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Volume 29 Number 4
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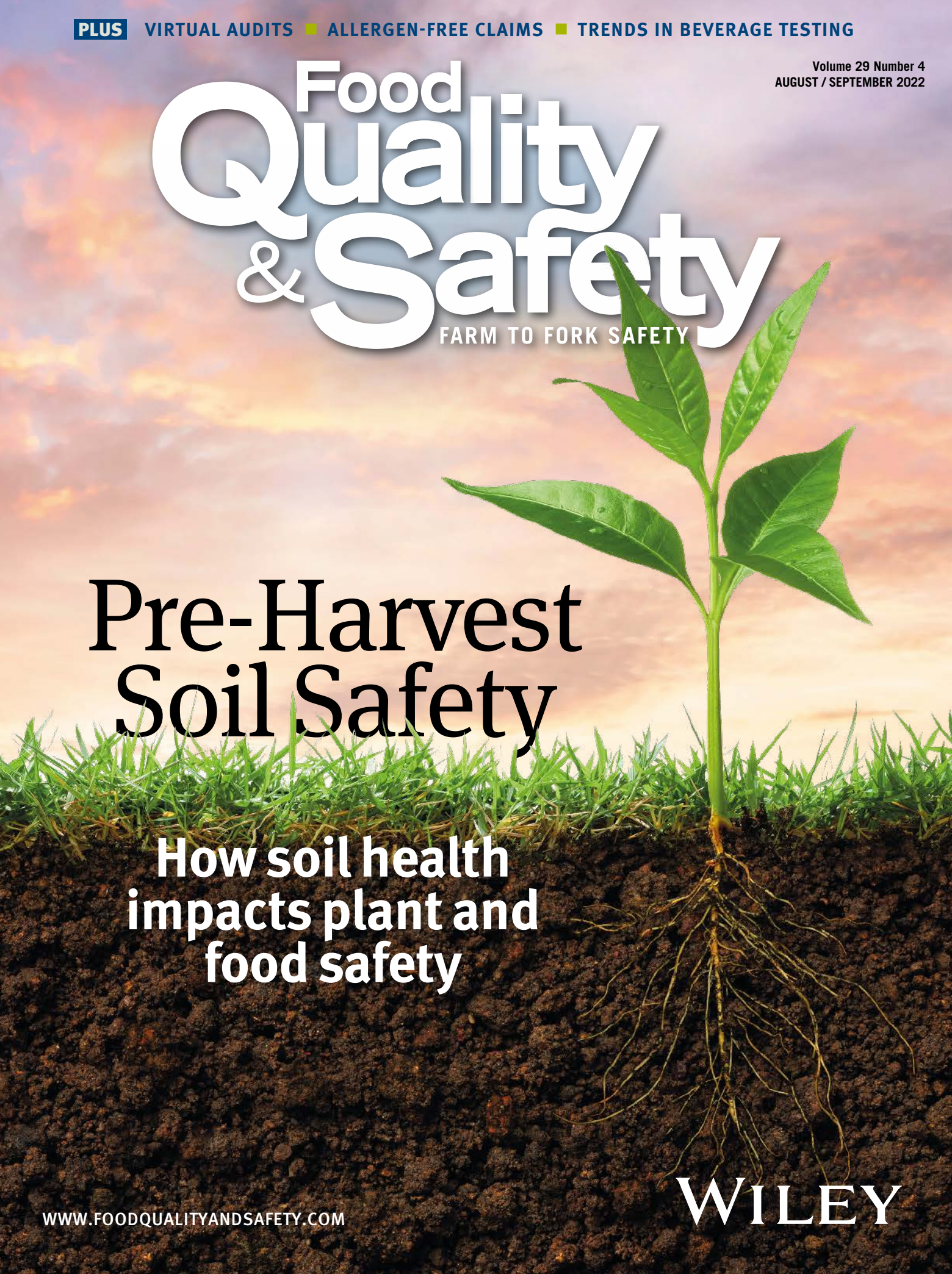
Food Quality & Safety

FARM TO FORK SAFETY



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From The Editor

A Return to (Nearly) Normal

The serial monotony of the pandemic period kept many otherwise frequent travelers grounded. Certainly, many continued to travel, and others have already returned to routine, but my situation kept me pretty much grounded until now. So, as I'm writing this column, I'm also dusting off a suitcase and preparing to head to the airport in a few days.

This year's IAFP marks yet another milestone in the return to normal, at least for me. The emails to colleagues are sent, the meetings arranged, and the countdown clock to departure day is running. The anticipation of seeing familiar faces again is tinged with a slight anxiety, too. The return to normal isn't quite complete, is it? Let's see: There's another coronavirus variant brewing, extreme flight delays, and last—but not least—recent WHO headlines about monkeypox to consider. Believe me, that's one I didn't have on my traveling risks bingo card and is not even close to normal.

I have to connect through Atlanta to get anywhere, so interrupted travel is more routine for me than most—way more routine. So, I can comfortably put that in the return-to-normal bucket. We have a new puppy that loves to chew things so much we named him Chewy. So, have I hidden all of my shoes? (He's gotten six pairs so far.) What about the TV remotes? (We lost one.) Are all the power tools in a place he can't get to? (Yes, he's even chewed up a power drill.) Are all the power cords tucked away? Check.

As for the rest? Packing is like riding a bike: Once you learn how to do it, you never really forget. Device chargers? Check. Comfy shoes? Check. But even this is a little different now. Will most people be wearing masks? Will masks be enough protection for traveling? How many do I need to bring? Disposable or fabric? Comical statement or designer fabric? These questions mark new ground to consider. Black disposable masks? Check.

On a more serious note, I'm looking forward to sharing my new role at *Food Quality & Safety* with colleagues I haven't seen for a while. It will be interesting to reengage on the pre-pandemic issues facing the food safety sector and learning about new ideas by attending as many sessions as possible. I'm excited to learn more about what others have been doing and can't wait to apply that knowledge to future issues of *FQ&S*.

As always, send me your thoughts at fqseditor@pawesta.com.

Patricia A. Wester
Executive Industry Editor

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FARM TO FORK SAFETY

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NEWS & NOTES

House Bill Calls for Single Food Safety Entity Under FDA

BY KEITH LORIA

A new bill, introduced by Rep. Rosa DeLauro (D-Conn.) and Sen. Dick Durbin (D-Ill.), looks to create a single food safety agency under the Department of Health and Human Services that would be responsible for keeping all food safe for market. The legislation, known as the Food Safety Administration Act, would ensure that a single, full-time, fully empowered expert leader oversees all aspects of FDA's food program.

"Food safety is currently a second-class citizen at the FDA," Rep. DeLauro says. "Right now, there are no food policy experts in charge of food safety at the FDA. That is unacceptable and contributes to a string of product contaminations and subsequent recalls that disrupt the supply chain, contribute to rising prices, and, in many cases, result in consumer illness and death."

Mitzi Baum, CEO of STOP Foodborne Illness, notes that in recent history, FDA has had seven commissioners, all of whom were medical professionals. "Naturally, their focus has been medical products; thus, the food program has not received the attention or leadership it requires," she tells *Food Quality & Safety*. "As the focal point has been on drugs and medical devices, which receive disproportionately more funding, it has become abundantly clear the food program needs to stand alone to remain focused on the ever-evolving food system, food safety, and its impact on public health."

Baum notes that appointing a food safety expert in a leadership role to direct the entirety of the Food Safety Administration would provide accountability across the programs, deliver coordinated responses to crises, improve communication, accelerate decision-making processes, and create a new culture of food safety across the agency. "The benefits are wide ranging but, most importantly, the impact would be on public health," she adds.

Thomas Gremillion, director of food policy for the Consumer Federation of America, says the legislation would bring much-needed attention and resources to overseeing the 80% of the food supply currently under FDA's jurisdiction. "More and more in recent years, FDA's drug and medical device programs have come to overshadow food," he tells *FQ&S*. "By moving the FDA food program units—the Center for Food Safety and Applied Nutrition (CFSAN), Center for Veterinary Medicine, and the Office of Regulatory Affairs (ORA)—under one roof, the Food Safety Administration administrator will be able to better manage resources and be held accountable to Congress."

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Additionally, the bill would also set mandatory inspection frequencies for certain high-risk facilities and, in particular, require inspections of infant formula manufacturers every six months, which will help to avoid a replay of the problems at Abbott Lab's Sturgis facility.

FDA Announces Review of Foods Program

On July 19, FDA announced that the agency will conduct an independent evaluation of its Human Foods Program, including the Office of Food Response and Policy and CFSAN, as well as relevant parts of the ORA.

"While America's food supply is safe … the program has been stressed by the increasing diversity and complexity of the nation's food systems and supply chain," said Robert M. Califf, MD, FDA's commissioner, in a statement. "Fundamental questions about the structure, function, funding, and leadership need to be addressed."

Daily Harvest Under Investigation for Outbreak of Serious Illness

FDA, along with the Centers for Disease Control and Prevention and local partners, is investigating an unusual outbreak of what it has characterized as "adverse reactions" to Daily Harvest brand frozen French Lentil and Leek Crumbles after consumers complained about gastrointestinal illnesses and abnormal liver function.

As of July 28, FDA has received 329 consumer complaints related to this product. Symptoms include severe bouts of vomiting, diarrhea, stomach pain, whole-body itching, dizziness, fever, dark urine, nausea, and headache. Abnormal liver function has been seen in some cases, and there are reports that some patients have required gall bladder removal. Daily Harvest reports it has received upward of 470 complaints as well, and the company is cooperating with FDA during the investigation.

Between April 28 and June 17, 2022, approximately 28,000 packages of the recalled product were distributed to consumers in the

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United States through online sales and direct delivery, as well as through retail sales at the Daily Harvest store in Chicago and a "pop-up" store in Los Angeles, the company stated in a press release. The voluntary recall was announced by Daily Harvest on June 23.

In July, the company announced that it had found that tara flour was the cause of the outbreak. They say that their investigation team will continue working with FDA, the tara flour producer, and others to help determine what made people sick.

Honey-Based Products Tainted with Viagra, Cialis

On July 12, 2022, FDA issued warning letters to four companies for illegally selling honey-based products that may pose a significant health risk to consumers. The agency's laboratory testing found that product samples contained active drug ingredients not listed on the product labels, including the active drug ingredients found in Cialis (tadalafil) and Viagra (sildenafil), which are FDA-approved drugs used to treat men with erectile dysfunction and restricted to use under the supervision of a licensed health care professional.

These undeclared ingredients may interact with nitrates found in some prescription drugs, such as nitroglycerin, and may lower blood pressure to dangerous levels.

"Tainted honey-based products like these are dangerous because consumers are likely unaware of the risks associated with the hidden prescription drug ingredients in these products and how they may interact with other drugs and supplements they may take," said Judy McMeekin, PharmD, FDA associate commissioner for regulatory affairs, in a statement. "Products marketed with unidentified ingredients may be dangerous and, in some cases, deadly to consumers. We encourage consumers to remain vigilant when shopping online or in stores to avoid purchasing products that put their health at risk, and instead seek effective, FDA-approved treatments."

The warning letters outline how companies violated federal law by selling active drug ingredients in products marketed as foods, such as honey, and by making unauthorized claims that their products treat disease or improve health. These products are promoted and sold for sexual enhancement on various websites and online marketplaces, and possibly in some retail stores.

The warning letters were issued to:

- Thirsty Run LLC (also known as US Royal Honey LLC);
- MKS Enterprise LLC;
- Shopaax.com; and
- 1am USA Incorporated dba Pleasure Products USA.

Companies marketing food products containing tadalafil and/or sildenafil violate federal law. Some of the products cited in the warning letters are also unapproved new drugs because they are intended for use in the cure, mitigation, treatment, or prevention of disease and they lack FDA approval. Additionally, some products cited in the warning letters are represented as dietary supplements even though tadalafil and sildenafil products are excluded from the dietary supplement definition.

FDA has requested responses from the companies within 15 working days stating how they will address these issues or providing their reasoning and supporting information as to why they think the products are not in violation of the law. Failure to promptly address the violations may result in legal action, including product seizure and/or injunction.

U.S. and Ukraine Team Up to Address Global Food Security

BY KEITH LORIA

USDA and the Ministry of Agrarian Policy and Food of Ukraine have agreed on a Memorandum of Understanding (MOU) in an effort to address global food security and strengthen collaboration in response to Russia's invasion of Ukraine.

The MOU is designed to enhance productivity, address supply chain issues, and identify food security challenges.

"Russia's actions are posing major threats not only to the people of Ukraine but

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to countries in Africa and the Middle East that rely on the grains and other staples produced in Ukraine," said Tom Vilsack, U.S. Secretary of Agriculture, in a statement. "Russia is using food as a weapon and a tool of war to threaten the livelihoods of those around the world, and that is something the agriculture community cannot and will not stand for."

As part of the MOU, a three-year partnership has been established between the countries that guarantees consistent sharing of information regarding crop production, emerging technologies, climate-smart practices, food security, and supply chain issues to boost productivity for both countries.

Additionally, USDA's Foreign Agricultural Service will provide Ukraine with technical assistance for animal health, biosecurity, and sanitary and phytosanitary controls. "This is an important step forward and when implemented will allow us to better fight global food insecurity together," Vilsack said.

Jeff Van Pevenage, CEO and president of Columbia Grain International, an organization that cultivates the growth of the food supply chain in the northwestern region of the United States, says that Ukraine needs the world's support now. He adds that fostering transparency by way of the exchange of information and expertise regarding crop production, emerging technologies, climate-smart practices, food security, and supply chain issues will boost productivity and enhance the agricultural sectors in both countries.

"U.S. farmers will help fulfill short-term demand for grain to mitigate offset and loss caused by the Russia–Ukraine crisis until infrastructure is rebuilt over time to lessen food insecurity threats," he tells *Food Quality & Safety*.

The Biden–Harris Administration also plans to use the Borlaug Fellowship Program and reestablish the Cochran Fellowship Program to enhance U.S.–Ukraine collaboration and research. Myron Rabij, senior counsel at Davidoff, Hutcher & Citron, worked as an attorney in Ukraine for more than 20 years and understands well the logistical and practical difficulties grain growers face. He says these fellowship programs are essentially exchange programs for scientists, researchers, and policy makers, sending them to U.S. universities for training. The Borlaug program is more extensive and sends U.S. mentors to visit the Ukrainians as well.

"It looks like [the MOU] is geared to improve Ukrainian farming to boost productivity—better animal health better and stronger seed varieties to improve productivity of harvests—and to improve standards to facilitate export," he says. "If the U.S. and Ukraine are now gearing to work closer in these fields, that means harvests in Ukraine will no doubt increase due to stronger U.S. seed varieties, [bringing] business to U.S. seed growers and traders. Hopefully, Ukrainian scientists and research institutes will also be able to register more of their own home-grown varieties for export to the U.S."

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Big Olaf Creamery Recalls Ice Cream Linked to *Listeria* Outbreak

FDA, along with the Centers for Disease Control and Prevention, is assisting the Florida Department of Health (FL DOH) and the Florida Department of Agriculture and Consumer Services (FDACS) in investigating an outbreak of *Listeria monocytogenes* infections linked to ice cream supplied by Big Olaf Creamery, which is based in Sarasota, Fla.

In response to the outbreak investigation, Big Olaf Creamery ceased production and distribution of its ice cream products on July 1, 2022. Big Olaf Creamery is now working to voluntarily recall all flavors and all lots of Big Olaf brand ice cream products, which were sold in plastic pint-sized containers, plastic half-gallon containers, and plastic 2.5-gallon tubs.

All flavors, lots, codes, and expiration dates through June 30, 2022 are included in this recall. The recalled product was sold at Big Olaf retailers in Florida as well as to consumers in restaurants and senior homes, and at one location in Ohio. Consumers, restaurants, and retailers should not eat, sell, or serve any recalled Big Olaf ice cream products and should throw the product away, regardless of the "best by" or expiration date.

FDA is concerned that retailers may still be selling the recalled products. Consumers, restaurants, and retailers who purchased or received any recalled Big Olaf ice cream products should throw the products away and use extra vigilance in cleaning and sanitizing any

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surfaces and containers that may have come in contact with these products to reduce the risk of cross contamination. *Listeria* can survive in refrigerated temperatures and can easily spread to other foods and surfaces.

This is an ongoing investigation, and FDA is continuing to work with FL DOH and FDACS to investigate.

FDA to Enhance Laboratory Testing Capacity During Public Health Emergencies

BY KEITH LORIA

A joint venture between FDA, the Centers for Disease Control and Prevention (CDC), and several non-government stakeholders is designed to address concerns in public health laboratory testing capacity within the three major agencies. The participants signed a memorandum of understanding (MOU) that will enhance laboratory testing surge capacity outside of CDC and public health laboratories both before and during public health emergencies.

In making the announcement, FDA said that partnerships and engagement between the public and private sector were crucial to support significant increases in demand for diagnostic testing during any public health emergency—a scenario that came to light during the COVID-19 pandemic.

Any emerging pathogen that spreads quickly and/or has the potential to cause significant disease in humans will lead to demands for a higher volume of laboratory diagnostic testing that likely exceeds the current testing capacity, the MOU noted. "Public health laboratories (PHLs) have expertise characterizing infectious organisms, handling clinical and non-clinical samples, and many have the ability to scale up routine operations to provide surge capacity during a response," the statement noted.

It's not uncommon for PHLs to assist during times of crisis, as they did for the anthrax scare of 2001, the response to the Middle East Respiratory Syndrome, and recent Ebola outbreaks. Still, these laboratory systems are not currently designed to handle and execute diagnostic testing at a large scale and scope beyond the initial critical phases of public health emergencies. "Based on these experiences, partnerships and engagement between the public and private sector are crucial to supporting a significant increase in demand for diagnostic testing during a public health emergency and to respond to emerging public health threats before reaching the level of a pandemic," the MOU stated.

Because food is always a top priority in laboratory testing, it will be a vital component of the MOU. "If we can ensure the safety of our staff and ensure accurate, legally defensible data, [we] will always be willing to help support public health and safety in any way we can," Derrick Tanner, general manager of Portland, Ore.-based Columbia Laboratories, tells *Food Quality & Safety*.

Emily Volk, president of the College of American Pathologists, notes that the MOU is important when it comes to discovering new solutions for testing as well. "Pathologists have been on the front line of the COVID-19 crisis, responsible for developing and selecting new test methodologies, validating and approving testing for patient use, and expanding the testing capabilities of the communities they serve to meet urgent and evolving needs," she says.

Going forward, CDC will collaborate with the MOU partners to enhance existing relationships with other government agencies and stakeholders in the laboratory community to support external laboratory surge testing capacity for any emerging public health threats. ■

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Washington Report

USDA Aims to Transform the U.S. Food System

The multi-billion-dollar plan is designed to bolster the resiliency of the country's food chain | BY KEITH LORIA

In June 2022, Tom Vilsack, USDA's Secretary of Agriculture, unveiled a $2 billion plan to "transform" the food system in the United States.

The efforts are expected to increase competition, capacity, and supply, and—ultimately—ease inflation. More than that, the plan is designed to improve the supply chain, make things fairer for smaller producers, improve the affordability of nutritious food, and boost underserved communities.

"As the pandemic has evolved and Russia's war in Ukraine has caused supply chain disruptions, it has become clear we cannot go back to the food system we had before," a spokesperson with USDA tells *Food Quality & Safety*. "The Biden–Harris Administration and USDA recognize we must build back better and strengthen the food system across the supply chain, from how our food is produced to how it is purchased, and all the steps in between."

For that reason, USDA announced this framework to transform the food system with a goal to build a more resilient food supply chain that provides more and better market options for consumers and producers while reducing carbon pollution, combatting market dominance, and helping producers and consumers gain more power in the marketplace by creating new, more, and better local market options.

Gary Iles, senior vice president for marketing and business development at TraceGains, a Westminster, Colo.-based technology company that helps global suppliers manage their food supply, product development, safety, and compliance issues, says a plan like this is welcome—and long overdue. "We need to upgrade the department when regulators across the board are struggling to keep up with the markets they're regulating," he says. "It also recognizes that today's supply chain is broken and that fixing it requires just two things: technology and diversity. Technology is essential for supply chain transparency and, by extension, supply chain security."

The impact of the pandemic over the last two years has painfully revealed how critical it is to diversify the next generation of the supply chain, with Iles noting that it's naïve to think anyone can rely on a single supplier or region.

What to Expect

The funding is targeted at food production, processing, distribution, and consumers, including up to $300 million to help transition farmers to organic production methods and up to $75 million to support urban agriculture. "Overall, the administration clearly wants to make a significant push in leveling the playing field in the meat and poultry markets, whether it's investment help for startups, a renewed commitment to organic and urban operations, or pulling financial levers to rein in rising costs," Iles says. "But it also looks like the best chance for success here are the efforts at diversifying the supply chain, with a straightforward push at supporting local and regional suppliers. This is where we'll see a real difference in the supply chain that will benefit everyone, from the rancher to the consumer."

Catie Beauchamp, PhD, vice president of food science, quality, and safety at ButcherBox, a direct-to-consumer meat

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brand in the U.S., says that responding to the opportunities that were highlighted over the last two-and-a-half years is critical, and there are opportunities within this plan for food safety professionals to take advantage of. "I believe the funding opportunities directly related to supporting [the] private sector's ability to adapt or respond to needs identified during the pandemic have the most opportunity to be successful in the longer term," she says. "It may not be directly related to food safety, but I also believe that funding and development within the urban agriculture sector has much potential for success as well."

Bryan Quoc Le, PhD, a food scientist and consultant based in Puyallup, Wash., believes that the plan is moderate and does not address some serious systemic issues in the food industry. "I'd be curious to see, for example, how point one on building a more resilient food supply chain that's more regional will be implemented in practice," Dr. Le says. "I'm also curious to know how the organic and urban agriculture elements in the plan will be implemented. Will that be sufficient to curb the impact of transporting produce and other agricultural goods, or should investments be placed into more sustainable infrastructure for existing manufacturers, such as solar panel installation, advanced wastewater treatment systems, and electric transportation vehicles?"

However, Dr. Le feels the investments spent on processing will likely be successful, as many manufacturers have aging or un-updated equipment. "As we are moving toward more automated and digital systems, these investments will help support processors in designing state-of-the-art facilities with more robust monitoring of food safety hazards," he adds. "I believe having a response to the current way the food system is operating is important, especially as we've seen its weaknesses during the pandemic."

How Is Food Safety Represented?

However, while the transformation is geared toward the resiliency of the food chain, Vilsack's announcement said very little about food safety.

Iles notes that the plan isn't as heavily focused on food safety, but that's not to say it ignores it either. In theory, food safety professionals can expect better support from regulators in terms of training and technical assistance, especially at smaller operations, which is a big focus of this initiative. "As it stands right now, the USDA appears to be earmarking $100 million to help develop a more reliable pipeline of well-trained workers and investments in safer workplaces," he says. "Also, it looks like Vilsack wants to establish a 'robust technical network' by investing $25 million in technical assistance for meat and poultry processing plants, including a focus on compliance."

As we are moving toward more automated and digital systems, these investments will help support processors in designing state-of-the-art facilities with more robust monitoring of food safety hazards

—Bryan Quoc Le, PhD

Plus, the $200 million the plan sets aside for Food Safety Certification for Specialty Crops will be a boon for those operations. Additionally, one of the largest impacts on food safety will be the $600 million investment in cold storage, refrigerated trucks, and processing facilities as well as food safety certifications.

When it comes to food safety, Dr. Beauchamp notes that the plan covers technical assistance network development related to start-up or expanded processing facilities, access to lending and education related to lending opportunities, funding to support workforce training, and, most obviously aligned with food safety, the financial support for food safety certifications for on-farm operations. "I believe all of the aforementioned areas impact food safety, as individuals in the food safety arena often play key roles in new plant start-ups, expansions, the challenges of staff turnover, burnout and generally effective training, and in creating and maintaining successful food safety programs," she says. "This strategy is consistent with the areas that Secretary Vilsack has identified as important, and highlights several of the critical gaps in supply chain infrastructure or food access that arose during the pandemic."

Dr. Le feels that more money will be available for food safety professionals to upgrade their equipment and facilities, as well as receive advanced training. "The cost of testing has also always been out of reach, and sometimes smaller players do not have the capital to put money into food safety testing," he adds. "Hopefully, this investment will help provide that needed funding."

Challenges

Any time you have regulators trying to "motivate" banks and lenders to help, it can be tricky, Iles notes, citing the Food Supply Chain Guaranteed Loan Program, which will back private lenders that invest in independently owned food processing, distribution, and aggregation infrastructure, along with other projects along the middle of the supply chain.

USDA has deployed $100 million to make more than $1 billion in guaranteed loans available immediately. "The ideas, especially the loan guarantee program, are undoubtedly exciting, but things like that are much easier said than done," Dr. Loc says. "Whether you care about food safety, food equity, or you're ambitious enough to want to remake the entire supply chain, there's a lot here to work with. But it's just as important to remember that the federal government moves at its own pace."

Extensive funding of federal programs has potential to benefit the broader industry, Dr. Beauchamp says, warning that it's imperative that the relationships between federal agencies and the food production industry are strengthened, versus creating silos of information that are difficult to understand or access. "Collaboration with industry, related to the support needed to strengthen industry outcomes as aided by federal agencies is essential," she adds. "Solutions designed by any party without the input from professionals with intimate knowledge of the nuanced issues at hand make implementing those solutions difficult for all parties involved." ■

Loria is a freelance science writer based in Virginia. Reach him at freelancekeith@gmail.com.

Allergen Control

Allergen-Free Claims

The safest and most transparent strategies you can adopt for these product claims

BY **STEVE L. TAYLOR, PHD, MELANIE L. DOWNS, PHD,** AND **JOE L. BAUMERT, PHD**

To some degree, food products with "free from" claims, especially those with gluten-free and dairy-free claims, have been on the market for years. In recent years, however, the number and diversity of products with claims relating to allergen-free status has grown much larger. With the passage of an FDA regulation defining gluten-free claims at <20 ppm gluten, the gluten-free market niche has been very active in recent years. Dairy-free products have been available for some time, but the terminology can differ now, with labels that include dairy-free, milk-free, lactose-free, and non-dairy phrasing.

Additional free-from claims have started to appear in the marketplace, including nut-free, peanut-free, egg-free, soy-free, and even allergen-free terminology that goes beyond the required labeling. Compared with gluten-free claims, the number of products available in the market with other free-from claims is smaller and less diverse. Food products with "free" claims definitely appeal to the segment of the market representing consumers with allergies and related illnesses to specific foods. Additionally, some consumers are also known to select products with gluten-free labels based more on their personal lifestyle choice rather than a clinical need for avoidance of gluten. Presumably, the same behavior also occurs when it comes to products with other free-from claims.

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While market opportunities exist for food products with free-from claims, potential risks also exist and must be avoided when using these claims. Let's examine both sides of this issue, with the goal of identifying the safest and most transparent strategy to use for such product claims.

Market Appeal and Challenges

Of course, products with free-from claims appeal to consumers with allergies or intolerances to those specific foods; in fact, they rely solely on ingredients labeling to choose foods safely. Specific food allergies have a prevalence of 1% or less among the U.S. population, however, so the size of the market would be rather small if these products only appealed to consumers who actually had specific food allergies or intolerances. In such situations, marketing of products to the affected and most interested consumers can be quite challenging and may involve specialized approaches, such as online sales and other forms of direct-to-consumer marketing.

Beyond the allergic consumers themselves, however, products with free-from claims can also appeal to consumers who interact with and purchase food for periodic occasions that include food-allergic individuals, such as nuclear and extended family members and organizers of school events and extracurricular activities such as team sports. As companies consider these specialized market niches, the possibility that the specific niche might have broader appeal should be examined on a case-by-case basis.

Dairy-free, milk-free, lactose-free, non-dairy claims: The universe of dairy-free foods has evolved over the decades, but the use of multiple terminologies for these claims can be confusing. Part of the confusion stems from the fact that dairy-free foods can appeal to several categories of consumers: milk-allergic individuals, lactose-intolerant individuals, vegans, and those following certain types of kosher restrictions.

Originally, many dairy-free products were simply intended for lactose-intolerant consumers. Lactose intolerance affects a very large segment of the consuming public because it is a genetically acquired condition that worsens with advancing age and affects many older children and adults, primarily in certain ethnic groups. Affected consumers experience mild intestinal discomfort (flatulence, bloating, cramping, diarrhea) after eating dairy products containing the milk sugar lactose. Lactose-intolerant consumers can often tolerate small doses of lactose in their diets without experiencing symptoms. Some dairy-free products are essentially free of lactose but still contain other milk-derived ingredients, especially milk protein fractions such as caseinates or whey protein concentrates. Some products are specifically labeled "lactose free," which is the appropriate terminology if the product is free of lactose but contains other milk-derived ingredients.

Lactose-free or dairy-free products containing milk protein would be unsuitable and even hazardous for milk-allergic consumers who must diligently avoid ingestion of any levels of milk protein. Even very small amounts of milk protein are sufficient to provoke adverse reactions in such individuals. The symptoms are variable and can involve the skin (hives, itching, swelling), the intestinal tract (vomiting, diarrhea), and/or the respiratory tract (asthma, rhinitis); very severe anaphylactic reactions and even deaths can occur in some milk-allergic consumers upon inadvertent ingestion of milk proteins. The percentage of consumers with milk allergy is rather small. Up to 2% of infants younger than 3 years of age have a milk allergy, but most of them outgrow that condition to the point where milk allergy is much rarer in adults, although an accurate prevalence estimate is not available for adults.

Few foods in the marketplace are labeled as milk free, but producers are required to include the common name in the ingredients list for products containing caseins and other milk-derived proteins. Dairy-free products are more widely available, but some dairy-free products are not suitable for milk-allergic consumers because these products still contain milk proteins. It could be argued that dairy-free products would ideally contain no detectable lactose or milk proteins so that they are well suited for both types of consumers.

"Non-dairy," another term encountered in the U.S. marketplace, is usually applied to coffee creamers. Curiously, non-dairy products are required to contain caseinates. Since casein is a major allergenic protein in cow's milk, non-dairy products pose a serious risk to milk-allergic consumers if these consumers neglect to read the ingredient declaration. The presence of casein is typically identified in the ingredient list, and non-dairy products may even have a "contains milk" statement, but the prominent labeling of the product as non-dairy can cause consumer confusion. Non-dairy coffee creamers may be safe for consumers with lactose intolerance.

The market for dairy-free products has wider appeal beyond those with milk allergy or lactose intolerance. Dairy-free products appeal to vegan consumers and others who do not consume dairy products as a matter of choice. Additionally, some Jewish consumers follow kosher pareve diets, which prohibit the ingestion of milk or meat. Kosher pareve foods cannot contain any milk-derived ingredients and are typically certified by various rabbinical organizations that then allow the application of their symbols on the labels. Kosher pareve foods should be dairy-free but are not always also labeled as dairy-free. It is also important to recognize that as Kosher pareve certification is not focused on food allergen risks and does not use analytical methods for verification of its absence, so it is possible for products labeled as Kosher pareve to contain detectable levels of milk protein, and sometimes at sufficient levels to provoke allergic reactions in milk-allergic consumers.

Egg-free claims: Egg-free products obviously appeal to consumers with egg allergy, although the number of consumers with egg allergy is actually quite small. As with allergies to milk, egg allergy mostly affects young infants and children, with a prevalence of about 2%. Most egg-allergic children outgrow this condition,

so egg allergy is not common among older children and adults. The symptoms of egg allergy are similar to those noted for milk, and reactions can be triggered by exposure to very small amounts of egg protein. Egg-free products likely exist in the marketplace because they appeal to vegan consumers and are often available as replacements for products that would otherwise typically contain egg. Examples would include egg-free mayonnaise and egg-free noodles. While the vegan market niche is growing, any egg-free product must be formulated and produced to contain no detectable egg protein so that it is also safe for egg-allergic consumers.

Nut-free and peanut-free claims: The phrase "nut free" on food products can be confusing because it is unclear if this term also means peanut free in all cases. Peanuts are, of course, legumes that are different from the various tree nuts except for their form and texture. "Peanut free" is a labeling term that is much clearer. For consumers, "nut free" should be construed to mean free of the various tree nuts, but not necessarily peanuts. As always, review of the ingredients statement is recommended for clarity Tree nuts as a group are not defined similarly in all countries of the world. A recent expert panel assembled by the Food and Agricultural Organization of the United Nations and the World Health Organization identified walnuts, pecans, cashews, pistachios, hazelnuts, and almonds as the most important tree nuts from an allergy perspective on an international basis. Brazil nuts, macadamia nuts, chestnuts, and pine nuts are identified as tree nuts for labeling purposes in two or more countries, which perhaps reflects regional differences in the allergenicity of tree nuts. The U.S. has an even longer list of tree nuts considered allergens that includes coconut and lychee, even though these examples are not truly nuts by botanical definition.

Peanut- and nut-free products are primarily targeted to peanut- and tree nut-allergic consumers. Peanut allergy affects 1% to 2% of U.S. consumers, while tree nut allergies affect about 0.6%, although some tree nut-allergic individuals can tolerate some of the nuts. About one-third of peanut-allergic individuals are also allergic to tree nuts, so some consumers must avoid both. Allergic reactions to peanuts and tree nuts can on occasion be quite severe and are among the leading causes of deaths due to food anaphylaxis. The doses needed to elicit reactions are very low in some susceptible individuals. Thus, peanut-free and nut-free products should not contain any detectable protein from any of those sources. The market for these specialty free-from products is likely restricted to the allergic segment of the population.

PEANUT FREE

The use of the word "free" suggests that the food should contain no detectable protein residues, but the availability, specificity, and sensitivity of detection methods to support such claims can vary.

Soy-free claims: Soy-free products appeal to the soy-allergic segment of the population; however, the prevalence of soy allergy is very low, affecting less than 0.1% of the population. At one time, soy allergy was more common among infants due to the popularity of soy-based infant formula, a frequent substitute for milk-based formula for infants who develop cow's milk allergy; however, the popularity of soy formula for infants has declined and fewer infants are now identified as soy allergic. Like milk and egg allergy, soy allergy is often outgrown, so its prevalence among older children and adults is rather small.

Achieving soy-free status for a food product is challenging due to the ubiquity of soy-based ingredients and the frequency of agricultural comingling of soy with other commodity crops such as wheat, oats, corn, and other legumes. The doses of soy protein needed to provoke allergic reactions are not as low as those needed for peanut, milk, tree nuts, or eggs. The use of the term "soy free" indicates that the products should not contain any detectable soy protein. The suitability of analytical methods for the detection of soy residues is more challenging due to the use of soy-based ingredients, which may contain isolated fractions of the soy proteins, some ingredients with altered structure, chemical modifications, and solubility, and others with varying degrees of hydrolysis. The clinical reactivity of susceptible individuals to these soy-based ingredients is uncertain, leading to the assumption that such ingredients may be hazardous to soy-allergic consumers even if residues cannot be detected.

Allergen-free claims: In the U.S., "allergen free" typically means that the product is free of all of the priority allergenic foods identified in the Food Allergen Labeling & Consumer Protection Act: peanut, tree nuts, milk, eggs, fish, crustacean shellfish, soybeans, and wheat (sesame seeds are soon to be added to this list). Rather obviously, these foods are targeted toward that segment of the consuming public with food allergies. The overall prevalence of food allergies in the U.S. is a matter of some debate but likely falls between 4% and 11% of the U.S. population. Affected individuals can suffer from any or several of a range of symptoms. In some cases, allergic reactions can be triggered by low provoking doses.

The formulation of allergen-free foods can be challenging because it can be hard to find suitable replacement ingredients for some types of food products. Because of the low provoking doses, these foods must not contain any detectable protein from any of these commonly allergenic sources. Most food-allergic consumers would need to avoid the specific food they're allergic to, but may not wish to avoid all commonly allergenic foods. Thus, the appeal of allergen-free products is likely far less than the overall prevalence of food allergies in the population; however, the prevalence of consumers with multiple food allergies (three to five foods) is increasing for unknown reasons, which could create

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a market for such products. Additionally, some of these products may also be vegan depending upon other components of the formulation. While analytical methods with reasonable sensitivity and specificity exist for many of the priority allergenic foods, good methods don't exist for the detection of all tree nuts or for fish.

Vegan claims: Just as dairy-free and egg-free products can appeal to vegan consumers, vegan product labeling may imply to some consumers that the product is dairy free and egg free. Vegan labeling is often applied primarily as a lifestyle or consumer preference claim, rather than for consumers with medically necessary dietary restrictions, but it would be prudent for food-allergic consumers to interpret these label claims with caution. Food manufacturers should also recognize that vegan-labeled products may appeal to milk- and egg-allergic consumers and evaluate allergen risks accordingly. Other pseudo-free-from claims, such as "school safe" or "classroom safe," are even more ambiguous and challenging for consumers to interpret.

Regulatory Limitations

Gluten free is the only one of these free-from claims that has a regulatory definition: less than 20 ppm gluten in most countries in the world. The use of other free-from statements on packaged foods is voluntary and is not specifically defined or restricted but must be truthful and not misleading. The use of the word "free" suggests that the food should contain no detectable protein residues, but the availability, specificity, and sensitivity of detection methods to support such claims can vary. The selection of test methods will affect the veracity of these free-from claims.

Recommended Strategy

While "free from" products may appeal to wider audiences of consumers, the food industry must be vigilant about potential risks to that subset of consumers with allergies or intolerances to the specific food(s). For gluten-free claims, the existence of a regulatory definition establishes the manufacturing objective. Gluten-free ingredients must be sourced, and the potential for cross contact from the use of facilities or equipment used for the manufacturing of gluten-containing foods must be carefully managed. A suitable method for the detection of gluten residues must be selected.

No regulatory definition exists for use of these terms other than the free-from claims mentioned herein. As noted, the claim must not be false or misleading. The Food Allergy Research and Resource Program (FARRP) recommends that food manufacturers establish their own definition for a claim and post it in publicly accessible locations such as product websites. The definition should identify and specify the nature of the claim and carefully distinguish among possible variations, e.g., milk free versus dairy free versus lactose free. The definition should identify the allowable levels of allergen residues and the analytical methods used for compliance, e.g., peanut-free products contain less than 5 ppm peanut protein as measured using XX method (specific for peanut protein residues).

With the other free-from claims, food manufacturers need to source ingredients that are reliably and consistently free of detectable residues of the relevant allergenic food(s). As mentioned earlier, sourcing can be quite difficult for ingredients that are sourced from agricultural commodities subject to comingling, particularly with respect to soy and wheat (gluten) residues. FARRP recommends analysis of individual lots of ingredients for use in products with free-from claims and the retention of samples of all such ingredients to use in investigating any potential problems.

While "free from" products may appeal to wider audiences of consumers, the food industry must be vigilant about potential risks to that subset of consumers with allergies or intolerances to the specific food(s).

EGG FREE

The selection of suitable analytical methods to support free-from claims can be challenging. Enzyme-linked immunosorbent assays (ELISAs) specific for proteins from the allergenic source are the most frequently used. For support of free-from claims specifically, FARRP recommends the use of the quantitative, well-based ELISA methods as opposed to lateral flow devices (LFDs). If a company does utilize LFDs for qualification of ingredients or analysis of finished products, it is highly recommended that an evaluation of the LFD in the ingredient or food matrix is conducted to ensure that the matrix does not affect the sensitivity and reliability of the LFD.

For some allergenic foods such as peanut and gluten, several excellent ELISA methods are commercially available; however, the availability of robust ELISA methods requires more care as methods may not have equivalent sensitivity, utility in specific matrixes, or reliability in detecting processed versions of the proteins from the allergenic source.

Food products free of specific allergens or groups of allergens can have market appeal beyond the segment of consumers with food allergies and intolerances. Market opportunities may exist but would not be expected to generate the magnitude of the gluten-free market unless they also become market trends generating their own inertia. The size and profitability of these "free" markets is uncertain, however. The degree of difficulty involved in making products for such markets is variable, and great care must be taken to protect those consumers who are truly sensitive to small amounts of these allergenic foods, because they will be among the consumers attracted to such products. ■

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Cannabis Corner

Cannabis Career Opportunities for Food Safety Professionals

Are you ready? | BY **KATHRYN BIRMINGHAM, PHD**

In recent years, the legalization of cannabis for medical and adult use in states across the United States has opened doors for new careers—and career advancement—throughout the industry.

Since California became the first state to allow marijuana sales in 1996 through a medical marijuana program, 38 more states (and Washington, D.C.) have passed medical marijuana legislation and 18 have passed adult-use laws. In addition, the 2018 Farm Bill legalized the production of hemp products, leading to many cannabidiol (CBD) tinctures and edible offerings. However, some states still restrict the possession and production of CBD hemp.

Career Opportunities in the Cannabis Industry

As with many industries, the job market is hot at cannabis companies. Cannabis industry-specific recruiters such as Vangst, CannabizTeam Worldwide, and Careers Cannabis, in addition to more common hiring sites like ZipRecruiter and Indeed, currently list hundreds of cannabis industry jobs on their sites, from gig workers to personnel trained in food safety at facilities that make edibles throughout the U.S.

CannabizTeam Worldwide, which reports more than 320,000 people employed in the cannabis industry, expects this number to expand to 500,000 jobs by 2024. Vangst puts that number at around 900,000 by the end of the 2020s.

In recent months, food safety experts have also expressed concerns about turnover amongst food safety personnel and highlighted the need for continued recruitment and mentoring. With jobs opening up—from harvesters to executives and managers at cannabis edibles companies—the outlook for cannabis careers brings good news for those looking for career changes and opportunities to advance. This includes avenues for food safety professionals looking for a career boost.

Food Safety Training

Hiring practices can vary widely in different industries and even at companies within the same industry. Still, human resource experts agree that skills training is critical when bringing on new talent. Indeed, choosing the right person for the job will bring a solid background to the role, but it's incumbent on the company doing the hiring to ensure that employees have proper training when they're on the job.

At non-cannabis food companies, food safety training fulfills regulatory mandates outlined in the Food Safety Modernization Act, including the requirement to have a trained preventive controls-qualified individual on staff at every facility. A lack of federal oversight has led to varied state cannabis regulations with respect to current good manufacturing practices (GMPs), hazard analysis and critical control points (HACCP), and preventive controls. Training employees to understand hazard analysis and preventive controls can ensure that each facility operates at a high standard for food safety.

Management and food safety teams at companies making cannabis-infused

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Pre-Harvest Soil Safety

How soil health impacts plant and food safety

BY **KAREN APPOLD**

When aiming to achieve pre-harvest agricultural soil safety, the key is to maintain the level of beneficia l soil microorganisms while minimizing the potential contamination of foodborne pathogens and plant disease from agricultural inputs used to produce crops, says Achyut Adhikari, PhD, associate professor and extension food safety specialist in the School of Nutrition and Food Sciences at Louisiana State University AgCenter in Baton Rouge.

Soils are often enriched with biological soil amendments of animal origin (BSAAO) to increase nutrient values, enhance water-holding capacity, and support crop growth and yield, says Kali Kniel, PhD, professor in the department of animal and food sciences at the University of Delaware in Newark. Soil amendments can be delivered to soils as raw animal manure, treated or composted manures, and compost teas.

Using animal manure as a fertilizer on agricultural farms is a common practice in the United States because it's a good source of macro- and micronutrients required for crop production, Dr. Adhikari says. In addition, organic matter present in manure helps improve physical, chemical, and biological properties of soils. It also improves water infiltration, enhances nutrient retention, reduces wind and water erosion, and promotes the growth of beneficial organisms.

According to the Food and Agriculture Organization (FAO) of the United Nations, livestock contributes 40% of the global value of agricultural output and supports the livelihoods and food and nutrition security of almost 1.3 billion people. But, despite their benefits, BSAAOs can also contribute to food safety risks. They can be contaminated with zoonotic pathogens or enhance the growth of zoonotic pathogens in and around the growth of raw agricultural

It's important that growers use soil amendments appropriately to grow healthy efficient crops as well as avoid the excessive use of soil amendments that could affect agricultural water if contamination occurs by run-off into produce fields.

—Kali Kniel, PhD

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commodities, says Dr. Kniel. "It's important that growers use soil amendments appropriately to grow healthy, efficient crops, as well as avoid the excessive use of soil amendments that could affect agricultural water if contamination occurs by runoff into produce fields," she adds.

Potential Problems

Poor soil health can cause plants to become diseased, contaminate fruits and vegetables, and ultimately lower food production, says Dr. Adhikari. In addition to the indigenous microflora of soil, pathogens and other microorganisms can be introduced into soil from different inputs such as contaminated irrigation water, runoff water, and unfinished or improperly treated compost or raw manure application, as well as both domestic or wild grazing animals.

The persistence of bacterial and viral pathogens in raw animal manure is based on the manure type, how it's applied and incorporated into soils, soil type, storage of manure before application onto soils, and the microbial diversity present and nutrient ratios in manure-amended soils, says Dr. Kniel. Persistence and survival of bacterial pathogens in manure-amended soils depend on geographical and environmental factors.

According to Michael Mahovic, PhD, branch chief of the division of produce safety within FDA's Center for Food Safety and Applied Nutrition in College Park, Md., among the most commonly occurring foodborne pathogens are:

1. *Salmonella spp.*, which can come from domesticated and wild animals and their feces as well as humans and their feces. Some strains have become resident in the environment.
2. *Shiga toxin-producing Escherichia coli*, which can come from domesticated and wild animals, particularly ruminant animals (e.g., cattle, sheep, goats, and deer), and their feces.
3. *Listeria monocytogenes*, which can be found in soil, decaying vegetation, water, and domesticated and wild animals and their feces.
4. *Cyclospora cayetanensis*, which can come from humans and their feces.

Using untreated or partially treated animal manure as a fertilizer in crop production may result in contaminating fresh produce with enteric pathogens, Dr. Adhikari says. Once contamination occurs, it is difficult to remove pathogens completely from fresh produce, even with chemical and physical decontamination treatments. As plants uptake water, soil-borne pathogens can enter the fruit, making it impossible to wash away, leaving heat as the only means of rendering the produce safe.

Furthermore, human exposure to untreated animal manure or insect vectors may put workers at risk of pathogen infection, says Dr. Adhikari. Therefore, it's essential to adequately treat or compost animal manure before application, and to use proper strategies during application and storage of raw manure to ensure reduced risk of contamination.

Notable Outbreaks of Foodborne Pathogens

When USDA's good agricultural practices (GAPs) aren't followed or adhered to, there's a higher risk of contamination of fruit and vegetable commodities. "Even when a grower or producer is working with a good GAPs framework, there is still an opportunity for the contamination of fruits and vegetables which may be consumed raw," says Kali Kniel, PhD, professor in the department of animal and food sciences at the University of Delaware in Newark. "This is why it's critical to have good hygienic practices in place, including appropriate cleaning and sanitizing and good temperature control across the food supply chain."

One of the most significant foodborne illness outbreaks occurred when cantaloupe from Jensen Farms in Colorado became contaminated with *Listeria monocytogenes* in 2011. CDC data shows the outbreak was linked to at least 147 infections, 143 hospitalizations, and 33 deaths in 28 states, making it one of the country's deadliest foodborne illnesses associated with fresh produce and one of just a few outbreaks that have resulted in severe penalties to the owners. In this case, CDC and FDA reports identified the initial source of contamination as likely cow manure that was found on company vehicles and fruit crates used to haul cull fruit to a nearby feedlot and were reused without proper cleaning. Further testing revealed the standing water in the fruit coolers tested positive, and supported additional growth of *Listeria*, which contributed to the spread. However, the biggest culprit was determined to be a piece of recently added equipment to wash the fruit, which was originally a potato washer. A consultant convinced the owners it would save water, but they failed to include the need to use of chlorine in the rewash water to clean the fruit.

In 2018, there was an outbreak of *E. coli* O157:H7 infections linked to romaine lettuce. Sixty-two people from 16 states and the District of Columbia were infected with Shiga toxin-producing *E. coli* O157:H7. FDA, along with the CDC and state partners, investigated farms and cooling facilities in California that were identified in traceback, says Achyut Adhikari, PhD, an associate professor and food safety specialist in the School of Nutrition and Food Science at Louisiana State University AgCenter in Baton Rouge. CDC identified the outbreak strain of *E. coli* O157:H7 in sediment collected within an agricultural water reservoir on Adam Bros. Farming Inc., a farm in Santa Barbara County, Calif., which was identified in the traceback investigation.

It was determined that the source of contamination was the irrigation water, which may have contaminated the soil or the harvestable portion of the crop during irrigation. In this case, *E. coli* O157 was found on the sediment soil of the agricultural water reservoir, says Dr. Adhikari. Romaine has since been involved in additional recalls that are the target of ongoing research to better understand the causes involved.

In another instance, in 2006, a nationwide outbreak of *E. coli* O157:H7 in bagged spinach was traced to four ranches on the central California coast. Twenty-six states and Canada reported 205 cases of illness and three deaths. Investigators found that feral swine contributed to the contamination of agricultural fields and surface waterways, Dr. Adhikari says. Isolates from feral swine, cattle, surface water, sediment, and soil at one ranch were matched to the outbreak strain.—*KA*

Agricultural water can be another vehicle for produce contamination. It can easily become contaminated with rainwater, surface runoffs, wildlife access, animal fecal deposits, and many other things. Surface water that is open to the environment is the most prone to microbial contamination, says Manreet Bhullar, PhD, research assistant professor in the department of horticulture and natural resources at Kansas State University in Olathe. Water can carry pathogens from soil to a plant's surface through splashing, sprinkling, or other modes of irrigation or crop management practices. Excessive rainfall that causes runoff that can also be a source of contamination from seemingly distant locations. In addition, using contaminated water for irrigation may deposit pathogens that can survive and persist in soil for longer periods of time, depending on several factors.

Water quality is crucial for fresh produce that is consumed raw, says Dr. Adhikari. Water used for irrigation should be routinely tested to ensure its safe to use. Once contaminated, pathogens are difficult or even impossible to remove from fresh produce even after vigorous washing with sanitizers. Municipal waters are potable and safe for agricultural purposes but are not always available. Due to the limited supply and access growers must depend on surface water or well water to meet production requirements.

Mitigating Potential Issues

The Food Safety Modernization Act (FSMA) shifted the focus from reacting to problems after they occurred to preventing food safety problems, Dr. Adhikari says. When using BSAAOs per the FSMA Produce Safety Rule (PSR), Dr. Bhullar says the following criteria should be applied:

- To minimize the risk of contamination, soil amendments must be treated to destroy pathogens.
- Aerated compost should be treated at 131°F or 55°C for three days, followed by curing; turned composting should be treated at 131°F or 55°C for 15 days, followed by curing.
- Use a thermometer to check the temperature of the compost pile.

When using and applying soil amendments of animal origin:

- Maximize the time interval between application and harvest.
- Minimize runoff and access by animals.
- Separate raw and finished manure to prevent cross-contamination.
- Designate special tools for treated soil amendments and clean them after use.
- Do not allow manure to contact the edible portion of the plant.

Growers can also mitigate pathogen survival in soils by following guidance from the USDA National Organic Program (NOP) and the California Leafy Greens Handler Marketing Agreement. The NOP recommends that raw (untreated) manure be applied at least 120 days before harvest for crops that are likely to contact the soil and 90 days for crops less likely to contact soils. "This is to provide sufficient time for pathogens to die off in soil and minimize their likelihood of transfer," says Manan Sharma, PhD, a research microbiologist in the Environmental Microbial and Food Safety Laboratory of USDA's Agricultural Research Service (ARS) in

FSMA's PSR guidelines don't fit all farms and only provide scientific recommendations on the common routes of contamination in order to minimize risks. It's important to identify all potential concerns of contamination on a farm and to consider them when developing a farm food safety plan.

—Manreet Bhullar, PhD

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Beltsville, Md. "Currently, the FDA has 'no objection' to the NOP interval for the application of manure and harvest of fruit and vegetable crops, but is evaluating data to determine if the NOP interval is appropriate for produce."

Research published in 2019 in the journal *Applied Environment Microbiology* indicated that weather and regionality drive survival of pathogens in soils, more than soil type or manure amendment type, says Dr. Sharma. Rainfall and soil moisture affect pathogen survival duration. Specific amendment types, such as those based on poultry litter, have supported longer survival durations than dairy cattle manure or horse manure in previous studies conducted collaboratively by USDA ARS, the University of Maryland Eastern Shore, and FDA.

A collaboration among USDA ARS, the University of Delaware, and FDA, led by Drs. Kniel and Sharma and published in 2021 in *Applied and Environmental Microbiology*, showed that the transfer of pathogens to cucumbers from soils occurred at higher levels in seasons with greater rainfall, says Dr. Sharma. Pathogen survival in soils also increased in seasons with more rainfall. Studies are currently underway in different states (e.g., California, Georgia) that examine the survival of pathogens in soils and transfer to specific commodities (e.g., onions, leafy greens), for both untreated (raw) manure amendments and heat-treated amendments. These studies are part of a USDA SCRI-funded grant called CONTACT, a multi-institution produce safety research project.

Despite its benefits, the major concern about using raw manure is that it's a significant source of human pathogens, says Dr. Adhikari. In fact, growers must avoid using raw manure if they're growing crops that are consumed raw. Developing practices of using properly composted materials on produce farms will reduce the risks associated with microbial contamination.

Using Good Agricultural Practices

The best way to reduce risks associated with contamination of raw agricultural commodities is to promote the use of USDA's good agricultural practices (GAPs), says Dr. Kniel. GAPs include good handling practices of soil amendments, which may reduce risks of contamination with zoonotic pathogens (i.e., bacteria, viruses, and protozoa that can cause illness in animals and humans). "Growers should use color-coded tools to reduce the risk of contamination of treated and untreated soil amendments," Dr. Kniel says. For example, "use tools with 'green' handles for untreated soil amendments and don't use those tools with other soil amendments. Be sure that those tools don't come into contact with crops at or near harvest time."

It's also important for growers to know if the soil amendments they're using are properly composted, Dr. Kniel says. This requires certification by the retailer or proper monitoring of time and temperatures if a grower does their own composting.

Managing soil amendments can reduce food safety risks. This includes assessing risks from the soil amendment being used, selecting low-risk crops for application (e.g., agronomic), and reviewing the application method (e.g., incorporated, injected, or surface applied) and timing (e.g., days to harvest, season of application) to reduce risks, says Dr. Kniel. For this reason, raw manures are more often applied to agronomic crops rather than to raw agriculture commodities.

Another GAP, according to Amanda Deering, PhD, associate professor in the department of food science at Purdue University in West Lafayette, Ind., is limiting the amount of time that fresh produce touches the soil when possible; however, this is not possible for crops such as cantaloupe, which grow on the ground. Also, fresh produce items that are dropped and touch the ground after harvest should never be sold because they can become damaged when hitting the ground. Cuts and bruises on fruits and vegetables can release nutrients (sugars) from a plant and may be a source of food for any bacteria that are present, which will allow them to grow to high numbers and cause illness in those consuming the fruit or vegetable.

Going Forward

Managing risks in produce production includes addressing potential sources and routes of contamination, such as those described in FSMA. Additionally, if farms aren't covered by this ruling or face additional distinctive challenges due to their local conditions or practices, they should consider implementing appropriate GAPs, Dr. Mahovic says.

Understanding one's farming operations is critical to establishing microbially safe practices for safe, fresh produce production. "FSMA's PSR guidelines don't fit all farms and only provide scientific recommendations on the common routes of contamination in order to minimize risks," Dr. Bhullar says. "It's important to identify all potential concerns of contamination on a farm and to consider them when developing a farm food safety plan."

Risk-based preventive controls will continue to help minimize risks of contamination; however, there is no such thing as a one-size-fits-all plan. "Microbial food safety risk depends upon pre- and post-harvest practices, agricultural inputs, commodities grown, and environmental factors," says Dr. Adhikari. "Conducting a risk assessment that is geared toward a particular farm and developing practices to minimize the risk of contamination will help to mitigate specific risks." ■

FDA Extends Compliance Period for Agricultural Water Requirements

In July 2022, FDA extended compliance dates for pre-harvest water provisions as outlined in the 2021 agricultural water proposed rule. This rule would require farms to conduct annual systems-based water assessments to determine appropriate measures to minimize potential risks associated with agricultural water. FDA is now proposing the following compliance dates for covered produce other than sprouts:

- Two years and nine months after the effective date of a final rule for very small businesses;
- One year and nine months after the effective date of a final rule for small businesses; and
- Nine months after the effective date of a final rule for all other businesses.

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Dust Control Strategies for the Food Industry

How to reduce cross-contamination concerns

BY **RICK KRECZMER**

Dust control is essential for the food industry to ensure food quality, prevent cross-contamination, and create a safe and comfortable workspace for employees. An efficient and effective dust control strategy involves three critical elements: dust reduction, housekeeping, and dust collection. While there is no "one-size-fits-all" dust collection solution for the industry, understanding the basics of dust control and how they apply to your processes can help you make the right decisions for your facility.

The Importance of Dust Control

Uncontrolled food dust can present significant problems for food manufacturers, especially if multiple products with varying ingredient types are produced in the same facility. Fugitive dust is one of the major causes of cross-contamination or cross contact with allergens in food production facilities. Dust that escapes from mixers, blenders, sifters, and other production processes can easily propagate through the facility, contaminating other production equipment and conveyor lines as it settles. It's much easier to control dust at the source than

clean it up once it spreads through the facility.

Food dust can also create other hazards in the facility:

- **Microbial growth:** Excess dust settling on surfaces and in crevices creates conditions that support the growth of bacteria, yeast, and molds, many of which can cause foodborne illnesses.
- **Employee health, safety, and comfort**: Food dust can present risks to workers, too. Breathing in flour, for example, can lead to a form of asthma called "baker's lung." Some spices and additives are dangerous to inhale, and other ingredients can cause allergic reactions with repeated exposure. Even if dust is not especially dangerous, a dusty environment is not comfortable to work in, which can create recruiting and retention problems for food manufacturers.
- **Combustion risk**: Most types of dust found in the food industry—including flour, sugar, cocoa, starches, and powdered milk—are combustible. In fact, the food and agriculture sector has the most reported combustion incidents, according to the 2021 Combustible Dust Incident Report (available at dustsafetyscience.com). Controlling combustible dust is essential for plant safety.

Dust Control Basics: Dust Reduction, Housekeeping, and Dust Collection

To prevent cross contamination and other issues caused by fugitive food dust, manufacturers must implement a multipart dust control strategy that includes dust reduction, housekeeping, and dust collection.

- **Dust reduction**: First, look for ways to reduce the volume of dust created or the amount of dust that becomes airborne. For example, low-speed/high-volume conveyor systems can reduce airborne dust. Transfer and dumping points can also be engineered to reduce dust cloud formation. Finally, some processes and conveyors can be enclosed to prevent dust from propagating to other parts of the facility. However, when enclosing dust-producing applications, dust collection must be used to prevent dust clouds from reaching explosive concentrations within the enclosure.
- **Housekeeping**: Good housekeeping practices are also required to reduce the buildup of dust on surfaces and equipment. Dust that is allowed to settle on surfaces such as light fixtures, the tops of equipment, roof beam systems, and floors and worksurfaces is easily transferred to other parts of the facility through human activities or disturbances that cause it to go airborne. To avoid creating airborne dust clouds, a National Fire Protection Association-compliant vacuum system should be used to clean up loose dust. Food contact surfaces should be scrubbed and sanitized frequently, especially when switching between ingredients.
- **Dust collection**: The dust control strategy will almost certainly include some form of dust collection system. A dust collector filters particulate out of the air and returns clean air to the facility. Dust collection can be used to pull dusty air out of enclosed applications and conveyor systems and to clean air for the facility as a whole. Collecting and filtering airborne dust prevents it from settling on surfaces, which will significantly reduce the housekeeping burden and cross-contamination concerns. Dust collection also prevents dust from accumulating to combustible levels in the air.

> It's much easier to control dust at the source than to clean it up once it spreads through the facility.

Designing an Effective Dust Collection System for Food Applications

Dust collection solution design for food applications is generally highly customized. The solution will depend on several factors.

- **Dust characteristics**: What is the volume of dust produced? Is it combustible? Is it hazardous to inhale? Is it controlled under the FDA Food Allergen Labeling and Consumer Protection Act? Is it coarse and abrasive, ultrafine, hygroscopic, or sticky?
- **Process characteristics**: How is dust being created (e.g., mixing, sifting, grinding, conveying)? Can the process be enclosed, or must it remain open? Does dust need to be reclaimed for reuse? Is the process connected to other production processes/manufacturing lines? At what point in production does the process occur (e.g., ingredient prep, ingredient mixing, or packaging)? Are there vapors or gas-phase emissions that need to be considered as well?
- **Environmental characteristics**: How much humidity is in the air? What is the temperature? Are there heat or ignition sources in the area? What are the physical constraints in the facility and production lines? Are humans working in the area where dust is generated?

Capture Method: Source Capture or Ambient

The first step in designing a solution is determining the best way to capture airborne dust. There are two general approaches to dust collection: source capture and ambient.

- A source capture solution collects dust close to the point where it is generated.
- An ambient solution cleans air for the facility as a whole.

For most food applications, source capture is preferred—especially where cross-contamination or cross contact with an allergen is a concern. Source capture prevents dust from one application or production line from reaching other parts of the facility. It is also more efficient than ambient capture; the closer you can collect dust to the source, the less air you have to move. Source capture requires a hood or enclosure to pull dust into the dust collection system. There are a multitude of different hood designs, but they can generally be grouped into three categories.

- Enclosing hoods, as the name implies, enclose the application within a walled or curtained structure. Enclosing hoods provide the greatest protection from dust migration.
- Close-capture hoods, such as fume arms, are placed very close to the generation source to collect dust as it

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is generated. Fume arms are a good option for food applications that can't be enclosed entirely. For example, a fume arm may be placed at the base of a sifter or at a dump point to suck in dust created when powdered ingredients are disturbed.

- Receiving hoods are placed above an application to collect rising dust and fumes. These may look similar to the ventilation hood placed over a standard kitchen stovetop. They may not work as well on particulates that tends to settle.

For food production, ambient air filtration is most often used as a backup system if source capture is not able to fully contain the dust.

Another option to consider when designing the capture system is the use of positive and negative pressure zones. Negative pressure is created when more air is pulled out of a space than is replaced. Because air pressure is lower inside the space than outside, contaminated air will not flow out of the space to the surrounding environment. Negative pressure zones can be used to prevent propagation of food dust from "dirtier" to "cleaner" areas of the production lines.

Dust Collector Selection

Next, designers must decide what kind of dust collector to use, how it should be sized, and where it should be placed. In the food industry, cartridge dust collectors have become the collector of choice for most applications. Compared with alternatives such as baghouse or cyclone collectors, cartridge dust collectors have a smaller physical footprint, higher efficiency, and are easier to maintain. They also have a wide range of filter options available, making them a great choice for ultrafine or hygroscopic dusts that are difficult to collect by other methods.

A cartridge-style dust collector, aptly named, uses cartridge filters of various shapes, sizes, and configurations to collect dust. Dust is pulled into the filter chamber using a blower. Dust settles on the filters while air passes through. Clean air is returned to the facility. Collected dust is pulsed off the filters and into a collection bin. When choosing a cartridge collector, there are several considerations.

CREDIT: COURTESY OF ROBOVENT.

A cartridge dust collector pulls dirty air through a filter chamber and returns clean air to the facility.

- **Sizing**: The dust collector is sized according to how much airflow, measured in cubic feet per minute (CFM), is required to capture the dust. The more air that must be moved, the higher the CFM needed. Designers also consider how much filter media is needed for the airflow (air-to-cloth ratio). The more particulate you are collecting, the more filter media you will need for each CFM of airflow.
- **Placement**: Some facilities can be served by a centralized dust collection system that can be placed outside the facility. The collector is ducted to all of the applications and conveyor lines that require dust collection. In other cases, collectors are placed inside—sometimes with individual small collectors for different applications.
- **Filter media selection**: Dust collector cartridge filters come in a variety of materials and minimum efficiency reported value ratings (MERV), which is a measure of the filter's ability to capture particles of different sizes; the higher the rating, the better the ability to capture smaller particulate. The filter should be selected based on the dust size and characteristics. For ultrafine dust, look for a cartridge with a higher efficiency rating (MERV 15 or 16) and consider the use of a HEPA afterfilter. If dust is sticky or hygroscopic, you may need filters with special coatings that reduce sticking and caking.
- **Safety**: Because most food dust is combustible, the dust collector should be equipped with a deflagration package that meets National Fire Prevention Association standards. These systems—which typically include explosion venting, isolation valves, and rotary airlocks between the filter chamber and collection bin—are designed to mitigate damage to the facility if an explosion occurs inside the collector. The dust collector should also have some form of fire suppression, such as water sprinklers, carbon dioxide gas, or a clean agent fire suppression system.

Depending on the application, there may be other considerations as well. For example, if dust must be collected for reuse, that will impact both dust collector placement and the materials used for the filters, collection bin, ductwork, and hood.

Because system design is complex, it is best to work with a manufacturing engineer with specific experience in air filtration and ventilation system design. The ACGIH Industrial Ventilation Manual, now in its 30th edition, is considered the definitive guide for the industry. By following industry best practices in solution design, food manufacturers can find a solution that reduces cross-contamination and food safety concerns and meets the needs of employees. ■

Kreczmer is president of RoboVent, an air filtration manufacturer.

The Virtual Audit

Has its time come? | BY **RICHARD F. STIER**

The rise of COVID-19 in February and March 2020 changed the world, and that included the food processing industry.

The pandemic, which now seems to have evolved into an endemic, caused many changes in how the industry carried on their business: Regulatory inspections ground to a halt, supply chain issues at many levels caused numerous companies to rethink where and how they purchased ingredients; staffing issues, which remain to this day, were abundant; and food companies scrambled to enact programs to protect their workers from the virus. And, there were many more effects.

Unlike some businesses, food processing could not take a break during the worst of the pandemic; billions of people around the world had to eat. The industry had to operate short-handed in many cases, however, and many of those who were out sick were those responsible for food safety. The food industry as a whole was somewhat fortunate from a food safety perspective; while there have been recalls and outbreaks over the past two and a half years, until the recent issue with infant formula, there was really nothing that was exceptionally high profile. The food industry may well have dodged a bullet from a food safety standpoint; however, there were other issues, one of which was the inability to conduct regular audits of facilities by certifying bodies and buy-

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ers. Travel and visits were curtailed for months, and, in addition, many companies established "no visitor" policies that lasted for a year or more—so, no auditors were allowed.

Elements of an Audit

Audits have become an integral part of conducting business in the food industry, and the smart companies view them as an important element in their continuous improvement program. A fresh set of eyes often sees things that company people take for granted.

Audits generally incorporate several different elements, including:

1. A review of documented procedures;
2. A record review;
3. Inspection of the plant and grounds; and
4. Determination of whether procedures are being followed.

In short, an auditor should review and understand the programs and procedures included in the food safety plan and then confirm their implementation and effectiveness at controlling hazards through observation of operations and assessment of the facility and grounds.

The first two elements are often referred to as desk audits. There has been a push among many audit firms to place a greater emphasis on the time spent in a plant so that the focus of the audit is more on what's going on rather than on the review of documents and records. While it's not uncommon to find perfect records, it's rare to find perfect plant practices or pristine facilities.

As an example of the importance of observing what goes on in a plant, here is a story from a long-time auditor I spoke with. The auditor was asked to conduct a GMP/food safety audit of a plant. He met with plant management who basically gave him free access to the whole facility. The auditor found a niche in a balcony overlooking the production floor and made himself comfortable. The plant manager, who was a very hands-on person, came by several times over the next few hours and observed the auditor sitting up on the balcony. He finally waved the fellow down and wanted to know why he had planted himself in one place—he was paying for an audit. The auditor then proceeded to show the plant manager several pages of adverse observations that he had made just sitting. This underscores the importance of observing the process.

So, if one cannot visit a facility and conduct this observation in person, what is the alternative? Enter the virtual or remote audit, an audit conducted via a web-enabled remote system.

The Virtual Audit

Many companies mandate that their suppliers successfully pass one of the Global Food Safety Initiative (GFSI) certification schemes and these programs all require an annual on-site audit. Early in the pandemic, GFSI provided a six-month extension on audit requirements while continuing certification. When the pandemic showed no sign of abating quickly, GFSI allowed the use of virtual or remote audits in lieu of further extension of certification without any audit at all. Proponents of remote auditing saw this as a move forward; however, there are those who opposed their use even in such extenuating circumstances. Let's look at the pros and cons of the virtual or remote audit.

I spoke with Warren Edde, manager of supply chain for the J.R. Simplot Company, a potato and French fry producer based in Boise, Idaho. As part of his job duties, Edde manages and conducts audits directly for Simplot:

"About June of 2020, when I realized travel would be off the docket for quite some time, I began to conduct virtual audits. At that time, though, it was only put on as a bridge and was not intended to be a long-term program. Two years later, the virtual audit program has continued to be an integral part of my supply chain verification activities, especially with foreign suppliers and new suppliers.

The virtual audits I perform are conducted over video conferencing tools. These platforms provide the ability to review programs, ask clarification questions, and review implementation records to ensure the food safety programs are being followed. This gave me confidence that the hazards had been properly assessed, the preventive controls necessary were in place, and that the facility was performing essential monitoring, verification, and corrective actions according to the written programs. The virtual audits are an essential component during no-travel times and, quite honestly, are a useful tool for assessment of programs for new and existing vendors. The downside [is that] they do not allow for conducting operator interviews, facility observations, assessing hygiene controls, [or for] adherence to cGMPs, which are essential components of the on-site audit.

That said, the virtual audit will remain in my toolbox and will continue to be incorporated into future auditing, not replacing the on-site audit, but acting as an extension to the onsite audit. This approach will allow for review of programs and records prior to the onsite review and allows me to better schedule my time. I can conduct multiple virtual audits in a week, and in many cases I can then travel to a process location and perform multiple onsite inspections at a future time. I can honestly say that I prefer conducting the program and record review at my desk where I have plenty of room and plenty of monitors."

Virtual audits are an essential component during no-travel times and, quite honestly, are a useful tool for assessment of programs for new and existing vendors. The downside [is that] they do not allow for conducting operator interviews, facility observations, and assessing hygiene controls and adherence to cGMPs, which are essential components of the on-site audit.

—Warren Edde

While virtual audits do have a role in managing food safety, auditors, certifying bodies, and the companies under audit need to understand the potential concerns and the commitments that are required for this remote inspection to be successful.

So, there are pros and cons to a virtual audit program in Edde's mind, but he is very clear that on-site audits are not going away. One point that should be underscored is that having access to documents and records before going into a plant is important; reviewing these materials beforehand can considerably recuce the time spend in the plant.

John Surak, PhD, professor emeritus of food science at Clemson University in Clemson, S.C., and past chair of the United States delegation that helped develop the ISO 22000 for safety standard told me that he has similar thoughts on virtual audits:

"I do not support virtual audits when the auditor is in the production part of a site. For example, [when] auditing PRPs. I also believe that virtual audits are not effective when auditing the lab. The auditor has a limited view of what is happening. In addition, the auditor is at the mercy of the person holding the camera. You do not have the ability to smell or clearly hear what is happening in the manufacturing part of the facility.

However, there is some value in the virtual audit. I was working with a plant in the pre-COVID days. The manufacturing plant was located in the U.S., and corporate was located in Germany. Two individuals on the plant's organizational chart were located in Germany. The question was, do these individuals need to travel from Germany to the U.S. for a one-to-two-hour interview as part of the audit? There was substantial interaction between the managers located in Germany and the United States. To eliminate needless waste, the audit interview of the German managers was conducted via video conference. I observed the interview, and I did not see any problems. The auditor was able to access any needed documents electronically.

I can see the use of video conferences as a useful tool for auditors. It can increase efficiency in the audit process when the auditor is auditing a portion of the food safety management system that is carried out by professionals at remote locations such as at the corporate location. When this is done, the auditor should assess the effectiveness of the communication between the two different sites. This process could be useful in the days of unannounced audits. It would allow the interviewing of the management team that may be away from the facility because of travel."

In chatting with other food industry professionals, I found that they echoed similar thoughts. One individual stated that she participated in a virtual audit, but when travel opened up and she was able to actually visit the plant, she found much in the plant itself that the camera did not show. This same person acknowledged that the desk audit could be done virtually, however.

The Value in the Virtual Audit

Dr. Surak's comments about utilizing all the senses when doing an audit are absolutely correct. There are those who say that one way to evaluate cleanliness is to ensure that the equipment looks clean, smells clean, and feels clean, and that test results verify this. You really can't do any of these activities virtually; even looking through a camera lens isn't always as effective as the human eye.

So, while virtual audits do have a role in managing food safety, auditors, certifying bodies, and the companies under audit need to understand the potential concerns and the commitments that are required for this remote inspection to be successful. The company has to be willing to share information via hard copy or electronically with the auditor. This means that signing a nondisclosure agreement may be an essential first step in the audit process; however, there needs to be a culture of nondisclosure for all participants involved in the audit process. If documents are shared, the auditor may be asked to return them at the end of the audit or erase them from their computer, a procedure to be avoided since the documents form the completed audit record. With programs such as Zoom, completed records may be shared in real time, but such a session may not give the auditor enough time for a proper review.

On the upside, virtual audits can drastically reduce travel costs, which could increase audit frequency. In many cases, travel costs can account for as much as 60% to 75% of the total audit. More importantly, it reduces wear and tear on auditors, a significant concern in a field that is chronically understaffed; auditor burnout is common

Another upside is the value of training new auditors using virtual audits. Sending a trainee to accompany an auditor can add as much as $5,000 to travel costs, which can severely limit the amount of training new auditors receive before going out alone.

Still, the on-site audit should never be ignored. The time in plant allows the auditor to verify that what they saw in the documents and records is accurate and true. Remember, there are places with great records that are imperfect when the records or procedures are viewed against actual practices. Even though cameras and cell phones will provide access to a plant, they only provide an incomplete snapshot of what is actually going on. Auditors need to use all their senses, including hearing. A well-run plant may be compared with one's own car; the owner can usually detect issues by how the car sounds. The same is true with a food plant that is up and running well—it has its own sound.

As virtual audits increase in use, procedures and practices will improve, as will the auditor's skills in detecting hidden problems. Technology improvements will also contribute to improved results as demand increases. The ultimate answer to the question of on-site versus virtual audits likely lies somewhere in the middle. A hybrid using local third-party staff guided remotely by a seasoned auditor seems like the best of both worlds. ■

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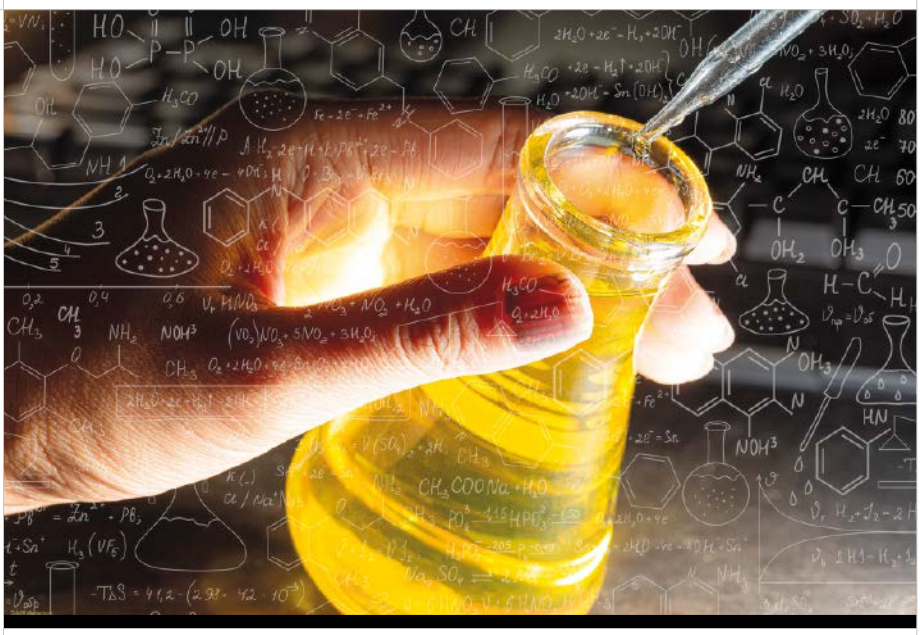
Testing



Trends in Beverage Testing

Increased adulteration underscored the importance of testing in the beverage industry; see what's available for your product

BY **LORI VALIGRA**

The bad news began to leak just as the 2008 Summer Olympics in Beijing were starting: Adulterated infant formula was sickening babies in China. After testing, the formula was found to contain melamine, a chemical that is used to produce plastics and coatings and that can cause kidney damage when ingested. It also can be used to increase the nitrogen content in diluted milk, making it look as though the milk has more protein when it is tested for quality. That is what happened in China, where the adulterated milk ultimately caused illnesses in more than 50,000 infants and killed six.

Melamine was found in other products, including eggs and dry milk, sold by the company that produced the infant formula, and some of the products found their way around the world in candies and other foods and drinks. The incident stands as one of the most poignant impacts on the beverage industry and underscores the importance of testing these products for quality and safety.

Adulteration remains a threat today, with supply chain disruptions and baby formula shortages raising product vulnerability issues. Some products may contain substituted ingredients because there are shortages of the original ingredients. Other switches are made for economic gain, to swap out a more costly ingredient with a cheaper one. Any switched ingredients need to be tested because there can be health consequences to consumers.

"Any time there is a shortage, that brings up potential vulnerabilities in the supply chain as far as adulteration," says Daniel Berg, analytical services manager for Eurofins Food Chemistry Testing in Madison, Wisc. "There's a lot of need to further verify that the product being produced is safe and formulated with the same quality."

Testing for adulteration is a growing area in beverage testing, says Tarun Anumol, PhD, director of global food and environment markets at Agilent Technologies in Wilmington, Del. The company sells equipment such as mass spectrometers and gas chromatographs that can detect molecular mass to four decimal places of accuracy. "You typically see this [testing] in higher value, economically upscale items such as alcoholic beverages like spirits, distills, and some beers," he says. "But the onus falls more on the manufacturer than on regulations because they need to protect their brand identity." Substitutions can include taking out one flavor and adding another that costs less. Agilent's equipment can differentiate specific molecules and fraudulent chemicals or flavors, he says.

What to Test

Aside from adulteration tests, beverages and their ingredients are checked for nutritional content, contaminants, allergens, pathogens, and taste, among other factors. The testing can be conducted at various stages in the product's lifecycle, starting with ingredient testing, tests at a co-packer, and tests at the manufacturer or even at the retailer. Tests can be done either in house or at independent testing laboratories. Some manufacturers may want to outsource pathogen culture tests to an independent laboratory, for example, to avoid possible contamination of their product at the factory, says Berg.

A beverage must contain what its label claims it does. This is especially true if they are "functional" beverages with added vitamins or protein. It is important to have the correct amounts of ingredients in a drink, as more or less protein, for example, could negatively affect a consumer's health. That includes the amount of sugar, especially if there is a "sugar-free" claim, and the alcohol content, says Dr. Anumol. Approximately 100 parameters are tested in basic nutrition, safety, and quality checks, although producers can choose to test for more.

CREDIT: COURTESY OF AGILENT TECHNOLOGIES, INC.

A liquid chromatography instrument for testing beverages.

CREDIT: COURTESY OF EUROFINS.

A rotary evaporator at a beverage and food testing laboratory.

Another large class of chemicals that are tested are pesticides. A 2008 study in the journal *Analytical Chemistry* heightened concern about pesticides in fruit-based soft drinks, although drinks sampled from the United States had relatively low levels compared with those in the United Kingdom and Spain. The study still raised concerns globally about what pesticides are used on fruit that ends up in beverages and water sources used in manufacturing that might contain chemicals from runoff.

Chemical and microbiological analyses are key measures taken to ensure the safety and quality of a product and help determine its shelf life once it has entered the market. Chemical testing for beverages could include measurements for pH, titratable acidity, turbidity, or relative clarity and contaminants such as nitrates and nutrients.

FDA guides most of the testing parameters, although companies may choose to conduct broader tests. Changes to the FDA Nutrition and Supplement Facts panel on packaged foods, including labels on beverages, went into effect on January 1, 2021 for larger companies. The updated nutrition panel now includes potassium and vitamin D, because people do not always get the recommended amounts, says Gayle Gleichauf, applications lab manager at Thermo Fisher Scientific, a test equipment manufacturer based in Chelmsford, Mass.

Gleichauf says the trends toward automation and speedier results are pushing demand for equipment such as automatic titrators for testing titratable acidity, vitamin C, and sulfites, as well as qPCR instruments for microbiological testing.

Spoilage organisms pose a risk for producers and have the potential to influence the end product. Beverage companies may test for the presence of specific strains of wild yeast used in fermentation that need to be closely monitored.

Traditionally, this type of microbiological testing has been conducted by culturing and incubating samples overnight or longer, but the use of qPCR can make testing faster and more cost effective for bacteria and yeast assays, she says.

Testing Trendy Drinks

Fermented and functional drinks are two trendy parts of the beverage industry that present their own testing challenges. Fermented drinks, which use yeast and other ingredients to create a specific taste, need to be monitored closely, because they can form undesired byproducts during processing.

Ethyl carbamate, for example, is a naturally occurring component of all fermented foods and beverages, but FDA issued an advisory based on its potential for carcinogenity in high doses in animal tests. The wine industry, for one, is interested in reducing ethyl carbamate levels in its products. FDA also established a level of concern for inorganic arsenic in apple juice.

But fermented drinks are touted by their makers as having health benefits, especially for good digestion and gut health. Beverages including kombucha, kefir, and yogurt drinks can be monitored during fermentation for pH, titratable acidity, sugar, microorganisms (beneficial and otherwise), and other parameters to ensure safety, consistent quality, and shelf life, says Gleichauf.

The pH affects the microorganisms that will be found in the beverage, as well as enzyme reactions, color, shelf-life stability, flavor, and clarity. Titratable acidity is generally considered to be more closely tied to flavor than pH, says Gleichauf, so a low titratable acidity can make a beverage taste flat or soapy, while high titratable acidity results in a tart or sour beverage.

She says the market for other fermented beverages, including craft beer, cider, and wine, is expanding rapidly as well, so similar testing is needed for those products.

Plant-based drinks, which are functional drinks with alternative proteins and claims of being more sustainably produced, also are becoming popular. While manufacturers claim they can control the entire production process in a lab without introducing environmental contaminants, the factory must be kept very clean, says Dr. Anumol.

Sensory testing, especially for new beverages in R&D, is another key part of a beverage's success. Jerald O'Kennard, executive director of the Beverage Testing Institute in Chicago, says that now is a creative time for new beverages with lower alcohol or more exotic flavors. But producers need to test new products to try to ensure they'll be a success, he adds.

The institute uses blind taste testing to rank mostly adult beverages by structure, aroma, acidity, balance, flavor, and their intended use. It also looks for flaws and determines whether a wine, for example, is sellable and whether its taste meets a standard of identity for the product category.

"You only get one chance, because the market is very competitive," says O'Kennard. "If you mess it up, you might not only hurt your brand, but possibly the whole category of the drink for everyone." ■

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The Future of Pathogen Testing and Detection

Where we were before the pandemic, and where we're headed

BY **LUKE THEVENET**

One of the outcomes of the COVID-19 pandemic has been an increased awareness of and sensitivity to food safety issues by the general public. As government regulators, food testing laboratories, and food producers have become better at conducting outbreak tracing, companies are realizing the necessity of having a robust pathogen testing program in place to avoid the risk of an outbreak.

As a result of the increased awareness, food testing labs faced some challenges early in the pandemic while trying to meet demand for pathogen testing and detection. At the same time, some new trends and ideas have come about, demonstrating how the understanding of food pathogens and food safety is always advancing.

The Current State of Food Safety Pathogen Testing

Generally speaking, the U.S. public is well aware, either through personal experiences or conversation, of the ongoing labor shortages caused in part by the pandemic. The food manufacturing industry has also felt the effects of these shortages—from lab technician turnover and struggling to find new technicians to replace those who are leaving, and issues with working in person in a laboratory setting where social distancing requirements are enforced. Meanwhile, as restaurants, schools, and other food service venues closed, food production in retail spiked, sending demand for retail food testing to new heights.

On top of this elevated retail demand, consumers have become more invested in the safety of the food they are purchasing, and more demanding of food safety testing information. As a result, food manufacturing labs have had to keep up with increased customer demands, such as those calling for robust validations, including different sample sizes than typically used, requesting quicker turnaround times, and requiring novel matrices.

To keep pace with these increased demands among ongoing labor shortages, labs have relied more heavily on implementing the most efficient testing solutions. Automation in the lab can provide a solution that allows for time savings, while also taking out the subjectivity of the test method and results interpretation.

Where Pathogen Testing Is Heading

One rising solution to labor shortages is the use of automation in food testing laboratories. As labs struggled to source employees during the pandemic, there was a major shift toward using contract labs to help keep up with testing demands; however, contract labs have faced the same worker shortage struggles and are leaning heavily on automation technologies as a result. In fact, some contract labs are now leading a shift to testing automation because these technologies help food testing labs increase efficiency by reducing technician time when testing for pathogens. Additionally, the learning curve when hiring new technicians to replace lost workers is significantly shorter with automated testing, as the technician does not need to manually count.

Customer demand influences the future of pathogen testing and detection. Historically, pathogen testing has been a qualitative result—looking to see whether there is a presence or an absence of the target pathogen. However, a new concept of pathogen testing has emerged due, in part, to increased knowledge and sensitivity around food safety. Customers are increasingly demanding quantitative testing. With quantitative testing, labs are now looking for the number of a target pathogen that is present in food. This method is of major interest to the poultry industry, which is currently the leading industry seeking advancement for quantitative testing. Quantitative results are especially

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Cationic Polar Pesticide Determination

IC-MS/MS has been used to analyze quat pesticide levels in a range of some of the most widely consumed foods | BY **WAI-CHI MAN**

Pesticides are used extensively on a global scale to protect crops, ensuring they can be successfully grown, stored, and transported to meet consumer demands. The type of pesticide used varies widely depending on the produce in question, with insecticides, herbicides, rodenticides, and fungicides being the most common. A recent review by the Pesticide Action Network showed that there are more than 17,000 pesticide products currently on the market.

Solvent-based pesticides have traditionally been the pesticide of choice, but in light of growing health concerns, less toxic ionic pesticides are being more widely adopted. For example, glyphosate—an anionic pesticide—is now the most widely used pesticide in the world on GMO-engineered glyphosate-resistant crops. Recently, though, there has been growing public concern that any pesticide contamination in food could be a potential health risk, especially as pesticides can often remain in food at trace levels. This has resulted in increased attention from regulatory agencies and health researchers, who are seeking to better understand and monitor these residues.

To ensure that only minimal levels of pesticides are present in food, accurate quantification is required. Many methods exist for determination of pesticides, but gas chromatography (GC) and liquid chromatography (LC) combined with mass spectrometry (MS) are the standard techniques in regulatory test methods; however, these traditional analytical methods aren't as effective for determining ionic pesticides, as the compounds are too polar to be retained and separated. In addition, it is difficult to maintain low baselines when analyzing ionic pesticides, making them an analytical headache. These challenges in current analytical approaches have been driving the need for more effective analytical techniques to continue protecting public health. *(Continued on p. 34)*

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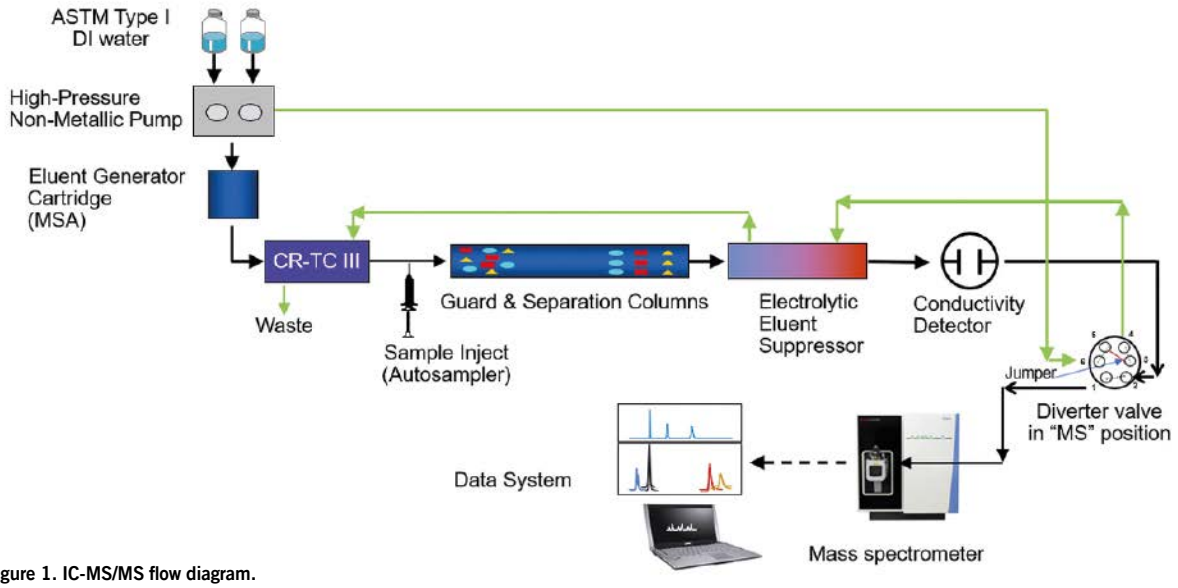

Figure 1. IC-MS/MS flow diagram.

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Taking Charge with IC-MS/MS

Ion chromatography coupled with tandem mass spectrometry (IC-MS/MS) can be used to effectively overcome the challenges faced by existing methods when it comes to anionic pesticide determination (see figure 1, above). Crucially, the technique is ideal for separating polar compounds and has been used to determine anionic polar pesticides such as glyphosate and glufosinate.

IC-MS/MS has a number of benefits that make it ideally suited for this application. The technique offers high selectivity and sensitivity, as tandem MS detection using selected reaction monitoring (SRM) eliminates sample matrix interference by only scanning for ions of interest. The method also provides low chemical noise, overcoming the baseline issue of GC-MS and LC-MS. With this technique, analytes are also provided in their ionic form, meaning electrospray can be used and the molecular ion retained. Further improvements in pesticide determination are enabled by the electrolytic suppressor, which neutralizes eluent and lowers the background while offering increased sensitivity for conductivity detection and improving the compatibility for MS.

Anionic samples are typically prepared for IC-MS/MS using the quick polar pesticides method (QuPPE) developed by the European Union Reference Laboratory for Pesticide Residues in Fruits and Vegetables (EURL-FV). This acidified methanol-based extraction method has been widely used and accepted for extraction of polar pesticides, according to a 2012 review published in the journal Analytical and Bioanalytical Chemistry, giving excellent results. IC-MS/MS used with QuPPE extraction provides a highly useful and sensitive approach for anionic pesticide determination, ultimately helping analytical scientists to better protect public health.

Table 1. Summary of measured results and recoveries of added standard in cereal samples.

	Chlormequat			Mepiquat			Paraquat			Diquat		
	Measured (µg/L)	RSD	Recov (%)	Measured (µg/L)	RSD	Recov (%)	Measured (µg/L)	RSD	Recov (%)	Measured (µg/L)	RSD	Recov (%)
Oatmeal/formic acid-methanol	0.36 ± 0.02	5.7	117	0.08	--	116	0.22 ± 0.02	9.1	113	0.36 ± 0.02	5.6	113
Oatmeal/ HCl-methanol	0.51 ± 0.03	5.9	98.9	<0.08	--	118	0.24 ± 0.02	8.3	95.4	0.37 ± 0.02	5.4	96.3
Toasted oat cereal/formic acid-methanol	<0.09	--	85.8	<0.08	--	85.6	0.29 ± 0.02	6.9	88.2	0.42 ± 0.03	7.1	94.3
Toasted oat cereal/ HCl-methanol	<0.09	--	96.5	<0.08	--	113	0.24 ± 0.03	12.5	95.4	0.37 ± 0.03	8.1	90.8

+ added 5 µg/L

The Rise of Cationic Pesticides

Cationic quaternary amines, or quats, are a new class of ionic pesticide now gaining popularity. Unlike glyphosate, quats are permanently charged species, regardless of pH. Of these, paraquat, diquat, mepiquat, and chlormequat (see figure 2, p. 36) are among the most important and commonly used.

Although ionic pesticides are generally less toxic than solvent-based ones, compounds such as paraquat and diquat are still highly toxic. Often, these pesticides are used late in the plant's life as desiccants to kill the plant before the harvest. By doing this, farmers can bring the crops in earlier, before they are contaminated with mold during the rainy season. While this practice helps to guarantee the food supply, the late addition of these pesticides to the crop can cause problems as they can bind to the plant, creating a higher risk of food supply contamination.

The use of these cationic pesticides, and the risk of contamination, varies globally. Paraquat, for example, is a restricted-use pesticide in the US, and neither paraquat nor diquat are approved in the EU, but chlormequat and mepiquat are allowed. Alongside country-by-country restrictions on usage of different pesticides, the permissible quantities of these pesticides vary too. For chlormequat and mepiquat, the EU's Maximum Residue Levels (MRLs) generally range from 0.01 – 0.05 mg/kg. These differences in approvals and MRLs mean that for products to meet the individual requirements of different countries, it is essential to be able to chromatographically resolve different ionic pesticides from each other to allow separate quantitation.

But to date, cationic polar pesticide analysis has lagged behind analysis of anionic pesticides, even by IC-MS/MS. Most notably, analysis is hindered by poor chromatographic resolution and high costs. While the permanent charge of quats makes them highly effective as pesticides, this feature also makes them highly impractical to derivatize for detection. Second, it also means they adhere, often irreversibly, to glass, metal surfaces, and particles such as clay. This leads to tricky sample preparation, and means chromatographic separation is not reproducible.

Table 2. Instrument apparent recoveries for four quaternary amine polar pesticides in wheat flour over a period of seven days.

Compound	Corrected apparent recoveries in QuPPe extracted wheat flour (1/10) (%)		
	1.0 µg/L	10 µg/L	100 µg/L
chlormequat	107%	97%	98%
mepiquat	108%	97%	98%
paraquat	108%	98%	97%
diquat	113%	101%	101%

Table 3. Instrument apparent recoveries for four quaternary amine polar pesticides in carrot food over a period of seven days.

Compound	Corrected apparent recoveries in QuPPe extracted carrot baby food (1/10) (%)		
	1.0 µg/L	10 µg/L	100 µg/L
chlormequat	96%	97%	97%
mepiquat	103%	97%	97%
paraquat	102%	99%	97%
diquat	102%	100%	98%

Table 4. Instrument apparent recoveries for four quaternary amine polar pesticides in green tea and white tea over a period of seven days.

Compound	Corrected apparent recoveries in green tea (1/10) (%)		
	1.0 µg/L	10 µg/L	100 µg/L
chlormequat	94%	97%	98%
mepiquat	100%	99%	100%
paraquat	102%	99%	98%
diquat	98%	98%	98%
	Corrected apparent recoveries white tea (1/10) (%)		
	1.0 µg/L	10 µg/L	100 µg/L
chlormequat	92%	98%	98%
mepiquat	97%	98%	98%
paraquat	106%	99%	97%
diquat	99%	98%	98%

IC-MS/MS: A Powerful Quat Pesticide Determination Approach

With recent improvements in column stationary phases, IC-MS/MS can now be used to tackle challenging separations of cationic polar pesticides, including paraquat and diquat, which has been exceptionally difficult due to their similar structures and close m/z values for molecular and fragment ions (a difference of less than 2 a.m.u) (see figure 3, p. 36).

Thanks to these advances, IC-MS/MS has been used to analyze quat pesticide levels in a range of some of the most widely consumed foods, showing promising results.

Here, we highlight two such studies: one examining cereals, and the other investigating wheat flour, baby food, and tea. In these experiments, the samples were prepared for analysis using QuPPE or adaptations of it. Overall, the IC-MS/MS method provided adequate resolution of the analytes of interest from the rest of the complex food matrix, giving more accurate results.

(Continued on p. 36)

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Cereals

Cereals are a principal component of many diets, yet the EU's MRLs are much higher for pesticides in oat cereals. This is primarily because more pesticides are expected to be present in the produce due to higher levels used in cereal crop production. Matrix interference from complex samples makes it challenging to obtain accurate values, too, so this is factored into the MRL. With more analytical labs now using IC-MS/MS, these MRLs could be lowered in line with other produce, as matrix interference is reduced with IC-MS/MS.

The study in question demonstrated that quaternary amine pesticides can be accurately and sensitively determined in oat cereals within 15 minutes using IC-MS/MS. Here, the sample extraction followed QuPPE and was passed through a Thermo Scientific Dionex IonPac CS21-Fast-4µm ion exchange column paired with a triple quadrupole mass detector. For determination of paraquat, diquat, mepiquat, and chlormequat, recoveries of 86% to 118% were obtained, and limits of detection (LODs) <0.1 µg/L or 0.5 µg/kg (see table 1, p. 34).

Wheat Flour

Wheat flour is another dietary staple across the globe, and USDA estimates that 131.1 pounds of wheat flour was consumed in the U.S. per capita in 2019. Grain and grain products have particularly complex matrices, making samples challenging to prepare for determination. A simplified version of the QuPPE method has been used for the extraction of anionic polar pesticides, and this approach was also used for extracting cationic polar pesticides from wheat flour in the second study. Using IC-MS/MS here delivered excellent results, with apparent recoveries in QuPPE extracted wheat flour ranging from 97% to 113% (see table 2, p. 35).

Baby Food

MRLs in the EU for specific prohibited pesticides in baby food were previously set between 3–8 µg/kg; however, the European Food Safety Authority (EFSA) believes this may not be sufficiently protective for infants younger than 16 weeks of age. Yet, to date, there have been no further reductions to MRLs, as suitable analytical methods for detection with improved sensitivity are scarcely used.

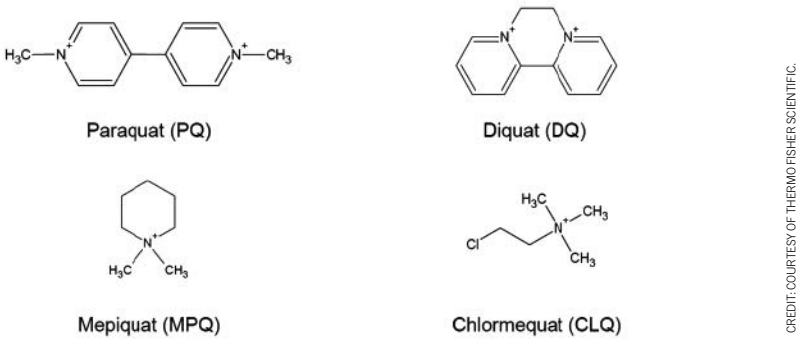

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Figure 2. Polar cationic pesticides now widely used in agricultural production.

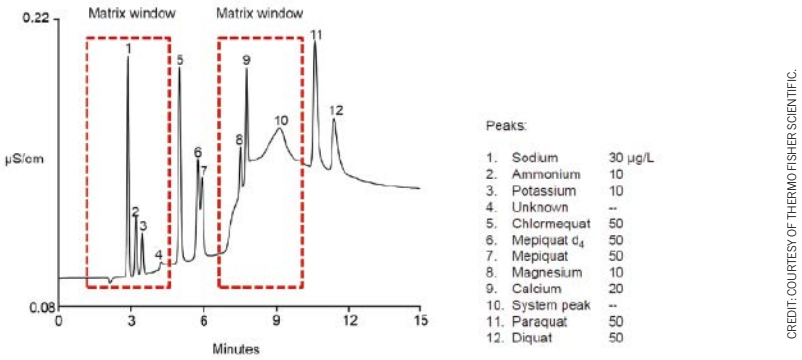

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Figure 3. Mixed cation and quaternary amine pesticide standard showing highlighted matrix windows, with pesticides of interest eluting outside the zones.

IC-MS/MS can be used for effective determination of quaternary pesticides in baby food, though. Following the approach used with wheat flour (in the same study), the simplified QuPPE method can be used to prepare samples and extract pesticides from carrot baby food. The IC-MS/MS method, using the Dionex IonPac CS21-Fast-4µm ion exchange column paired with a triple quadrupole mass detector, worked extremely well, giving apparent recoveries of the pesticides ranging from 96% to 103% (see table 3, p. 35).

Tea

Testing and regulation of beverages have also greatly increased over recent years. One of the most widely consumed beverages—tea—can suffer from pesticide contamination; that is, pesticides that remain in tea leaves can leach into the drink when hot water is added. Determination of these compounds is therefore essential.

To show the versatility of the IC-MS/MS method, tea infusions from both green tea and white tea were prepared as part of the second study and filtered for analysis by IC-MS/MS. The method effectively separated the four common quat pesticides, and corrected apparent recoveries were 94% to 102% for green tea and 92% to 106% for white tea (see table 4, p. 35).

Paving the Way for Food Safety

Quaternary ionic pesticide use is growing, which is bringing many advantages to food production and distribution. While cationic compounds have typically proved difficult to analyze, advances in ion chromatography column technology are now enabling IC-MS/MS methods that can accurately and sensitively determine them while significantly simplifying analysis.

Eventually, as such IC-MS/MS approaches continue to gain traction for the analysis of quats, the possibility opens for MRLs to be lowered. These lower MRLs will drive improved agricultural practices, alleviating concerns for consumers and regulators and ultimately improving the protection of human health. ■

Man is product marketing manager specializing in ion chromatography at Thermo Fisher Scientific. Reach her at wai-chi.man@thermofisher.com.

Think Shrink

How grocers and food distributors can reevaluate their truck fleet life cycle to reduce food waste expenses

BY **BRIAN ANTONELLIS**

For grocers and their food distribution divisions, food shrink is a continuing issue that cuts into profits and contributes to food waste. "Food shrinkage" refers to spoiled or wasted products from distribution to a grocery store. Consumers today are also concerned about sustainability efforts, placing additional pressure on grocers and distributors to make improvements in their overall operational strategies.

In the U.S., food spoilage and waste are estimated to be between 30% and 40% of the overall food supply, according to USDA. For their part, grocers have traditionally relied primarily on inventory management solutions to reduce fresh food waste; however, new solutions are needed because, in addition to a greater focus on sustainability by consumers, the continued problem of food shrink is costing food retailers more than $52 billion annually.

Industry players are having a difficult time reducing this cost. Reducing shrink can lower operating costs by 15% to 20%, or more, Martin Gooch, PhD, chief executive officer of Value Chain Management International, told *Produce Business*. In retail, a 1% reduction in shrink helps improve the financial bottom line equivalent to a 4% or higher increase in revenue, simply because organizations reduce the subsidies of ineffective operations.

Food shrink also adds financial pressure as grocers must restock their shelves. More than 60% of grocers say they have had to significantly increase fresh inventory to keep up with demand, according to a whitepaper by Shelf Engine, a Seattle-based technology firm focused on food waste.

Improving On-Time Deliveries to Reduce Spoilage

There may be other ways to reduce food shrink, and a closer focus on improving on-time deliveries among food distributors may help. Many grocers leverage private trucking fleets for their grocery delivery and, according to the 2021 National Private Truck Council's Benchmarking Survey Report, 68% of fleets measured on-time performance for 2021, versus 82% in the prior year.

Improving on-time delivery rates alone could have a profound impact on saving food from spoilage. In many cases, trucks arrive late to a store due to weather or traffic delays; however, when older trucks remain in a distributor's fleet, maintenance and repair (M&R) problems and other mechanical breakdowns can cause more serious delays, further damaging delicate produce that needs to arrive at the store on time.

When isolated down to an aging truck fleet, organizations aren't just losing billions because of food shrink. These older trucks can further erode a grocer's or food distributor's bottom line when M&R costs and lease structures are factored in.

Older Trucks Mean More Spoilage and Additional Expenses

Distributors and transportation fleets have had their eye on improving truck M&R in their operations for years, especially since operational expenditures can significantly add up over time on aging and older trucks. These companies believe it's such a big problem that M&R was the largest reason why fleets renewed, replaced, or upgraded their trucks according to the most recent industry benchmark report from Fleet Advantage.

M&R costs on a 2016 sleeper model-year for grocer distributors total $25,392, compared with $2,244 on a 2023 model-year truck, which provides a savings of $23,148. Across a fleet of 100 tractors, this amounts to $2.3 million.

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These cost savings become even more significant when you look beyond the typical M&R expenses, including tires, tubes, liners, and valves, and include preventive maintenance measures, brakes, expendable items, exhaust systems, fuel systems, and more. The older the truck, the costlier the repairs become. What's more, technician time becomes more expensive, too, because fleets end up requiring more technician time for service.

Lease Agreements

Aside from the specific costs involved with M&R on older trucks, distributors are also paying closer attention to the type of lease agreement they have (full service versus unbundled lease [UBL]), which can also dramatically impact the expenses involved with maintaining their fleet of trucks.

Distributors must realize that in long-term lease or ownership of the vehicles, they are locked into a higher "fixed" cost for M&R. In contrast, a shorter lease life cycle of two trucks using a UBL agreement equates to a sliding scale of M&R costs. At about 48 months, the costs reset to newer truck cents per mile (CPM). This means M&R costs are much lower over time and can help improve margins toward the bottom line.

Furthermore, M&R is "front loaded" in an full-service lease agreement. As an example, companies will pay a minimum of .07 CPM in year one versus .02 CPM when unbundling (national average for year one). All trucks come with a bumper-to-bumper two-year warranty that can be extended to four years. Expenses for year one include wearable items (tires, brakes) plus preventive maintenance. A shorter truck life cycle produces long-term savings beyond the first year. In a UBL, the CPM average equals 5.675 cents over five years. However, in a full-service lease agreement, fleets pay up to 9 CPM.

Innovative Programs Deliver Cash Infusions

Strategic fleet partners today can help offset financial losses from food shrink in other ways. Innovative programs are now available to help distributors with an infusion of cash while also upgrading trucks for future growth. These "sale-leaseback programs" allow distributors to select the assets from their fleet that are older models so that flexible lease partners can purchase those assets and lease them back to the distributor for an interim period until they place an order and transition to new equipment when available. Using a sale-leaseback program can help provide a cash infusion to offset food shrink losses and position a company for future growth.

Food shrink is an industry issue that has been around for years and will continue to be a challenge going forward; however, grocers and food distributors should expand solutions beyond inventory control and rethink their truck fleet life cycle strategies to improve on-time deliveries and reduce other operating expenses that can add up in costs. ■

Antonellis is senior vice president of fleet operations at Fleet Advantage.

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The Emulation Advantage

Embrace manufacturing emulation software for lower risk and greater reward

BY **TYLER PHILLIPS**

With the constant influx of new flavors, new ingredients, new sizes, and new shapes, the food and beverage industry is constantly adapting. From changing consumer trends to sourcing and supply chain disruptions, the demand for flexibility is real. Navigating demand fluctuations and ever-changing products are not the only priorities for food manufacturers today, however—consistency and quality are also top of mind. Without these key areas, profitability can plummet.

From the onset of product ideation, food manufacturing teams must plan how to implement any new equipment and new lines needed and modify existing production to accommodate them. As with any implementation or modification, risks can arise—specifically, risks in reduced quality, reduced output, and breakdowns in safety. In a pivotal industry with a small margin for error, food producers must employ new ways to maximize their yield without risking their operations.

Reactive to Proactive

If you are implementing a new system or process at your facility and are waiting for physical testing to determine equipment readiness or discover errors, you are already too late. When design and controls meet for the first time, rework is almost inevitable. Working backward to replicate, repair, and retest results is lost time and money. Unlike some fortunate industries, the food and beverage sector must also navigate the challenge of working with time-sensitive ingredients. From the moment an error is discovered, the race is on to diagnose and repair before you encounter major product loss and break promises to your customer.

Designing and commissioning new machinery or processes entails a significant investment. Manufacturers must think proactively and leverage technology to help protect their investment. What if there was a way to virtually commission new machines, new lines, or new automation technology for faster time to market, or a way to identify potential breakdowns or inefficiencies before they occur? There is, and the answer lies in emulation.

Why Emulation?

The consumer packaged goods industry, from food production to goods manufacturing to fulfilment, is realizing substantial savings by using emulation software to optimize configurations based on digitally recreated environments that account for business needs. With advancements in visualization and training, emulation is even easier to employ and can quickly become a competitive advantage.

Specifically, emulation software can help you:

- **Dive deeper with digital twins**: Create a virtual model of your equipment and system to simulate your manufacturing environment for scenario testing;
- **Model integrations**: Predict and solve complex integration challenges before they occur;
- **Demonstrate value early on**: Reduce the need for physical demonstrations and the risks associated with them by performing virtual testing; and
- **Build quickly**: Access a resource library of standard equipment to help design a digital twin of your operations.

Risk Reduction

Changes in the food and beverage industry are pushing manufacturers to employ new technology and rapidly adapt automation. Each change to your operations, whether you are introducing a new product or updating outdated machinery, opens the door to additional training requirements, unexpected downtime, and/or safety breakdowns. While embracing new technology and innovation can be an overwhelming undertaking, using emulation software can support deployments and help reduce risks associated with them.

Additionally, quality and output are highly dependent on one another and are equally vital to producers. Without visibility into machine behavior, when a line changeover is needed, questions start to surface, such as:

- "Will changing the product size require new equipment?"

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- "How can we ensure that the new packaging process will be successful?"
- "What impact will adding a new product to the mix have on system throughput?"

With strategic planning and the right technology, these questions can be answered before existing operations are disturbed. Simulating changeovers allows you to test and validate in a virtual space before making any adjustments. Additional efficiencies and speed can be realized by using an emulation software's resource library to build your virtual factory floor and tailor the simulation to your unique operations. The insight gained from employing emulation helps maximize output while meeting stringent quality expectations.

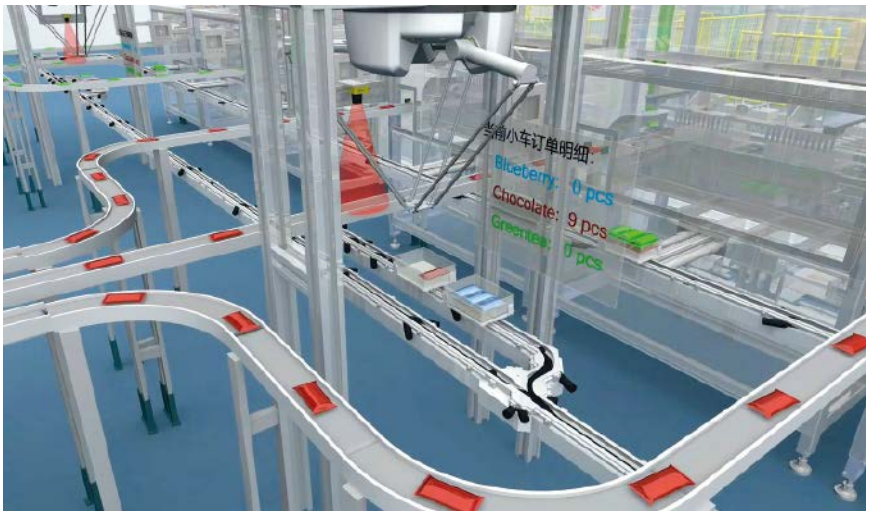
Once a bottleneck is discovered or a malfunction occurs during control integration, the time to make the necessary changes to the system has passed. Unfortunately, many manufacturers find themselves in these situations, in which the changes must be made against the clock. Additionally, with supply chain disruptions and longer lead times on replacement parts, unplanned downtime can come with excess costs.

In addition to time and cost, anytime a change or reroute is needed, an opportunity for a safety issue is introduced as well. When production must abruptly stop and an operator must dislodge an unruly package, or cross contamination occurs on a line, safety is compromised. Testing your changeover in a virtual environment before implementing it could help prevent package mishandling or eliminate the need for manual intervention and associated cross contamination risks. Leveraging technology to limit intervention helps reduce risks that could impact your quality and output, and compromise safety—all of which impact the bottom line.

Engage Stakeholders in a New Way

Manufacturers across the country are feeling the effects of workforce challenges, and food and beverage producers are no exception. Between retirees leaving the organization and taking their knowledge with them and the next generation being more technology savvy from the start, there is an added benefit to introducing emulation into your operations.

For those exploring emulation options or currently using the technology, having a dynamic representation of your factory floor can help your workforce gain a comprehensive view of your operations. Being able to showcase your entire footprint, combined with the power of augmented/virtual reality, you can help get new workers up to speed more quickly. Emulation software can also be used when introducing machine changes to current employees or training an employee on a piece of equipment they are not familiar with. When a problem occurs, simulations can be created to provide a high-fidelity virtual environment with troubleshooting options so that a solution can be applied with unparalleled speed.



Frozen food line simulation featuring independent cart technology.

Why Now?

Emulation software solutions are not new, but with advancements in technology and robust 3D simulation, companies are quicker to adapt and realize their potential. Workers are also ready for innovation. Introducing emulation tools is no longer a daunting task when now, more than ever, workers are trained to work with advanced technology. In fact, many workers have come to expect it. While companies make changes to embrace more innovative and enhanced cultures, employees are also seeking better and safer workplaces. With all of the technology available at our fingertips outside the workplace, employees are not interested in struggling to use outdated technology when they come to work. Workers are ready to embrace new technology such as emulation. Are you and your operations ready?

> Emulation software generates a digital depiction of your equipment or system to model scenarios and tests for desired outcomes

Additionally, consumer demands are constantly fluctuating, and companies must be prepared to implement new lines, change what their technology looks like, and incorporate different machines in different ways. Applying emulation can support these changes and assist your teams in producing the high-quality goods your customers count on. Not only does the application help maintain quality and output, but it also helps mitigate unnecessary risk by reducing the manual intervention needed when scenarios are run digitally in advance.

In today's competitive environment, companies can't afford lack of visibility and costly changeovers. It's time to move the needle from reactive to proactive and explore what emulation can do for your bottom line. ■

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NEW PRODUCTS

In-Line Inspection Machine

Antares Vision Group has introduced a series of inspection machines offering customizable packaging inspection for food and beverage applications. To meet wide-ranging customer quality control needs, the company's all-in-one equipment portfolio incorporates multiple inspection controls into single machines, maximizing production space and manpower efficiencies while offering exemplary quality assurance. Combinable features for the series include regulatory compliance, container integrity, micro-leak (micro-hole) and contaminants detection, weight control, and labeling/print verification for parameters such as expiration date and lot code. **Antares Vision Group, antaresvisiongroup.com.**

Trailer Refrigeration Units

Carrier Transicold has introducing four performance trailer refrigeration units that offer double-digit fuel efficiency improvements and lifetime compliance with emissions requirements of the California Air Resources Board (CARB). The new systems include two single-temperature units, the Vector 8700 and X4 7700, and two multi-temperature units, the Vector 8800MT and Vector 8811MT. All reduce particulate emissions by 96% when compared with current offerings and, depending on the application, improve fuel efficiency from 5% to 20%. All four models also use R-452A, a CARB-compliant, new-generation refrigerant with a global warming potential 45% lower than that of the traditional TRU refrigerant. Additionally, all are equipped with a telematics solution for remote monitoring of temperatures, location, movement, and system operating performance. **Carrier Transicold, carrier.com.**

Microbial Count Plates

PerkinElmer, Inc., has announced the global availability of its Microfast microbial count plates for food safety testing. The new microfilm plates are designed to provide quantification of aerobic, *E. coli*, coliform, *enterobacteriaceae*, yeast and mold, and *Staphylococcus aureaus* contamination in dairy, meat/poultry, fruit, vegetable, baked goods, and environmental surface samples. All six plate types have received AOAC performance tested methods certification. Geared toward food companies and contract labs, the kits feature a three-step workflow: Users place the liquid sample on the leak-free culture area featuring automatic diffusion and lower the film without pressing, incubate the plate, and wait for the new-generation microbial coloration to show rapid proliferation of microbial contaminants. Data is available sooner, revealing results in 48 and 72 hours for yeasts and mold versus 120 hours and five days, respectively, using traditional culture methods. The plates reduce human error by providing standardized protocols and offer a small footprint to save space in incubators and storage areas. **Perkin Elmer, perkinelmer.com.**

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Portable Hygrometer

The battery portable PPM2 hygrometer from Edgetech Instruments uses a fundamental principle and a diffusion barrier to measure trace water vapor in gases from 0.1 to 1250 ppmv. Recalibration is not required under normal usage. The PPM2 is a trace moisture analyzer for monitoring dew/frost point temperature or ppmv water vapor content in gases. It is configured to meet remote, spot sampling or semi-permanent absolute humidity measurement requirements. The detectible range is from 0.1 to 1250 ppmv water vapor. The PPM2 is ideally used for relatively clean, dry, inert gas measurement. Applications include air separation and purified gases, medical and pharmaceutical gases, semiconductor manufacturing. **Edgetech Instruments, Inc., edgetechinstru-ments.com.**

PET Processor Trays

TekniPlex has launched a new line of 100% PET processor trays that offer product display while addressing common packaging challenges prevalent in the poultry industry, and particularly higher-end products such as those labeled organic, non-GMO, or sustainably sourced. The trays are 100% PET and contain up to 50% postindustrial recycled content and are designed to survive the rigors of the case-ready environment. They are shatter-resistant even in harsh, cold environments, reduc-ing breakage, product loss, leaks, and the risk of safety recalls. trays use a technique called hidden rim technology that prevents the overwrap film from tearing and creates freight and shipping effi-ciencies. Because the trays pack denser, customers can increase shipping volume per truck, reduc-ing the number of truck trips needed. The trays are available in clear (natural), translucent colors, and opaque colors. Clear and translucent trays are accepted into the recycling stream at many mate-rial recovery facilities across the country. **TekniPlex, tekniplex.com.**

Dust Collector

Tri-Mer Corp., a manufacturer of air pollution control systems for industrial dust emissions from submicron to 30+ microns, has introduced a sanitary design version of its MCD Whirl/Wet dust collector. The modular conveyor disposal system was designed for applications requiring a sanitary design that also have continuous or intermittently high dust loadings. Collected particulate is continuously removed from the collection hopper via a removable conveyor system, allowing operation and routine maintenance to continue. The newer sanitary design system can be used for appli-cations requiring both clean-in-place and external

washdown capabilities without shutdown. The Whirl Wet is 95% to 99% efficient for soluble and insoluble particulate. Energy generated inside the unit prevents system clogging so that the glutinous residues that are common with some dust collectors are not an issue. The system is manufactured in capacities from 1,000 to 60,000 cfm. **Tri-Mer Corporation, tri-mer.com.**

Metal Detector

Fortress R&D has upgraded its pipeline metal detector. It is available in standard 2, 3, 4 and 5-inch pipe diameters and are engineered to detect metal in high-viscosity foods and liquids (such as meat products, gravies, and syrups) to eliminate contaminants in the processing line. A modular design reduces the external surface area by more than 60% and routed connectors inside the unit retain hy-giene while being easy to dismantle for operatives. The system also features auto-balance, which rebalances coil heads within the unit to maintain metal detection sensitivity. It satisfies QA mandates, ensuring compliance with North American processing requirements, including GFSI/SQF, BRC, and HACCP. **Fortress Technology, fortresstechnology.com.**

SCIENTIFIC FINDINGS

For access to the complete journal articles mentioned below, go to "Food Science Research" in the August/September 2022 issue at foodqualityandsafety.com, or type the headline of the requested article in the website's search box.

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Food Fraud in Seafood

Due to complex, valuable, and often extremely opaque supply chains, seafood is a commodity that has experienced a high prevalence of food fraud throughout the entirety of its logistics network. Fraud detection and prevention require an in-depth understanding of food supply chains and their vulnerabilities and risks so that food business operators, regulators, and other stakeholders can implement practical countermeasures. This study examines reported seafood fraud incidents from the European Union's Rapid Alert System for Food and Feed, the Decernis Food Fraud Database, HorizonScan, and LexisNexis databases between 2010 and 2020. Illegal or unauthorized veterinary residues were found to be the most significant issue of concern. For internationally traded goods, border inspections revealed a significant number of reports with fraudulent or insufficient documentation. This analysis underlines the need for a standardized and rigorous dataset through which food fraud can be scrutinized to ensure enforcement. ***Comprehensive Reviews in Food Science and Food Safety*. Published July 8, 2022 online ahead of print. DOI: 10.1111/1541-4337.12998.**

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How to Improve Bread Flavor

With a long history of fermentation technology and rich flavors, bread is widely consumed by people all around the world. While the consumer market for bread is large and the demand is wide, the formation mechanism of bread baking flavor has not been completely defined. To improve the bread-making process and the quality of bread, the main flavor substances produced in bread baking, the formation mechanism, and the detection technology of bread baking flavor are carefully summarized in this article. The generation conditions and formation mechanism of flavor substances during the bread baking process are expounded, and the limitations of some current bread flavor detection technologies are proposed, which will provide theoretical basis for effectively regulating the generation of flavor substances in the bread baking process and making bread with good flavor and rich nutrition in the future. ***Journal of Food Science*. Published July 27, 2022 online ahead of print. DOI: 10.1111/1750-3841.16254.**

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Microbial Inactivation in Milk Using PEF Technology

Pulsed electric field (PEF) is a technology that can preserve milk into dairy products with sensory quality similar to fresh milk. Adoption of PEF at industrial level is challenging due to the various variables that may influence the microbial inactivation studies. This review aimed to quantify the inactivation effect by PEF on microbial population in milk through meta-analysis. The order of microbial resistance to PEF from the highest to lowest

was bacterial spores, Gram-positive, followed by Gram-negative bacteria. The effect of pulse shape on microbial inactivation from the highest to lowest was bipolar square, monopolar square, and monopolar exponentially decaying. Increasing the intensity of PEF processing parameters increased microbial inactivation. The processing parameters influencing microbial inactivation from the highest to lowest were pulse shape, inlet temperature, treatment time, pulse width, electric field, pulses number, and frequency. ***International Journal of Food Science and Technology*. Published June 28, 2022 online ahead of print. DOI: 10.1111/ijfs.15942.**

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(Continued from p. 43)

Ozone Technology in Winemaking

Ozone is an emerging eco-friendly technology that has been widely used in the beverage industry due to its broad spectrum of usages, such as fermentation, microbial inactivation, clean-in-place systems, and postharvest treatment. Ozone technology as an alternative approach to conventional methods to inhibit microbes in wine processing and wineries has attracted researcher attention, as this emerging technology will probably play an important role in wineries in the future. This review discusses the prospective applications of ozone in winemaking and wineries and elaborates on ozone's antimicrobial effects on the control of the broad spectrum of microorganisms during wine processing. This paper also discusses the effects of ozone on wine quality. Ozone treatments can improve yeast fermentation by impacting the yeast ecology of postharvested wine grapes, mainly by affecting apiculate yeasts and adjusting the population of undesirable yeasts during the fermentation process. Furthermore, ozone treatment may enhance wine's anthocyanin concentration, physicochemical properties, color, pH, oxidative stability, and concentration of pleasant volatile compounds and esters. ***Comprehensive Reviews in Food Science and Food Safety*. 2022;21:3129-3152.**

Using Vegetable Fermentation to Reclaim Food Waste

Fermentation of eight vegetables was studied as an alternative for reclamation of surplus volumes. Fermentation performance was predicted by comparing the amounts of acid that could be produced from the intrinsic sugar content with that buffered by the fresh vegetable matrices prior to reaching an inhibitory pH for fermentative microbes (3.30). Native fermentations were brined with 345.0 mM sodium chloride, 40.0 mM calcium chloride, 6.0 mM potassium sorbate, and vinegar to adjust the initial pH to 4.70. High-performance liquid chromatography analysis, pH, and carbon dioxide measurements and spiral plating on selective media were employed to monitor the progress of fermentations. The average colony counts for yeast and/or molds and *Enterobacteriaceae* declined to undetectable levels from 3.6 ± 1.5 log CFU/ml within seven days of fermentation. Fermentation of vegetables with low sugar content, such as broccoli, green leaf lettuce, and green pea, proceeded to completion. Fermentation of vegetables with a moderate sugar content, such as green bell pepper, red-ripened tomato, and green beans, were incomplete. Vegetables are the second-most wasted commodity in the U.S. and a substantial constituent of the global food waste. Development of fermentation to reclaim surplus vegetables offers opportunities to ameliorate economic losses and environmental impact and add value to waste. ***Journal of Food Science*. 2022;87:2121-2132.**

Colloids in Bourbon Whiskeys

The dilution of whiskey with water can lead to the formation of unwanted haze which is exacerbated at lower temperatures. This phenomenon is well known in the whiskey industry and it's normal practice to use cold filtration to produce a clear product and improve product stability. To date, there has been no quantitative characterization or understanding of the size and concentration of the colloidal particles as a function of whiskey dilution, temperature, and maturation. This report uses light scattering techniques to characterize the formation of colloids in bourbon whiskeys of different aging periods. Higher water dilution decreased the size of

the colloidal particulates and increased their stability. Aged samples were found to be more stable, having a higher concentration of colloids at lower dilutions. This work demonstrates that dynamic light scattering can be useful for quality control in the spirits industry. ***Journal of the Institute of Brewing*. 2022;128:66-72.**

Have something to say? Send your thoughts to skuehne@wiley.com.

Cannabis Career Opportunities for Food Safety Professionals *(Continued from p. 17)*

edibles should strive to instill a culture of food safety in new employees. Including training on food safety expectations for each position can help foster a food safety culture and position employees for professional growth.

How to Climb the Corporate Ladder

Experience counts, until it doesn't. In most cases, a job candidate who has worked in the industry (with good references) will stand out among candidates without a similar background. With so many jobs projected to be available in the coming years, however, most candidates will compete against others who are also new to the industry.

Many seeking to advance their careers can do so, even if it's crossing over from a non-cannabis position. For example, a member of the food safety team at an FDA-registered company that makes candy or baked goods is well prepared for supervisory and quality control roles at a company manufacturing cannabis edibles. Additionally, those with experience in company departments such as IT, marketing, and accounting will find that similar roles at a cannabis company require many of the same skills.

Here are some tips for employees climbing the corporate ladder in the cannabis industry:

- **Research, research, research**. The cannabis industry continues to reinvent itself as legalization spreads, and each state brings its own regulations for food safety and other oversight. Someone seeking career advancement at a company in another state must learn about the similarities and differences in the rules before the job interview.
- **Certification needs.** Some states require employees in specific roles to undergo training and certification. Background checks are also standard in roles that involve handling and accessing cannabis and cannabis-infused products.
- **Find a mentor and network.** The cannabis industry is still relatively new, and mentors can provide valuable advice and guidance when seeking a promotion or career advancement. It's also smaller and more close-knit than many other industries, and networking with others could pay off with referrals and recommendations from colleagues.
- **Prepare for the future**. Because cannabis is still illegal at the federal level, there are no FDA food safety mandates for edibles; however, experts in the industry believe that it's just a matter of time before Congress legalizes the drug at the federal level, bringing around nationwide regulatory measures. Therefore, companies that offer access to training and employ FSMA-compliant policies (including preventive controls-qualified individual [PCQI] training) will be ahead of competitors. Likewise, someone who is already a PCQI could find themselves in demand.

Remote Training

Robust food safety training doesn't have to be complicated. When 100% online training is available, there's no need to send new hires to in-person classes in another city or delay food safety duties while waiting for classes to be available. Look for a web-based platform that offers food safety training built specifically for the cannabis industry and for all employees—from the front line all the way up to management. ■

Dr. Birmingham is chief operation officer and vice president of research and instructional development at ImEpik, an online food safety training company that caters specifically to the cannabis industry.

The Future of Pathogen Testing and Detection *(Continued from p. 32)*

important for *Salmonella* testing in the poultry industry, as the pathogen is widely present, and knowing the qualitative result of *Salmonella* testing is not as valuable as knowing how much of it is present.

Another concept at the forefront of pathogen testing is the idea of serotyping. Serotypes are groups within a single species of microorganism that have distinctive surface features that may make them more of a food safety risk. For example, certain *Salmonella* serotypes have a higher propensity to cause foodborne illness, so if food manufacturers can concentrate on limiting the levels of these *Salmonella* serotypes, they will produce a safer food for their consumers. As the industry continues researching pathogens, scientists can further understand the different strains of each pathogen, allowing pathogen testing and detection methods to continue advancing.

As the industry continues researching pathogens, scientists can further understand the different strains of each pathogen, allowing testing and detection methods to continue advancing.

Our knowledge of pathogen testing is ever-changing as we continue to research prevalent and emerging food pathogens and continue to make advancements in testing technologies and detection methods. As we try to recover from the lasting effects of the pandemic, automation technology and new testing methods will help shape the industry moving forward. ■

Thevenet is a U.S. and Canada technical sales manager and pathogen manager for 3M Food Safety.

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Aug. 22-Sept. 1
AOAC Annual Meeting and Exhibition
Scottsdale, Ariz.
Visit aoac.org/annual-meeting-exposition.

OCTOBER 2022

17-19
Cannabis Quality Conference and Expo
Parsippany, N.J.
Visit cqcexpo.com.

19-21
Food Safety Consortium Conference and Expo
Parsippany, N.J.
Visit foodsafetyconsortium.org.

19-21
Fresh Food, Packaging and Sustainability Summit
Clemson, S.C.
Visit sonocofreshsummit.com.

23-26
Pack Expo International
Chicago, Ill.
Visit packexpointernational.com.

NOVEMBER 2022

2-4
Dairy Practices Council Annual Conference
Bloomington, Minn.
Visit dairypc.org/dpc-conferences.

JANUARY 2023

15-17
Winter Fancy Food Show
Las Vegas, Nevada
Visit speciatlyfood.com.

MARCH 2023

1-3
Consumer Food Safety Education Conference
Arlington, Va.
Visit cfsec.org.

18-22
Pittcon
Philadelphia, Penn.
Visit pittcon.org.

28-30
SIAL America
Las Vegas, Nevada
Visit sialamerica.com.

APRIL 2023

24-28
Conference for Food Protection
Houston, Texas
Visit foodprotect.org

MAY 2023

8-11
Food Safety Summit
Rosemont, Ill.
Visit food-safety.com/food-safety-summit.

20-23
National Restaurant Association Show
Chicago, Ill.
Visit nationalrestaurantshow.com.

JULY 2023

16-19
International Association for Food Protection
Toronto, ON, Canada
Visit foodprotection.org.

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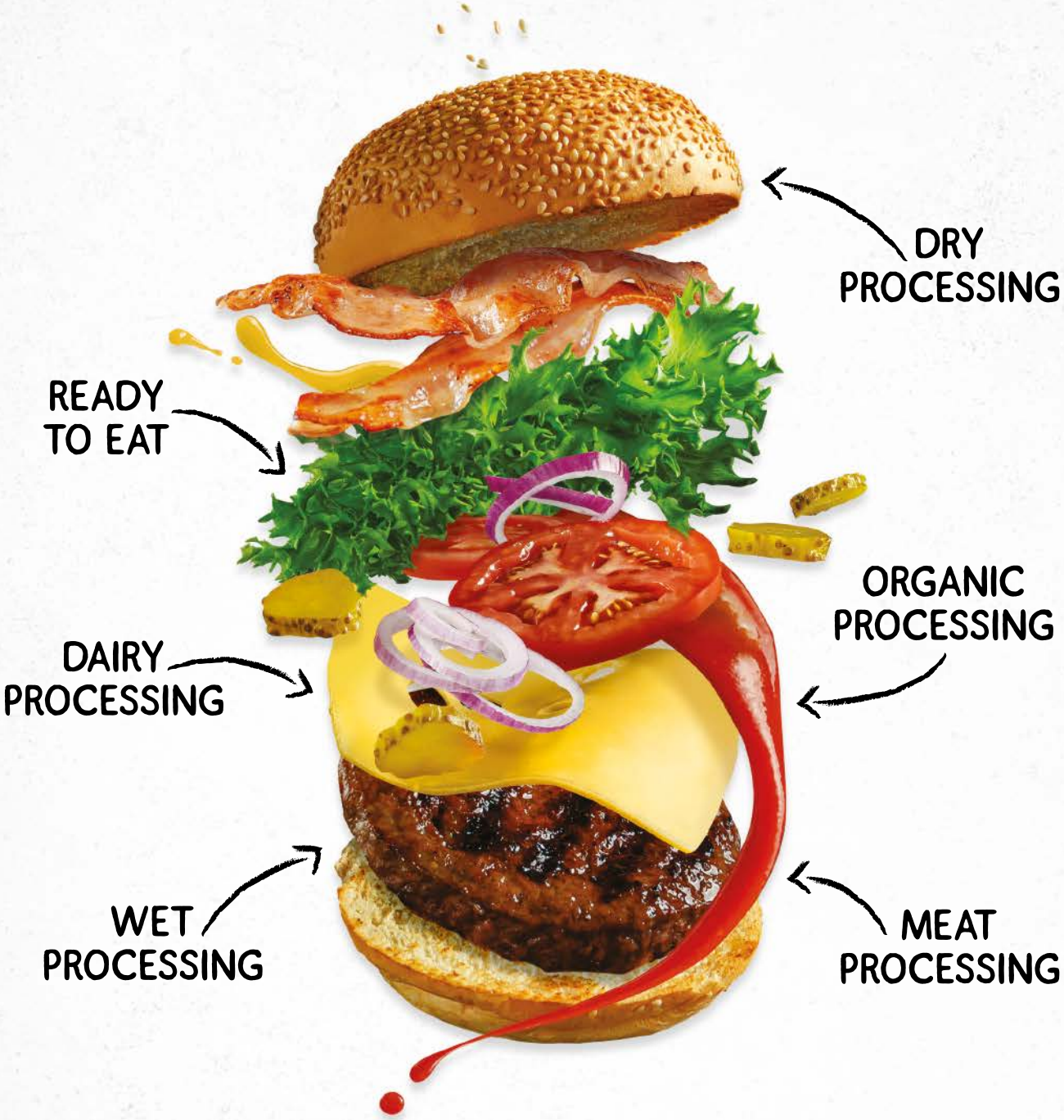

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