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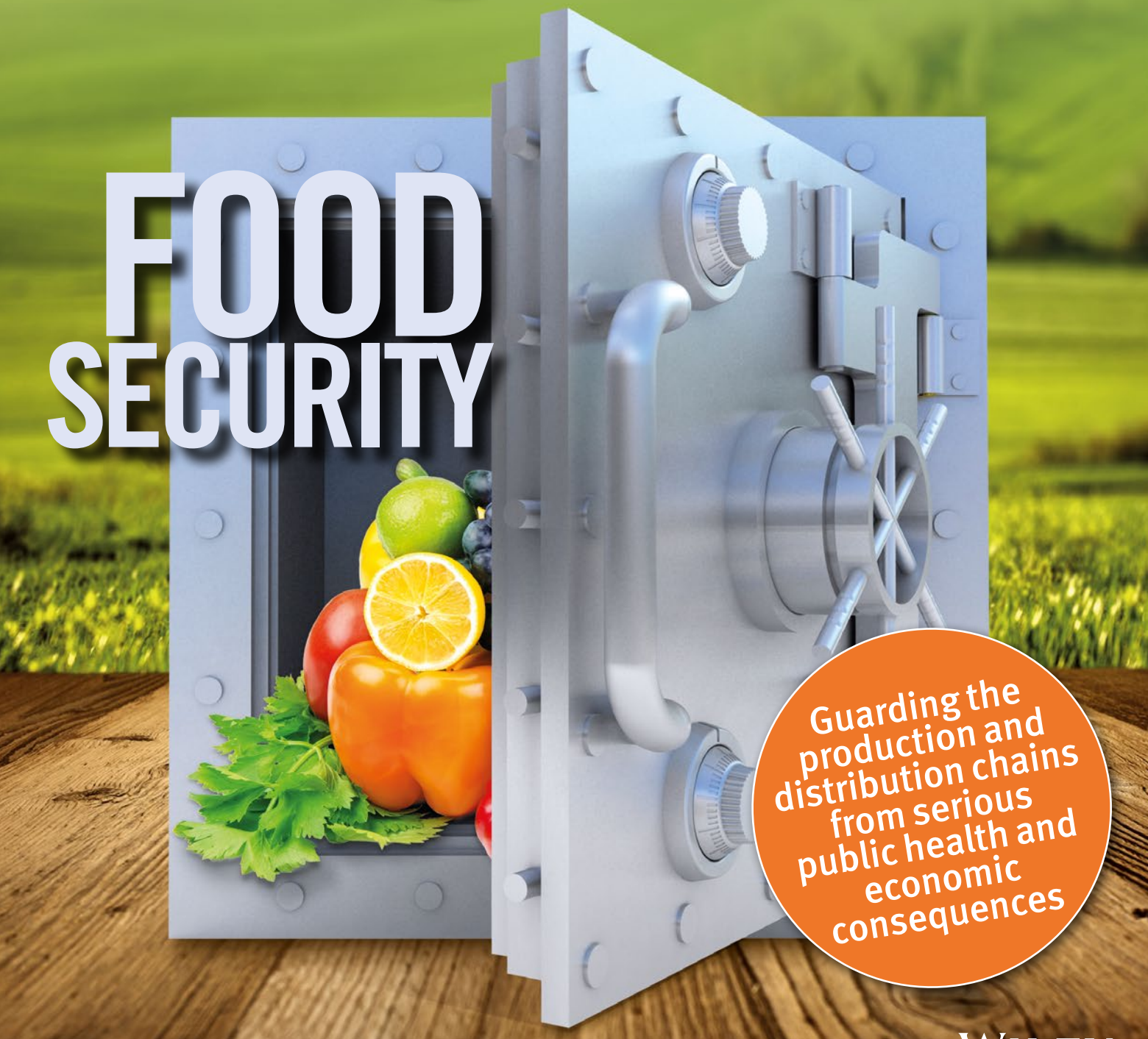
Volume 21 Number 5
OCTOBER/NOVEMBER 2014

Food Quality & Safety

FARM TO FORK SAFETY



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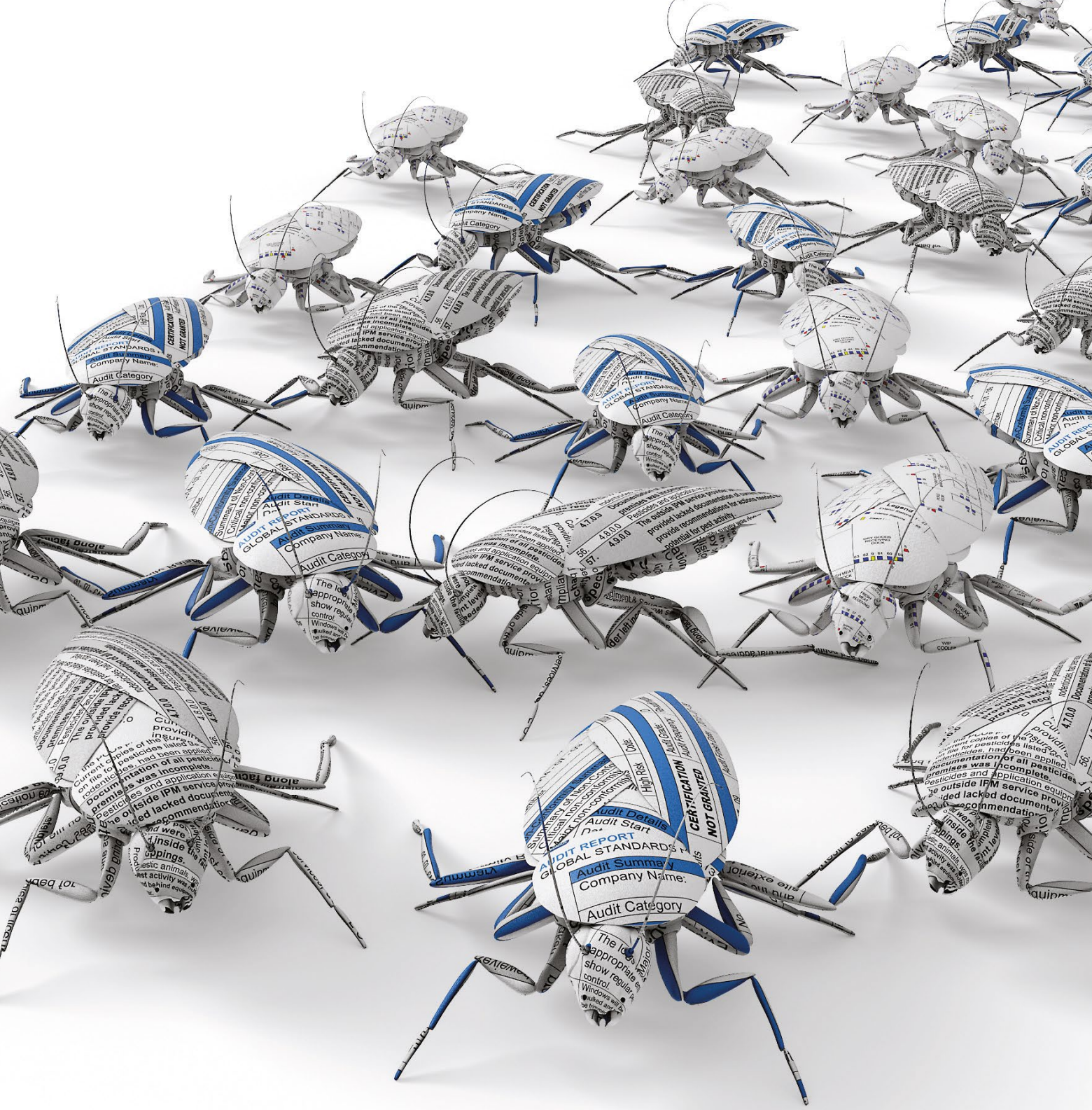

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FOOD SECURITY

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Testing

In The Lab

Manufacturing & Distribution

Exclusive Online Content

To read these articles, go to the October/November issue on www.foodqualityandsafety.com:

- USDA Food Safety Postcards—A Father's Take on 'Wish You Were Here'
- The Case for Product Lifecyle Management in Combatting Food Fraud

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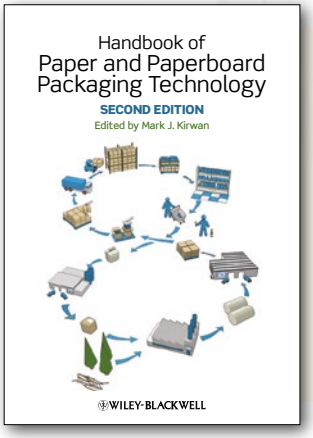
Departments

CORRECTION

On page 44 in the New Products section of the August/September 2014 *Food Quality & Safety* issue, Heat and Control's metal detection image incorrectly ran on the previous page. The following is an abbreviated summary of the listing with correct image.

CEIA MS-21 Multi-Spectrum metal detectors eliminate the waste and delay of false rejects to increase inspection productivity and efficiency. It uses a simultaneous and continuous spectrum of frequencies to distinguish between metal contaminants and product effect conditions without reducing metal detection sensitivity. For more information, contact Heat and Control at 800-227-5980 or www.heatandcontrol.com.

HOTTEST TITLES IN FOOD PACKAGING



Handbook of Paper and Paperboard Packaging Technology, 2nd Edition

Mark J. Kirwan

978-0-470-67066-8 • Hardcover • 428 pages • February 2013

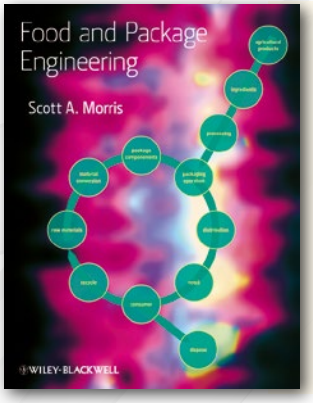
The definitive industry reference on the paper and paperboard packaging sector.

Food Industry Design, Technology and Innovation

Helmut Traitler, Birgit Coleman, Karen Hofmann

978-1-118-73326-4 • Hardcover • 312 pages • November 2014

In this ground-breaking book, the role of design in relation to food technology of every kind--including packaging--is described, discussed, challenged and put into proper perspective.



Food and Package Engineering

Scott A. Morris

978-0-8138-1479-7 • Hardcover • 480 pages • August 2011

Structuring the text around the package use cycle, the book takes a holistic approach to the systemic nature of the packaging industry.

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From The Editor

Are detection methods getting "smarter?" It certainly sounds that way.

For example, University of Alberta professors Anastasia Elias and Dominic Sauvageau and their research team in Canada are developing "smart labels" to detect harmful microbes that cause foodborne illnesses before products reach consumers.

While labels have already been developed to detect temperature change, temperature is only an indirect indicator of food spoilage. The material used to make the smart labels will be able to directly indicate the presence of bacteria, such as *E. coli*, *Salmonella*, or *Listeria*, by changing color.

Supported by the Alberta Meat and Livestock Agency, the project involves developing and combining three technologies: the stimuli-responsive polymer from which the smart material is made, the biological detection system, and food microbiology.

"With the smart materials, food suppliers and even consumers will instantly be able to see if a product has been contaminated just by looking at the color of the packaging," Sauvageau explains. The smart materials could also help pinpoint where and when the problem occurred, so action can be taken immediately to fix the problem. The research team is now two years into this three-year project, but still has work to do before commercial production.

In addition, there are smart utensils under development in China. This past summer, hundreds of eateries in Taiwan were found selling dishes made with cheaper cooking oil from sewers and garbage disposals. Naturally, this has the public clamoring for an easy solution to ensure that the oil used to prepare their food isn't adulterated with gutter oil. Chinese search engine company Baidu, the nation's equivalent to Google, says it has an answer: "smart chopsticks."

Baidu recently unveiled its prototype, named Kuaisou, which can allegedly identify the quality of cooking oil. The chopsticks are fitted with sensors that connect to a smartphone app to give users analyzed readings. When chopsticks are dipped into edible oil, an "excellent" reading is given. When dipped into recycled cooking oil, a "bad" reading appears—indicating the used oil is not safe.

As our food supply gets more complicated, the detection of contamination and adulteration cannot depend on traditional safety strategies, so smart detection methods like the above are promising and are hopefully precursors to more innovative processes.

"Technology is always evolving," adds Elias. "So there is room for constant improvement and alternative applications."

Marian Zboraj
Editor

Food Quality & Safety
FARM TO FORK SAFETY

PUBLISHER Lisa Dionne, ldionne@wiley.com
ASSOCIATE PUBLISHER Ken Potuznik, kpotuznik@wiley.com
EDITOR Marian Zboraj, mzboraj@wiley.com
DESIGN Maria Ender, mender@wiley.com
PRODUCTION Claudia Vogel, cvogel@wiley.com
Christiane Potthast, cpotthast@wiley.com
Elli Palzer, palzer@wiley.com
MANAGER, DIGITAL MEDIA & STRATEGY Jason Carris, jcarris@wiley.com

Advertising Sales Director
Stephen Jezzard
350 Main Street
Malden, MA 02148-5089
(781) 388-8532
sjezzard@wiley.com

Sales Office
U.S./Canada/International
Ken Potuznik
29822 N 51st Place, Cave Creek, AZ 85331
(480) 419-1851 • fax (480) 718-7719
kpotuzni@wiley.com

Editorial Office
111 River Street, Hoboken, NJ 07030-5774, USA
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NEWS & NOTES

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New Food Whistleblower Website

The Government Accountability Project has redesigned its mobile-friendly website for its Food Integrity Campaign at www.FoodWhistleblower.org. Campaign aims to protect and empower employees who speak out against waste, fraud, abuse, or violations of law along the food supply chain. The new site features a short animated video that highlights the community effort needed to safeguard food and the key role whistleblowers play to help keep the food system honest. Through the site's interactive Know Your Rights tool, whistleblowers can answer a brief series of questions to find out what legal rights they have, get details on the relevant laws, and decide whether to request legal assistance.

Joint Food Safety Efforts for U.S. and China

The Grocery Manufacturers Association and the Chinese National Food Industry Association sign a Memorandum of Understanding to intensify their joint food safety efforts in China and U.S. At a formal signing ceremony held in Beijing, the two organizations agreed to increase government-industry exchanges and dialogue on food safety, trade facilitation, and other common interests and to also seek opportunities to collaborate regionally and globally. Together, both organizations represent more than a thousand industry members, whose experiences are vital to ensuring food safety regulations are practical, focused, and deliver results.

Changes to Four FSMA Rules

The FDA has released significant updates to four proposed rules under FSMA. In Produce Safety, updates were made to water-quality and testing requirements, as well as to provisions on manure use. For Preventive Controls for Human Food, FDA updated requirements for product testing, environmental monitoring, and supplier controls; as well as changes to requirements for farms that pack or hold food from other farms. In Preventive Controls for Animal Food, updates in product testing, environmental monitoring, and supplier controls were made; as well as changes to requirements for human food facilities providing a byproduct to animal food. And for Foreign Supplier Verification Programs, a proposal for a more comprehensive evaluation of food and supplier risks was made, as well as a more flexible approach to determining supplier verification activities. The FDA will accept comments on revised provisions for 75 days after publication in Federal Register.

Allergen Controls at Retail

After being approached by several state food safety program managers about developing guidelines, the Association of Food & Drug Officials (AFDO) has now assembled an Ad-hoc Committee charged with creating a guidance document for controlling food allergens in retail food and food service establishments. Volunteers from federal and state government, the retail food industry, industry trade associations, and the Food Allergy Research & Education have agreed to participate in this effort. AFDO hopes the guidance can be developed in time to distribute at its Annual Conference in June 2015.

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Seafood Traceability Financial Tool

The Institute of Food Technologists Global Food Traceability Center's new Seafood Traceability Financial Tool assists organizations in the seafood industry in understanding the financial impact of implementing traceability. Developed with input from seafood business leaders and owners, and as part of its service to the seafood industry, this tool is accessible online at www.seafoodtraceability.org. It helps businesses identify the payback from traceability by asking basic questions about the organization, such as industry segment, revenue, current traceability level, and reasons for investing in traceability.

Business Briefs

Klüber Lubrication receives National Sanitation Foundation ISO 21469 certification at its facility in Londonderry, N.H.

Frommelt Safety Products (a division of Rite-Hite Doors) changes its name to **Rite-Hite Machine Guarding.**

Sterigenics International, a provider of outsourced contract sterilization services, receives ISO/IEC 17025:2005 food and chemistry accreditation in Mexico.

AEGIS Food Testing Laboratories changes its name to **Vanguard Sciences.**

The GFSI Board of Directors recognizes **IFS** and **BRC Global Standards** against the Guidance Document Sixth Edition for the scope of Storage and Distribution.

UL Registrar is now licensed by SQF to provide GFSI Certifications to the SQF Code.

Hanovia and its U.S. sister company **Aquionics** launch a new UV Application Center in Shanghai, China, for food, beverage, and other markets.

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Washington Report

The Fight Is On Over Food Label Changes

Industry submits an avalanche of objections to FDA's proposed revisions for the Nutrition Facts label | BY **TED AGRES**

Earlier this year, FDA issued two proposed regulations to update the nearly 20-year-old Nutrition Facts label on food packages to reflect "new public health and scientific information" regarding dietary recommendations and serving sizes. The 151 pages of proposed regulations elicited close to 600 comments from manufacturers, trade and consumer associations, medical and public health experts, and others when the comment period closed Aug. 1, 2014. Many applauded the changes, saying they were long overdue; some said they didn't go far enough; and others called them costly and potentially misleading to the public.

"The FDA is proposing a new Nutrition Facts label for packaged foods to reflect the latest scientific information, including the link between diet and chronic diseases, such as obesity and heart disease," said FDA Commissioner Margaret A. Hamburg, MD, when the regulations were published in March 2014. "The new label would help consumers make better, more informed choices about the foods they eat and help support a healthy diet."

While FDA has not indicated when it expects to finalize the regulations, the rules will become effective 60 days after publication and industry will have two years to comply. Implementing the label changes will cost industry $2.3 billion in one-time labeling, reformulation, and recordkeeping expenses in addition to "small" annual recordkeeping costs, FDA estimates. The agency says these costs will be far outweighed by national economic benefits, which will total $21.1 billion to $31.4 over 20 years. Foods imported into the U.S. must comply with the new rules.

But the FDA has likely underestimated the compliance costs. "There may be additional costs including potential product reformulations to maintain current nutrient claims and to reduce the amount of 'added sugar,' which is a new required declaration," says David Acheson, MD, CEO, The Acheson Group and a former FDA associate commissioner for foods. Companies will also have to update and develop new policies and procedures and train employees. "All of these elements would add extra costs. As with all such types of changes, it is important to determine the public health benefit as well as the cost to industry from both an economic as well as a pure health perspective," Dr. Acheson tells *Food Quality & Safety*.

Proposed Rules

The first proposed rule, "Food Labeling: Revision of the Nutrition and Supplement Facts Labels," would update packaging labels with new mandatory and voluntary nutrient and reference values. These requirements reflect the most "current science" as reported in "Dietary Guidelines for Americans, 2010" issued by the Department of Health and Human Services. Among the many changes, FDA is proposing to list separately the amount of "added sugars;" require listings for potassium and vitamin D while making optional listings for vitamins A and C; revise the Daily Values for sodium, dietary fiber, and other nutrients; and remove Calories from Fat, because the type of fat is considered more important than its source.

The second proposed rule is called, "Food Labeling: Serving Sizes of Foods That Can Reasonably Be Consumed at One-Eating Occasion; Dual-Column Labeling; Updating, Modifying, and Establishing Certain Reference Amounts Customarily Consumed; Serving Size for Breath Mints; and Technical Amendments." It would update the single-serving size ("Reference Amount Customarily Consumed" or RACC) and require dual "per serving" and "per package" calorie and nutritional columns for packaged goods that could be consumed in one or more sittings, such as a 24-ounce (oz.) bottle of soda, a 19-oz. can of soup, or a pint of ice cream. The dual column format would be required if the package contains between two and four times the single serving size.

Eating habits have changed significantly since the 1970s and 1980s, when many RACCs were established. For example, a pint of ice cream is currently considered to be four servings, but FDA says two

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servings is more realistic. "The fact is, for many foods, we're eating larger portions than we used to," says Jillonne Kevala, PhD, an FDA supervisory chemist. The agency is proposing to change RACCs for about 30 food items. These revisions will likely have marketing implications. For example, if the serving size for ice cream doubles, so too would the calories, fat, sugar, and sodium content on the Nutrition Facts label. This, in turn, will impact manufacturers' ability to make health and nutrition claims.

"If you are right on the cusp of 20 percent of the Daily Value for fat, saturated fat, cholesterol, or sodium, and a new RACC puts you over that limit, you may lose the right to make a health claim" for that food, said Bruce Silverglade, a principal at the Olsson Frank Weeda Terman Matz lawfirm, Washington, DC. RACCs for some foods would get smaller. Yogurt, for instance, was sold in 8-oz. single serving containers, but today is more commonly marketed in 6-oz. packages. But when the serving size is decreased, "you may lose the right to make a 'Good Source' claim for a vitamin or mineral," Silverglade said during a presentation at the American Conference Institute's Advanced Regulatory and Compliance Summit on Food and Beverage Marketing and Advertising meeting in Chicago in July 2014. (A nutrient must have 10 to 19 percent of its Daily Value per RACC in order for it to be labeled a "Good Source," and 20 percent or more to be labeled a "High, Rich In, or Excellent Source.")

Bitter Fight Over Sugar

By far, the most contentious of FDA's proposed changes is the requirement to separately list sugars that are naturally part of the food and sugars that are added. FDA bases this requirement on U.S. consensus reports and recommendations to reduce overall sugar consumption, a citizen's petition, and public comments. The requirement has numerous supporters, including the American Diabetes Association, the American Heart Association, the Center for Science in the Public Interest, and the Union of Concerned Scientists. Unsurprisingly, the sugar industry, including bakers, cereal manufacturers, and many others, strongly disagree.

"Sugar is sugar, regardless of the source," wrote the Campbell Soup Company, maker of Prego and Pepperidge Farm products, in a letter to the FDA. The Grocery Manufacturers Association commented: "By mandating the separate labeling of added sugars, most GMA members believe that FDA is strongly implying to consumers that added sugars are indeed distinct and different (and less healthful than) inherent sugars, when they are not. Thus, added sugar labeling may convey false and misleading information to consumers." GMA and the American Beverage Association further noted the FDA's definition of "added sugars" would allow 100 percent fruit juice not from concentrate to boast 0 grams of "added sugars" on the new label, whereas 100 percent fruit juice from concentrate would have to declare all these sugars as being added because they were isolated and concentrated during manufacturing. (Similar requirements might befall nonfat dry milk, dry whole milk, and certain concentrated whey and dried whey products, the National Dairy Council noted.)

Dietary Fiber and Nutrients

Another disagreement surrounds the proposed definition of "dietary fiber" as only those having FDA-approved health benefits, such as beta-glucan soluble fiber and barley beta-fiber. Bayer Healthcare and the International Dairy Foods Association are among those that disagree, arguing that no other nutrient is required to demonstrate physiological benefit. Listing a nutrient in the Nutrition Facts "does not constitute a claim for anything other than the nutrient's presence in the product," Bayer commented. If FDA's definition stands, manufacturers of approved dietary fibers would gain an unfair competitive advantage because food companies would be forced to reformulate their products, the Calorie Control Council argued.

And if proposed changes in Daily Values are finalized, milk would lose its historical place as an "Excellent Source" of vitamin D. With proposed increases in Daily Values for vitamin D from 10 micrograms (mcg) to 20 mcg, and for potassium from 3,500 milligrams (mg) to 4,700 mg, "milk would no longer qualify as an excellent source of vitamin D or as a good source of potassium," the International Dairy Foods Association argued. Similarly, some natural cheeses and yogurts could lose their eligibility as being an excellent source of calcium if that Daily Value rises from 1,000 mg to 1,300 mg. The Juice Products Association argues that industry lacks the technical ability to increase the amount of vitamin D and calcium (Daily Value from 1,000 mg to 1,300 mg) in products "without nutrients precipitating out of solution or causing cloudiness in the juice."

Canada Following Suit

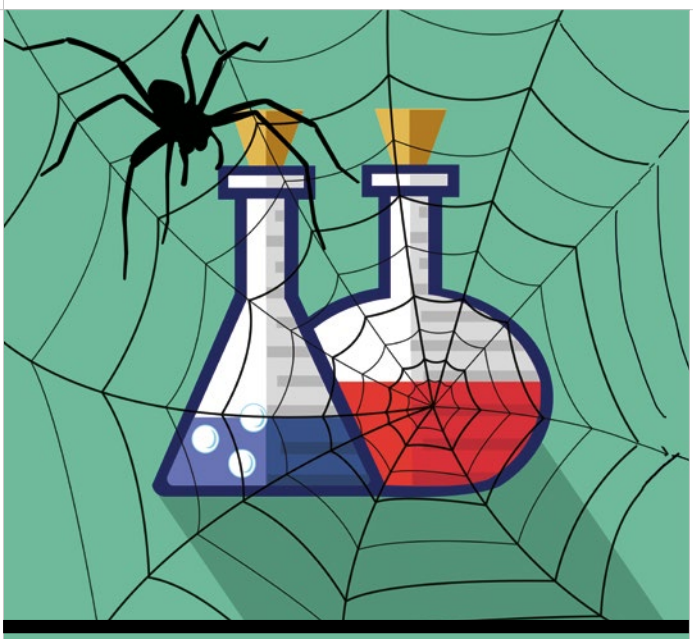
Canada has been following a parallel track in recommending changes to nutrition information presented on food labels. The proposed changes include the format of the Nutrition Facts table, the lists of ingredients and nutrients, and the Daily Values. In the ingredient list, sugars from all sources would be grouped together rather than listed by quantity, and serving sizes would be more consistent among similar products. The Canadian government accepted comments until Sept. 11, 2014 but has not announced when the final rules would be published.

Meanwhile, two U.S. lawmakers who last year introduced legislation that would have mandated major changes to food labels said the FDA's latest proposals do not go far enough. "While we are pleased that the Nutrition Facts label has been redesigned and updated to reflect the latest nutrition science, we are disappointed that FDA has remained silent on many critical features that could help consumers make healthier choices to combat the dangerous obesity and diabetes epidemics that our country faces," said Sen. Richard Blumenthal and Rep. Rosa DeLauro, both Democrats from Connecticut, in written comments.

The lawmakers, who had introduced the Food Labeling Modernization Act of 2013, would have preferred front-of-package labeling that contains more accurate representations of sugar, caffeine, and artificial colors and sweeteners. They also urged FDA to establish definitions for common terms that are "oftentimes used to mislead and deceive consumers," such as "whole wheat," "natural," and "healthy." ■

Agres is a freelance writer based in Laurel, Md. Reach him at tedagres@yahoo.com.

FSMA Update



Are Laboratories Being Left in the Dust?

As the move towards laboratory standards slowly progresses, food labs should not wait on a federal mandate to raise the bar on quality testing | BY **ROBIN E. STOMBLER**

Already several rules have been proposed by the FDA outlining how the Food Safety Modernization Act (FSMA) may be implemented. These rules address risk-based preventive controls, produce safety, foreign supplier verification, accrediting of third-party auditors, sanitary transport, and intentional adulteration. Yet, one important component still awaits FDA rulemaking, the oversight of the food lab.

Food laboratory testing is considered an integral part of a modern food safety system. In fact, a majority of the proposed rules issued to date reference lab testing, as does the law itself. FDA notably states that it "plays a very important role in ensuring the safety of food." The agency explains, "an important purpose of testing is to verify that control measures, including those related to suppliers and those verified through environmental monitoring, are controlling the hazard. Testing is used in conjunction with other verification measures in the food safety system, such as audits of suppliers, observations of whether activities are being conducted according to the food safety plan, and reviewing records to determine whether process controls are meeting specified limits for parameters established in the food safety plan." The Federal Food, Drug and Cosmetic Act states that owners, operators, or agents in charge of a food facility must verify that preventive controls "are effectively and significantly minimizing or preventing the occurrence of identified hazards, including through the use of environmental and product testing programs..."

Despite recognition of its role, there's currently little known about the state of food labs, and standards for testing are largely voluntary. There is not an exact tally of the number of food laboratories that exist, nor is there an accounting of the skills and training of the food lab workforce, quality control processes employed, or access to technology. This information deficiency and lack of standardization means the country may not have the capacity to respond effectively to biological or chemical foodborne threats. It means that food producers may have difficulty discerning among laboratories with appropriate capabilities. It also makes it more difficult to trace the source of multi-state foodborne outbreaks.

According to the Law...

FSMA calls for the recognition of laboratory accreditation. Section 202 of the law states that a program for the testing of food by accredited labs shall be established by the Secretary of Health and Human Services (HHS). The program would recognize laboratory accreditation bodies that meet criteria established by the HHS Secretary. It would include independent private laboratories and labs run and operated by federal agencies, states, or localities that demonstrate a capability to conduct one or more sampling and analytical testing methodologies for food. Labs that operate outside of the U.S. may become accredited as long as they meet the same accreditation standards applicable to domestic labs. This provision was to be enacted within two years of the passage of the law.

The details on how this program would operate and the criteria on which it would be based are not yet known. However, the law does outline critical elements of the program and provides insight into the intention of the policymakers.

For example, to ensure compliance, accreditation bodies would be re-evaluated periodically, at least once every five years. Auditors from an accreditation body may be accompanied by HHS to ensure they meet criteria. Accreditation bodies not in compliance with requirements may have their recognition revoked.

FSMA also requires the establishment of a publicly available registry of accreditation bodies. Labs accredited by a recognized accreditation body would be included in the registry. This registry would maintain the name, contact info, and other details about the accreditation organizations and laboratories. While the Secretary of HHS would determine, through rulemaking, how to recognize these bodies, the law makes clear the desire to make public the identities of those facilities that meet essential criteria.

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The law does not stop at merely registering organizations that meet desired criteria. The HHS Secretary is compelled to work with recognized laboratory accreditation bodies to increase the number of labs qualified to perform testing. In fact, the law provides another deadline—no later than 30 months after the enactment of FSMA—for food testing to be conducted by federal or non-federal labs that have been accredited for the appropriate sampling or analytical testing methodology. While this requirement applies to testing specific to a food safety problem or in support of certain import conditions, it is clear that accreditation is a desired credential.

For a lab to become accredited for a specific sampling or analytical testing methodology, it must meet model laboratory standards. The HHS Secretary may consult existing standards for guidance, but the law specifies what, at a minimum, model standards should include. These standards are to include methods that ensure appropriate sampling, analytical procedures, and commercially available techniques are followed. Reports of analyses are to be certified as true and accurate. Internal quality systems must be established and maintained. From a lab perspective, this means utilizing lab quality controls and participating in proficiency testing. Training and experience qualifications for lab personnel are considered another model element. Procedures to evaluate and respond promptly to complaints round out the list of model standards, but additional criteria may be added by the HHS Secretary.

The details of these model laboratory standards and how they may be incorporated into the accreditation process will be the subject of future rulemaking by the FDA. However, the framework for the future of food laboratory testing is written within the law.

More Coordination

FSMA outlines several instances where lab coordination should occur. The law requires a progress report in implementing a national food emergency response laboratory network. This network would provide "accessible, timely, accurate, and consistent food laboratory services throughout the United States." It would coordinate the food laboratory capacities of state, local, and tribal food laboratories, and improve national situational awareness by encouraging data sharing with federal agencies.

As part of the governmental coordination process, a methods repository would be created to share resources among federal, state, and local officials. Through an integrated consortium of laboratory networks, there would be an agreement on common lab methods to reduce the time required to detect and respond to foodborne illness outbreaks as well as encourage information sharing. This effort would be managed by the Secretary of Homeland Security, in collaboration with the Secretaries of HHS, Agriculture, Commerce, and the Administrator of the EPA.

From an international perspective, FSMA also outlines elements of a plan for building the capacity of foreign governments and their food industries with respect to food safety. These governments would conceivably export foods to the U.S. One element of a future, comprehensive plan is to provide for the multilateral acceptance of laboratory methods, testing, and detection techniques.

Accountability

Congress, in drafting FSMA, sought accountability for this new comprehensive food safety law. As such, the law requires the HHS Secretary, in coordination with counterparts at the Departments of Agriculture and Homeland Security, to submit a status report—specifically a progress update on lab accreditation.

In May 2013, FDA followed on this deliverable in its report, "Building Domestic Capacity to Implement the FDA Food Safety Modernization Act." FDA explained how it was working to develop performance standards, oversight and accountability to ensure "adherence to national standards," sample collection and analysis procedures, and lab control. The report notes that FSMA provides FDA "with important new tools," including the requirement that certain testing be conducted by accredited laboratories and the FDA "establish a program for laboratory accreditation to ensure that U.S. food testing laboratories meet high-quality standards."

What Now?

While the laboratory provisions of the law are pending interpretation and regulatory action by the FDA, food producers may use the time to ask about the standards followed by their in-plant and contract laboratories. Food labs too need not wait for a federal mandate to raise the bar on quality. The law demonstrates a desired move toward lab accreditation and standards for testing. Savvy food labs will not wait to consider their options for implementing recognized quality testing processes and credentials. ■

Stombler is president of Auburn Health Strategies, LLC, in Arlington, Va. She also serves as director of the Food Laboratory Alliance. Reach her at Rstombler@auburnstrat.com.

FOOD SECURITY

Guarding the production and distribution chains from serious public health and economic consequences

BY **TED AGRES**

From intentional contamination and economic fraud to terrorism and global climate change, the world's food supply appears to becoming increasingly insecure. This is despite record-high levels of food production in many countries and heightened levels of international cooperation to keep production and distribution chains secure. Many experts believe the situation is unlikely to improve anytime soon, as the global food chain becomes longer and more complex and threats—both man-made and natural—continue.

"The potential of food-based pandemics or the spread of toxic elements in an increasingly

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globally integrated food chain raises major concerns," concludes the World Economic Forum's latest report on global risks, which places "food crises" as among the 10 highest concern risks in 2014. "The global food supply is only as strong as its weakest link, and you've got a lot of food products coming into the U.S. from overseas," adds Donald Hsieh, director of commercial and industrial marketing, Tyco Integrated Security. "There is a heightened awareness within the food industry of the need to put controls in place before something happens. It is more important to prevent problems than to react to them afterwards."

In years past, "food security" referred primarily to the adequate supply of and access to food. The concept has since been expanded to preventing intentional contamination or adulteration from such illegal actions as economic fraud, sabotage, and, especially since 9-11, terrorism. "The goal is to protect the food supply from those who may attempt to cause large-scale public health harm," says Michael R. Taylor, JD, FDA deputy commissioner for foods and veterinary medicine. "Such events, while unlikely to occur, must be taken seriously because they have the potential to cause serious public health and economic consequences."

Intentional Adulteration

Currently front and center of the nation's food defense efforts is FDA's proposed rule on protecting food from intentional adulteration by acts of terrorism—one of half the dozen major regulations required by the Food Safety Modernization Act (FSMA). The proposed rule, "Focused Mitigation Strategies to Protect Food Against Intentional Adulteration," was published on Dec. 24, 2013. The public comment period was extended to June 30, 2014 and FDA is required to post the final rule by May 31, 2016.

The regulation would require all domestic and foreign food facilities that register under Section 415 of the FD&C Act to review their production systems for any of four activities considered most vulnerable to intentional adulteration: bulk liquid receiving and loading; liquid storage and handling; secondary ingredient handling; and mixing and similar activities. Companies must identify actionable steps or procedures that require mitigation strategies and prepare and implement a written food defense plan. They would also need to conduct training, take and monitor corrective actions, and keep records documenting their activities. Large companies would need to comply within one year after final publication while small businesses (fewer than 500 employees) would have two years. Very small business (less than $10 million in total annual sales) would have three years to comply or could be exempt along with farms, transportation carriers, facilities that hold food (except in liquid storage tanks), and facilities that pack, repackage, or label food products.

While one might think that it would be more challenging for larger companies to comply, the opposite is more likely. "The vulnerability is especially for small- to mid-sized producers because they may not have the discipline or the resources that the larger companies have to put the necessary plans and processes in place," says Tyco's Hsieh. Typically, larger companies have been more concerned about protecting consumers and therefore their brands. "For the most part they are probably better-equipped to address the regulatory requirements and probably will exceed them," Hsieh says. "The smaller companies may not be as rigorous in preventive controls and, thus, they may be the ones putting the whole supply chain at risk," he tells *Food Quality & Safety*.

For many industry experts, the proposed rule doesn't go far enough because it ties intentional adulteration only to acts of terrorism, which may be relatively rare, and not to economically motivated adulteration (EMA), such as food fraud, counterfeiting, or acts of disgruntled employees, all of which are more likely to occur and may also result in injury or death. For example, in 2008 dairy processors in China added melamine to milk and infant formula to artificially inflate laboratory protein measurements and conceal dilution. The adulteration killed several children and sickened thousands more. Disgruntled employees can also adulterate foods during production and shipping while malicious consumers can tamper with foods on shelves.

The FDA does not consider intentional adulteration by disgruntled employees, competitors, or consumers to be of "high risk" because, it says, such acts are not intended to cause widespread public health harm. The agency does plan to address EMA in a preventive controls framework where it is "reasonably likely to occur." Not everyone agrees. "Each of these motivations, regardless of intent, takes advantage of a vulnerable point in our food supply and can cause catastrophic health effects," argues Amy Kircher, DrPH, director of the National Center for Food Protection and Defense. She recommends a supply chain focus for food defense that identifies and closes gaps wherever they exist, such as during transportation. "Using a supply chain approach allows companies to cost effectively target their food defense efforts," Dr. Kircher says.

On the other hand, the Association of Food and Drug Officials (AFDO) supports the exclusion of economically motivated adulteration from the rule because "it is fundamentally different than intentionally introduced contamination that is intended to produce great public health harm." But AFDO believes that seafood and juice facilities, which carry their own Hazard Analysis and Critical Control Points (HACCP) imposed restrictions, should not be exempt from economically motivated adulteration, as the agency currently proposes. AFDO is also concerned that imported food products will not be held to the same standards as domestic products, and that the domestic industry will be thus placed at an unfair disadvantage. "Import rules and inspection and compliance programs must ensure parity and consistency between domestic and foreign facilities," it argued in its submitted comments.

Fighting Fraud in the U.K.

The U.K., which last year was rocked by revelations of widespread adulteration of beef with horsemeat, may be adopting a different approach to combatting intentional adulteration—creating a national crime unit. Last year, up to half the samples of packaged ground beef sold in U.K. supermarkets were found to

contain horsemeat. In a comprehensive report released in September 2014, Chris Elliott, professor of food safety and director of the Institute for Global Food Security at Queen's University Belfast, concluded that while the U.K. has one of the world's safest food systems, organized criminal gangs were "adulterating, tampering, stealing, and counterfeiting" food. Among the report's recommendations: creation of Food Crime Unit within the Food Standards Agency (Britain's counterpart to the FDA) to counter the growing problem of food fraud.

"Food fraud becomes food crime when it no longer involves a few random acts by 'rogues' within the food industry but becomes an organized activity perpetrated by groups who knowingly set out to deceive and/or injure those purchasing a food product," the Elliott report says. "Food crime is a global problem, growing in scale," the report explains. While the extent of the fraud is unknown, "what we do know is that it can be a cause of major food safety risks which severely undermines consumer trust in the food industry," says David Richardson, a vice president at NSF International. A food crime unit could cost upwards of $6 million, and the British government is evaluating the recommendation.

Criminology is useful for examining events and perpetrators but is only one prong of a multidisciplinary approach needed to counter food fraud, says Doug Moyer, PhD, a food packaging expert at Michigan State University. Other strategies should include food science, packaging science, and supply chain management or logistics. Packaging science can provide anti-counterfeiting security features and enable track-and-trace pedigrees in addition to protecting food and conveying product information. Knowing the source and history of foods is important because "fraudsters perpetuate their crimes through vulnerabilities in food supply chains," Moyer told the Food Safety Summit in Baltimore earlier this year. "End-to-end visibility and supply chain transparency are critical management tools for brand owners," he added.

If food exporting countries had comprehensive food traceability systems in place, it would be easier to track points where adulteration and fraud entered the food chain. A study published in the September 2014 *Comprehensive Reviews in Food Science and Food Safety* compared food traceability regulations and requirements of 21 OECD (Organization for Economic Cooperation and Development) countries. Conducted by the Global Food Traceability Center at the Institute of Food Technologists, the study examined whether mandatory traceability regulations existed at each country's national level; whether regulations included imported products and the nature of the regulations; whether electronic databases for traceability existed and if so, their accessibility; and whether labeling regulations allowed consumer access to and an understanding of traceability.

The study found that European Union countries including the U.K. had overall "superior" scores for food and feed traceability regulations while the U.S., Canada,

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Australia, Japan, Brazil, and New Zealand had overall "average" scores. Unsurprisingly, China received a "poor" overall score, and there were insufficient data to grade Russia. The authors said the study highlights the importance of harmonizing traceability requirements to minimize delays, strengthen interoperability, "and to improve traceability of food products globally."

GFSI Tackles Food Fraud

The Global Food Safety Initiative (GFSI) last year directed its Guidance Document Working Group and Food Fraud Think Tank to develop recommendations in response to the growing prevalence of food fraud. In July 2014, GFSI released a guidance document carrying the following two major recommendations.

- The food industry should carry out a "food fraud vulnerability assessment" in which information is collected at appropriate points along the supply chain (including raw materials, ingredients, products, and packaging) and evaluated to identify and prioritize significant vulnerabilities for food fraud.
- Appropriate control measures should be put in place to reduce the risks of these vulnerabilities. Control measures can include strategies for monitoring, testing, origin verification, specification management, supplier audits, and anti-counterfeiting technologies. "A clearly documented control plan outlines when, where, and how to mitigate fraudulent activities," the GFSI document says.

The new requirements will be included in the next full revision of GFSI's Guidance Document 7th Edition, to be released in early 2016. "This represents yet another example of global collaboration and standards setting" that is essential for ensuring food security, says Melanie Neumann, vice president and chief financial officer, The Acheson Group.

The Role of Climate Change

While the science behind and implications of climate change continue to be debated, numerous U.S. and international agencies, public organizations, and private companies are exploring the ramifications of climate change on food security, meaning the adequate supply of and access to food. "Climate change poses a major challenge to U.S. agriculture because of the critical dependence of the agricultural system on climate and because of the complex role agriculture plays in social and economic systems," concludes the federal government's latest National Climate Assessment report, released in May 2014. Climate change will alter the stability of food supplies and create new food security challenges for the U.S. as the world seeks to feed nine billion people by 2050, the report says.

Agricultural productivity is vulnerable to direct impacts on crop and livestock development and yield from changing climate

conditions and extreme weather events, and indirect impacts through increasing pressures from pests and pathogens, the report says. Rising temperatures also affect food safety; for every degree the ambient temperature rises above 43 degrees Fahrenheit in an area, the occurrence of foodborne *Salmonella* increases by 12 percent. Rising air temperatures also result in corresponding increases in insects, weeds, and fungal pests due to milder winter temperatures. One possible result is growers may need to increase pesticide use to maintain production levels.

In a recently published study of pesticide applications of commercial soybeans grown in a band from Minnesota to Louisiana since 1999, scientists at the USDA's Agricultural Research Service (ARS) concluded that increases in total pesticide applications were positively correlated with increases in minimum winter temperatures. In temperate regions, low winter temperatures often keep the distribution and survival of agricultural pests in check. "One of our most crucial challenges is finding ways to maintain and increase crop production levels in the face of climate change," says ARS administrator Chavonda Jacobs-Young.

Until now, the U.S. agricultural sector has managed to adapt to climate change through a variety of strategies, the federal report says. "However, the magnitude of climate change projected for this century and beyond, particularly under higher emissions scenarios, will challenge the ability of the agriculture sector to continue to successfully adapt," it warns. As part of its Climate Action Plan, the Obama administration in July 2014 unveiled a program aimed at strengthening the resilience of the global food system in a changing climate. The White House called upon the private sector "to leverage open government data and other resources to build tools that will make the U.S. and global food systems more resilient against the impacts of climate change." In response, a number of federal agencies and private companies will be collaborating on "data-driven innovations." Some examples include the following.

Packaging science can provide anti-counterfeiting security features and enable track-and-trace pedigrees in addition to protecting food and conveying product information.

Microsoft and USDA will jointly launch a climate-change-focused "Innovation Challenge" to inspire the development of new tools and services that harness data available via the federal website www.data.gov, as well as an initial collection of USDA datasets

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that will be made available through Microsoft's Azure Marketplace.

The Coca-Cola Company will use data-driven tools to quantify its use of water, fertilizer, and energy, and monitor its greenhouse emissions. By the end of 2014, Coca-Cola will implement this initiative with two of its four leading suppliers; by the end of 2015, it will engage the initiative with farmers representing 250,000 acres; and by 2020, with farmers representing up to 1 million acres—equating to roughly half of the company's global corn supply.

AFDO is also concerned that imported food products will not be held to the same standards as domestic products, and that the domestic industry will be thus placed at an unfair disadvantage.

Nestlé will set greenhouse-gas reduction targets based upon science, incorporating both absolute-carbon and carbon-intensity aspects. The company will also incorporate climate change provisions into its responsible sourcing and traceability program, engage in further water stewardship programs, and extend education and training within its Farmer Connect initiative for good farming practices and water stewardship.

Monsanto will donate a multi-site/multi-year maize breeding trial dataset to open data portals maintained by the International Center for Tropical Agriculture and the Agricultural Model Intercomparison & Improvement Project. Opening these data will make it possible for public- and private-sector scientists to improve models being used to understand how climate and water-availability changes will impact crop productivity and food security.

Kellogg Company will use the University of Minnesota's Institute on the Environment agricultural data and climate-related maps to foster geographically relevant implementation in its global sourcing to help create efficient, adaptable, and sustainable supply chains as well as identify information gaps and needs to improve the resilience of the agricultural sector to climate change.

What Companies Should Do Now

In regards to the matter of U.S. food safety and security, companies should not wait until the FDA issues the final intentional adulteration rule before acting because many control measures can be put in place now. "Look at your vulnerabilities and assess where the gaps are," Hsieh recommends. "For instance, mixing areas have been identified as places needing access controls. Start to create your food defense plans now, ahead of the final regulations. In the end, it's not about regulations but about protecting the consumer and your company's reputation. You don't want to be the one that's been closed down because of a tragedy," Hsieh says. ■

Agres is a freelance writer based in Laurel, Md. Reach him at tedagres@yahoo.com.

Cybersecurity in Food and Beverage Industry

Managing and maintaining a security program allows companies to adapt as new threats surface and new technology emerges

BY **CARRIE STRAKA**

The food and beverage industry is as susceptible to cybersecurity threats and attacks as any other industry. The need to secure corporate private networks and intellectual property is at an all-time high, as is the need to protect the food supply.

According to Trustwave's 2013 Global Security Report, 24 percent of all reported data breaches occurred in the food and beverage industry, second only to retail. With one attack, retailer Target lost around 40 million credit and debit card numbers, resulting in a drop in consumer confidence and a loss of trust. Similarly, the company that manages a large hospitality chain found that a cyberattack had compromised payment information at 14 of its restaurants and bars across the U.S.

Interconnectivity among franchises poses a whole other area of cyberthreat. A breach at one restaurant chain between 2008 and 2011, for example, led to the stolen card data of more than 80,000 customers and was used to make millions in unauthorized purchases. Shockingly, 70 percent of food and beverage companies that are hacked go out of business within a year of an attack.

But the risk is not just financial. Agroterrorism, or the "intentional contamination of the food supply with a goal of terrorizing the population and causing harm," is an increasing risk. Every year, more than two million people die from food-related illnesses and more than 1.3 billion tons of food is wasted due to spoilage. Food irradiation (sometimes called electronic pasteurization), which is permitted in over 50 countries, is known as a way to help preserve food, but is not without its risks. If hackers gain access to a food supply company's network, they could have the power to introduce dangerous amounts of chemicals to the food being treated. Programmable logic controllers, or PLCs, which are used to control processes in many settings like energy plants, water treatment plants, and other industries, are "designed to blindly obey all commands, regardless of what impact they might have." All a hacker would need to do to cause a major catastrophe is to hack into these systems, and from there they could cause an explosion at a chemical facility or poison a food supply. Even the ability to remotely shut down refrigeration systems can be detrimental to food safety. Failing to introduce a comprehensive cybersecurity program that encompasses food quality and safety guidelines can lead to many illnesses and even fatalities.

What constitutes cybersecurity? Many companies believe perimeter point solutions, such as firewalls and antivirus software, are all it takes to become cybersecure. ANX Corp. identified eight major security gaps that affect food and beverage companies: outdated firewalls, insecure remote access, weak security configurations, operating system flaws, lack of staff training, flawed security policies, negligence, and poor change control procedures. All of these security gaps can be linked to a lack of security best practices. It's not unusual for a company to believe it is safe, especially if it can't see that it's at risk. Trustwave found that of the number of organizations who were victims of a breach, only 16 percent were able to detect it themselves. The remaining 84 percent relied on outside companies to report the information.

Cybersecurity is much more than a point solution—it is a comprehensive plan that complies with company objectives, corporate requirements, and/or federal and state government regulations. Once you have identified your cybersecurity needs, you can start to address cybersecurity technical requirements. This is why simply using point solutions can provide a false sense of security, since they are typically deployed quickly to address a perceived need. This is where the trouble lies. A good cybersecurity plan begins with a risk analysis to determine the current state of security and what you need to do to improve it.

A comprehensive cybersecurity program that is regularly managed and maintained is key for protection. Simply installing firewalls and antivirus software does not guarantee that critical company assets are safe from criminals if the firewall is not maintained properly and the antivirus software is never updated with approved patches. There must also be policies and procedures, proper employee security training, and regularly updated operating system patches, to name a few. The "it won't happen to me" mentality is no longer a valid defense.

Since cyberattacks are no longer a matter of *if* but *when*, companies in the food and beverage industry must plan for remediation if they fall prey to hackers, even if it means hiring additional specialized staff to help circumvent these attacks. It's important to have a plan in place before an attack occurs, rather than afterwards. If companies neglect cybersecurity best practices, they risk legal issues, fines, and souring their brand. They can lose customers, money, and future business opportunities. Because most food and beverage companies use the same IT systems across their

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stores and franchises, it's easy for criminals to duplicate attacks and cause extensive damage in a matter of minutes. And thieves are sure to make off with a lot of loot due to the high transaction volume of the food and beverage industry—which also contributes to its appeal to hackers.

Cybersecurity best practices should incorporate a security assessment to establish any security gaps and determine any risks to safe and reliable day-to-day business operations. Reviewing current policies and procedures on cybersecurity and comparing them to government, industry, or corporate requirements can help point out any security shortcomings, and determining how to protect critical assets from vulnerabilities and risks is key to adequately securing data. Most importantly, managing and maintaining a security program will allow food and beverage companies to adapt as new threats surface and as new technology emerges.

The National Institute of Science and Technology (NIST) Cybersecurity Framework that was released earlier this year offers guidance for businesses looking to bolster their current security programs as well as for businesses that are starting cybersecurity programs from scratch. The Framework is a best practice approach to security risk management, offering a common language that can be used across all industries—even the food and beverage industry. The NIST Framework is made up of three tenets: the Core, Profile, and Implementation Tiers. The Framework Core includes a template of activities and outcomes that organizations can use with existing best practices, suggesting ways to identify, protect, detect, respond, and recover from cyberattacks. The Framework Profile helps organizations align their cybersecurity activities with their business requirements, risk tolerances, and resources by mapping out where they are currently with their security programs and where they want to be, which helps establish security gaps. Last, the Framework Implementation Tiers help organizations rate their security readiness based on four levels of maturity: Partial, Risk Informed, Repeatable, and Adaptive. Although the framework was initially designed for critical infrastructure industries, it is readily applicable to any company, no matter its size or industry or country it is located in. The primary focus is on risk management through the implementation of the Tiers, helping organizations gauge their progress. The Framework offers a continuous improvement process, which is critical since these types of threats evolve as quickly as technology improves.

While many organizations have different approaches, they all have a common element—to establish a best practice approach to cybersecurity. Some basic practices include:

- Identifying and categorizing assets,
- Establishing a plan to eliminate significant vulnerabilities,
- Developing systems to identify and prevent potential attacks,
- Identifying, containing, and fighting back against known attacks,
- Applying and maintaining the latest operating system and application patches,
- Using current antivirus definitions,
- Updating authorized application software,
- Enabling network antivirus software,
- Not using a USB stick unless it's been scanned and confirmed that it is free of problems,
- Hardening servers and workstations,
- Changing default admin passwords,
- Controlling user rights,
- Implementing backup and restoration,
- Taking inventory of network assets,
- Using physical network isolation when possible,
- Using logical network segmentation (secure zones) when possible with strict firewall rules,
- Enabling firewall logging,
- Using Network Management Systems,
- Not clicking links or files that aren't verified, and
- Creating an incident response plan before an incident occurs.

Security researchers have predicted 2014 would see an increased number of these breaches and attacks, and so far, they've been right. There has been a 21 percent increase in incidents according to the Identity Theft Resource Center—and that's only reported attacks. The World Economic Forum's annual report ranked cyberattacks in the top five global risks in terms of likelihood. And research from Arbor Networks states "the number of DDos (distributed denial-of-service) events topping 20 Gbps (Gigabits per second) in the first half of 2014 are double that of 2013." Among the largest breaches this year are several food and beverage companies. In addition, security experts are now saying hackers aren't the biggest threat anymore. Simple mistakes and poor security best practices are quickly becoming just as dangerous. ■

Straka has a master's degree in Professional and Technical Communication from the University of North Texas and currently works as a cybersecurity consultant and technical writer for the Critical Infrastructure & Security Practice at Schneider Electric. Reach her at carrie.straka@schneider-electric.com.

REFERENCES FURNISHED UPON REQUEST

Food Defense Audits

Companies throughout the supply chain are bulking up on their food protection tactics

BY **MICHAEL GOVRO**

Although facilities follow food safety and quality measures, including Good Manufacturing Practices, to minimize hazards, safety can also be compromised by intentional and malicious tampering. While most food processors, packagers, and distributors don't think of themselves as targets of terrorism, many are implementing food defense controls in their operations to combat food tampering. Food defense plans are increasingly required for food safety certification and vendor qualification, as well as by the Food Safety Modernization Act (FSMA).

Food defense, or food security, is the prevention of purposeful contamination by malicious and intentional tampering of food by people outside the system. Cases of food tampering may be rare, but the consequences—on public health, the economy, and consumer confidence—are high. Food defense is also one of the top five areas of non-compliances NSF International encounters in food safety audits. That's why many companies are creating food defense plans and incorporating elements of food defense into their existing safety management system. A solid security plan can help companies achieve compliance in food safety audits as well as preserve their property from vandalism, control access to the grounds and buildings, keep track of visitors, and secure valuable and hazardous items.

Food companies at all levels of the supply chain can assess their level of food defense safety through a third-party food defense audit. A skilled auditor performs a comprehensive review of a facility's food defense systems including its efficiency in managing several critical areas, such as documentation, traceability, crisis management, staff training, and building security. Third-party audits, like those of NSF International, evaluate the adequacy of documentation, compliance to documented procedures, the effectiveness of the procedures to control the process, and the ability to implement corrective and preventive action plans.

Food processors, packagers, and distributors pursue food defense audits for several reasons: to assess or improve their level of food defense safety, to demonstrate compliance with food safety regulations, or client-defined standards, and to gain certification to a food safety standard.

Certification vs. Consultative Audits

Audits can be required for certification or to do business with a client, and will include feedback on a company's current food defense system. Audits not related to certification can be based on published standards that apply to any facility in a sector or on custom standards created by a particular client to address specific concerns like ethical sourcing, metal detection, and country of origin labeling.

Non-certification audits are consultative, where the auditor can comment on findings and suggest improvements, such as recommending a location for a card swipe entry. Consulting helps the food processor improve its food defense policy.

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Certification audits are also based on standards, but can be carried out only by companies accredited to ISO/IEC Guide 65. The most well-known certification standards are those benchmarked through the internationally recognized Global Food Safety Initiative (GFSI), such as SQF, BRC, FSSC 22000 and IFS, all of which contain criteria for food defense. Many companies, including Walmart, Daymon, McDonald's, Campbell's, Kroger, and ConAgra Foods, require food suppliers to be certified to GFSI benchmarked standards. Many also require suppliers to demonstrate compliance with company-specific requirements.

Certification audits are not consultative; the auditor records observances but cannot provide advice. An independent third-party audit is critical to preserving the value of certification. If the audit finds any non-conformances, the supplier must provide evidence that it is taking corrective actions to resolve them and the certification body must approve these actions before certification can be issued.

Third-party certifiers may provide consulting, independent of a certification audit and with different staff, to address high-level issues like supply chain management, traceability, risk assessments, analysis of food safety failure, behavior-based compliance, and crisis/recall assistance.

What Food Defense Audits Cover and What You Can Do

Food defense audits require a risk assessment that includes evaluation of the company's food defense plan. The risk assessment ensures that a company's food defense measures are applied appropriately based on the facility's size, number of employees, location, and the types of products it produces. It includes reviewing the food defense plan and evaluating conditions such as appropriate training and employee responsibilities in controlling access points, reporting suspicious activities, and fulfilling specific job activities related to control measures.

The audit risk assessment makes sure that measures are in place to control who has access to which areas of the facility. This includes which areas employees, drivers, and visitors may access and

To protect our food supply, the USDA's FSIS conducts surveillance to monitor and detect acts of intentional contamination of meat, poultry, and egg products.

which areas are restricted. Access control for strangers can include deterrents like bright outdoor lighting and physical barriers like fences, gates, guards, and locks—including keys, keypads, and card swipe machines.

But access control doesn't just apply to keeping intruders out. It also helps ensure employees have access only to the areas they have authorization to enter. Access control devices range from high-tech palm and retina scans and facial recognition software to more basic measures like ID checks or sign-ins at a guard gate or employee entrance.

It's also important to ensure that all drivers who come and go from the facility are legitimate, they are delivering only materials from trusted and expected sources, and they are taking out only authorized shipments and delivering them directly to the desired clients. Access control for drivers can be improved by making pick-up and delivery appointments, having check-ins at a vestibule, restricting driver access to the plant, and employing guards or mechanical gates with video feeds to the office before trucks are allowed to enter the premises. Using locked trailers tracked with GPS to monitor product transportation also helps control access to food products.

To keep track of vendors, job applicants, and other visitors, companies may want to make sure all guests can enter the building only through one controlled point where they must sign in and are always accompanied by an employee. In addition, guests can wear visitor ID badges, or if they are required for safety to wear protective clothing, hairnets, and vests—these should be in distinctive colors, different from what employees wear.

During the food defense risk assessment, the auditor determines the level of access control for employees, both during screening and when hired. The auditor reviews pre-hire employee screening activities, such as whether the company (or an employment agency hired by the company) conducts criminal background checks, verifies references and work history, and confirms work eligibility through the U.S. Citizenship and Immigration Services' E-Verify.

The audit examines how employees are monitored during day-to-day operations—whether video cameras are installed inside and outside the facility with adequate lighting and whether employee card swipes record entrance data to all areas. A food defense audit also includes a thorough examination of the company's data management practices. The auditor looks for controls such as limited, layered access to controlled documents (confidential information and process instructions, for example), password protection, and off-site backup of data.

Other items covered in a food defense audit include whether the company has specifications for off-site storage, what steps it takes to qualify or approve suppliers, how it manages non-conforming products, how it controls access to sensitive documents and chemicals, how it conducts product testing and verification procedures, whether it has a recall procedure in place, and its record-keeping procedures.

As mentioned, food defense is one of the top five areas of non-compliances NSF encounters in food safety audits. The most frequently found deficiency in these audits is unsecured doors. Other frequently encountered non-conformances related

The audit risk assessment makes sure that measures are in place to control who has access to which areas of the facility.

to food defense include businesses not following their own protocol for verifying visitor ID and sign in, unsecured perimeters, failure to review the food defense plan, and failure to properly train the food defense team. Additional areas that can thwart food defense are self-conducted risk assessments, unsecured utilities (such as electrical panels and water shutoffs), and inadequate shipping controls. For example, last year a man who presented falsified paperwork was able to steal a semitrailer of cheese valued at $75,000. In 2002, milk tampering in western New York resulted in more than 48,000 gallons of milk being destroyed, costing farmers tens of thousands of dollars.

What Government is Doing

Food companies are not the only defense to food threats. Homeland Security Presidential Directive 7 declared food and agriculture as one of 18 critical infrastructure sectors vulnerable to attack. To protect our food supply, the USDA's Food Safety and Inspection Service (FSIS) conducts surveillance to monitor and detect acts of intentional contamination of meat, poultry, and egg products. It developed a system to rapidly identify, respond to, and track intentional food contamination and other large-scale food emergencies. FSIS randomly tests processed products for threats and conducts food defense verifications to identify vulnerabilities that could lead to deliberate contamination.

FSIS import surveillance liaison officers oversee food defense issues relating to imported food products at borders, ports of entry, and in commerce nationwide. FSMA will also further control the safety of food products imported into the U.S.

Additional Resources

In addition to undergoing third-party food defense audits, companies can use several free online resources to help them assess their food defense readiness or develop a food defense plan. FSIS has developed food defense self-assessment checklists for warehouses and distribution centers and slaughter and processing plants.

The U.S. FDA's Food Defense Plan Builder helps food suppliers develop targeted defense plans. The FDA also provides the online course Food Defense 101, vulnerability assessments, mitigation strategies, webinars, and other tools and resources for the industry.

The NSF Supplier Assurance Audit also helps food companies assess their development, implementation, and control of systems that impact food defense, as well as food safety and quality. ■

Govro, technical/QA manager for NSF International, has over 35 years of experience in private industry and regulatory agencies as a food safety, quality, and public health professional. Reach him at 734-769-8010 ext. 5351.

Leveraging Innovative Technology to be Audit-Ready On Demand

How food safety technology helps companies be prepared for their regulatory, GFSI, and customer food safety audits

BY **BARBARA LEVIN**

I've never met a food safety and quality assurance (FSQA) professional who doesn't think audits are important. They help regulatory agencies, third-party standards, internal organizations, customers, and the consuming public have confidence in our products. And by helping to prevent food safety events or customer quality issues, it could be said that ultimately audits are an important tool in helping to protect market and brand value.

But today's FSQA departments have what is often referred to as "audit fatigue." Audits are resource-intensive. Even though most FSQA teams are doing a great job, it takes a lot of time and documentation to prove it. Between regulatory, third-party certifications such as Global Food Safety Initiative (GFSI), customer, and internal audits—some food and beverage companies are experiencing one or more audits per month. This will only intensify as third-party certification bodies move toward unannounced audits, basically requiring FSQA departments to be audit-ready all the time.

How Audit-Ready Are You?

Take a moment to complete the Food Safety Audit Readiness Quiz on page 27.

Have a few No's or Hmmm's? If so, you might not be as audit-ready as you need to be. The good news is that there are many FSQA technology innovations today to help you be audit-ready on demand. Not only to produce electronic records and documents, but to actually ensure that all of your food safety and quality programs are being followed so that you can pass with minimum deductions.

This article will cover audit readiness challenges, how FSQA automation technology can help, and the benefits that can be achieved .

Requirements

While audits have specific requirements depending on the type, all audits—whether it's a regulatory, GFSI, customer or internal audit—have the following four things in common.

1. You have to show that you "say what you are going to do." Are all of your food safety plans, risk assessments, preventive controls-related standard operating procedures (SOPs), prerequisite programs (PRPs), Good Manufacturing Practices, etc., defined, organized, and accessible?

2. You have to show you "do what you say." Can you verify scheduling and completion of tasks? Are you ensuring that test results become part of your FSQA records?

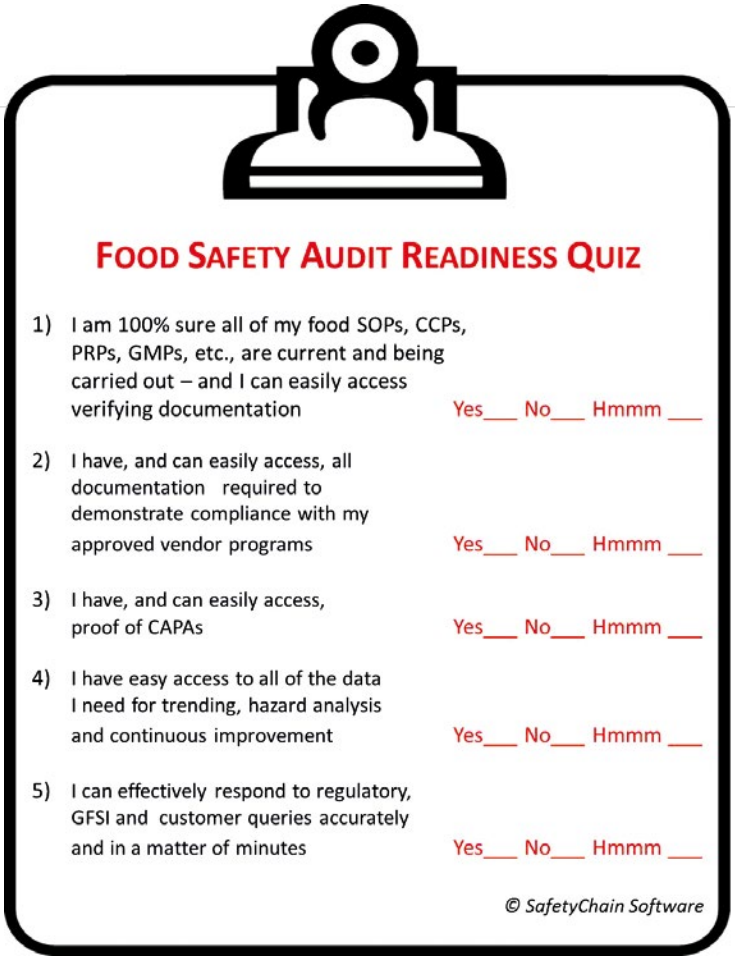
3. You have to "make sure it works." Can you prove, through analysis and scientific validation, that what you're doing is working? Can you validate that the frequency of your inspections is correct? Or that your Critical Limits are working? Are you getting timely information to put Corrective/Preventive Actions (CAPAs) in place? And, are you able to analyze data for continuous improvement?

4. You have to "make sure it's documented." Do you have accurate, audit-ready documentation for numbers 1 to 3? All responsible FSQA organizations are doing these things, but unfortunately, when it comes to audits, if it's not properly documented you might as well not have done it.

Obstacles

In addition to having many requirements in common, audits have something else in common: they present many of the same challenges to FSQA organizations. These challenges fall into the following main categories.

Sheer Volume of Paper. Gathering and maintaining all of the documents, records that verify and validate the various components of food safety plans,



SAFETYCHAIN

supplier compliance records, proof of CAPAs, and more is time consuming. Additionally, ensuring that everything is complete and accurate can become an even larger challenge.

Ensuring Plans are Carried Out Correctly. In addition to gathering records, there's also the challenge of making sure everything is in conformance with requirements. Preparing for an audit is not the time to find out that one facility is using old forms or wasn't aware of a new or modified Critical Limit or Preventive Control.

Managing Supplier/Vendor. Whether it's for the Food Safety Modernization Act's (FSMA) Foreign Supplier Verification Program, GFSI-approved vendor programs, customer requirements, or your own food safety plans—tracking supplier specifications, registrations, vendor audit documents, and more—is a huge challenge for most FSQA organizations.

Response Time. This time is really a direct result of the time associated with the above categories, which can be disruptive

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to say the least. And that's for the audits you know about. When it comes to customer, FDA, GFSI, and other unannounced audits, sometimes "disruptive" is the least of the challenges.

What Makes These Issues So Challenging?

It's the position of this article that the majority of audit challenges stem from the fact that most FSQA operations still operate very manually today. We hear all of the time about food safety folks having to spend their time entering versus analyzing data. Or having to sort through hundreds of supplier documents to find the one or two that require action. Or didn't realize key fields in forms were missing until the auditor found it. Or, at the time of the audit, requested sanitation records are missing—presumably filed in the wrong folder. Or the GFSI revision log is incomplete. Even when electronic systems *are* in place there can often still be issues if the various systems in different facilities don't "talk" to each other, i.e., integrate the data.

But there is a better way. Emerging FSQA technology innovations can help streamline and improve overall FSQA and help you be audit-ready on demand.

How Does FSQA Automation Work?

For the purposes of this article, audit readiness is more than simply being able to produce electronic documents. Additionally, audit readiness means supporting all of the programs on which you're being audited.

There are a variety of food safety and quality automation technologies on the market today—and companies must evaluate which solution best meets its needs. But to be audit-ready on demand, some key capabilities to look for in a technology solution are described below. These are focused around the ability to say what you do, do what you say, make sure it works, and make sure it's documented—in other words, the key pillars of audit readiness.

Say What You Do. Some FSQA automation solutions allow you to define all of your regulatory, third party, customer, and internal requirements within the system—GFSI code and customer specifications, for example. This can also include defining the food safety plans/components that support these requirements, like HACCP/HARPC, SOPs, and PRPs. Data sources—data from cooling equipment, or from internal/external labs, for instance—can also be defined and integrated into some solutions.

Do What You Say. Look for technology solutions that have workflow engines and automated task schedulers to ensure that the tasks associated with your requirements/programs are completed according to schedule. These solutions often have auto-notifications as well so that notices can be sent, for example, to a supplier that its GFSI audit certificate is due—or to a line manager reminding him/her that the metal detectors must be calibrated at a certain time.

Make Sure it Works. Some FSQA automation solutions have verification engines that analyze all data—such as safety assessments from mobile forms or test results from a lab—in real-time to the requirements and specifications defined in the system. If results are out of spec, alerts are issued. Some systems can then automatically generate a timely CAPA and track it to completion.

Make Sure it's Documented. The beauty of automation is that if you have the capabilities described in the above pillars from a single vendor, which is ideal, or have the solutions integrated if they are from separate vendors, every component discussed in the above pillars can be time/date stamped, with eSignatures where required, and accessible through a central repository of data as part of your permanent FSQA record. If using cloud solutions, then every document, test result, CAPA, and more from every facility can be accessed with a secure login from any or computer anywhere and at any time.

Key Audit Readiness Benefits

By adopting FSQA automation technology with these capabilities, you can be audit-ready on demand with the following key benefits.

- Your food safety plans, specifications, approved vendor programs, and the like are carried out on time and according to plan. Tasks happen when they are supposed to, and issues are dealt with in a timely, preventive manner.
- You have immediate access to all audit documents on demand, an "audit on a laptop," if you will. Because records can be time/date stamped (and, in many cases with 21 CFR Part 11 compliant eSignatures), you have unalterable records for greater audit efficacy.
- Audit documentation can be easily reported on and organized by type of audit, including not only your regulatory, GFSI, customer, and internal audits, but also reporting against internal Key Performance Indicators, or KPIs.
- If you are using cloud-based FSQA automation, with configurable security, you have the opportunity for greater transparency and visibility. A food co-packer, for example, could allow a customer access to a set of data pertaining to that customer's requirements—which could then, in turn, potentially reduce the number of that customer's onsite audits. Or, an ingredient supplier might allow its third-party auditor, under various schemes and potentially FSMA, to access portions of its records. The value of this is that because of technology configurability, this upstream, downstream, and internal visibility is completely up to the company and can provide as much or as little transparency as fits within an organization's policies and culture.
- Almost all FSQA audit schemes and best practices call for continuous improvement. With automation, your safety, quality, and operations management have access to a centralized repository of FSQA information across the entire company—from all facilities and products—from which true performance trending can take place.
- Last, the overall cost and disruptions associated with audits are significantly reduced. Automation can eliminate days and weeks gathering the legendary "forklifts full of binders," prevent you from finding incomplete records the night before the auditors show up, and mitigate damage to customer and consumer confidence. ■

Levin is a senior vice president and co-founder of SafetyChain Software. She is a frequent speaker and author in the food and beverage community on how to leverage FSQA automation to improve food safety and quality while optimizing operational KPIs and ROI. Reach her at blevin@safetychain.com.

Testing

POULTRY

Salmonella Control in Poultry

A PCR-based approach can offer a rapid option for assessing *Salmonella* contamination in poultry rinsates

BY **WENDY WARREN**

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Salmonella control is a top priority for regulatory agencies, public health organizations, and food production companies based on the steady number of associated foodborne illnesses. While much effort has focused on better understanding salmonellosis and managing *Salmonella* during food production, the estimated 1.2 million cases that occur in the U.S. each year are well above current public health goals of about 36,000 cases nationwide.

The basic ecology of agricultural and animal-derived food products results in a normal association with *Salmonella*. Accordingly, *Salmonella* management is a major challenge for the food production industry. Understanding salmonellosis is difficult because the number of *Salmonella* cells required is unclear. Scientists also do not understand whether every strain of *Salmonella* can cause illness. There are thousands of strains found in nature. Previous risk assessments have indicated that there is a dose-response relationship between the number of *Salmonella* present and the severity and number of individuals infected after consumption of contaminated poultry products. The ability to identify points in processing with higher levels of contamination would greatly assist processors in better managing *Salmonella* levels present in finished food products.

Public health data illustrate an important association between raw poultry and salmonellosis. Accordingly, the USDA Food Safety and Inspection Service (FSIS) and the poultry industry are working on programs to improve *Salmonella* control. This August, USDA-FSIS published the Final Rule for Modernization of Poultry Inspection. The new regulation is expected to have a direct impact on the number of *Salmonella*-associated illnesses each year with advancing inspection practices and more science-based detection methods. With a more preventive focus, this new inspection process will allow USDA-FSIS to verify safety programs and provide a more comprehensive assessment of process control by examining sanitation procedures, reviewing records, and collecting test samples for microbiological analysis.

Furthermore, poultry processors must consider *Salmonella* a food safety hazard. Failure to implement and manage control procedures could result in regulatory action. Therefore, processors will be expected to engage in food safety management, including sampling and testing programs for *Salmonella*.

The Need for New Techniques

Rapid detection assays have been used by the food processing industry for many years to detect extremely low levels of *Salmonella*. Based on currently available commercial technology, a sample enrichment period is required to reliably and qualitatively detect low levels of *Salmonella* in food products. Qualitative detection of foodborne pathogens indicates presence or absence in the test portion analyzed and is not intended to provide quantitative information on the starting levels of the pathogen. Thus, if a series of independent samples were determined to be positive, it would be unknown how many cells were originally present at the time of sampling and testing. Quantitative data, which would allow for a better understanding of contamination levels, would be useful to food processors of raw agricultural products that consistently have pathogens present. It can also be used to better understand the extent of contamination for a given sample type and point in the process or environment.

Quantitative pathogen analysis has typically been conducted using conventional microbiological methods. A most

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probable number (MPN) analysis is typically used to enumerate low concentrations of pathogens, while direct plating would be used for higher levels. These methods are time-consuming, labor intensive, and expensive. Their accuracy can also be confounded by the dynamics associated with enrichment and bacterial isolation. Specifically, MPN analysis relies on enrichment of a series of cultures that have been serially diluted and subjected to detection to yield a ratio of positive and negative samples. This ratio is then used to estimate the number of starting cells per gram or milliliter in the original, un-enriched sample. This approach is labor intensive and expensive due to the number of dilutions, enrichments, detections, and confirmations required per sample.

Direct plating typically occurs by preparing a homogenate of the test sample and using a portion to inoculate agar plates selective for a given pathogen. Background organisms that can grow on the same agar can confound the process, making it difficult to isolate the target pathogen. Also, injured or stressed cells may not grow at all. Thus, the reliability of this method varies based on the type of sample, state of the target pathogen, and presence of other microbial flora.

Both of these enumeration methods are time-consuming because of culture growth requirements, confounding factors, and requirement for hands-on technical interpretation. Food processing needs rapid, cost-effective methods that provide quantitative information on the contamination level to better support process control and pathogen management.

Evaluating a Quantitative Solution

Based on the association of *Salmonella* with raw poultry products and the limitations of conventional quantitative methods for *Salmonella* evaluation, processors face a big challenge in understanding overall process control and potential for high contamination levels. Despite limitations in the science for direct enumeration of low pathogen levels, a threshold determination based on little or no enrichment is possible with existing detection technology.

Vanguard Sciences (formerly AEGIS Food Testing Laboratories, Inc.) provides technical consultation and microbiological testing services. Vanguard Sciences in collaboration with Bio-Rad Laboratories and a poultry processor evaluated the feasibility of Bio-Rad's iQ-Check *Salmonella* II standard real-time polymerase chain reaction (PCR) method for direct

detection of *Salmonella* at a threshold of 100 colony-forming units (CFU)/milliliter (2.00 logCFU/ml). Feasibility and method (matrix) validation trials were performed using poultry carcass rinsate samples prepared as part of a routine *Salmonella* sampling and testing program in a commercial poultry processing facility.

For the feasibility trials, 10 carcass rinsate samples that tested *Salmonella* negative were shipped via overnight courier to Vanguard Sciences under refrigeration for inoculation within 24 hours of receipt. Samples were analyzed for background flora based on aerobic plate count (APC) by direct plating on 3M PetriFilm following AOAC method 990.12. In addition, *Salmonella*-negative status was verified with the iQ-Check direct PCR standard method prior to inoculation. A poultry isolate of *Salmonella* was used to inoculate 10 prepared poultry carcass rinsates and samples were serially diluted to above and below 100 CFU/ml (6 concentrations per rinsate; n=60). They were also directly analyzed without enrichment for the presence of *Salmonella* using the iQ-Check *Salmonella* II standard real-time PCR method.

After trials one and two, optimizations to the assay were made to improve accuracy and sensitivity, including adjusting the sample size and volume of lysate buffer. All inoculated rinsates were simultaneously direct plated on Bio-Rad's RAPID'*Salmonella* chromogenic agar at the time of testing to verify the presence of *Salmonella* at the target threshold level. Of the 60 rinsates analyzed during trial three using the optimized protocol, a total of 20 had *Salmonella* present on the plates, indicating levels of 20 to 1,000 CFU/ml (1.30 to 3.00 logCFU/ml). Of those samples, 18 were positive for *Salmonella* using the iQ-Check *Salmonella* II standard real-time PCR assay, ranging between 30 to 1,000 CFU/ml (1.48 to 3.00 logCFU/ml). Two samples at 80 and 20 CFU/ml (1.9 and 1.3 logCFU/ml) were PCR negative. A total of 10 rinsates were not inoculated and served as negative controls, and all were negative by direct plating and PCR. Background flora (APC) ranged from 10 to 8,600 CFU/ml. These data indicate the feasibility of this approach as a direct detection method for *Salmonella* at a specified threshold level.

Upon feasibility determination, a matrix validation was performed whereby representative bone-in, skin-on thighs (n=20) were inoculated with *Salmonella* and subjected to standard rinsate procedures to allow for recovery of approximately 100 CFU/ml (2.00 logCFU/ml) in the rinsate. These rinsates were then subjected to analysis using the optimized protocol for the iQ-Check *Salmonella* II real-time PCR assay in conjunction with a reference method following USDA-FSIS procedures published in the *Microbiology Laboratory Guidebook*. In addition, samples were direct plated on RAPID'*Salmonella* chromogenic media. A total of five samples were processed as negative controls. All samples were also processed for indigenous *Salmonella* and background APC.

Test samples were negative for indigenous *Salmonella* and had an average APC value of 2.7 logCFU/gram. For the 20 samples inoculated, *Salmonella* was recovered at 80 to 490 CFU/ml by direct plating. All direct unenriched samples were positive by PCR following the iQ-Check *Salmonella* II standard real-time PCR method and by the USDA-FSIS reference methods after standard enrichment procedure.

Collectively, these data illustrate that the iQ-Check *Salmonella* II standard real-time PCR method with modification can be used directly and reliably to detect *Salmonella* at a threshold of 100 CFU/ml (2.00 log CFU/ml) in poultry rinsates without enrichment. ■

Warren has provided technical support and guidance to the food and infection control industries for over 15 years and is currently vice president of government and regulatory affairs at Vanguard Sciences (formerly AEGIS Food Testing Laboratories). Reach her at wwarren@vgsci.com.

REFERENCES FURNISHED UPON REQUEST

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PHYSICAL PROPERTY TESTING

Measuring Color

Knowing how to accurately evaluate color can help meet quality standards and consumer expectations

BY **GIRI VEERAMUTHU, PHD**

Visual color is closely related to perceptions. Consumer perception or purchase decision is made even prior to tasting food. Color is defined as the impact of wavelength in the visual spectrum from 390 to 760 nanometers (nm) of the human retina. Reflected light is perceived as color. To detect the color, either the human eye or the instrument used must be capable of recognizing the object and translate the stimuli into a perception of color.

Various manufacturers of colorimeters and spectrophotometers market their equipment as portable, benchtop, and in-process equipment. In food, effect of color is very important to "determine effects of raw ingredients to the finished product; its shelf life or changes due to processing; ensure suppliers are guaranteeing a consistent colored material; and determine if the final product meets internal quality standards established," says Cliff Walsh, operations director at American Licorice Company.

Subjective Evaluation of Colors

Color in raw materials or in finished goods is important to a food processor. Easier said than done is the quick approach to check colors with the naked eye. "There are disadvantages associated with visual examination," comments Ramon Navoa, the director of innovation at American Licorice Company. "Judgment is influenced by lighting, visual deficiencies of the eye, or in a trained panel based on repeatability. All these affect variability," he adds.

A subjective evaluation system can include matching the colors, Pantone color matching system, and actual photos of finished or raw materials. Another system called Munsell is used by the USDA. The color system divides hue into 100 equal divisions around the color circle. Applications include dairy products such as milk, cheese, egg yolk, beef fruits, and vegetables. Food manufacturers use Royal Horticultural Society's color charts to standardize food colors. The Natural Color System Digital Atlas also has more than 1,950 colors that can be used to compare colors. Any visual examination or comparing of colors has inherent constraints and are product dependent.

Agricultural commodities may have batch to batch variation and getting a consistent supply may be more critical. For example, cinnamon's flavor may be perceived to be meeting the aroma specification, but the color is variant based on the region the cinnamon is harvested, bark color, age of the bark, intentional contamination, and country of origin. Knowing variability exists with the color is hard to explain to a consumer who has expectations on the end-product's visual appearance. Some naturally occurring colors also degrade based on exposure to heat, sunlight, processing conditions, and storage. This adds complexity to the color consistency expectations.

Artificial colors added to food have their inherent drawbacks. Colors are added to food to offset color loss due to light, air, extreme temperatures, storage, and moisture. Others use artificial colors to mask natural variations in color or enhance naturally occurring color. Artificial colors provide identity to the product, protect flavors and vitamins from damage, or are used for decorative purposes.

Colors, either natural or synthetic lakes or dyes, have inherent properties and applications. Applications dictate if the measurement of color becomes criti-

Some naturally occurring colors degrade based on exposure to heat, sunlight, processing conditions, and storage.

cal to monitor in process samples for color degradation or conformance to a standard. The product appearance may be a subjective phenomenon, but when it comes to color there are instruments available in the market. Many instrument manufacturers can provide assistance in providing equipment for specific applications.

The Instruments and Their Applications

Common colorimeters are Konica Minolta's chroma meter, HunterLab colorimeters, and Hach Lange colorimeters. Colorimeters use sensors and simulate how a regular person views an object and quantifies the color differences between a standard and a production sample. Colorimeters employ three photocells as receptors, just like a human eye. The same wavelength is used to measure, and hence, measurement conditions do not change. A light source and a microprocessor convert colors to internationally accepted numeric values. Colorimeters feature a wide range of apertures and illumination for specific applications and various levels of data processing. They are good for measuring and comparing color differences between two specimens, strength determination, fastness determination, and shade sorting.

The best way to measure opaque liquids, solids, pastes, or powders is to use a 45/0 degree geometry instrument with a horizontal sample port. A liquid sample can be poured into the sample cup and measured. Blocks of cheese or slices of meat can be placed directly to the sample port aperture. With a circumferential illumination and a large measurement port, flakes, chips, and/or chocolate disks can be measured. A QC may have a standard target color that must be repeatedly manufactured by the production team. Colorimeters are ideal when the standard and measured batch are non-metameric, e.g. production batches. Natural colors such as chlorophyll, carotenoids, and anthocyanins can be measured in a colorimeter and quantify the pigments present in a food.

An inline color monitoring system mounted over a production line can give real-time data. Translucent samples will pose a concern and a "ring and disk" assembly is used to measure this type of sample. Brewed tea, for example, can be poured into the transmission compartment and a reading can be obtained.

The amounts of red, green, and blue needed to form any given color are called the "tristimulus" values, X, Y, and Z, respectively. The measurement is expressed in terms of X-Y-Z and the user can pinpoint the differences in lightness, chromaticity, and hue between the target and the sample. The color measurement taken in one location can be compared with another location or a different time in an internationally accepted terminology. This eliminates color perceptions and judgmental differences between technicians.

The Commission Internationale de l'Eclairage (CIE) defined the color of an object on three primary stimuli: red (700 nm), green (546.1 nm), and blue (435.8 nm). Sometimes, tristimulus systems of representation of colors are not easily understood by the users in terms of object color. Other color scales, therefore, were developed to relate better to how we perceive color, simplifying the overall understanding.

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A three-dimensional rectangular *L, a, b,* color space uses *L* (lightness) axis – zero is black and 100 is white; *a* (red to green) axis – positive values are red, negative values are green, and zero is neutral; and *b* (blue to yellow) – positive values are yellow, negative values are blue, and zero is neutral.

There are two popular *L, a, b* color scales in use today: Hunter *L, a, b* and CIE *L*, a*, b**. They are similar in organization, but will have different numerical values. Hunter *L, a, b* and CIE *L*, a*, b** scales are both mathematically derived from X, Y, and Z values. Hunter scale is over expanded in the blue region of color space, while CIE scale is over expanded in the yellow region. The current recommendation of CIE is to use *L*, a*, b**.

A spectrocolorimeter is a hybrid instrument that gives data such as X, Y, and Z or CIE L* *a* b** values. These are priced similar to the spectrophotometer. They are basically a spectrophotometer except that it does not output spectral data (%R) at various wavelengths. They are mostly QC lab type instruments.

Spectrophotometers measure light reflected, transmitted, or absorbed from a food product to a known standard. They have more sensors and measure spectral reflectance of an object at each wavelength on a visible spectrum continuum. They work best for liquid samples. A specimen is exposed to light and the reflected light waves are displayed as a curve on a graph. The size and shape of the curve is called a reflectance curve and is unique to each color.

Reflectance measurement (reflectance factor) is basically a reflectance of a food sample at a given wavelength compared to reflectance of the perfect diffuse white measured under the same exact conditions. The reflectance color measurements are more rapid. These are expressed as %R. If transparency of a dye solution is measured, it is denoted as %T. This quantity is equal to the percent of light at a given wavelength, transmitted through a thickness of 10 millimeters.

Choice of instrument depends on the food and the application type. Color discrimination threshold of the human eye greatly differs from the color differences defined by CIE. Using CIE values, color modeling has been developed for specific applications. Reflectance data can be reported as CIE *L*a*b* values: L – Light, *a** – red, and *b** – yellow.

Color Modeling in Fruits and Vegetables

Research attempts have been made to model color values. For example, vegetables when over-blanched can change to a green color. Depending on chlorophyll and chlorophyllide destruction, a generalized model for vegetables could be found. Chromatic changes of broccoli under modified atmosphere packaging at 20 degrees Celsius in perforated and unsealed polypropylene film packages for a storage period of 10 days indicated that using

*L*c*h** color space diagram, the modified atmosphere generated inside the perforated film packages with 4 macro-holes was the most suitable in maintaining the chromatic quality of the broccoli heads (Rai et al. 2009).

An important parameter of the postharvest life of tomatoes is color. One color model correlates the color level and biological age at harvest (Schouten et al. 2007). Data were analyzed using non-linear regression analysis and found that biological age of tomatoes can well be predicted at farmers' level and can save a lot of postharvest losses. Interestingly, they also found a very good correlation between the color values and tomato firmness.

Precision of prediction using models having the parameters of a, b, and their product ($a \times b$) was verified by sensory evaluation of 55 ripe mangoes. It was found that the fruits predicted to be mature could ripe with high-satisfied taste, while the ones predicted to be immature or over mature were mostly rejected by the panels (Jha et al. 2007). Hence, these mathematical relationships between ripeness, overall quality, and freshness index can be calculated.

The relationship between color parameters and anthocyanins of four sweet cherry cultivars using *L**, *a**, *b**, chroma, and hue angle parameters (Berta et al. 2007) indicated that chromatic functions of chroma and hue correlate closely with the evolution of color and anthocyanin levels during storage of sweet cherries. It was also shown that color measurements can be used to monitor pigment evolution and anthocyanin content of cherries.

The above paragraphs indicate that significant attempts have been made to model color values or combination thereof for prediction of various surface, as well as internal quality parameters, of various fruits and vegetables. However, very limited work on modeling of color values of other foods, such as food grain and oilseeds, are reported for prediction of their quality parameters. The coefficient of determination of these models may not always be as high as expected. In such cases, one may try to obtain the complete spectra of specimen instead of individual color values (*L**, *a**, *b**, etc.) in the visible range of wavelength (400 to 700 nm) and develop models using the absorption or reflectance data.

Hue value—which identifies whether an object is red, yellow, green, or blue—research is underway and new equipment is being invented to address hue values. With more research underway and companies investing in color detection instrumentation, the visible color differences observed during stress of drought, heat, or other deficiencies or development of fruits will be possible in the near future. Subtle differences in color and purchasing decisions will be taken as a marketing advantage. ■

Dr. Veeramuthu works at American Licorioce Company as a senior QA manager and can be reached at 219-324-1464 or giri.veeramuthu@amerlic.com.

REFERENCES FURNISHED UPON REQUEST

Color Assessment for Beverages

Beverages can be opaque, translucent, or transparent, all of which requiring different instrumentation and techniques for successful color measurement

BY **JANET GEYER**

HUNTERLAB

Soft drink sample measured with transmission instrumentation.

Liquid refreshments, or beverages, consist of a broad group of consumable liquids—ranging from carbonated soft drinks, fruit/vegetable juices, and milk to coffee, tea, and hot chocolate, as well as spirits. These beverages are a key factor in human health and nutrition, and selection of these products is based not only on taste but often on color as it relates to taste memory.

Color and appearance measurements for the beverage industry are used to ensure that the overall product appearance is the same from lot to lot. Production, storage, and ingredient changes can alter the base color of a beverage resulting in the perception that the product is different or of lower quality.

When color is different than what a consumer expects, their minds tell them that the taste is different too. The goal of course is to make sure that the customer doesn't see objectionable differences or have color negatively influence a buying decision.

Natural lemonade in a 10 mm cell—illustrating scattering.

Measurement Overview

Beverages can be opaque, translucent, or transparent, and each form requires different instrumentation and techniques for successful color and appearance measurement. In developing a method for evaluation of a beverage, it is important to note that consistency in measurement is critical to comparing results from sample to sample or lot to lot.

Opaque liquids usually have a high solids content, therefore reflect light instead of allowing it to pass and are usually characterized by a high Brix value. These type samples are best measured using directional 45/0 degrees reflectance instrumentation. This is the geometry that most closely matches how the human eye "sees" color. Samples are typically placed in a 50 millimeter (mm) cell and then the cell is placed at the instrument port.

Translucent liquids possess a medium level of solids content, along with a lower Brix value and allow light to pass through diffusely. Both reflective and transmittance measurement modes may work well depending on the translucency of the sample. As a rule of thumb, if you can see slight details of your thumb or finger through the liquid, then transmittance is the preferred measurement method. If you cannot see slight details, then reflectance measurement using directional 45/0 degrees is preferred, though it is also possible to use diffuse d/8 degree sphere

Table 1

FDA-Approved Color Additives in Food	Color	Common Food Use
FD&C Blue No. 1 (Brilliant Blue FCF)	Bright blue	Beverages, icings, jellies, condiments, extracts, and confections
FD&C Blue No. 2 (Indigotine)	Royal blue	Ice cream, snack foods, confections, cereals, and baked goods
FD&C Green No. 3 (Fast Green FCF)	Sea green	Beverages, pudding, ice cream, confections, and baked goods
FD&C Red No. 40 (Allura Red AC)	Orange-red	Beverages, gelatins, pudding, confections, and condiments
FD&C Red No. 3 (Erythrosine)	Cherry-red	Fruit cocktail cherries, baked goods, snack foods, and confections
FD&C Yellow No. 5 (Tartrazine)	Lemon yellow	Beverages, ice cream, custard, cereals, confection, and preserves
FD&C Yellow No. 6 (Sunset Yellow)	Orange	Beverages, snack foods, cereals, ice cream, baked goods, and confections

HUNTERLAB

geometry. Regardless, translucent samples require a fixed path length and a constant background to allow measurement comparison.

Transparent liquids have a very low, or zero, solids content and allow light to pass through with little or no distortion so that objects on the other side can be clearly seen. These liquids can only be measured using transmission instrumentation. Examples of transparent liquids include soft drinks, sport health drinks, and coffees.

In addition to the color of finished products, the quality measurement of ingredient dyes, pigments, or other substances is valuable. There are seven colors approved by the FDA as GRAS (Generally Recognized as Safe), see Table 1 on page 36. Dye concentration is one of the raw materials measurements that can be determined using % absorbance measurements at certain wavelengths in transmittance.

Transmittance Measurements

Using an instrument with a diffuse d/8 degree geometry, transmission measurements for a wide range of transparent liquids or food colors/additives can be accomplished. As color saturation increases, a shorter path length transmittance cell is used. As color saturation decreases, a wider path length cell is used. An overview of path length selection is presented in Table 2.

Spectral data is typically measured and converted to Commission Internationale de l'Eclairage (CIE) Lab (10-degree observer/D65 illuminant). This color scale is based on color-opponent space with dimension L^* for lightness and a^* and b^* for the color-opponent dimensions (a for red to green and b for blue to yellow). Using these three numbers, a universal language for color can be communicated.

Tolerances are rather wide for these measurements, i.e. from 1.5 to 2.0 delta E CIE since the liquids are visually compared by consumers through drinking glasses or bottles.

Most color measuring instruments with d/8 geometry also have the ability to measure transmission haze. This haze value is frequently related to turbidity for products such as clear juice and brewed tea. ■

Geyer works at HunterLab and can be reached at janet.geyer@hunterlab.com.

Table 2

Beverage	Transmission Cell Path Length
Water – white beverage, i.e. water, carbonated water, and near-clear soda	20 mm
Yellowish/green/blue/purple beverage – lemonade, light beer, and sport drinks	10 mm
Reddish beverage – wine, grape juice, grapefruit juice, and sport drinks	10 mm
Brown beverage – coffee, tea, and cola	2 to 10 mm
Color additives	2 mm
Drinks concentrate – retail soda preparations	10 mm
Syrups – local beverage manufacturer	2 mm transmission cell or flow through cell

Placing a sample into an automated rapid microbiological tester.

Selecting a Rapid Microbiological Test Method

There are various factors influencing a rapid method's effectiveness that need to be taken into consideration | BY **ALAN TRAYLOR**

Food producers want to employ rapid methods in order to improve decision making. This implies the rapid method will provide superior information in addition to providing it faster. However, there are a number of indirect issues to consider when deciding to commit to a rapid test method that ultimately influence the method's overall effectiveness.

The Laboratory Environment

Among the elements to be considered are energy, space, and waste. Many of the existing approaches are culture methods that rely on the incubation of samples in a selective or nutrient medium in order to grow, count, and identify the relevant organism.

Routed in 19th century microbiology, classic culture methods come from an era when almost all processes were manual. For example, due to readability limitations of plate counting methods, multiple replicate plates are necessary. Successive dilutions of the original sample are needed to be able to identify target colonies.

These processes take up significant space in large incubators. Most culture methods are conducted for a fixed time. Therefore, the laboratory incubator ends up being large and energy inefficient. In places were energy costs are still relatively low, this might not appear to be a problem. However, in most of the world, energy cost reduction is a central driver to operating a successful business. When the rapid method is considered, the cost of the energy to produce a result is rarely taken into account.

Similarly, space is at a premium in the food QC laboratory because most of the space is naturally allocated for preparation, processing, production, and packing. As noted, the large incubators needed to operate internal microbiology QC have an impact on the space as well as energy cost.

Bench-top space is a major issue because most labs try to use flexible spaces for multiple tasks. Yet, introducing a piece of analytical equipment usually needs a dedicated space, so it makes sense that "footprint size" is considered for test equipment.

The use of consumables and labware has evolved considerably since the mid-20th century. While there is still a need for reusable glass dishes and containers, much of the developed world has moved to disposable labware. The amount of waste from the average lab operation has increased markedly. Once again, in the case of plating methods, the basic concept of serial dilution and pipetting of samples creates a lot of waste. Any rapid method should hope to mitigate waste generation.

It is interesting to consider alternate testing spaces. Some QC operations would like to test food samples as close to critical control point as possible. However, the constraints of the traditional methods force manufacturers to consider either a microbiology lab or a dedicated space within another functional lab, such as a chemistry or materials lab. QC professionals should seek out rapid methods that can be used outside the traditional lab environment.

A good example of placing a rapid method in a more productive location can be found in meat carcass cleaning and preparation operations. The traditional method is to swab the meat carcass at various stages of processing. This is done in order to ensure no contaminants have infiltrated the cleaning process.

Transporting swabs to the microbiology lab requires the use of transport media and coolers with ice packs to stifle microbial growth. Yet the use of a rapid method that can test on site affords the production and QC staff a number of advantages. One is the very short path to the analytical equipment. Another is the reduction in sampling and transfer steps. With good aseptic technique and adequate training, the measurement goal is achieved without the need for a traditional microbiology lab.

Human Resource Factors

Absolute automation of microbial sampling and analysis is still a theory, at least for the average food producer. People have to conduct sampling, testing, analysis, and recording with the goal of generating consistent, correct, and useful information to maintain quality. Adoption of a rapid method should seek also to reduce manual steps, thereby reducing variability. The technique may be fast, but it cannot be complete unless it removes as many potential error sources as possible.

Looking at plate count methods for microbial enumeration, it can be seen how manual processes provide a breeding ground for errors. Food samples are weighed and then initially diluted in

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a specified liquid medium. The weighing and measuring is an error source.

The next step for many plate-counting methods is the serial dilution of the sample in order to provide plate readability. This might require four or more successive dilutions where measuring and pipetting errors can creep in. Most accredited techniques require the testing of replicate samples, adding to the amount of sample material and hardware, all of which has to be properly disposed of.

Common Sources of Error

One of the most common sources of error in the microbiology lab is the incorrect pipetting of small volumes of liquid. Once the serial dilutions are prepared, each one might be plated due to a lack of confidence that one of them is the accurate count. Even with the general acceptance of agar plate alternative technologies, the act of preparing and applying the sample to many plates is prone to error.

Of course, the microbes don't comply with our need to see repeatable and clearly defined data. Colony counting is beset by subjectivity. Microbial colonies can vary in size and shape. They can swarm and spread. Some parts of the plated sample are unwanted artifacts that look like colonies. Plates might be contaminated from surrounding environment. This leads to one of the highest possibilities of error—plate counting itself. Once again, technology tries to rescue the situation with camera-based counters to remove the human element. So, it can be seen from the example of microbial plate counting that reducing steps is advantageous. Also, the right level of automation and correct choice of sampling equipment helps reduce errors.

Ergonomics

An often-unrecognized effect of manual methods in the QC lab is the physiological effect on the technician. Repetitive motion disorders are a real concern for companies who have invested time and effort in the training of skilled technicians. It seems to make sense that by reducing manual steps and the number and frequency of replicates, the physiological burden from staff members will also be relieved.

Choices of rapid methods in the dairy industry offer some insight into how the food companies' investment in skilled human resources can be supported and rewarded. By choosing a total plate count, or TPC, method that uses only the raw milk as a sample, the need for dilution media is removed. This in itself saves time in preparing media and storing it. Then the probability of error in pipetting and delivering the media is negated as well.

By choosing a technology with high sensitivity and dynamic range, the need for serial dilution is eliminated. By adopting a technology where the sample size is relatively large and the quantitative outcome is not adversely affected by errors in sample size, a more reproducible result is gained. The technician's job is more easily replicated with fewer repetitive motions.

Opportunity Costs

Buried in the justification for purchasing a new rapid test method is the opportunity cost. Trained technicians should be applied to the most challenging QC tasks that their training will support.

Not all test methods are created equal in terms of complexity of preparation or analysis. An evaluation of what tasks can be automated or outsourced will maximize the technician's productivity. Test workload continues to expand, driven by regulation and customer desire for safer food and more detailed evaluation of possible spoilage or health drivers.

With test volume increasing, the right degree of automation along with good data generation can assist in guiding critical tasks toward the best-equipped people.

Summary

Data generation speed is only part of the story when selecting an alternate or replacement test method. By considering the workflow and effect on the lab environment, food companies can save costs and increase productivity. By considering the number and complexity of tests and QC steps, the skills and wellbeing of the staff can be protected, producing a healthy and productive workforce. ■

Traylor is business manager, microbial detection, at MOCON. Reach him at ATraylor@mocon.com.

Manufacturing & Distribution

TRACKING & TRACEABILITY

Traceability: Costs, Benefits, and the Future

Understanding the challenges, new rules, recommendations, and investments on route to traceability | BY **JENNIFER MCENTIRE, PHD**

From time to time the food industry and regulators seem to place great emphasis on the need to improve traceability. And yet, with focus in the U.S. on FDA's proposed Food Safety Modernization Act (FSMA) rules, traceability seems to be taking a back burner. Still, there are pockets of activity, both in the U.S. and around the world, that direct some focus back to product tracing and traceability. Sometimes these are driven by public health and the inability to solve outbreak investigations, and sometimes they are driven by the economics of running a business.

While the term "traceability" is quite familiar, the range of concepts associated with traceability is broad. Many equate traceability with recall, as in "My company has great traceability. We successfully perform a mock recall every year/quarter/etc." Certainly being able to follow the flow of your products is important, but there's more to traceability than simply knowing where you received product from and where you sent it.

Pinpointing Challenges

As an example, let's look at the *Cyclospora* outbreak(s) of this past summer. This didn't make headline news, despite the fact that over 300 people became ill. In an event like this, the first questions that are asked are "What is causing illness? Is it even a food product? Are these illnesses related to each other?" Epidemiologists, initially at the state and local level, play a critical role in developing answers to these questions and work hand-in-hand with the regulators who initiate tracebacks on suspect products. At this point, investigators are still trying to figure out the food(s) causing illness—don't expect them to know the brand names, lot number, purchase order (PO) numbers, etc. yet! They are looking at the numerous "starting points" where people who became ill purchased or ate food, and following all of those pathways back to see if they intersect to determine if the ill patients have something in common.

And yet, when the food industry tests their internal traceability systems, they are often starting with the name of the product, lot numbers, PO numbers, etc. In the instance of the *Cyclospora* outbreak, the best the regulators could do was hypothesize that the cases in Texas were related to cilantro from Mexico, which was supported by the traceback investigations. But as the investigation went on, the illnesses decreased until CDC declared the outbreak was over. We can't definitively pinpoint the cause, and therefore, we're far from being able to implement corrective or preventive actions to stop this from happening again.

Sometimes determining what two different foods eaten in two different locations have in common can be challenging. Real-life difficulties in traceability sometimes prompt regulatory change. Take, for example, ground beef produced at retail.

New—Recordkeeping in Retail

On July 16, USDA announced a new proposed rule, "Records to be Kept by Official Establishments and Retail Stores that Grind Raw Beef Products." What prompted this? A 2011-2012 ground beef *Salmonella Typhimurium* outbreak impacting 20 people in seven states in which the actual source of contaminated beef could not be determined. Although the implicated meat was known to have been sold by Hannaford grocery stores, the investigation was unable to trace the meat back any further to determine the supplier because the retailer kept only limited records.

The rule, as proposed, would require retail outlets that make ground beef by mixing cuts of beef from various sources to keep clear records identifying the source, supplier, and names of all materials (including carryover) as well as their lot numbers/production dates used in the preparation of raw ground beef products. The proposed rule also requires records related to sanitation that help determine the "clean break" between lots of ground beef.

Although official establishments did have some recordkeeping requirements,

those for retail were voluntary, based on guidance. The Supplementary Information in the proposed rule shows that the Hannaford-associated outbreak was not the first time Food Safety and Inspection Service (FSIS) was unable to trace ground beef at retail. In the 28 foodborne disease investigations conducted by FSIS from October 2007 through 2012 in which beef products were ground or re-ground at retail stores, 11 retailers had complete records available for USDA review, as shown in Table 1 on page 42, enabling product to be recalled in six investigations. When the retailers' records were unavailable or incomplete, product was able to be recalled in only two of 17 instances.

IFT Recommendations

The food industry is still waiting to see what additional recordkeeping requirements FDA will propose. FSMA authorized FDA to issue such requirements, although only for "high risk foods." The law requires the agency to perform several studies and analyses and issue some reports before proposing a regulation related to traceability, and FDA is still going through these steps. FDA worked through the Institute of Food Technologists (IFT) to conduct several product tracing pilots aimed at exploring effective approaches to improve the accuracy and speed with which traceability could be achieved system wide. The IFT provided FDA with 10 recommendations, which are discussed in a comprehensive report. In short, IFT made the following recommendations.

1. FDA should establish a uniform set of recordkeeping requirements for all FDA-regulated foods and not permit exemptions to recordkeeping requirements based on risk classification.

2. The agency should require firms that manufacture, process, pack, transport, distribute, receive, hold, or import food to identify and maintain records of critical tracking events (CTEs) and key data elements (KDEs) as determined by FDA.

3. Each member of the food supply chain should be required to develop, document, and exercise a product-tracing plan. As noted above, this could be quite different from some recall plans that companies have in place today.

4. FDA should encourage current industry-led initiatives and issue an Advance Notice of Proposed Rulemaking or use other similar mechanisms to seek stakeholder input.

5. The agency should clearly and more consistently articulate and communicate to industry the information it needs to conduct product-tracing investigations.

6. FDA should develop standardized electronic mechanisms for the reporting and acquiring of CTEs and KDEs during product tracing investigations.

7. FDA should accept summarized CTE and KDE data that are submitted through standardized reporting mechanisms and initiate investigations based on such data.

8. If available, FDA should request more than one level of tracing data.

9. FDA should consider adopting a technology platform that would allow efficient aggregation and analysis of data sub-

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mitted in response to a request from regulatory officials. The technology platform should be accessible to other regulatory entities.

10. The agency should coordinate traceback investigations and develop response protocols between state and local health and regulatory agencies, using existing commissioning and credentialing processes. In addition, FDA should formalize the use of industry subject matter experts in product tracing investigations.

The Investment

Most food companies would like to believe that an outbreak won't be associated with them. While everyone wants to do the right thing for food safety, most companies feel that it's better to invest in prevention as opposed to response. And since the application of traceability described above, both in the *Cyclospora* as well as ground beef examples, is system wide, why should a company invest in traceability if they don't feel that they are the weak link in the supply chain? From a company perspective, it's important to look at the other benefits of traceability. What is the cost to enhance traceability (both long-term and short-term, and one-time and ongoing investments) and what does the company get in return?

Table 1

Status of Retail Grinding Record	# of Investigations	# Resulting in Recalled Product
Available and Complete	11	6
Not Available	11	1
Available, but Incomplete	6	1

The IFT has conducted many studies of traceability over the last six years, including a few related to the "cost" of traceability, and the value of the benefits. Since the practices within companies vary so widely, it becomes impossible to generalize costs and benefits. However, as companies were evaluated, it was clear that good recordkeeping—which is the foundation for traceability—is good for business.

Knowing which products are where allows for much better inventory control and stock rotation, decreasing the likelihood of economic losses due to products being out of date. Being able to identify and track products with granularity also is reported to improve the accuracy of filling orders, which makes customers happy and decreases the inefficiencies of dealing with complaints, refilling orders, etc.

For manufacturers, a system that requires products be scanned into production can prevent errors in formulation, including adding incorrect ingredients (like salt instead of sugar—yes, this has actually happened) or different grade/quality ingredients (e.g., using an organic ingredient in a non-organic product or vice versa). In a well-integrated and well-analyzed system, it should also be possible to link finished product quality data with specific ingredient suppliers.

Each of the "benefits" associated with better recordkeeping and traceability could be obtained in other ways and some firms have already reaped these benefits while having lackluster traceability systems. But for those firms that are in the process of examining systems to enhance other aspects of their business, they will be well served to see if there are some traceability add-ons that can be tacked onto a planned upgrade, for example in an enterprise resource planning or warehouse management system.

But what will it cost, and what is the ROI? IFT has developed a financial calculator to help companies understand the ROI of traceability. Although the calculator is specific for the seafood industry, a review of the main elements of the calculations suggest that it can have broad utility in doing the math to determine if traceability makes economic sense for a particular firm. The tool considers factors like new market opportunities, changes in insurance rates, the cost of recalls and any anticipated reduction due to better recordkeeping, and the cost of shrink/waste, as well as other factors. The tool also looks at the anticipated costs to achieve a desired level of traceability, whether that is moving from a paper-based system to a basic electronic system, or going beyond that to a more integrated electronic system.

In summary, as the *Cyclospora* outbreak demonstrates, traceability is still a challenge. And as the proposed FSIS rule illustrates, the government will take action to improve traceability if company practices are inadequate or inconsistent. Traceability is really a byproduct of good recordkeeping, and good recordkeeping can be used to realize other benefits. That said, we all recognize that there are costs, and the IFT tool can provide a start in gauging these costs and benefits. ■

Dr. McEntire is the vice president and chief science officer for The Acheson Group. Reach her at Jennifer@AchesonGroup.com.

The Do's and Don'ts of a Food Recall

Applying a standards-based approach allows food companies to trace products with precision and remove them from the supply chain when a withdrawal is necessary

BY **ANGELA FERNANDEZ**

Anyone in the food industry knows recalls or withdrawals are an inevitable food safety measure to keep the public safe. Being able to locate a food product anywhere in the supply chain should be considered a best practice for everyday business, not just something to think about in an emergency event. Staying proactive and vigilant in establishing business processes for recall preparedness can mean a faster, more efficient approach to isolating recalled product.

There are two primary drivers toward improved traceability in the fresh foods industry—legislation, such as the Food Safety Modernization Act (FSMA), and an increase in consumer demand for accurate and complete information about the food products, especially fresh foods that are more prone to spoilage, contamination, and potential harm to the public. Traceability combined with good communication and preparedness will ensure minimal damage when a recall or withdrawal is deemed necessary.

To be proactive about recalls, take note of the following best practices.

Do adopt and implement a standards-based approach to enable whole-chain traceability.

Whole-chain traceability means that a company's internal data and processes used within their own operations to track a product are integrated into a larger system of external data exchange and business processes that take place between trading partners.

For example, the GS1 System of Standards enables companies to uniquely identify products in the supply chain in order to achieve supply chain visibility and efficiency. Using GS1 identification numbers, including the GS1 Global Trade Item Number (GTIN) for product identification, companies around the world can identify trade items as well as supplementary information (expiration date, serial number, and batch/lot number) to facilitate the communication of product-specific information wherever a barcode is scanned.

Both processes are needed to effectively trace product up and down the supply chain. Organizations that fully embrace these processes reap the benefits of enhanced efficiencies and improved consumer trust. Enabling interoperable, automated processes translate to real-time inventory visibility, which is crucial for perishable product and being able to back up claims of freshness. Whole-chain traceability can minimize collateral damage to supply chain participants and consumers, and reduce unforeseen costs (legal, fines, forced renovation, lost contracts, and loss of customer loyalty).

Speaking a common supply chain language with all trading partners means locating potentially harmful product in minutes anywhere in the supply chain if the safety of the product comes into question. These whole-chain traceability processes help a company stay vigilant even before an event to protect their consumers and enhance their customers' perception of their products in the marketplace.

Traditionally, the consumer used to view all produce suppliers the same and did not pay much attention to brand names. However, fresh foods companies are learning from consumer goods companies' ability to market themselves and create brand loyalty. This was the trend described in a GS1 US case study showcasing the traceability implementation of SunFed, a privately held full-service produce company in Arizona that grows in 31 locations and delivers a diversity of fresh produce virtually year-round. Elliott Grant, chief technology officer for HarvestMark, SunFed's technology solution partner, says, "Historically, it has been tough for small- and medium-sized produce companies to create a brand that consumers would recognize consistently. That is changing. Fresh produce brands are emerging and they are taking lessons from consumer goods companies. SunFed has a great brand—it is a quality player that takes extra care in having a perfect product. They now have the ability to tell consumers what is different about a SunFed product—and shoppers become advocates through social media. This opportunity didn't exist before. Traceability technology communicates benefits to a consumer in a new way and tells the story with integrity."

Do communicate consistently.

More than 700 organizations, including the nation's largest supermarket chains, have subscribed to Rapid Recall Exchange, a Web-based service launched in 2009 by the Food Marketing Institute, the Grocery Manufacturers Association, and GS1 US. This industry-developed service provides suppliers, retailers, and wholesalers with two-way communication to execute timely and accurate product recalls and market withdrawals.

Rapid Recall Exchange enables a company issuing a recall or market withdrawal to send trading partners critical product data plus handling and reimbursement instructions, along with other trading partner-specific information, within one notification. The system records when the notification was read and who opened the message at what time.

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On the receiving end of the notification, recipients can relay this extensive data in a standardized format with images and attachments of additional documentation, such as a press release, all via the secure website. When they've completed the recall, they can inform the issuer, closing the loop.

Do stay prepared by running regular mock recalls.

Using a service like Rapid Recall Exchange, companies can more easily conduct mock recalls to stay vigilant. Regardless of how you conduct one, mock recalls help mitigate risk and measure your ability to react to an emergency event with as much precision as possible. It is widely recommended to conduct them at least quarterly, but some companies test less frequently (twice a year), depending on their specific products and manpower. This can be adjusted as mock recall reconciliation numbers improve or fail. A mock recall for a large global manufacturer can be conducted in as little as 30 minutes using today's technology, or it could take place over the course of a few days for smaller companies. Make sure you clearly define your goals and objectives during the exercise, as they can be done to ensure the efficiency of a specific process and identify any suspected weaknesses. Mock recalls confirm that your company can trace products throughout the supply chain and evaluate the strength of your communications plan.

While staying proactive using standards-based processes, it's also important to share some assumptions you should never make, which includes the following.

Don't assume all batches must go to waste.

Whole-chain traceability procedures help reduce the unnecessary discard of product, whether it is through reduced shrink (e.g. when the wrong fresh foods are shipped and received, they are usually discarded) or in the event of a recall. A recent National Resources Defense Council (NRDC) study revealed a whopping 40 percent of food available to Americans is discarded, and most of that uneaten food ends up rotting in landfills. While much of this is a result of consumer behavior after purchase, the retail grocery industry has an opportunity to pinpoint affected food in the event of a recall or withdrawal. The entire food supply chain can put more edible food onto American tables if whole-chain traceability programs are in practice. This massive amount of food waste is particularly glaring at a time when reportedly 50 million Americans go hungry every day and the general public has unprecedented access to food sustainability information.

Pinpointed accuracy of traceability has the potential to reduce confusion and avoid category-wide fear among consumers.

Don't underestimate the power of standards.

Mother Earth Mushrooms, LLC recently implemented a traceability program based on GS1 Standards. What once took hours of sifting through paper and deciphering handwriting now takes just a few minutes with the system reports that are available with just a few clicks.

"Improvements in our inventory management from implementing GS1 Standards for traceability have been huge. We used to go out and count everything on the floor every single night. Before we filled orders, we had to look in our cooler. It was exceedingly labor intensive and potentially inaccurate," says Meghan Klotzbach, regulatory manager at Mother Earth.

Mother Earth now has a real-time inventory of raw product received, which farm it originated from, and a final count of inventory. Also because the company sells not just to distributors, but also directly to restaurants and grocery chains, its across-the-board system is easy to manage. In addition to being well equipped to handle a recall, it can now fill orders quicker and has improved its overall operational efficiency.

Remember there can also be serious consequences without end-to-end traceability. Many in the industry vividly remember the case of the cantaloupes recalled in September 2011 because they tested positive for the *Listeria* bacteria. The fruit was linked to at least 28 deaths and dozens of illnesses—and the grower did not have labels on their cases. Had the melons been labeled by carton—or individually—the recall that involved 17 states may have been limited further by revealing the exact field from which the infected melons were harvested and determining where those melons were shipped. Pinpointed accuracy of traceability has the potential to reduce confusion and avoid category-wide fear among consumers.

Don't become complacent.

As history has shown, it's never wise to assume you are immune to a recall just because you are not considered "high risk." While a company may not have been linked to a food safety emergency before, this doesn't guarantee it won't be in the future, or even that its products have always been completely safe in the past. The sources of most food related illnesses are never identified. For example, for every one confirmed case of fresh food-caused salmonellosis, at least 29 others go unreported, according to the CDC.

An electronic-based system will allow companies to eliminate manual entry errors and precisely track where products go once they leave their possession. For retailers, more precise tracking can prove to customers that they are addressing their food safety concerns. Consumers lose confidence in retailers that sell unsafe products; some even refuse to purchase fresh food from them again if a food safety emergency has negatively affected their health. More precise recalls cannot only limit health damages in the future, but reduce customer attrition caused by loss of consumer confidence.

Think about traceability from the consumer's perspective. She now has more access to information about what she and her family buy and eat than ever before by simply having the ability to look up product information on her smartphone or scan a barcode with an app. As a result, food manufacturers, growers, distributors, retailers, and other trading partners are becoming more sensitive to consumers' higher expectations and are working to implement standards-based traceability processes to not only enhance their food safety program, but also to minimize the potential damage associated with a recall. ■

Fernandez is the vice president of retail grocery and foodservice for GS1 US. Reach her at afernandez@gs1us.org.

Making LIMS a Hub for Compliance and Much More

Lab information management systems harness data from myriad sources to not only prove product is safe for compliance, but to make production more efficient by pinpointing weak spots | BY **COLIN THURSTON**

Among the many powers granted to the FDA under the Food Safety Modernization Act (FSMA) is the "authority to order a recall of food." It can also "suspend," "detain," or otherwise disrupt product distribution if it suspects the public is at risk. And European Union (EU) Directive 178/2002 is no less restrictive.

While FSMA and EU directives represent a major shift by the regulators to move from response to prevention, the reality is that contamination does occur. As of this writing, contaminated sausage has been linked to an outbreak of listeriosis that killed 12 people in Denmark. This provides yet another stark reminder that prevention is critical, as peoples' lives depend on proper response. The solution lies in effective tracking and traceability.

Piloting Track and Trace

In 2011, the FDA tasked the Institute of Food Technologists (IFT) to execute product tracing pilots in collaboration with the USDA, state departments of agriculture, and nearly 100 other organizations. This led to two pilots intended to identify methods for improving tracing of foods across supply chains and develop ways to address foodborne illness outbreaks.

No surprise that the pilots showed the process of product tracking was exceedingly complex and "often times confusing." IFT highlighted inconsistencies in terminology, numbering systems, formatting, and legibility. While many pilot participants had instruments and processes to capture track and trace level data, performance ultimately came down to "the systems and processes in place within a firm to capture, store, and report this information." ("Pilot Projects for Improving Product Tracing along the Food Supply System—Final Report," August 2012, IFT).

IFT's conclusion was that "uniformity and standardization, improved recordkeeping, enhanced planning and preparedness, better coordination and communication, and the use of technology" were key to rapidly handling "tracebacks" and "traceforwards" in the face of contamination and/or recall.

More Than Tracking and Tracing

The IFT pilots put a point on standardization, recordkeeping, planning, and coordination. These are hallmarks of a modern laboratory information management system (LIMS). But its strength in these areas goes far beyond track and trace—its value starts much earlier in the process.

The starting point for many manufacturers is a "preventive controls plan," which is based on the Hazard Analysis and Critical Control Points (HACCP) methodology. Developing this plan is not easy, but there's a reason for that—it's one of the most important steps a modern food or beverage manufacturer must take as society works to reestablish, or, in some cases, build, public trust in our food supply.

LIMS excels at managing data. Its role in collecting data—from many different instruments and other data sources—is obvious, but it's the data management role that's most important, especially in tracking and tracing. A LIMS can be central to effective monitoring and recording at the batch level, creating a record that traces the journey of a batch as it moves from farms through various stages of production to packaging. This end-to-end visibility is possible because a modern LIMS is—or should be—tightly integrated with other enterprise management systems.

The ability of a LIMS to be a hub for track and trace starts with the preventive controls plan, and that plan comprises five steps: evaluating the hazards, specifying preventive steps, specifying how the facility will monitor its controls, maintaining monitoring records, and specifying corrective actions to correct problems.

LIMS and Preventive Controls

1. Evaluating the Hazards. Hazards most often occur in obvious places: where materials are added, where vessels are opened, and where products are packaged. Each of these steps in production, and countless more, requires human or

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machine intervention, and this opens the door for misstep. What's more, in multi-ingredient processes, the source of each ingredient is essential as well. This is the complex environment where manufacturers "traceback" when an incident occurs.

Because it can map these process "pinch points" (changes and hand-offs in the process flow) and then manage the flow of information using metadata such as serial numbers, supplier information, etc., it's clear why a LIMS is truly a hub for FSMA. First it helps establish the most efficient and safest route to follow from a HACCP standpoint and then, once monitoring begins, it not only oversees the flow of data—massive amounts of it—it can also alert producers to problems before they escalate and provide standardized operating procedures for when they do.

2. Specifying Preventive Steps. Operators make mistakes during production. Equipment becomes outdated or begins to perform poorly. New materials are introduced. There are many fail points in a process, with new ones introduced regularly, so controlling each step requires discipline and structure. A LIMS provides this.

Quality, integrity, and competency must be controlled at every stage during production. When the steps necessary to do this are already codified in software, the likelihood of adherence increases dramatically. A LIMS can, for example, structure operator training requirements for employees both inside and outside of a food production lab. If employees fall behind on training, they cannot rejoin the workflow until they are properly certified or retrained. Likewise, if a sampling instrument is due for maintenance, the LIMS can ensure it's taken offline until the work is finished and formally documented.

The LIMS can also prevent raw materials or in-process product from reaching the next production stage if pre-established quality thresholds are unmet, and this creates stage gates at critical hazard points. And all of this—from training and instrument calibration to materials assessment—is automated and linked to communications systems, alerting key stakeholders inside and outside the lab to non-conformance as it happens.

3. Monitoring Controls. Without an effective sampling plan and related data management, adherence to a preventive controls plan, as well as future track and trace responsiveness, is nearly impossible. The LIMS ensures that sampling occurs at all necessary control points, that alert thresholds are set, and that data is available for rapid analysis and retrieval.

Sampling plans for control points can be managed as a group, enabling producers to use consistent protocols for each stage of production. Management can compare data from one batch to another and data is available on-demand whenever it's required—whether for routine quality control or compliance or if an actual hazard is detected.

4. Maintaining Records. Recordkeeping is often seen as audit-related activity, but it's much more. A LIMS does simplify the process of storing and retrieving data in a paperless environment, but this downplays the value of the information. Records stored within the LIMS are searchable, secure, and authenticated by electronic signatures and audit trails, which significantly streamline routine compliance, but the same data is indispensable following a control point breach. If a hazard is contained, the data can inform future process changes. If the contaminated product has already left the facility, the LIMS will play an important role in isolating the contamination and ensuring a rapid and thorough response.

5. Specifying Corrective Actions. As mentioned above, when a food safety incident occurs, a LIMS will likely be the first place a producer turns to begin corrective action. Fortunately, these steps will be clearly defined in advance and each member of an extended enterprise team will have a specific role. As the IFT pilots made clear, it's during this critical time that "the systems and processes in place within a firm to capture, store, and report this information" are most important. There's little time to search, compile, and report critical batch information. FDA will expect rapid analysis that can trace contamination to the source, whether it's a control point within a facility or a raw material producer downstream.

Law of Unintended Consequences

Many manufacturers are learning that by taking a disciplined, data-driven look at their process control points they're also achieving new efficiency and productivity gains. Even the relatively straightforward task of automating processes such as training and equipment maintenance scheduling can deliver demonstrable productivity gains. Couple that with data that provides insights into raw materials management, process speed, and costly errors and it's clear how the benefits of LIMS extend far beyond FSMA compliance alone.

For many, the impetus for change may be FSMA, but the outcomes—with a LIMS in place—are much broader and can impact quality, efficiency, and long-term profitability.

Conclusion

While easing compliance burden and identifying greater efficiencies are benefits that resonate loudly with food and beverage manufacturers, the hard costs of recalls are even more resounding. Even a small recall is expensive, and the longer it goes on the more costly it becomes. The investment made in better information management today pales in comparison to the costs of handling a recall with an inefficient management system.

A data management system, especially one as comprehensive as a LIMS, could be the unsung hero of FSMA compliance.

But FSMA continues to evolve. Consider a recent amendment that requires changes to the Reportable Food Registry, an FDA portal that's been in place since 2009 to gather data about threats to the food supply. Designed as a first line of protection for consumers, FDA now envisions a more far-reaching purview. Notice requirements under the amendments would put an onus on manufacturers to prepare plans in advance that demonstrate rapid response procedures. So clearly we should expect more oversight in future, not less.

Rapid response, remaining compliant, and discovering avenues for greater efficiency are areas where mastery of data management and a system to do so is required. And when it comes to data and managing lab testing, analysis, and reporting—especially in support of something as far-reaching as FSMA—LIMS is a platform suited to the task.■

Thurston is the project director for Thermo Fisher Scientific. Reach him at +44-161-942-3000.

Reducing Seafood Shrinkage

Retailers using enhanced electronic traceability to manage their seafood supply chains can achieve less waste, better sustainability, and more satisfied customers

BY **DAG HEGGELUND**

The seafood industry, and society at-large, has a strong focus on sustainability. Most agree that a well-managed seafood resource is in everyone's best interest. However, sustainability efforts should not stop at the seafood resource, but rather be an integral part of the complete supply chain. Statistics show that around half of every pound of harvested seafood protein ends up as waste; 10 to 20 percent pre-distribution and retail, eight percent at retail, and 31 percent at the consumer's home.

Members of the supply chain have differing explanations of this waste problem. Some argue poor purchasing procedure, others argue large variation in demand, and others argue varying product qualities. All of the reasons are interrelated; varying quality leads to varying demand; varying demand makes it difficult to predict how much to order. The end outcome is often increased product waste either by the retailer or by the consumer.

At Trace Register, we have found that lot-by-lot variation for seafood products can be a serious contributor to increased shrink at retail. For instance, it is assumed in the supply chain that the age and therefore quality of the product is constant. Unfortunately, these assumptions do not always hold true.

This variation in product attributes is a measurement of the product's quality. If a product attribute such as age, fishing method, and harvest area is outside of the expected range, then the product has a quality problem. Therefore, we recommend restating the problem from one of "reducing seafood shrinkage" to one of "improving seafood quality."

The Cost of the Problem

According to the USDA, the average shrink for seafood in retail stores is 10 percent. This means that for a retailer that sells $500 million of seafood annually, the shrink represents a $50 million loss.

Solving this problem has clear benefits, not only from a monetary basis, but also from the point of being a "good citizen of the world" and creating a more sustainable food supply chain.

The seafood industry is not the first to face quality problems or experience the effect of quality differentiation. Our acceptable level of quality changes over time. The American auto industry provides a good example. During the 1930s, most drivers expected to have a flat tire during any lengthy journey. Throughout the 1950s, we expected cars to overheat. By the 1970s the American auto industry suffered multiple quality issues and experienced significant competition from higher quality Japanese manufacturers. Imagine trying to compete in today's automobile market with a car having the reliability of an American car from the 1970s. This is the challenge facing the seafood industry today. Just as quality improvements dramatically changed the landscape for the auto industry, it is now changing the landscape for the seafood industry.

Some people think that this problem cannot be solved, that the problem is simply inherent to the business. Seafood is not like dealing with nuts and bolts, but rather biological products that naturally decay.

However, the problem can be solved by implementing a continuous improvement process, a similar methodology that has been applied to manufacturing, data management, insurance, and sales industries over the years. It's estimated that by applying this process, a 10 percent reduction in shrink can be achieved each year.

The Solution

There is a silver lining to this story—from the sea to the store to the consumer's plate, the industry is starting to work together to make changes and create a more sustainable seafood supply chain.

While some view traceability simply as a risk-mitigation cost, others are recognizing the tremendous value that traceability data can deliver. Retailers are now using enhanced electronic traceability systems to manage their seafood supply chains. They realized conventional systems based on item codes (SKU numbers) do not provide enough information.

(Continued on p. 48)

(Continued from p. 47)

Managing a supply chain based on item codes (SKU numbers) assumes that the lot variable attributes (LVA) set is small and consistent. Many retailers are finding that the size of the LVA is larger and less consistent than expected. These retailers are addressing this fact by employing enhanced traceability systems that collect and manage LVA. They apply advanced automated validation routines to ensure that their products consistently meet their product requirements on a lot-by-lot basis.

For example, knowing it is a "fresh wild Alaskan sockeye salmon fillet" is not enough. Retailers want to know where, how, and when it was caught, to determine whether it really is premium salmon that deserves $25 per pound price instead of the $15 other salmon fillets bring. Knowing when it was caught is also critical for estimating the remaining shelf life of this high-priced perishable product.

Bottom-Line Benefits for Retailers

Traditional traceability is viewed as only a cost used for record keeping, point-in-time auditing, and correcting problems after they happen. Enhanced traceability, with its powerful analytic tools, enables companies to monitor and analyze their seafood supply chains in near real-time to proactively prevent problems, reduce waste, and improve supply chain performance and product quality.

By reducing costs and delivering more consistent quality food, retailers are seeing a positive impact on their bottom line and consider enhanced traceability as a must-have for their seafood supply chains.

Reducing Seafood Shrink

Improving consistency of an inherently inconsistent product like seafood is one way that enhanced traceability can be used to reduce shrink. Often retailers may not really know when their fish left the water. One delivery of fresh fillets of fish might be four days old, while the next delivery of the same product is eight days old. With such variation in remaining shelf life, it becomes extremely difficult to avoid discarding good product while not selling bad fish to the consumer.

Retailers using enhanced traceability will be able to automatically monitor the age of fresh fillets they buy, and work with their vendor to only supply fillets that are either four or five days old. More consistent product will enable the retailer to better manage shelf life and reduce shrink.

The scanned QR code displays Wood's Fisheries traceable path for shrimp.

Verifying Sustainability Programs

Retailers' seafood sustainability programs typically make representations to customers about the seafood they sell. However, they struggle to guarantee these claims because they may lack supporting information or the data they do have is too voluminous to monitor and check manually.

For one retail client, Trace Register estimated they would have to manually check a stack of papers 16 stories high to verify their seafood sustainability claims. To manually check even a portion of this data would require many employee hours and cost hundreds of thousands of dollars. Retailers that do not authenticate such claims run a higher risk of misrepresenting the products they sell to customers..

Enhanced traceability enables retailers to capture and verify sustainability information for each seafood product as it arrives to measure its compliance with program requirements. Essentially, it enables retailers to check 16 stories worth of data automatically, without any extra labor. Specific feedback can then be provided to suppliers delivering non-compliant product about what they need to do in order to improve their performance.

Building Consumer Confidence

The Gulf of Mexico has suffered many recent disasters including a drought, Hurricane Katrina, and the BP oil spill. Because of this, U.S. consumers lost confidence in the seafood coming from the Gulf States.

To regain the confidence and trust of consumers, the Gulf States Marine Fisheries Commission launched the Gulf Seafood Trace Program. This program provides assurance to the consumer that the product was traceable back to the Gulf where it was harvested, and that the data was checked and verified. Trace Register provided the following three main components on the back-end to power this program.

- Electronic Traceability Platform—enables companies in the seafood supply chain to easily and efficiently link and share data and information about the seafood they buy and sell.
- Data Checking—provides assurance that shared data is valid and reliable.
- Marketing Module—enables seafood businesses to tell consumers a compelling and unique story about why their seafood is healthy and good to eat.

The Gulf Seafood Trace program continues to be successful with program participants reporting increased sales.

Another example of a successful consumer campaign is the "Every Shrimp Has a Tale" campaign hosted by the Mississippi Hospitality and Restaurant Association. This consumer-engaging program targeted restaurants instead of retailers, and informed consumers where their shrimp originated—assuring consumers about the quality and safety of the seafood.

Using Trace Register's marketing module, restaurants encouraged diners to scan a QR code with a smart phone to learn about the seafood they ordered off the menu. This storytelling tool allowed diners to view the exact origin of their seafood as well as track the shrimp's path from fishing vessel to processor to retailer or restaurant. Consumers gained a sense of control over their food buying choices, and felt reassured by the availability of reliable information.

In conclusion, companies need to understand that if you can't measure it, you can't manage it. By implementing a continuous improvement process and enhanced traceability, the seafood industry can improve product quality, which will ultimately enable companies to reduce waste, increase margins, and deliver consistently good food to consumers. ■

Heggelund is the chief technology officer at Trace Register. Reach him at dheggelund@traceregister.com.

REFERENCES FURNISHED UPON REQUEST

TRACE REGISTER

NEW PRODUCTS

Detectable Shoe and Sleeve Covers

Detectamet's resilient shoe and sleeve covers are made entirely from a detectable material—ideal for visiting food safety auditors or customers. The blue shoe covers are available in boxes of 1,000 (500 pairs) and are supplied within Detectamet's ISO 9001:2000 accredited quality management system. The Detectable Non-Woven oversleeves are made from the same detectable material as the overshoes and are also available in packs of 500. With no metallic strip to position, these covers are quick and easy to put on. They are elasticized at both ends. Both the sleeve and shoe covers have been approved for safe contact with food under the relevant EU and U.S. FDA requirements. **Detectamet Ltd., www.detectamet.co.uk.**

Integrated Food Protection Services

Detect + Protect Solutions service combines the knowledge of a global team of experts in food microbiology, microbial detection, and food protection with proprietary analytical processes to give food manufacturers customized solutions. Program is comprised of three fee-for-service modules: Assess – the microbial environment through sampling and biomapping; Monitor – the microbial evolution in products; and Control – unwanted organisms with antimicrobials and/or processing hurdles. The Detect + Protect food microbiologists use DuPont capabilities, including genotyping methods and specific media, high-throughput microbial screening equipment, as well as knowledge in food applications and antimicrobial solutions. **DuPont Nutrition & Health, www.food.dupont.com.**

Liquid Chromatography Systems

The data acquired by the two new Prominence-i and Nexera-i systems via interactive communication mode (ICM) is sent to a lab's data center by the LabSolutions network and managed uniformly by a server. ICM allows users to perform operations such as purging mobile phases and confirming analytical results from anywhere in the facility with a smart device. It also permits easy access to a system installed in a closely supervised area, such as under a hood where highly active ingredients are being analyzed. In addition to the temperature control function in flow cells, the systems harness new technology for detector optical systems called TC-Optics, which provides baseline stability. **Shimadzu Scientific Instruments, 800-477-1227, www.ssi.shimadzu.com.**

Gluten Test Kit For Environmental Samples

AllerFlow Gluten is a specific allergen test kit for the detection of gluten residue on surfaces. It is a two-part kit featuring a sample collection swab device and lateral flow cassette. Hygiena's patented environmental sample collection device contains pre-measured extraction buffer that is mixed with the sample by a simple snap and squeeze activation and then poured in the cassette fill well. Results are ready in 10 minutes with sensitivity to 5 ppm. Rapid allergen surface residue testing enables food processors to assess the efficacy of cleaning protocols and prevent cross-contamination of products. **Hygiena, 888-494-4362, www.hygiena.com.**

Water-Based Rapid Test for Total Aflatoxin

The AgraStrip Total Aflatoxin Quantitative WATEX test kit allows food, feed, and grain producers to test for aflatoxins without using organic solvents, such as methanol, which are flammable and must be disposed as hazardous waste. According to the company, with the new dissolvable and pre-weighed extraction buffer bags, no time-consuming or buffer preparations steps are needed. Since there isn't a filtration or centrifugation step needed due to the extraction equipment, the use of additional extract clarification is obsolete. The test kit features a quantitation range of 0 to100 ppb, a limit of detection of 3ppb, and a total time-to-results of 8 minutes, including extraction, sample preparation, and strip test development. **Romer Labs, 636-583-8600, www.romerlabs.com.**

In Other Product News

Lamitech's production facility achieves AIB third-party food safety recognition, signifying the company produces clean, safe paperboard products qualified for use in food industry.

Waters Corp. acquires Rapid Evaporative Ionization Mass Spectrometry (REIMS) technology from **MediMass**. According to company, REIMS can potentially break new ground in food safety research. A real-time food test can check for contamination by instantly determining if a food is fresh, spoiled, or improperly labeled; or identify deadly bacteria.

Invisible Sentinel partners with **Victory Brewing Company** to develop *Veriflow* brewPAL, a diagnostic assay to detect beer-spoiling microbes.

SCIENTIFIC FINDINGS

For access to complete articles mentioned below, go to the "Scientific Findings" section of the October/November 2014 issue at www.foodqualityandsafety.com.

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ARTICLE: An Eco-Friendly, Quick, and Cost Effective Method for the Quantification of Acrylamide in Cereal-Based Baby Foods

Acrylamide in cereal-based baby foods is a concern due to its possible health effects. Derivatization followed by gas chromatography/mass spectrometry is one of the most common methods to quantify acrylamide. However, it requires the use of toxic chemicals and is time-consuming. The aim of this study was to develop an eco-friendly, rapid, and inexpensive method for the determination of acrylamide in cereal-based baby foods. ***Journal of the Science of Food and Agriculture, Volume 94, Issue 12, pages 2534–2540, September 2014.***

ARTICLE: Demonstration of Persistent Contamination of a Cooked Egg Product Production Facility with *Salmonella Enterica* Serovar Tennessee and Characterization of the Persistent Strain

The aim of this study was to investigate whether continuous contamination of light pasteurized egg products with *Salmonella enterica* serovar Tennessee (*S*. Tennessee, which has been associated in hatching facilities) at a large European producer of industrial egg products was caused by persistent contamination of the production facility and to characterize the persistent strains. Seventy-three *S*. Tennessee isolates collected from products over a three-year period with

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intermittent contamination, and 15 control strains were compared by pulsed field gel electrophoresis using two enzymes. ***Journal of Applied Microbiology, Volume 117, Issue 2, pages 547–553, August 2014.***

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ARTICLE: Applications and Perceptions of Date Labeling of Food

The variation in date labeling terms and uses contributes to misunderstanding by industry and consumers and leads to unnecessary food loss and waste, misapplication of limited resources, unnecessary financial burden for the consumer and food industry, and may also lead to potential food safety risk in regards to perishable foods. This paper provides an introduction to the issue of food product date labeling and its history in the U.S., different terms used and various practices, U.S. and international frameworks, quality compared with safety, adverse impacts of misconceptions about date labeling, and advantages of technological innovations. Conclusions include a call to action to move toward uniformity, thereby decreasing confusion among stakeholders and reducing food waste. ***Comprehensive Reviews in Food Science and Food Safety, Volume 13, Issue 4, pages 745–769, July 2014.***

ARTICLE: Irradiation for Mold and Mycotoxin Control—A Review

Implementing good practices to avoid fungal growth and mycotoxin production on agricultural commodities is essential to achieve most restrictive safety standards; however, the contribution of novel technologies that may act on post-har-

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vesting and post-storage situations may be equally important. Several methodologies have the possibility to be used for this purpose. This work reviews the role, contribution, and impact of irradiation technology to control the presence of fungi and mycotoxins in food and in feed. The effect of this technology on the viability of mold spores and on the elimination of mycotoxins is considered. A critical evaluation of the advantages and disadvantages of irradiation in this context is also included in the review. ***Comprehensive Reviews in Food Science and Food Safety, Volume 13, Issue 5, pages 1049–1061, September 2014.***

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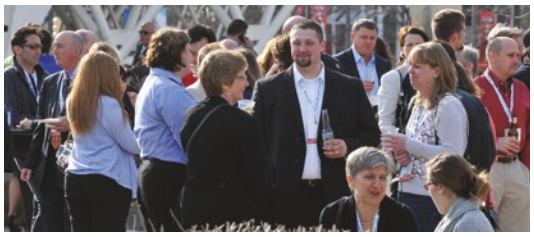

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