

Minimizing *Listeria* Contamination in Smoked Seafood: Training Plant Personnel

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SUMMARY

The Smoked Seafood Working Group (SSWG), a collaboration of two national industry trade organizations, smoked seafood processors and academia, has developed guidelines for controlling *Listeria monocytogenes* in smoked seafood operations. The SSWG identified five elements in a complete *L. monocytogenes* control program: *Listeria*-specific sanitation and GMP controls, employee training, environmental monitoring and testing, raw material controls, and finished product controls. This manuscript describes specific employee training strategies for enhancing sanitation and GMP controls to minimize *Listeria* contamination in smoked seafood operations. Three employee-training programs in the form of PowerPoint™ presentations are described. One provides generic training for all employees, the second provides training to workers who handle finished products to minimize cross contamination, and the third provides training for all individuals who conduct cleaning and sanitizing activities to ensure that both general and specific procedures to control *Listeria* are implemented and conducted properly. All three employee-training programs can be downloaded from the following Web site at Cornell University: <http://www.foodscience.cornell.edu/wiedmann/TrainingIndex.htm>.

INTRODUCTION

Since 2001, a collaborative effort between two national industry trade associations, representatives from smoked seafood processing companies across the US, and academia has been under way to develop guidelines to minimize *Listeria monocytogenes* contamination in smoked seafood manufacturing plants. The intent of this effort is to gather current information on *Listeria monocytogenes* and on appropriate measures to reduce its prevalence in smoked seafood products, and to help processors of smoked seafood products evaluate and implement effective controls in their operations. The individuals and organizations involved in this effort are working together as the Smoked Seafood Working Group (SSWG) of the National Fisheries Institute and the National Food Processors Association. Representatives of both national industry trade organizations, individuals from at least 10 smoked seafood firms, and food safety or seafood specialists from Cornell University, Virginia Tech and the Sea Grant programs in New York and Delaware are participating in SSWG activities. The SSWG utilized the experience and expertise of industry, trade association and academic participants to adapt and apply general guidelines for *Listeria* control to the specific environment of smoked seafood processing plants.

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L. monocytogenes is a Gram-positive, foodborne pathogen that can grow under many different environmental conditions, including at temperatures from 1° to 45°C (34° to 113°F) and between zero and 10% water phase salt (NaCl). Under current US regulatory policy, if any *L. monocytogenes* is detected in a 25-gram sample of a Ready-To-Eat (RTE) product, including smoked seafood, the product is considered adulterated. Its presence in smoked fish and other RTE food products has resulted in numerous product recalls and economic loss. *L. monocytogenes* is widespread in the environment and can be readily isolated from humans, domestic animals (including pets), raw agricultural commodities, food processing environments, and the home (21). The organism is found in a wide variety of foods, including meats, poultry, vegetables, dairy products, and fishery products (5, 11, 19, 21). It has frequently been isolated from smoked seafood (4, 6, 11, 16, 18). Previous studies have reported a prevalence of 6-36% in RTE cold-smoked salmon and cooked fishery products (3). A recent survey by the National Food Processors Association Research Foundation suggests a prevalence of about 5% in smoked seafood in the US (11). Although *L. monocytogenes* present in raw fish may survive process treatments typical for many minimally processed seafoods, such as cold-smoked products (7), contamination from the processing plant environment during or after processing appears to be the major source of finished product contamination for smoked seafood, as well as for other RTE foods (1, 13, 20, 26).

Because *L. monocytogenes* is ubiquitous, there can be a constant re-introduction of the organism into the plant environment. Contamination of smoked seafood that supports growth of *L. monocytogenes*, even with small quantities of this organism, is a particular concern to the food industry because of the organism's ability to multiply at refrigeration temperatures during storage.

L. monocytogenes can survive in non-host environments, including processing plants, into which it may be introduced via a variety of routes, including raw materials, employees' shoes or clothes, and containers and equipment (boxes, crates, carts). *L. monocytogenes* tolerates and can grow in conditions (e.g., refrigeration temperatures and high salt levels) that prevent the growth of many other foodborne pathogens. *L. monocytogenes* also has the tendency to establish persistent resident

populations that colonize niches in the plant (13, 17, 25, 26) that are not easily eliminated by routine sanitation procedures and general-purpose cleaners and sanitizers.

An Institute of Food Technologists (IFT) expert panel identified several methods to control *L. monocytogenes* in the smoked seafood processing environment. Reduction of *L. monocytogenes* in the processing plant was directly dependent on adherence to Good Hygienic Practices (GHPs) and Good Manufacturing Practices (GMPs) (15). Employees and processing personnel represent a potential source for the introduction of *L. monocytogenes* into the processing plant environment; not only can they transfer *L. monocytogenes* from one area of the plant to another on their shoes, clothing, hands, etc., but they may also serve as direct sources of contamination if they are involved in post-processing handling of products. It has been shown that 1-10% of healthy adults may be fecal carriers of *L. monocytogenes* (8, 23).

Training in the area of food safety, particularly of the training-the-trainer type, has been shown to have a substantial impact in changing the audience's attitudes and behaviors about food handling. This holds true whether the training is for extension agents (who are trained to educate consumers), food service managers, food processing operators, regulators, or plant workers (2, 9). Food safety training is common sense and an essential part of good food operations; having well-trained employees may provide benefits such as avoiding the costs related to a foodborne illness outbreak, improving employee performance and morale, and increasing customer satisfaction, and increasing compliance with regulations. In addition, Sagoo et al. (22) have shown a direct relationship between microbial quality of ready-to-eat salad vegetables and the food safety training of management and the implementation of effective food safety procedures. The Hunter Health (14) training materials produced by the Australian government also indicate that groups that cater to high-risk populations, such as nursing homes, can benefit from targeted food safety training. A 2002 USDA (27) study that surveyed 861 meat slaughter and processing plants about HACCP costs and food safety technologies found that almost 100% indicated that on-the-job training and specific instructional training for both new and experienced workers on safe food handling practices was best. Stivers and Gates (24), in a survey of gro-

cery store seafood employees, found that HACCP awareness positively influenced seafood sales and recommended that it be included in employee training programs.

The first manuscript in this series described targeted sanitation procedures and GMP controls that should be considered when developing a *Listeria* control plan for smoked seafood operations (10). This manuscript will focus on the employee training programs that the SSWG determined are necessary to ensure that *Listeria* controls are effective and properly implemented.

TRAINING PLANT PERSONNEL

To implement an effective *Listeria* Control Program, each employee must understand his or her role in the program, why it is important, and the expectations of management. Control strategies are not likely to be effective if employees do not cooperate or do not understand what they are expected to do, why control strategies are important, and that expected procedures or behavior will be monitored and actions taken to reward compliance or penalize those who are non-compliant. Firms involved in the SSWG determined that employee training is best accomplished through a series of focused training activities conducted in the plant, by plant managers or other company personnel. Training is an ongoing process that should be conducted when employees are hired, before they start work, or if their position is changed, and then at least once per year afterwards. All training activities should be documented for all employees.

Three targeted training programs for *Listeria* control

The SSWG determined that three different targeted training programs should be delivered to employees and evaluated by each plant as part of their overall *Listeria* control plan: (1) Basic training for all employees who work at the plant, to ensure that they understand the importance of *Listeria* controls and their role in a firm's control plan; (2) Training for all employees who handle or work in exposed finished product areas, to ensure that they understand how to prevent cross contamination and; (3) Training for all employees who conduct cleaning and sanitation tasks or activities, to ensure that they understand the sanitation procedures necessary to reduce or eliminate *Listeria* contamination in the plant .

The basic training program should be conducted first and include basic information on *Listeria* as well as importance of employee hygiene, hand washing, and of adhering to established control procedures. Next, an additional training program should be provided to employees who work in areas where exposed finished products are handled to ensure that employees understand and follow procedures to prevent cross contamination, including descriptions of procedures or policies regarding work attire, hand washing, and the movement of equipment and personnel. Finally, individuals responsible for cleaning and sanitizing operations in all areas of the plant need to be trained to ensure they understand and follow established plant procedures necessary to reduce or eliminate *L. monocytogenes*. Basic training lessons, videos and support materials have been produced to help company personnel design and deliver training that will have the greatest impact in each individual situation. Specific on-site demonstrations of plant procedures should be included wherever possible.

Basic training can be accomplished in one session for all employees or can be separated into several sessions for employees who work in specific areas of the plant. After the basic training for all employees is completed, the two additional special training sessions should be conducted.

Cornell University and New York Sea Grant developed three training programs in collaboration with the Universities of Delaware and Maryland, Virginia Tech, Louisiana State University, the National Fisheries Institute, and National Food Processors Association. Each program is a PowerPoint™ (PPT) slide presentation that can be used by plant personnel to deliver the training in their plants. The PPT presentations consist of a series of slides designed to emphasize the information that should be delivered to employees during the training program. Each slide is accompanied by a set of “instructor notes” designed to provide ideas on how to deliver these programs, what points to emphasize, and demonstrations that can be used to facilitate training.

Obtaining the three employee training programs

Each of the employee training programs can be downloaded from the Internet at the following Cornell Univer-

sity Website: <http://www.foodscience.cornell.edu/wiedmann/TrainingIndex.htm>. At the bottom of the page is the following description:

“Each of the three training programs consists of a set of PowerPoint slides that can be used by management to train their employees. Each slide is accompanied by an extensive set of “speaker notes” designed to help plant management deliver an effective training program. These training programs are available on-line. Please click on the training program of interest to view the material on-line or download each presentation to your computer.”

- *Listeria* Training Program for All Employees
- Plant Cleaning & Sanitizing Training Program for *Listeria* Control
- Cross Contamination Prevention Training for *Listeria* Control Program

Note: If you are unable to download the programs from the Internet they are also available from New York Sea Grant. Contact Ken Gall by E-mail at klg9@cornell.edu. The PPT slide programs can be sent as attached files via E-mail or on a CD.

Conducting employee training in the plant

Specific training programs may need to be delivered in different ways. One session for all employees could be used to deliver the basic training program, or training can be separated into several sessions for employees who work in specific areas of the plant. These PPT training presentations can be presented using an LCD (liquid crystal display) projector or, for small groups of people, they can be shown on a computer screen. Another option for training small groups of people is to show the PPT training programs on your desk or laptop computer screen on a table or desk that everyone can see. If a simpler format is necessary (for example, if there is no access to a computer screen or to a LCD projector) overheads or handouts can be produced directly from the PPT presentations. With overheads (slides copied onto clear acetate sheets), the training can take place with small or larger groups. If no audiovisual aids are available, employees can simply follow along with the discussion by providing each employee with a printed copy of each slide in the presentation as a handout. For all training formats, providing copies of the slides in each PPT training presen-

tation can help reinforce the important points covered in the training session.

Before conducting employee training, it is important that each company evaluate its policies and make any necessary modifications regarding employee hygiene, hand washing, and movement in the plant. Each company must decide ahead of time, how policies and procedures that are taught in these training programs will be monitored and enforced before conducting training. If changes or modifications in company procedures are needed to enhance *Listeria* control, the employee training programs provide a good opportunity to start the implementation process. It may also be easier for employees to understand and adopt these changes if the changes are discussed in the context of specific actions to control *Listeria*.

Firms should also determine who is going to conduct the training. Training can be conducted by one or more instructors, including plant supervisors, managers, owner, or quality control/assurance personnel. A team of one or several individuals in these roles could be involved in each specific training program. Each plant will need to decide who will be involved in training to maximize effectiveness and facilitate the implementation of the specific policies and procedures needed for an effective *Listeria* control plan. Each company must decide ahead of time how policies and procedures that are taught in these training programs will be monitored and enforced. Each of the training programs includes hands-on activities and demonstrations suggested to reinforce what is taught. Each company trainer needs to think through, plan and determine how the demonstrations will be staged. For example, one demonstration may focus on hand washing, and the instructor will need to think through how this demonstration will be conducted. The instructor should determine how and where to demonstrate hand washing, who will be involved and whether or not supplemental materials such as the use of Glo Germ™ (www.glogerm.com) will be used, as suggested in the instructor notes of the PPT presentation.

It is important to document and keep records of the date and type of training received by each employee. Instructors should decide what procedures would be used to document training prior to conducting the training program. A procedure should also be in place to ensure that employees receive the training relevant to their job(s) at least once per year.

Figure 1. PPT training program for all employees

Listeria Controls for Smoked Fish

- What is Listeria?
- Why are we concerned about Listeria?
- Where is Listeria found?
- What can I do as an employee of a smoked fish, crab or crawfish processing plant?



Figure 2. Preventing cross contamination PPT training presentation

Listeria Controls in Finished Product (Higher Risk) Areas Preventing Cross Contamination



Figure 3. Cleaning and sanitation PPT training presentation

Plant Cleaning and Sanitation to Control Listeria



Basic Listeria training for all employees

The basic *Listeria* Training Program for All Employees is a short PowerPoint™ presentation that can be used to train all company employees, including office workers, management, and sales and maintenance staff, as well as plant production personnel. All employees need to understand what *Listeria* is and why it is a concern. All employees, even those who visit production areas only infrequently, should understand the firm's *Listeria* control efforts and the role of employees in preventing the movement of contamination in the plant. In this way, all employees can be vigilant and part of the firm's team effort to help control this tenacious organism.

The PPT training program can be downloaded from the Cornell Web site as described above by clicking on the words: *Listeria* Training Program for All Employees. The first slide in this presentation is provided in Fig. 1.

Major topics included in this training program are: (1) Background information that includes an introduction to *Listeria*, potential impacts on customers (high-risk groups, mortality rate, etc.) and companies (recalls, examples of plants closing, etc., that can result in loss of employee jobs and income), FDA/FSIS risk assessment and current regulations. (2) A review of company policies and procedures related to personal and bathroom hygiene, food handling practices, and movement in the plant. (3) A review of company policies and procedures on hand washing; this may include a demonstration on how to wash hands properly and a review of when to wash hands.

Focused training for workers in areas where finished products are handled

All employees who handle exposed finished products or work in finished product areas should receive this training. For smoked seafood operations, this will likely include employees who smoke product and employees who handle, trim, slice and pack exposed finished products. This training is a "How To" session and should be conducted on site. Employees should understand what cross contamination is, how their activities or mistakes can cause finished product to become contaminated with *Listeria*, and the potential consequences of that contamination. All of the necessary employee

Figure 4a and 4b. Example slide (A) and accompanying instructor notes (B) for the plant cross contamination training program

You prevent Cross Contamination by Washing Your Hands



- ✓ Before you start work
- ✓ After using the bathroom
- ✓ After leaving your work area
- ✓ Before returning to your work area
- ✓ After touching your body
- ✓ After touching dirty objects

Sample Slide Instructor Notes:

This slide is designed to focus on how people in the plant can cause cross contamination with their hands. Give examples of how your hands can get contaminated:

- On your way to work
- While you're in the bathroom
- When you leave the work area for lunch, breaks or go to raw product areas
- When you touch your body such as your face, nose, mouth, hair, etc.
- When you touch dirty objects such as the floor, trashcans, waste bins, etc.

Emphasize that the only way to prevent the transfer of bacteria from these sources is to properly clean and sanitize your hands before working with products.

hygiene and food handling practices should be discussed and demonstrated, as well as any sanitation procedures that these employees conduct.

This PPT training program can be downloaded from the Cornell Web site as described above by clicking on the words Cross Contamination Prevention Training for *Listeria* Control Program. The first slide in this presentation is provided in Fig. 2.

Major topics included in this training program are: (1) Overview and control of cross contamination; (2) Description of how the movement of employees

and equipment into and out of specific areas of the plant can result in contamination of products by racks, carts, splashing, materials, and other plant utensils; (3) Importance of hand washing and sanitizing after touching unsanitary objects such as raw product, trash containers, surfaces from outside areas, floors and other specific contamination sources in the plant; this may include demonstrations on hand washing and (4) Description of special company policies and procedures for employee attire, hygiene and hand washing procedures in finished product areas.

Focused training for cleaning and sanitation personnel

This training program is designed to provide instruction on how and when cleaning and sanitation procedures should be conducted. All employees who conduct these activities should be trained. Specific training may need to be conducted for individuals responsible for cleaning and sanitizing specific areas of the plant, since the procedures used in finished product areas may be different from those in raw material handling areas. Individuals responsible for specialized cleaning and sanitation tasks, such as cleaning and sanitizing coolers, smokehouses, smoker racks carts, dollies, etc., may also need specialized training. This training program should be conducted on site in small groups to demonstrate how to do all of the different sanitation procedures correctly and should be primarily a "How To" session. Companies need to be sure that they make all necessary changes in their sanitation procedures, including the type of cleaners and sanitizers that will be used, the equipment and cleaning tools that will be used, color coding schemes, procedures, and monitoring requirements, before they conduct this training.

This PPT training program can be downloaded from the Cornell Web site as described above by clicking onto the words: Plant Cleaning & Sanitizing Training Program for *Listeria* Control. The first slide in this PPT presentation is provided in Fig. 3.

Major topics included in this training program are: (1) Overview of company procedures for cleaning and sanitation of each plant area and a description of the products and equipment used and when the procedures must be conducted; (2) Detailed description and demonstration of specific procedures conducted by those who are being trained; specific procedures may need to be covered for drains, end-of-shift/day cleaning and sanitizing, utensils and portable items, coolers, smokehouses, racks and other conveyances, special equipment such as slicers and other procedures as necessary; and (3) Monitoring, reporting, and problem solving and other special procedures to be used when problems are identified.

Using PPT instructor notes to help deliver the training programs

Instructor notes are included in each of the three PPT training program to help the instructor(s) plan and deliver their training sessions. The instructor notes can

TABLE 1. Learning objectives of the safe food depends on your training guide

1. Trained workers will understand the importance of and adopt good hand washing techniques, wear appropriate attire in the processing plant, and practice proper hygiene.
2. They will understand how proper cooling and storage methods, recommended cooking times and temperatures, and holding methods minimize risk.
3. Workers will learn how cross contamination occurs and how to prevent it from happening.
4. The workers will understand the importance of proper cleaning and sanitizing procedures.

be found below the image of each slide when the presentation is opened in the appropriate view. Selecting the “Notes Pages” as the option under “Print What” can also print out a copy of the slide with instructor notes. The instructor notes are talking points designed to remind the instructor what points to cover with each slide in the presentation. Tips for demonstrations or other activities are also included in this section of the presentation so that the instructor can provide additional information to help the plant workers who are being trained to understand the material better. An example of the slide and instructor notes provided in the cross contamination *Listeria* PPT training program are in Fig. 4A and 4B.

Customizing the training materials

The PowerPoint™ presentations were designed to provide a structure that will help plant management deliver effective training on *Listeria* controls. They were specifically designed for smoked fish and other seafood processors, but can be easily adapted for use in plants processing other RTE foods. Inserting pictures of your own plant, employees, and equipment to replace the photographs that are provided in the presentations can also customize the presentations. The sample procedures provided in the presentations can also be customized to include the specific cleaning, sanitizing, hand washing, and hygiene procedures and policies used in each individual plant. The tools needed to customize these presentations are widely available and include a digital camera to take appropriate photos in the plant, commonly available software for loading digital photos into a computer, and the

PowerPoint™ software program. Firms who have used these training programs have provided positive feedback on their success in customizing them for their specific plant and employees.

OTHER TRAINING RESOURCES

Other resources to facilitate employee training are available from a number of public and private sources. These materials can include a variety of different training aids including lessons, videotapes, manuals, workbooks, and activities. A specific training program developed for food handlers in processing plants entitled “Safe Food Depends on You” is described in detail below. A brief list of government, trade association, and other Web sites that contain lists of other training resources available from a variety of sources is provided at the end of this section.

Safe food depends on you – training guide for food handlers

A training tool that can be used to supplement the basic employee PowerPoint training programs described above and help instructors plan specific activities or demonstrations is the “Safe Food Depends on You” Training Guide. The purpose of this publication is to assist in training entry-level, English and Spanish-speaking workers in the food processing industry (12). “Safe Food Depends On You” was developed by food safety specialists from the University of Delaware and the University of Maryland, with partial funding provided by USDA CSREES Food Safety and Quality Competitive Project Number 95-EFSQ-1-4157. The

Training Guide emphasizes the importance of food handling practices that can reduce the risk of foodborne illness. These training materials were designed for low-literacy workers, but can be used with all educational levels. The materials were designed to help the food industry meet the continuing high expectations for a safe food supply and the HACCP regulations, which require a more formal educational program for all workers, including those working directly on the processing line. The theme or underlying story of “Safe Food Depends on You” emphasizes a system of values and sharing of the learning (training) process. For many workers, knowledge gained from the training provided in the video and activities in this guide can be practiced at home and with their co-workers. “Safe Food Depends on You” is designed to teach workers, using an enjoyable and not-too-technical approach, how and why we handle food products a certain way.

The “Safe Food Depends On You” training materials cover four important areas that are critical for workers to understand in order to follow a company’s Sanitation Standard Operating Procedures (SSOP). Table 1 lists the learning objectives of the “Safe Food Depends On You” Training Guide. In addition to the Training Guide, there is a video that can be used by itself or with the Guide to help illustrate what happens in actual processing plants. The “Safe Food Depends on You” training manual also includes hands-on activities to help reinforce each of these learning objectives. In addition, there are pre- and post-tests, in English and Spanish, to help assess the effectiveness of the training. The manual can be downloaded from the Internet at the Maryland Sea Grant Web site: http://www.mdsg.umd.edu/Extension/safe_seafood.pdf.

In addition to the Training Guide and video, ten food safety posters have been designed to assist with training and serve as reminders of appropriate behavior in the food processing facility. An example is provided in Fig. 5. The trainer can use these posters to explain appropriate food safety practices during the training. The poster can then be placed in appropriate places in the plant to remind employees of what they learned and how they can help keep the food the company produces safe to eat.

Other resources for information on *Listeria* and training resources

Many resources are available to food processors, retailers and food service busi-

TABLE 2. Web site resources for information on *Listeria monocytogenes* and training

Government Agencies –

USDA/FDA Foodborne Illness Education Information Center –
<http://www.nal.usda.gov/fnic/foodborne/haccp/index.html>

FDA <http://www.cfsan.fda.gov>

USDA <http://www.usda.gov/>

AFDO <http://afdo.org/>

National Seafood HACCP Alliance for Education and Training –
<http://www-seafood.ucdavis.edu/haccp/training/training.htm>

Trade Organizations –

National Fisheries Institute – <http://www.nfi.org/>

National Food Processors Institute – <http://www.nfpa-food.org/>

University Resources –

UC Davis web site Training Resources –
<http://seafood.ucdavis.edu/Pubs/99resources.htm>

Cornell Department of Food Science –
<http://www.foodscience.cornell.edu/wiedmann/index.html>

New York Sea Grant –
<http://www.nyseagrant.org/seafoodtechnology>

University of Delaware Sea Grant –
<http://www.ocean.udel.edu/seagrant/outreach/seafood.html>

University of Maryland Sea Grant –
<http://www.mdsg.umd.edu/Extension/sftechnology.html>

Virginia Tech – <http://www.cfast.vt.edu/>

Louisiana State University Department of Food Science –
<http://www.agctr.lsu.edu/foodscience/>

Pennsylvania State University –
<http://foodsafety.cas.psu.edu/>

nesses to provide additional information and help. These resources include professionals from the private sector and public universities and cooperative extension programs, such as the authors of this manuscript, government agencies, trade organizations, the Internet, research papers and reviews, and consultants. Table 2 gives brief list of some of the key Internet sites providing information that can be used as training material and in training programs for employees in seafood and other food processing plants, retail stores, restaurants, and other food service businesses. Many of these sites contain information specific to *L. monocytogenes* and

its control. Links to almost all of these materials can be found at the first location on the list, the USDA/FDA Foodborne Illness Education Information Center.

SUMMARY

Employee training is an integral part of an effective *Listeria* control program, and the SSWG has identified three different targeted training programs that should be delivered to employees in the plant and taught by plant personnel. These training programs consist of: (1) Basic training for all employees who work at the plant, to ensure that they understand

Figure 5. Example of poster icons used in safe food depends on you



Keep Area Clean/Mantengan
Superficie Limpia

the importance of *Listeria* controls and their role in a firm's control plan, (2) Training for all employees who handle or work in exposed finished product areas, to ensure that they understand how to prevent cross contamination of product, and (3) Training for all employees who conduct cleaning and sanitation tasks or activities, to ensure that they understand the sanitation procedures necessary to reduce or eliminate *Listeria* in the plant. Three PowerPoint™ (PPT) slide presentations developed by Cornell University and New York Sea Grant in collaboration with the Universities of Delaware and Maryland, Virginia Tech, Louisiana State University and the National Fisheries Institute and National Food Processors Association, are available to help plant personnel deliver training programs. Sources for other training resources are also available from government, trade association and university programs.

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NY. The experience, expertise, time and commitment that each of these individuals contributed to this effort provides an exceptional example of the type of industry collaboration and cooperation needed to solve difficult food safety issues such as those posed by *Listeria monocytogenes* for manufacturers of ready-to-eat foods like smoked seafood.

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