that comply with this policy. Drafts of submissions and presentations will be reviewed for commercialism concurrently by both staff and technical reviewers selected by the Program Committee chairperson. All reviewer comments shall be sent to and coordinated by either the Program Committee chairperson or the designated staff. If any submissions are found to violate this policy, authors will be informed and invited to resubmit their materials in revised form before the designated deadline.

4.3 Author Awareness

In addition to receiving a printed copy of this policy, all authors presenting in a forum will be reminded of this policy by the Program Committee chairperson, their session convenor, or the staff, whichever is appropriate.

4.4 Monitoring

Session convenors are responsible for ensuring that presentations comply with this policy. If it is determined by the session convenor that a violation or violations have occurred or are occurring, he or she will publicly request that the author immediately discontinue any and all presentations (oral, visual, audio, etc.) and will notify the Program Committee chairperson and staff of the action taken.

4.5 Enforcement

While technical reviewers, session convenors, and/or staff may all check submissions and presentations for commercialism, ultimately it is the responsibility of the Program Committee chairperson to enforce this policy through the session convenors and staff.

4.6 Penalties

If the author of a submission or presentation violates this policy, the Program Committee chairperson will notify the author and the author's agency or company of the violation in writing. If an additional violation or violations occur after a written warning has been issued to an author and his agency or company, the Association reserves the right to ban the author and the author's agency or company from making presentations in the Association forums for a period of up to two (2) years following the violation or violations.

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December 2005

Fellow IAFP Members:

As we prepare for a new year, I want to encourage you to become involved in the International Association for Food Protection's Committees and Professional Development Groups (PDGs). From personal experience, I can tell you that participation in IAFP's Committees and PDGs is truly a win-win. Through your involvement, you can help provide guidance and information for the Association, your profession, and fellow IAFP Members. And while you are helping the Association and others, you'll be networking with leading experts in the field, learning from their experiences, and developing valued relationships.

Committees and PDGs are a vital component of IAFP. They meet during the Annual Meeting and share information throughout the year via conference calls or E-mail. Therefore, even if you're unable to attend IAFP 2006 in Calgary, your involvement is still possible. Please review the Committees and PDGs and their mission statements listed on the following pages. If you find one that sounds interesting, simply contact the IAFP office to let us know which group you want to join. Getting started is really that simple.

For those of you who have participated in our Committees or PDGs in the past, I want to thank you for your service and encourage you to stay involved. Your continued participation is important to the success of the Association.

As usual, your comments, questions, and suggestions are welcomed. Please do not hesitate to contact the IAFP office or myself if we can be of help.

In closing, remember that learning is a lifelong journey. I invite you to take an important step in this journey by getting involved in IAFP's Committees or PDGs. Together we'll learn from one another and help *Advance Food Safety Worldwide*.

Best Regards,

Gary R. Acuff
Vice President, IAFP

"Our mission is to provide food safety professionals worldwide with a forum to exchange information on protecting the food supply."
Publisher of the *Journal of Food Protection* and *Food Protection Trends*

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IAFP COMMITTEES, PROFESSIONAL DEVELOPMENT GROUPS, TASK FORCE, AND AFFILIATE COUNCIL MISSION STATEMENTS

STANDING COMMITTEES

FPT Management Committee

The mission of the *FPT* Management Committee is to provide guidance to the Executive Board on matters concerning *Food Protection Trends*.

JFP Management Committee

The mission of the *JFP* Management Committee is to provide guidance to the Executive Board on matters concerning the *Journal of Food Protection*.

Program Committee

The mission of the Program Committee is to develop the Annual Meeting program, evaluate abstracts, identify symposia and speakers, identify all sessions' convenors, and oversee Developing Scientist Awards Committee.

SPECIAL COMMITTEES

3-A Committee on Sanitary Procedures

The mission of the 3-A Committee on Sanitary Procedures is to serve as IAFP representatives to the 3-A Sanitary Standards Committee; to review and provide comments on proposed changes and revisions to the 3-A Sanitary Standards.

Audiovisual Library Committee

The mission of the Audiovisual Library Committee is to review and evaluate audiovisual materials for accuracy and appropriateness of content, make recommendations regarding the purchase of audiovisual materials, and provide guidance on matters concerning the AV Library.

Awards Committee

The mission of the Awards Committee is to select recipients for the IAFP awards.

Black Pearl Committee

The mission of the Black Pearl Selection Committee is to select the recipient of the Black Pearl Award.

Committee on the Control of Foodborne Illness

The mission of the Committee on the Control of Foodborne Illness is to review information on epidemiology and control of communicable diseases of primary concern to food safety and related areas, and prepare manuals and articles addressing investigation of control of food safety-related problems.

Constitution and Bylaws

The mission of the Constitution and Bylaws Committee is to review and study the Constitution and Bylaws of IAFP and make recommendations to the Executive Board for changes to be considered for submission to the Membership for ratification.

Developing Scientist Awards

The mission of the Developing Scientist Awards Committee is to select finalists and judge the Developing Scientist Awards Competition at the IAFP Annual Meeting.

Fellows Selection Committee

The mission of the Fellows Selection Committee is to solicit nominations and make recommendations to the Executive Board for eligible Members to be confirmed as Fellows by the Executive Board.

Foundation Fund Committee

The mission of the Foundation Fund Committee is to oversee IAFP Foundation monies, solicit gifts to the Foundation, and identify and fund programs which further the goals and objectives of the Association.

Membership Committee

The mission of the Membership Committee is to develop strategies to retain current members and attract new members.

Nominating Committee

The mission of the Nominating Committee is to select and submit names of nominees for the office of Executive Board Secretary for election by the IAFP Membership.

Past Presidents' Committee

The mission of the Past Presidents' Committee is to serve as an advisory committee to the Executive Board.

Tellers Committee

The mission of the Tellers Committee is to count and certify the results of each election and other membership votes.

PROFESSIONAL DEVELOPMENT GROUPS

Applied Laboratory Methods PDG

The mission of the Applied Laboratory Methods Professional Development Group is to provide a forum for the exchange and sharing of information related to the development and use of laboratory methods for the analysis of food and related commodities.

Beverage PDG

The mission of the Beverage Professional Development Group is to provide a forum to discuss and develop symposia on issues facing the beverage industry.

Dairy Quality and Safety PDG

The mission of the Dairy Quality and Safety Professional Development Group is to provide a forum to discuss items of interest for the production and processing of safe and quality dairy products and to develop program topics and symposia for presentation at the IAFP Annual Meetings.

Food Hygiene and Sanitation PDG

The mission of the Food Hygiene and Sanitation Professional Development Group is to provide information on the developments in hygiene and sanitation in the food industry.

Food Law PDG

The mission of the Food Law Professional Development Group is to provide an international forum for the exchange of information on the scientific issues associated with food laws, regulations and policy.

Food Safety Network PDG

The mission of the Food Safety Network Professional Development Group is to provide IAFP members with information on current trends and issues in food protection.

Food Toxicology and Food Allergens PDG

The mission of the Food Toxicology and Food Allergens Professional Development Group is to facilitate communication on topics in food toxicology including food allergens.

Fruit and Vegetable Safety and Quality PDG

The mission of the Fruit and Vegetable Safety and Quality Professional Development Group is to provide a forum to discuss items of interest to the safe production of fruit and vegetable products and to develop program topics and symposia for presentation at the IAFP Annual Meetings.

Meat and Poultry Safety and Quality PDG

The mission of the Meat and Poultry Safety and Quality Professional Development Group is to provide a forum to discuss items of interest to the safe production of meat and poultry products and to develop program topics and symposia for presentation at the IAFP Annual Meetings.

Microbial Risk Analysis PDG

The mission of the IAFP Microbial Risk Analysis Professional Development Group is to facilitate communication on the topic of microbial risk analysis (MRA), promote application and use of MRA and encourage research and data reporting methods that support MRA.

Outreach Education PDG

The mission of the Outreach Education Professional Development Group is to develop and disseminate outreach educational materials for consumers and educators.

Retail Food Safety and Quality PDG

The mission of the Retail Food Safety and Quality Professional Development Group is to provide the retail food safety industry worldwide with information to prepare and serve safe food.

Seafood Safety and Quality PDG

The mission of the Seafood Safety and Quality Professional Development Group is to provide a forum to discuss items of interest to the safe production of seafood products and to develop program topics and symposia for presentation at the IAFP Annual Meetings.

Student PDG

The mission of the Student Professional Development Group is to provide students of food safety with a platform to enrich their experience as Members of IAFP.

Viral and Parasitic Foodborne Diseases PDG

The mission of the Viral and Parasitic Foodborne Disease Professional Development Group is to promote awareness of non-bacterial causes of foodborne disease by encouraging food safety professionals and others to seek education and training that will enable them to contribute to preventing non-bacterial foodborne infections and outbreaks.

Water Safety and Quality PDG

The mission of the Water Safety and Quality Professional Development Group is to provide a forum to discuss items as to the role the safety and quality of water plays globally in the farm-to-table chain and to develop program topics and symposia for presentation at the IAFP Annual Meetings.

TASK FORCE

Rapid Response Task Force

The mission of the Rapid Response Task Force is to identify developing conditions affecting food safety and organize meetings on these issues to educate IAFP Members.

AFFILIATE COUNCIL

The Affiliate Council is an advisory body to the IAFP Board, represents Affiliate Associations' interests, responsible for IAFP Awards Committee, interchanges ideas and recommendations on programs, awards and procedures between Affiliates and the Board.

NEW MEMBERS

CANADA

Kevin R. Lyons
New Food Classics
Saskatoon, Saskatchewan

Solange K. Mikanagu
3M Canada Company
London, Ontario

Rocio Morales-Rayas
University of Guelph
Guelph, Ontario

Leslie J. Rea
Saskatoon Health Region
Saskatoon, Saskatchewan

GERMANY

Karolina Heed
Profos AG
Regensburg, Bavaria

NEW ZEALAND

Gregory Simmons
Auckland Regional Public Health Service
Auckland

SWITZERLAND

Stefanie P. Templer
Universitat Bern
Worb, Bern

UNITED STATES

ALASKA

Cherie Rice
State of Alaska
Wasilla

ARIZONA

Grant B. Ripp
Scottsdale Culinary Institute
Tucson

CALIFORNIA

Darren Blass
Jack in the Box
San Diego

Heather Boggs
Jack in the Box
San Diego

COLORADO

Michael J. DeLaZerda
Coleman Natural Foods
Golden

D. Frank Kelsey
Highland Fresh Technologies
Grand Junction

FLORIDA

Gail A. Yip-Chuck
Dietary Support Services, Inc.
Tampa

GEORGIA

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Tucker

Mohammad M. Obaidat
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Athens

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Jayne A. Nosari
Illinios Dept. of Public Health
Sherman

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Atin R. Datta
FDA
Rockville

Jerome T. Ferguson
JT Ferguson Env. Svcs.
Pikesville

MASSACHUSETTS

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Chelsea

MINNESOTA

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University of Minnesota
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Matthew R. Garner
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Ithaca

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Jon-David S. Sears
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OREGON

Gregory P. Parks
Parks Consultation & Auditing
Salem

PENNSYLVANIA

Tony M. Petrucci
ARAMARK
Philadelphia

WASHINGTON

George E. Berkompas
WSDC-NOAA-NMFS-WIB
Ferndale

WISCONSIN

Steven L. Foley
Marshfield Clinic Research Foundation
Marshfield

NEW GOLD SUSTAINING MEMBER

John F. Schulz
Marriott International
Washington, D.C.

NEW SUSTAINING MEMBERS

John H. Collins
Elena's
Auburn Hills, MI

Gerard P. Ruth
Charm Sciences, Inc.
Lawrence, MA

UPDATES

Susan M. Bond to Join International Food Information Council

Susan M. Bond, a 17-year veteran of the Food and Drug Administration (FDA), has joined the International Food Information Council (IFIC) as a senior vice president, effective November 28, 2005.

Ms. Bond comes to IFIC after an accomplished and diverse FDA career in science and public policy, consumer and public affairs, and program and administrative management. Most recently she served as director of scientific policy development, reporting directly to the FDA commissioner. As such she was a senior advisor to the commissioner and executive liaison to all FDA centers, including the Center for Food Safety and Applied Nutrition (CFSAN), as well as the commissioner's link to external constituents.

Ms. Bond's experience at the agency included work in a variety of food safety and nutrition issues, as well as science communications. She was co-executor of FDA's Obesity Working Group and the commissioner's coordinator for FDA activities in Bovine Spongiform Encephalopathy (BSE), as well as agricultural biotechnology issues. Prior to that, Ms. Bond served as special assistant to the commissioner and deputy commissioner and spent several years as a senior science policy analyst in FDA's Office of Science and Health Coordination, where she managed and directed the agency's premier, annual scientific forum and the commissioner's blue ribbon panel of experts on the FDA Science Board Advisory Committee. Early in her FDA tenure, she was the special assistant to the associate commissioner for consumer affairs, coordinating public outreach, education, and participation.

Incoming IFIC President and CEO David Schmidt said, "We are delighted to have someone with Susan's science communications experience and regulatory background join IFIC's staff. Her understanding of the challenges of communicating food safety and nutrition should prove invaluable, and her administrative experience will help make IFIC even more efficient and productive."

Ms. Bond earned a master's of science in technology management (biotechnology) from the University of Maryland University College. She received a bachelor of arts degree in government from West Virginia Wesleyan College.

Christian Robert, New Director General, Takes Over at IDF

The appointment of Mr. Christian Robert as International Dairy Federation (IDF) director general took effect October 18, 2005.

In accepting the position, Christian Robert has undertaken to build on IDF's unique strengths as an influential and valuable global player. Mr. Robert said there is an unprecedented interest in the IDF which has seen its membership grow to 49 countries with Armenia and the recent cooperation with ESADA in Africa. Indeed, this now represents almost 80% of the world's total milk production. He also said that it is important for IDF to be outward-looking and to foster dialogue with all the audiences. By being more representative and reaching all the audiences, IDF will consolidate its strong international position and its status as international advisor. IDF must promote the dairy industry and its interests.

Novazone Inc. Appoints Ram Prasad Vice President of Operations

Novazone has announced the appointment of Mr. Ram Prasad as vice president of operations. Mr. Prasad is responsible for all functions of operations for Novazone, and will report directly to Paul White, president and chief executive officer.

Mr. Prasad will be instrumental in implementing key operational processes. He brings 15 years of operations, manufacturing and quality experience to Novazone. During his career, he held numerous executive positions in emerging technology markets including aerospace, petrochemical, semiconductor and contract manufacturing.

Before joining Novazone, Mr. Prasad was vice president of new product operations and business process development for Asyst Technologies, Inc. Prior to Asyst, he was director of operations for Amber Networks, Inc., a start-up of high-end telecom equipment. Previously, Mr. Prasad held management positions at Sieger Engineering, Inc., Applied Materials, Inc., and Whessoe Varec, Inc.

Mr. Prasad holds a master's degree in mechanical engineering from New Mexico State University, and a bachelor's degree in mechanical engineering from Bangalore University, India.

International Association for Food Protection® NEWS

Outbreak of Norovirus Infections Associated with Consuming Food From a Catering Company

Ingeborg Lederer, Daniela Schmid, Anna-Margaretha Pichler, Regine Dapra, Peter Kraler, Andreas Blassnig, Anita Luckner-Hornische Centre for Infectious Disease Epidemiology, Österreichische Agentur für Gesundheit und Ernährungssicherheit, Vienna, Austria.

On September 7, 2005, a cluster of acute gastroenteritis cases was reported to a public health department in southern Austria. All cases were in staff at a factory manufacturing electrical appliances and had symptom onset on September 6. About 120 of 1,357 employees had vomiting and /or diarrhea (attack rate 8.8%). The large number of cases with symptom onset on the same day indicated a point-source outbreak. The factory provides food items from a local caterer for its staff, including snacks (with sandwiches for breakfast and afternoon breaks), lunch, and dinner for workers on the second shift.

Initial investigations, including interviews of the catering company's staff, revealed that a female catering company staff member reported having been ill from September 4–5. She had worked on these days, and prepared sandwiches without wearing gloves. Further interviews revealed that one of the cooks at the catering company had become ill on September 1, and further employees had become ill on September 4 (1 employee), September 6 (2 employees), September 7 (1 employee), and September 8 (2 employees).

A cohort study of the staff of the appliance factory is underway to identify the cause of the outbreak and to assess how this outbreak is related to the cluster of cases among the staff of the catering company. The regional food inspection agency closed the catering company late on September 7 and provided recommendations for disinfection. The company stayed closed for one week until hygiene measures were completed (excluding ill employees from work, cleaning and disinfection of all areas, and discarding all foodstuffs prepared by the catering company). Sick employees from both companies were requested not to return to work until they had had no nausea, diarrhea or vomiting for at least 48 hours.

Stool specimens from cases were tested for bacterial pathogens; all samples were negative. On September 12, RT-PCR testing of the samples revealed that norovirus was the causative agent for the outbreak: all 19 stool samples tested gave positive results (11 employees from the catering company and 8 from the factory). The isolates from the catering staff were indistinguishable of those from the factory workers.

The source of the outbreak in the electrical appliance factory has not yet been determined. This outbreak underlines existing guidelines for food business managers: anyone suffering from diarrhea and/or vomiting should report this to the manager and leave food handling areas immediately. If there is only one episode of diarrhea and/or vomiting in a 24-hour period and no fever, then the person can return to work. If symptoms persist, then he or she should return to work only when vomiting has ceased for 48 hours and/or there have been no loose stools for 48 hours.

FSAI New Nationwide Food Safety Campaign Aimed at Meat Outlets

The Food Safety Authority of Ireland (FSAI) has announced details of a new national information campaign focused on food safety practices in butcher shops and meat counters. Environmental health officers (EHOs) across the country have been working closely with food businesses in this particular sector of the food industry to encourage an increase in the adoption of food safety management systems based on the principles of HACCP (Hazard Analysis Critical Control Point). The FSAI has devised an information campaign to support this work, specifically aimed at butcher shops and meat counters which includes a suite of literature to assist food businesses in this sector to implement a HACCP program.

A recent survey undertaken by EHOs throughout the country has identified approximately 1,100 butcher shops and 500 meat counters within supermarkets across Ireland. Through this campaign the FSAI will target high-risk butchers which have been

identified as those selling ready-to-eat meat products in addition to raw meat products. Survey results show that from the 961 high-risk butchers examined, approximately 27% are compliant and an additional 60% have started the process, with 13% who have yet to show any compliance with HACCP requirements. A core focus of the FSAI campaign is to significantly increase this level to achieve 100% compliance in the interest of protecting consumer health.

According to Dr. Wayne Anderson, chief specialist food science, FSAI, good hygiene practice and HACCP are crucial for safe food management. "Implementing a food safety management system is crucial in today's environment of increasing customer demands. By not complying with the principles of best food safety practice, food businesses not only place the viability of their business in question by flouting the law, they also place the health of their customers at risk. If a system of checks and balances, such as those offered by a tailored HACCP system, are not in place, a food business is at greater risk of a food safety problem."

The FSAI has previously implemented similar campaigns focused on other sectors of the food industry including hotels with function catering, hospitals and nursing homes which resulted in a significant increase in the level of compliance with HACCP. In addition to the current campaign targeting butcher shops and meat counters, the FSAI will be focusing on other categories of the food industry in the near future to ensure compliance with HACCP is achieved throughout the entire spectrum of the Irish food industry.

"Some businesses perceive the development of a food safety management system as a complicated procedure involving a lot of paperwork. While it may be seen as an onerous task, HACCP can be implemented with minimum difficulty as demonstrated by the majority of compliant food businesses. At this point there is no excuse for non-compliance and every food business must know the steps in their business that are critical to food safety and take responsibility for controlling them. Besides obvious food safety benefits, HACCP offers other advantages to the everyday operation of a business such as reducing product losses and helping to keep staff aware of food safety issues," concludes Dr. Anderson.

Since 1998 all Irish food businesses are required by law to have a food safety management system based on the principles of HACCP. It is a systematic approach to identifying and controlling hazards that could pose a danger in the preparation of safe food. HACCP helps food managers identify what could go wrong in their food business and assists them by putting plans and systems in place to prevent negative occurrences. The principles of HACCP incorporate: identifying hazards; determining the critical control points (CCPs); establishing critical limits; establishing a system to monitor control of the CCP; establishing the corrective action when monitoring indicates a CCP is not under control; establishing procedures for verification to confirm the HACCP system is working effectively, and establishing documentation concerning all procedures and records appropriate to these principles and their applications.

FSIS to Post Information on New Technologies on Its Web Site

The USDA's Food Safety and Inspection Service (FSIS) has announced that summary information on new technologies approved for use in the production of meat, poultry and egg products will be available on its Web site. Posting the brief descriptions of new technologies will encourage public and industry awareness by small and very small plants, thus helping to improve public health protection.

FSIS established the New Technology Staff (NTS) in 2003, to review new technologies that companies intend to use in the slaughter of livestock and poultry and in the processing of meat, poultry, and egg products. Review by NTS ensures that the use of new technologies will not adversely affect product safety, inspection procedures or the safety of FSIS inspectors.

FSIS defines the term "new technology" as new, or new applications of, equipment, substances, methods, processes or procedures affecting the slaughter of livestock and poultry or processing of meat, poultry, or egg products. The new technologies have contributed to the reduction of threats posed by pathogenic microorganisms in the recent years. For further details on the new technologies, visit www.fsis.usda.gov.

This notice became effective on November 18, 2005.

Expert Panel Analyzes Risk-based Approach to Fight Listeriosis

An expert panel recently completed the most comprehensive risk-based review of effective strategies for combating the foodborne illness listeriosis and have identified specific types of foods, sub-populations and practices which increase a consumers' risk of contracting the deadly illness. The expert panel was convened by the International Life Sciences Institute (ILSI) and was co-funded by several leading food organizations including the American Meat Institute Foundation (AMIF). Its findings were published in the September 2005 issue of the *Journal of Food Protection*. The expert panel convened by ILSI included leading authorities worldwide from academia, government, the public health community and industry.

The panel found that a "continuum of risk is observed in the human population," ranging from very sensitive groups – pregnant, the elderly, and the immunocompromised – to members of the general population who appear to have minimal risk for the disease. "Identifying the groups most at risk for listeriosis, combined with the knowledge of which foods may bear a higher risk, is a giant step forward in educating the public in an ongoing effort to stamp out this illness," said Dr. Randall Huffman, vice president of scientific affairs at AMIF.

The panel identified several risk factors that placed subjects at higher risk for contracting listeriosis, primarily individuals with compromised immune systems, senior citizens and pregnant women. "The ILSI Research Foundation is very pleased to have had the opportunity to contribute to the resolution of this public health problem. This panel report represents a landmark accomplishment that establishes a new paradigm for addressing microbial foodborne hazards," said Dr. Suzanne Harris, acting executive director.

The scientists also identified sub-population groups at elevated risk. For example, Hispanic women appear to be at a higher risk for listeriosis than Caucasian women. Additionally, the panel identified that some foods bear higher risk of contamination and warrant greater attention when formulating a *Listeria* control strategy.

Researchers offered three main strategies for continued reduction in listeriosis:

1. Preventing contamination in the packaging/processing process;
2. Inhibiting growth of the bacteria once the food is packaged and prior to consumption;
3. Science-based education for high risk groups and caregivers on safe food strategies.

The study concluded that diligent commitment by the food industry to fighting *Listeria* at multiple points in the manufacturing process, like safe and sanitary operational procedures, regular and intensive sampling procedures, careful time and temperature controls and approved post-packing antimicrobial methods are essential to improving *Listeria* contamination rates. "As an industry, we have made tremendous strides in reducing the occurrence of *Listeria* in ready to eat food products, yet we must continue our keen focus on these three strategies to continue the downward trends seen in foodborne listeriosis in the US. We must include an emphasis on providing clear guidance to high risk individuals on healthy eating practices, food preparation and steps they can take to avoid this possibly fatal illness," said Huffman. "And that education needs to start at a very young age," he added.

For a copy of the report, click here: http://www.ingentaconnect.com/content/iafp/jfp.

New Zealand Food Safety Authority to Assess the Safety of Raw Milk and Raw Milk Products

New Zealand Food Safety Authority is undertaking research to assess the risk to New Zealand consumers from the consumption of raw (unpasteurized) milk and milk products, which are not currently allowed to be sold in New Zealand.

New Zealanders travel widely and sample an ever increasing and exotic range of foods in all sorts of places. People who have sampled the raw milk cheeses of Europe are keen to be able to buy and eat these when they get back home.

However, before the New Zealand standard for unpasteurized milk and milk products can be changed, a comprehensive assessment of the risks, both to consumers and to our vital animal based industries, must first be undertaken, NZFSA acting executive director Sandra Daly says.

As part of the assessment, NZFSA, in partnership with Fonterra, other government scientists and univer-

sities, will undertake world-leading studies to measure the effectiveness of the pasteurization process under modern commercial conditions.

"By knowing exactly what level of protection the pasteurization process delivers, the Authority will be able to assess the relative risks of unpasteurized milk and milk products and consider what measures may be available to manage these risks," Mrs. Daly says.

Raw milk cheeses may contain pathogens such as *Listeria monocytogenes*. In countries such as France, where a lot of raw milk cheese is eaten, serious illnesses associated with these foods are known to occur, and in some cases result in death, she says.

While countries with a long history of eating raw milk cheeses accept this risk to their consumers, New Zealand has historically required all milk and milk products to be pasteurized before sale. This step has been an important part of the protective measures that have reduced the New Zealand incidence of diseases such as tuberculosis.

"We know that New Zealand consumers are keen to have access to these products and that is why we are looking at how this might be possible while protecting public health and New Zealand's international reputation as a supplier of safe food," Mrs. Daly says.

Fonterra's unique facilities and expertise are being made available to conduct the research, which is well underway, but the methodology has been developed by scientists from NZFSA, ESR and Massey University and any resulting decisions will be made solely by NZFSA.

"This research will also be used to evaluate whether new technologies for treating raw milk and raw milk products can achieve the same level of food safety as pasteurization while having the advantage of not resulting in any food quality changes," Mrs. Daly says.

The developed risk assessment will avoid having to consider the import and domestic production of dozens of raw milk cheeses on a case-by-case basis, she says.

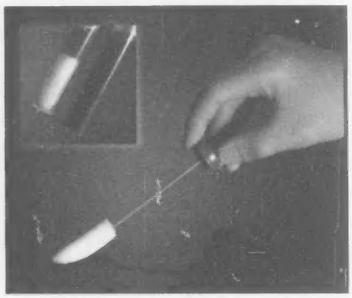
The research is expected to take about two years. Mrs. Daly says that while the research will take a holistic approach to the safety of raw milk cheeses, work already done by Australian scientists specifically on Roquefort cheese, a soft blue vein cheese made from sheep's milk, may see it being sold in New Zealand earlier than other unpasteurized products.

This follows an application Food Standards Australia New Zealand received some years ago from the French Government to amend the Australian New Zealand Food Standards Code to permit the sale of Roquefort in Australia.

NZFSA has also been asked by the French Government to consider allowing Roquefort to be sold in New Zealand. NZFSA has initiated a specific risk assessment to consider this request in the context of the New Zealand environment. A decision is expected early in 2006.

The Authority has a regulatory obligation to carry out its own tests but intends to make use of the Australian research, Mrs. Daly says.

INDUSTRY PRODUCTS



Hardy Diagnostics

Hardy Diagnostics PDX-LIB *Listeria*: The Easiest *Listeria* Test Available

Presumptive results are available for the most common *Listeria* spp., within 30 hours. *Listeria* Indicator Broth (PDX-LIB) is intended to be used in the food processing environment on food contact surfaces to detect the presence of *Listeria* species. Simply swab the surface, add the *Listeria* Indicator Broth to the sample and incubate. No complicated sub-culturing or specimen transfers required, thus reducing any chance of cross contamination. A color change from yellow to brown or black is considered presumptive positive. The *Listeria* Indicator Broth contains a patented formula of antibiotics, growth enhancers and color-changing compounds. The antibiotics function synergistically to inhibit most non-*Listeria* microorganisms. Growth enhancers provide recovery nutrients to support the growth of sub-lethally injured *Listeria*. Indicator compounds will turn the broth from yellow to black by utilizing the ß-glucosidase enzyme produced by *Listeria* species. A brown or black color after 30 hours at 37°C indicates a presumptive positive test for *Listeria* spp. The PDX-LIB media has recently earned AOAC approval. Compared to UVM and BLEB, the new PDB-LIB provides equivalent or superior recovery and faster detection as low as 10–50 heat injured *Listeria monocytogenes* organisms per mL within 24 to 30 hours of incubation. The testing method is 98% sensitive and 99% specific, and provides comparable results to the USDA methods. The PDX-LIB can be used as an economical pre-screen for environmental *Listeria* instead of performing expensive PCR or other more complicated assays on every sample.

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

Nilfisk-Advance America Industrial Vacuum Increases Productivity by Compressing Scraps

Maintaining cleanliness through the product packaging process is a major challenge for packagers everywhere. The removal of build up at source can effectively ensure a high-quality process, and to meet that need, industrial vacuum manufacturer Nilfisk-Advance America has developed the CFM R Series of vacuums for packagers. A valuable resource, the CFM R Series vacuums efficiently capture packaging material such as cardboard, foil, plastic and paper at the source, then compress it up to 300%, greatly reducing the number of times per shift the tank needs to be emptied.

The CFM R Series combines the collection and compression of packaging scraps to not only increase total collection capacity, but also improve overall productivity.

Saving companies valuable maintenance time and effort, the CFM R Series vacuums deliver the powerful performance of large, continuous-duty vacuums in a compact machine. In addition to their scrap-compacting capability, the vacuums also have a small footprint (4–8 square feet) and a vertical-base configuration, making them ideal for packaging suites where floor space is at a premium.

The R Series is designed to run virtually maintenance-free across extended periods of use, and features a simple, streamlined user interface. Other key features include container latches for quick access to the collection tank and a viewing window so operators can see when the polyester filter bag needs to be emptied. Mounted on wheels for easy maneuverability, the vacuum also runs quiet, increasing user comfort.

Nilfisk-Advance America
877.215.8322
Malvern, PA
www.nilfisk-advance.com

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

Flowserve Limitorque Launches the MT Series of Bevel Gear Operators

Flowserve Corp., a global provider of fluid motion and control products and services, announces the launch of the Limitorque Actuation Systems MT series of bevel gear operators. The MT series operators are optimized to deliver reliable performance in power industry valve applications.

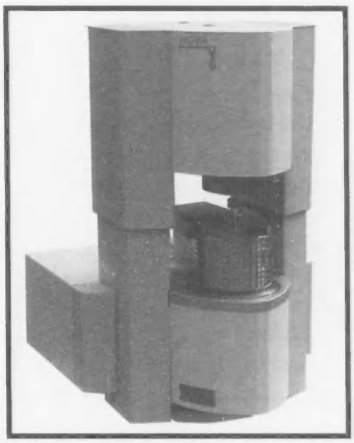
Designed as a superior combination of a bevel gear operator torque housing with a new thrust base design, the MT series is ideally suited for torque-seated valve applications and applications involving elevated process temperatures. MT series bevel gears and thrust base housings are made of ductile iron.

The MT series features robust thrust bearings and drive sleeve/stem nut design. These combine to offer the most rugged bevel gear operator available for handling the seating and unseating forces of high-pressure gate and globe valves found in power plants around the world. The MT operator stem nut is shouldered in the drive sleeve to capture thrust forces within the thrust housing without transferring those forces to the torque housing.

Available in torque ranges to 8,000 ft-lb and thrust ranges to 325,000 lb the MT series provides high efficiency and strong design for every application. When motorized by the Limitorque MX, SMB or L120 series electric actuators, the MT series offers flexibility for a wide range of valve opening and closing times.

"With the MT series, Flowserve once again leads the market with its product offerings for the power industry," says Earnest Carey, manager, product management, Flowserve Flow Control, Limitorque Actuation Systems. "Backed by our unsurpassed sales and service support, the MT series is further evidence of Flowserve's unwavering commitment to deliver the technology needed for reliable power plant valve operation today and in the years to come."

Flowserve Flow Control
972.443.6500
Irving, TX
www.flowserve.com



ATS RheoSystems

ATS RheoSystems NOVA Features Nano-Torque and Nano-Strain Rheological Measurement Control and Analysis

The New NOVA Rheometer from ATS RheoSystems features a unique "Net-Zero" bias bearing system. This null balance system allows for Nano-Torque and Nano-Strain measurement control and analysis.

Also featured is an innovative, low inertia Drag Cup Motor utilizing novel "Feed Forward" strain and speed control. The torque range is from 3 nNm to 200 mNm. It is possible to extend this to 1 nNm on the low end and 230 mNm at the high end for certain test parameters. Strain Resolution is 0.01 µrad.

Additional standard features include "auto-detect" measuring systems, video and image software, and high performance open-source instrument control software.

Also featured are patented differential pressure normal force sensor, a camera viewer, ethernet communications, high-speed USB port and RheoExplorer V6 software.

ATS Rheosystems
609.298.2522
Bordentown, NJ
www.atsrheosystems.com

Farr Air Pollution Controls New Air Quality Booth Protects Workers from Dust, Offers Convenient Modular Design

A new "Gold Series® Booth" (GSB) from Farr Air Pollution Control (APC) provides a convenient, manufacturing-friendly system for protecting workers from dusty environments. The new GSB encloses the work environment on three sides and creates a cross draft in the work area, pulling the dust away from the breathing zone and providing high efficiency removal of nuisance dust, fumes and other particulates. The booth encloses and isolates areas associated with industrial "dirty work" and may eliminate the need for respirators – making it ideal for production of castings or other parts subjected to grinding,

sanding, abrasive blasting, welding, powder painting and similar operations.

A special feature of the Farr GSB is a cantilevered roof over the dust collection module. This design creates a large, continuous work area without support poles, walls, fume arms or hoods, allowing for better production flow in and out of the booth. The system can be easily installed by maintenance crews with no ductwork required. The modular design of the GSB allows booth arrangement in any desired manner to accommodate airflow requirements of 5,400 up to 100,000 CFM.

The GS Booth uses Farr's new high efficiency (99.99 percent on 0.5 micron) "HemiPleat™" filter cartridge. The HemiPleat filter is the first in the dust collection industry to feature a patent-pending, open pleat media that results in greatly extended service life and lower pressure drop compared to standard cartridges — typically double the life at half the delta P. This open pleat design, together with the cartridge's patented inner cone, also cause dust to release readily for more efficient pulse cleaning. Pulsed-off dust collects in large capacity, easy-to-service pullout drawers.

The GSB is offered as a self-contained unit with blowers, light fixtures and easy-to-access controls. The roof can be enclosed to create a "push-pull" system and an optional front curtain added to increase velocity at the front of the booth.

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

New Bilsom® Leightning® Hi-Visibility Earmuffs Do Double Duty: Noise Attenuation and High Visibility

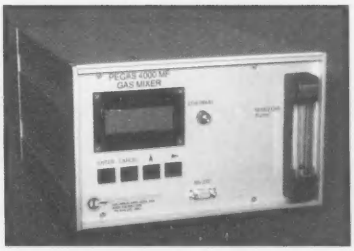
While workers face the challenge of protecting themselves from noise on the job, they often face additional safety risks that require a high degree of visibility. That's where the new Bilsom® Leightning® Hi-Visibility Earmuffs come in. Delivering dual protection both night and day, Leightning Hi-Visibility Earmuffs offer both maximum attenuation and total visibility, especially in outdoors or in low-lighting situations.

Eye-catching fluorescent green earcups on Leightning Hi-Visibility Earmuffs contrast noticeably against dark backgrounds, in low-lighting or in inclement weather. Plus, Leightning Hi-Visibility is the only earmuff on the market that incorporates a reflective headband that illuminates when exposed to light, providing additional safety, day or night.

Utilizing Bilsom's Air Flow Control™ technology, Leightning Hi-Visibility Earmuffs provide better overall protection and more consistent noise attenuation, especially at low frequencies. Convenient snap-in ear cushions can be easily replaced if they become soiled or damaged. Rugged steel wire headband construction provides needed durability while the foam padded headband relieves pressure on the head for long-wearing comfort. Leightning Hi-Visibility is available in the standard L3HV headband style [NRR 30], as well as a convenient folding design with optional belt storage case, providing protection up to NRR 27.

Bilsom Leightning Hi-Visibility Earmuffs are an excellent choice for a wide range of industrial applications, including roadway construction and utility crews, airport ground and flight crews, survey engineers, ferry service operators, emergency response workers, railroad workers, or others who need both hearing protection and increased visibility on the job.

Bacou-Dalloz Hearing Safety Group
800.430.5490
San Diego, CA
www.hearingportal.com



Columbus Instruments

Columbus Instruments New PEGAS 4000 Precision Gas Mixer

Columbus Instruments' PEGAS 4000MF Gas Mixer is a multi-gas mixer, which can blend from 2 to 4 gasses in a precise mixture available upon demand. The PEGAS 4000MF uses thermal mass flow controllers to provide an exact flow of each component gas. The system is equipped with an internal microprossor to perform all of the needed calculations and to provide signals to the flow controllers. The user only needs to enter the total flow and the concentration of each component gas. Front panel

rotometer shows flow of mixed gas. External input for contact closure control to shut off gas flow. Options available: Remote control by a PC via RS-232 serial connections and user-programmed overpressure shut off.

Columbus Instruments
614.276.0861
Columbus, OH
www.colinst.com

Strategic Consulting, Inc. Food Microbiology Testing Market Undergoing Major Changes

According to a new market report entitled Food Micro — 2005, the worldwide food microbiology market in 2005 represents over 625 million tests with a market value in excess of $1.65 billion.

Simply put, Food Micro—2005 is a market research report published by Strategic Consulting Inc. (SCI). SCI's reports have become accepted widely by leading diagnostic manufacturers and investors as highly credible industry analyses. Food Micro—2005 includes a thorough review of the global market for microbiology testing generated by the food processing industry along with detailed examinations into its four main sub-sectors—meat, dairy, fruits/vegetables, and processed foods.

The food sector represents the largest market segment within the industrial microbiology market and represents almost 50% of the total market. The food sector is more than double the size of any of the other industrial segments including the pharmaceutical, personal care products, beverage, environmental, and the industrial process sectors.

Over the past decade there has been a heightened concern regarding food safety. This report details the current conditions in the food microbiology testing market. Food Micro—2005 also reviews the macro market changes underway that are impacting testing requirements and competitive practices. Given this foundation, Food Micro—2005 then makes thorough market projections through to 2010.

Since 1998 the market value for food microbiology testing has grown significantly and has had an annual average growth rate of 9.2%. However, as food processing companies have characterized their plants for microbiology issues, made process improvements, changed production practices, increased employee training, and generally become much more proactive, the rate of growth in microbiology testing has normalized. In fact, during the past year the market value for food microbiology testing grew at only a 6.8% rate. A key factor in this decline in annual market value growth rates is explained by changes in pathogen testing practices. During the 1998 to 2002 period many companies were conducting one-time plant-wide audits to document potential pathogen issues. This led to a very rapid growth in pathogen testing. However, as these audits have diminished, growth rates have returned to a more sustainable level.

"The market value for these tests will grow at a faster rate than testing volumes. Driving this higher increase is an acceleration of the conversion from traditional microbiological testing methods to rapid methods," says Tom Weschler, president of Strategic Consulting. These newer methods have a higher price per test but are being used more frequently because they provide faster results and/or ease-of-use benefits versus the traditional methods.

Traditional methods currently account for approximately 65% of the tests performed worldwide in 2005 in the food microbiology market. Rapid methods (including convenience-based, immunoassay-based, and molecular-based methods) accounted for the remaining 35%, or approximately 220 million tests.

By 2010, however, much will have changed. Traditional methods will still be the predominant methods used at 428.2 million tests, but will represent only 52% of all tests, which is a reduction of 12.4% based on percentage of tests performed. All the types of rapid methods will make significant gains in usage during the coming 5 year period. When combined, the annual test volume of rapid methods will almost double from current levels and reach 394.6 million tests in 2010. The gain in the market value for rapid methods will be even more pronounced than the testing volume increases since the rapid methods have much higher average prices per test than traditional methods.

Throughout Food Micro—2005 there is extensive analysis of testing methods used by organism, by subsector, and by major geographical region.

The report is based on information from a broad cross-section of sources internationally, including interviews with quality and safety managers at the processing plants in each of the 4 food sub-sectors, regulatory officials, industry associations and diagnostic companies.

Strategic Consulting, Inc.
802.457.9933
Woodstock, VT
www.strategic-consult.com

COMING EVENTS

JANUARY

- **10–11, Milk Pasteurization and Process Control School,** University of Wisconsin-Madison, Madison, WI. For more information, contact Dr. Scott Rankin at 608.263.2008 or go to www.cdr.wisc.edu.
- **16–18, Principles of Microbiological Troubleshooting in Your Factory: Real Problems/Real Answers,** San Diego, CA. For more information, call Robert Behling at 608.772.2992; E-mail: rbehling@msn.com; Web site www.kornackifoodsafety.com.
- **25–27, 2006 International Poultry Expo,** Georgia World Congress Center, Atlanta, GA. For more information, call 770.493.9401 or go to www.ipe06.org.

FEBRUARY

- **7–9, FPA's 2006 Food Claims and Litigation Conference,** San Juan, Puerto Rico. For more information, go to www. fpa-food.org.
- **8–9, Quality Milk Conference,** University of Wisconsin-Madison, Madison, WI. For more information, contact Dr. Scott Rankin at 608.263.2008 or go to www. cdr.wisc.edu.
- **13–14, ISO 22000 Food Safety Management System Essentials,** Mississauga, Ontario, Canada. For more information, call Canadian Standards Association at 800.463.6727; E-mail: seminars@csa.ca.
- **20–23, 2nd International Conference on Microbial Risk Assessment: Foodborne Hazards,** The Sofitel Wentworth Hotel, Sydney, Australia. For more information, call 61.2. 8399.3996; E-mail: aifst@aifst.asn.au.
- **21–25, 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.
- **26–March 3, International Meeting on Radiation Processing,** Hilton Kuala Lumpur, Malaysia. For more information, go to www.imrp2006.com.
- **28–March 1, Wisconsin Process Cheese Short Course,** University of Wisconsin-Madison, Madison, WI. For more information, contact Dr. Bill Wendorff at 608.263.2015 or go to www.cdr.wisc.edu.

MARCH

- **8–10, Food Safety World Conference and Expo,** Washington, D.C. For more information, go to www. foodsafetyworldexpo.com.
- **16–18, International Conference on Women and Infectious Diseases: Progress in Science and Action,** Atlanta Marriott Marquis Hotel, Atlanta, GA. For more information, contact Sakina Jaffer at 404.371.5308; E-mail: smj1@cdc.com.
- **19–22, Annual Conference of the Association for General and Applied Microbiology,** Jena, Germany. For more information, call 49.(0)3641. 65.66.42; E-mail: vaam@conventus.de.
- **22–24, Food Safety Summit,** Mandalay Bay Convention Center, Las Vegas, NV. For more information, call 800.746.9646 go to www.foodsafety summit.com.
- **26–29, Food Microbiology Research Conference XX 2006,** Radisson Hotel Northbrook, Northbrook, IL. For more information, call 847.298. 2525 or go to www.radisson.com. fmrc.

APRIL

- **7–12, Conference for Food Protection,** Hyatt on Capitol Square, Columbus, OH. For more information, contact Trevor Hayes at 408.848.2255; E-mail: TWHgilroy@starband.net.
- **12–13, ISO 22000 Food Safety Management System Internal Auditor,** Mississauga, Ontario, Canada. For more information, call Canadian Standards Association at 800.463.6727; E-mail: seminars@csa.ca.

MAY

- **12–14, Interbake China 2006,** Guangzhou International Convention & Exhibition Center, Guangzhou, China. For more information, go to www. faircanton.com.

IAFP UPCOMING MEETINGS

AUGUST 13-16, 2006
Calgary, Alberta, Canada

JULY 8-11, 2007
Lake Buena Vista, Florida

AUGUST 3-6, 2008
Columbus, Ohio

The index and/or table of contents has been removed and photographed separately within this volume year.

For roll film users, this information for the current volume year is at the beginning of the microfilm. For a prior year volume, this information is at the end of the microfilm.

For microfiche users, the index and/or contents is contained on a separate fiche.

CAREER SERVICES SECTION

QUALITY ASSURANCE SUPERVISOR

At Wayne Farms, our recipe for success begins with the highest-quality ingredients: our employees. Each one plays a critical role in creating our professional, collaborative environment and contributing to our success as the most technically advanced producers of superior poultry products. We are currently seeking QA Supervisors in the Northeast Georgia area. Under the direction of the QA Manager, supervises QA activities and monitors product quality and workmanship in manner consistent with the standard operating procedures of the company. Prefer Bachelor degree in food science or closely related discipline plus 6-24 months experience in food processing quality environment. See all our career opportunities at http://waynefarms.hodesiq.com/job_start.asp.

SCIENTIST, MICROBIOLOGY

The Food Products Association is the voice of the $500 billion food processing industry on scientific and public policy issues involving food safety, food security, nutrition, technical and regulatory matters and consumer affairs. The scientists and professional staff represent food industry interests on government and regulatory affairs and provide research, technical assistance, education, communications and crisis management support for the Association's U.S. and international members.

The Scientist, Microbiology will perform research for FPA members and will serve as a technical resource to FPA staff and members in the areas of microbiology and microbiological safety of food. Core job duties include: perform research, publish/present research findings, identify external funding for research, provide input to the identification of emerging issues, provide information to staff and members provide guidance to junior level technicians and scientists, and serve as instructor for various FPA training, workshops and seminars. Requirements: Master's degree in food microbiology/food science with 6 yrs. of work exp. in a food microbiology related position, Ph.D. preferred with 2 yrs. of work exp. in a food microbiology related position, Publication/presentation record in Food Microbiology arena, Ability to develop a food microbiology research program, Excellent written/oral communication skills; strong interpersonal skills.

To apply email resume and salary requirements to FPAHRMail@fpa-food.org, fax to (202) 637-8069, or mail to FPA, 1350 I St., Suite 300, NW, Washington, D.C. 20005.

EOE

IAFP Members

Did you know that you are eligible to place an advertisement if you are unemployed and looking for a new position? As a Member benefit, you may assist your search by running an advertisement touting your qualifications.

INTERNATIONAL ASSOCIATION FOR FOOD PROTECTION

General Fund Statement of Activity For the Year Ended August 31, 2005

Revenue:	
Advertising	113,918
Membership & Administration	498,379
Communication	785,376
Annual Meeting	827,795
Workshops	25,022
Total revenue	$2,250,490
Expense:	
Advertising	99,249
Membership & Administration	586,884
Communication	754,311
Annual Meeting	483,251
Workshops	14,784
Total expense	$1,938,479
Change in General Fund:	**$312,011**
Net Assets as of 8/31/05:	
General Fund	502,735
Foundation Fund	297,527
Restricted Fund	44,077
Speaker Travel Fund	55,420
Total net assets	$899,759

ADVERTISING INDEX

Journal of Food Protection®

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Official Publication

International Association for Food Protection®

Reg. U.S. Pat. Off.

Vol. 68 | November 2005 | No. 11

Research Notes

* Asterisk indicates author for correspondence.

AUDIOVISUAL LIBRARY ORDER FORM

The use of the Audiovisual Library is a benefit for **Association Members only.** Limit your requests to five videos. Material from the Audiovisual Library can be checked out for 2 weeks only so that all Members can benefit from its use.

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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

Member # _____

First Name _____ M.I. _____ Last Name _____

Company _____ Job Title _____

Mailing Address _____

Please specify: ❒ Home ❒ Work

City _____ State or Province _____

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Telephone # _____ Fax # _____

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PLEASE CHECK BOX NEXT TO YOUR VIDEO CHOICE

(Allow 4 weeks minimum from date of request.)

DAIRY

- ❒ D1010 The Bulk Milk Hauler: Protocol & Procedures
- ❒ D1020 Causes of Milkfat Test Variations & Depressions
- ❒ D1030 Cold Hard Facts
- ❒ D1040 Ether Extraction Method for Determination of Raw Milk
- ❒ D1041 Dairy Plant
- ❒ D1050 Food Safety: Dairy Details
- ❒ D1060 Frozen Dairy Products
- ❒ D1070 The Gerber Butterfat Test
- ❒ D1080 High-Temperature, Short-Time Pasteurizer
- ❒ D1090 Managing Milking Quality
- ❒ D1100 Mastitis Prevention and Control
- ❒ D1105 Milk Hauling Training
- ❒ D1110 Milk Plant Sanitation: Chemical Solution
- ❒ D1120 Milk Processing Plant Inspection Procedures
- ❒ D1125 Ohio Bulk Milk Hauling Video
- ❒ D1130 Pasteurizer: Design and Regulation
- ❒ D1140 Pasteurizer: Operation
- ❒ D1150 Processing Fluid Milk
- ❒ D1160 Safe Milk Hauling – You're the Key
- ❒ D1170 3-A Symbol Council
- ❒ D1180 10 Points to Dairy Quality

ENVIRONMENTAL

- ❒ E3010 The ABC's of Clean – A Handwashing and Cleanliness Program for Early Childhood Programs
- ❒ E3020 Acceptable Risks?
- ❒ E3030 Air Pollution: Indoor
- ❒ E3031 Allergy Beware
- ❒ E3040 Asbestos Awareness
- ❒ E2012 Better TEDs for Better Fisheries
- ❒ E3050 Down in the Dumps
- ❒ E3055 Effective Handwashing – Preventing Cross-Contamination in the Food Service Industry
- ❒ E3060 EPA Test Methods for Freshwater Effluent Toxicity Tests (Using Ceriodaphnia)
- ❒ E3070 EPA Test Methods for Freshwater Toxicity Tests (Using Fathead Minnow Larva)
- ❒ E3075 EPA: This is Super Fund
- ❒ E3080 Fit to Drink
- ❒ E3090 Food-Service Disposables: Should I Feel Guilty
- ❒ E3110 Garbage: The Movie
- ❒ E3120 Global Warming: Hot Times Ahead
- ❒ E3125 Good Pest Exclusion Practices
- ❒ E3128 Integrated Pest Management (IPM)
- ❒ E3130 Kentucky Public Swimming Pool and Bathing Facilities
- ❒ E3131 Key Pests of the Food Industry
- ❒ E3133 Physical Pest Management Practices
- ❒ E3135 Plastics Recycling Today: A Growing Resource
- ❒ E3140 Putting Aside Pesticides
- ❒ E3150 Radon
- ❒ E3160 RCRA-Hazardous Waste
- ❒ E3161 The Kitchen Uncovered: Orkin Sanitized EMP The New Superfund: What It Is and How It Works
- ❒ E3170 Tape 1 – Changes in the Remedial Process: Clean-up Standards and State Involvement Requirements
- ❒ E3180 Tape 2 – Changes in the Removal Process: Removal and Additional Program Requirements
- ❒ E3190 Tape 3 – Enforcement & Federal Facilities
- ❒ E3210 Tape 4 – Emergency Preparedness & Community Right-to-Know
- ❒ E3220 Tape 5 – Underground Storage Tank Trust Fund & Response Program
- ❒ E3230 Tape 6 – Research & Development/Closing Remarks
- ❒ E3235 Regulatory and Good Manufacturing Practices
- ❒ E3236 Rodent Control Strategies
- ❒ E3240 Sink a Germ
- ❒ E3245 Wash Your Hands
- ❒ E3250 Waste Not: Reducing Hazardous Waste
- ❒ E3251 Would Your Restaurant Kitchen Pass Inspection?

FOOD

- ❒ F2005 A Lot on the Line
- ❒ F2007 The Amazing World of Microorganisms
- ❒ F2008 A Recipe for Food Safety Success
- ❒ F2009 Basic Personnel Practices
- ❒ F2010 Close Encounters of the Bird Kind
- ❒ F2011 Available Post Harvest Processing Technologies for Oysters
- ❒ F2013 Control of *Listeria monocytogenes* in Small Meat and Poultry Establishments
- ❒ F2014 Controlling Food Allergens in the Plant
- ❒ F2015 Controlling *Listeria*: A Team Approach
- ❒ F2016 Bloodborne Pathogens: What Employees Must Know
- ❒ F2020 Egg Handling and Safety
- ❒ F2021 Egg Production
- ❒ F2030 "Egg Games" Foodservice Egg Handling & Safety
- ❒ F2035 Fabrication and Curing of Meat and Poultry Products
- ❒ F2036 Emerging Pathogens and Grinding and Cooking Comminuted Beef
- ❒ F2037 Cooking and Cooling of Meat and Poultry Products
- ❒ F2039 Food for Thought – The GMP Quiz Show
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- ❒ F2081 Food Safety Begins on the Farm
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- ❒ F2100 Food Safety for Food Service Series I
  Tape 1 – Food Safety for Food Service: Cross Contamination
- ❒ F2101 Tape 2 – Food Safety for Food Service: HACCP
- ❒ F2102 Tape 3 – Food Safety for Food Service: Personal Hygiene
- ❒ F2103 Tape 4 – Food Safety for Food Service: Time and Temperature Controls
- ❒ F2104 Food Safety for Food Service Series II
  Tape 1 – Basic Microbiology and Foodborne Illness
- ❒ F2105 Tape 2 – Handling Knives, Cuts, and Burns
- ❒ F2106 Tape 3 – Working Safely to Prevent Injury
- ❒ F2107 Tape 4 – Sanitation
- ❒ F2110 Food Safety is No Mystery
- ❒ F2111 Controlling *Salmonella*: Strategies That Work
- ❒ F2120 Food Safety: For Goodness Sake Keep Food Safe
  Food Safety Zone Video Series
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- ❒ F2162 Tape 2 – Personnel and Personnel Practices
- ❒ F2163 Tape 3 – Building and Facilities
- ❒ F2164 Tape 4 – Equipment and Utensils
- ❒ F2165 Tape 5 – Production/Process Controls
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- ❒ F2501 Tape 2 – Receiving and Storage
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- ❒ M4020 Eating Defensively: Food Safety Advice for Persons with AIDS
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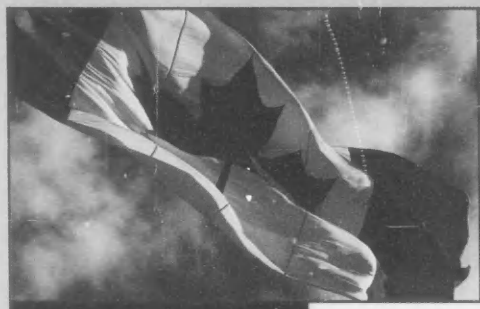




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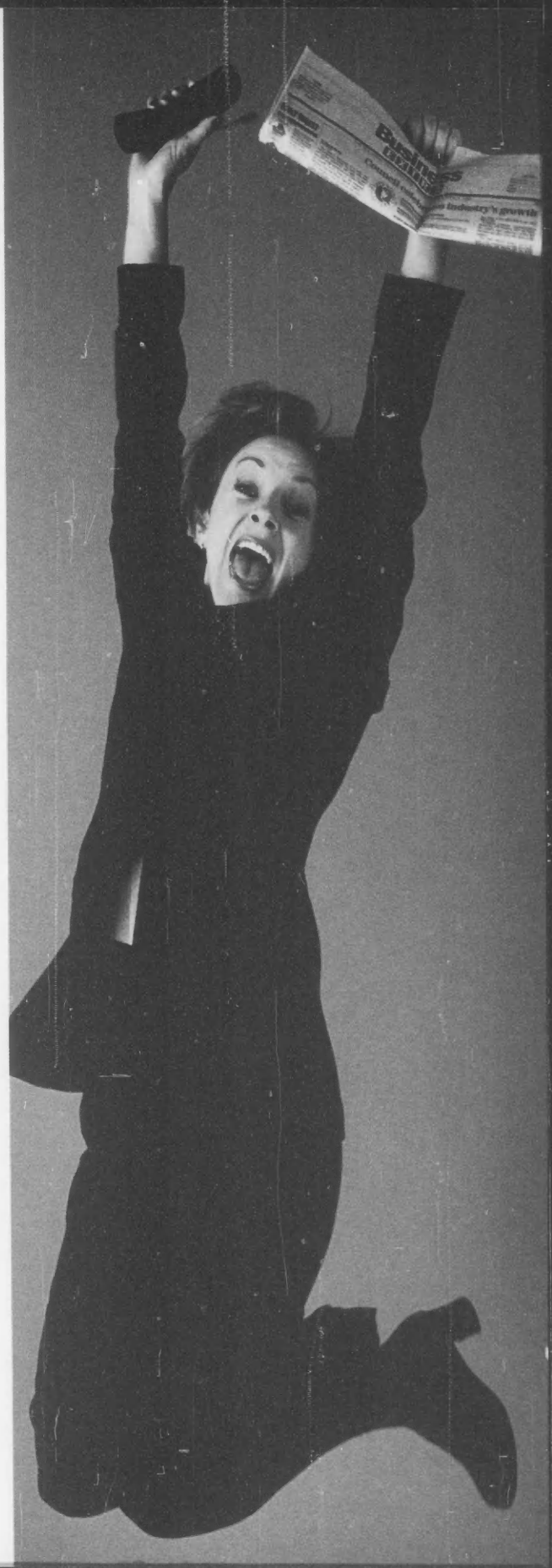

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