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Volume 31 Number 3
JUNE / JULY 2024

Food Quality & Safety

FARM TO FORK SAFETY

RISING RISK

How a changing climate could impact food safety

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Food Quality & Safety (ISSN 2572-8644) is published 6 times a year in Feb/Mar, Apr/May, Jun/July, Aug/Sept, Oct/Nov, Dec/Jan by Wiley Subscription Services, Inc., a Wiley Company, 111 River St., Hoboken, NJ 07030-5774.
Print subscriptions are free for qualified recipients. Annual paid subscriptions are available to European readers at €171, U.K. readers at £139, and rest of the world readers at $258.
For subscription questions, email customer service at wileygit@vuservice.de.

APEX, Folio Ozzie, and ASBPE award winner for editorial and graphics excellence.
POSTMASTER: Send all address changes to *Food Quality & Safety*, Wiley Periodicals LLC, c/o The Sheridan Press, P.O. Box 465, Hanover, PA 17331 USA

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From The Editor

A Fond Farewell

John Wiley & Sons will cease publication of *Food Quality & Safety*, effective with this issue.

When *Food Quality & Safety* launched more than 30 years ago (then called *Food Quality*), our mission was to inform and advise all levels of quality and safety decision makers in food manufacturing, food service and retail, agriculture, and regulatory and research institutions regarding the strategic and tactical approaches required in a rapidly changing food market.

Throughout the years, the field has witnessed extraordinary advancements in technologies, significant regulatory changes, and monumental outbreaks—such as the 2006 *E. coli* outbreak linked to spinach and 2022's outbreak of *Cronobacter* that impacted the infant formula supply—all of which played pivotal roles in advancing food safety and quality. *FQ&S* has covered the evolution of best practices—from the early days of the Food Safety Modernization Act to the New Era of Smarter Food Safety. We have showcased the innovators and pioneers who have driven these changes and shared their research and insights to inspire and educate.

Through our print and digital products, we have provided a platform for experts to share their knowledge, discuss challenges, and propose solutions. We hope that our legacy is one of fostering a community that values science, transparency, and continuous improvement.

We encourage you to continue to uphold the highest standards and strive for innovation in the field of food production. The future of food safety depends on the foundation we have built together.

I want to thank all of our editorial staff and board members, both past and present, and all of our readers.

Thank you for being a part of our journey.

Samara E. Kuehne
Editor

Food Quality & Safety
FARM TO FORK SAFETY

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Printed in the United States by Dartmouth Printing, Hanover, NH.

NEWS & NOTES

FDA Publishes Long-Awaited Ag Water Rule for Produce Safety

FDA has released a final rule on agricultural water that represents an important step toward enhancing the safety of produce. The revised requirements are intended to enhance public health by improving the safety of water used in produce cultivation. The revisions are also designed to be practical across various agricultural water systems, uses, and practices, while remaining adaptable to future advancements in agricultural water quality science.

The final rule replaces certain pre-harvest agricultural water requirements for covered produce (other than sprouts) in the 2015 produce safety rule with requirements for systems-based agricultural water assessments to determine and guide appropriate measures to minimize potential risks associated with pre-harvest agricultural water.

Specifically, this rule:

- Establishes requirements for agricultural water assessments that evaluate a variety of factors that are key determinants of contamination risks associated with pre-harvest agricultural water. This includes an evaluation of the water system, water use practices, crop characteristics, environmental conditions, potential impacts on water from adjacent and nearby land, and other relevant factors.
- Includes testing pre-harvest agricultural water as part of an assessment in certain circumstances.
- Requires farms to implement effective mitigation measures within specific time frames based on findings from their assessments. Hazards related to certain activities associated with adjacent and nearby land uses are subject to expedited mitigation.
- Adds new options for mitigation measures, providing farms with additional flexibility in responding to findings from their pre-harvest agricultural water assessments.

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Farms are required to conduct assessments of their pre-harvest agricultural water annually and, whenever a significant change occurs, to identify any conditions likely to introduce known or reasonably foreseeable hazards into or onto covered produce or food contact surfaces.

These revised requirements reflect recent science, findings from investigations of several produce-related outbreaks, and feedback from a variety of stakeholders on the agricultural water requirements in the Produce Safety Rule, which were previously published in 2015. These revisions will more comprehensively address a known route of microbial contamination that can lead to preventable foodborne illness.

The rule also finalizes the dates for compliance with the pre-harvest agricultural water requirements for non-sprout covered produce as follows:

- For very small farms: two years, nine months after the effective date of the final rule;
- For small farms: one year, nine months after the effective date of the final rule; and
- For all other farms: nine months after the effective date of the final rule.

The rule does not alter existing requirements for agricultural water for sprouts, for which compliance dates have passed. It also does not alter existing requirements for harvest and post-harvest agricultural water activities. Additional information about compliance dates can be found on the FDA Proposes Compliance Date Extension for Pre-Harvest Agricultural Water Requirements webpage.

New Rapid Method for *Vibrio* Detection Could Improve Food Safety in Seafood

BY KEITH LORIA

Vibrio parahaemolyticus, a Gram-negative, salt-loving bacterium common in marine environments, is the leading cause of acute hepatopancreatic necrosis, also known as "early death syndrome," in aqua-

culture, and is responsible for a significant number of foodborne illnesses.

Over the past two decades, the bacteria has led to a significant rise in infections in humans, more so than other foodborne pathogens. These infections primarily result from consuming raw fish and seafood, and particularly, shellfish.

Climate change, causing rising ocean temperatures and ocean acidification, has resulted in increased abundances of Vibrio parahaemolyticus in oceans worldwide. In fact, the most recent FoodNet annual report indicates that the overall incidence in 2021 rose by 45.5% when compared with the annual incidence from 2016 to 2018.

Traditional detection methods for bacteria are labor intensive and time consuming, falling short of the need for accurate, rapid, and convenient detection required by food safety supervision and food enterprises; however, researchers in Shanghai, China, have developed a point-of-care detection method that allows for the quick and sensitive identification of the bacteria in seafood.

This new method uses advanced techniques called recombinant polymerase amplification (RPA) and the CRISPR/Cas12a system, along with a test strip. The method provides a low-cost, simple, and visually clear way to quickly detect *Vibrio parahaemolyticus* in seafood.

The researchers note that RPA-CRISPR/Cas12a-ICS can detect *Vibrio parahaemolyticus* in salmon sashimi at extremely low levels, as little as 154 CFU/g, without needing to enrich the sample first. "Our innovative detection platform represents a significant advancement in the rapid and sensitive detection of *Vibrio parahaemolyticus*, proving especially valuable for ensuring seafood safety and preventing public health crises," corresponding author Haijuan Zeng, leader of the Biotechnology Research Institute at the Shanghai Academy of Agricultural Sciences, said in a prepared statement.

Zeng, who designed and performed the experiments and analyzed the data, explained that by using this platform, Vibrio parahaemolyticus can be detected in approximately 30 minutes, with a limit of detection of 250 copies/μL for plasmid samples and 140 CFU/mL for bacteria. The platform has been validated with artificially contaminated food samples and various clinical isolates.

Furthermore, in the report, the researchers noted that adjusting the crRNA sequences could enable the identification of various other targets, allowing the optimized ssDNA concentration to be used for detecting different targets. Therefore, the RPA-CRISPR/Cas12a-ICS platform could be employed to detect foodborne pathogens linked to humans, adulterated foods, and even viruses.

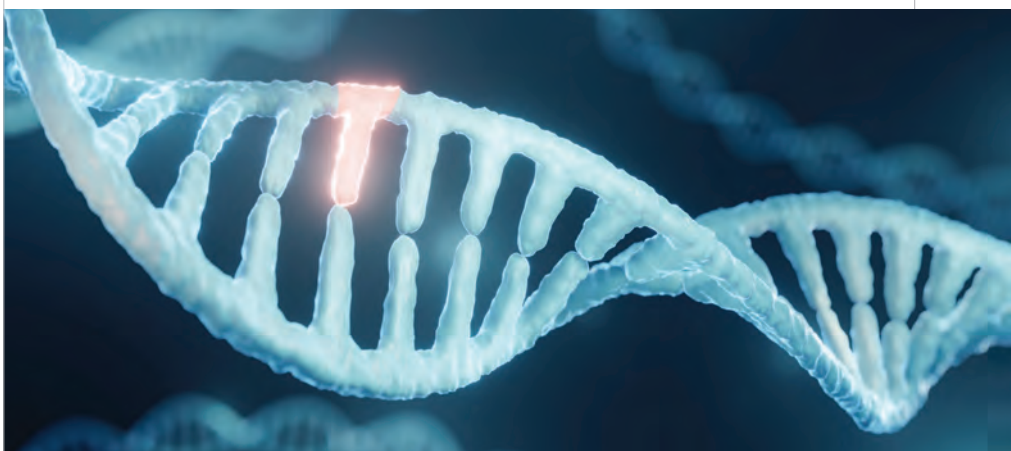
FDA Updates Regulations for Genomic Alterations in Animals

BY KEITH LORIA

FDA has released new regulatory processes for intentional genomic alterations (IGAs) in animals, citing the need to update due to evolving science and innovations in animal biotechnology. "These updated guidance documents demonstrate our commitment to facilitating innovation while ensuring product safety," Tracey Forfa, director of FDA's Center for Veterinary Medicine, said in a prepared statement. "These technologies hold great promise for many uses and public and animal health benefits, such as animal disease resistance, control of zoonotic disease transmission, improved animal husbandry, and increased food production and quality."

Elizabeth Presnell, an attorney with Food Industry Counsel, tells *Food Quality & Safety* that IGAs in animals refer to modifications made to an animal's genomic DNA using advanced molecular technologies, and FDA has established a risk categorization that splits IGAs into three categories based on risk to both animals and the food supply. "Category 1 is alterations not subject to approval; category 2 is going through a partial approval process where FDA will evaluate the risk and then determine whether or not the alteration needs to go through full approval; and then category 3 is where there is a risk to the food supply where a full approval will be undertaken."

She explains that this will look a lot like what drug approvals currently go through.



C.L. Mike Schmidt, an attorney from Schmidt and Clark who focuses on food safety and regulatory compliance, calls this a significant development that could have profound impacts on food safety in the years ahead. "This modernization could result in greater regulatory flexibility, predictability, and efficiency," he tells *FQ&S*. "For example, the FDA may not require developers of specific types of IGAs in animals to file an application or obtain FDA approval before marketing their product. This could speed up the introduction of these products to the market."

Some experts believe that the expedited process may raise food safety concerns. While genomic changes can provide advantages such as disease resistance, heat tolerance, faster growth, and feed efficiency, they may also introduce new risks. "For example, changes that result in faster growth may have an impact on the nutritional value of the food produced by these animals," Schmidt says. "Therefore, it's crucial that these products are thoroughly evaluated for their potential impacts on food safety before they are introduced into the market."

In this regard, FDA has established a memorandum of understanding with USDA to clarify roles and responsibilities for regulating IGAs in animals. "It's an interesting action by FDA as there are critics on both sides," Presnell says. "With animal agriculture geneticists saying this isn't going far enough, and then people opposing it because some of the processes are easier to achieve."

EPA Sets Limits on PFAS in Drinking Water

BY KEITH LORIA

On April 10, the Environmental Protection Agency (EPA) implemented first-ever restrictions on the perfluoroalkyl and polyfluoroalkyl (PFAS) substances in drinking water, a pivotal move in shielding public well-being from waterborne hazards.

EPA's cap target six PFAS compounds, including two of the oldest and most widespread PFAS—PFOA and PFOS—at four parts per trillion. The rule also sets limits of 10 ppt for PFHxS, PFNA, and HFPO-DA (also known as GenX), thereby establishing a benchmark for the most stringent health thresholds concerning these impurities in potable water.

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Under the new rule, public water systems are required to monitor these PFAS compounds, with an initial monitoring period of three years, concluding by 2027, followed by ongoing compliance checks. Additionally, these systems must disclose information regarding the levels of these PFAS in drinking water, commencing in 2027. Further, public water systems are allotted five years—until 2029—to implement remedies aimed at decreasing PFAS levels if monitoring reveals that these levels exceed the designated maximum contaminant levels (MCLs).

Nicknamed "forever chemicals" because of their resistance to be degraded or destroyed, PFAS have been associated with several health issues, including high cholesterol, cancer, and thyroid disease. "There's no doubt that these chemicals have been important for certain industries and consumer uses, but there's also no doubt that many of these chemicals can be harmful to our health and our environment," Michael Regan, EPA Administrator, said on a call to media this week.

Starting in 2029, public water systems found to have PFAS concentrations in drinking water surpassing the MCLs must take measures to reduce these levels and notify the public of the violation.

In an effort to help with enforcement, EPA announced it would make $1 billion in funding available through the Bipartisan Infrastructure Law to help states implement PFAS testing and treatment at public water systems and to help owners of private wells address PFAS contamination.

FDA Commissioner Asks Congress to Take Lead on CBD Regulation

BY KEITH LORIA

Robert Califf, U.S. commissioner of food and drugs, reiterated the FDA's year-

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Washington Report

Retail Milk Tests Positive for HPAI

FDA findings likely don't pose a health threat to humans, experts say

BY **KEITH LORIA**

In mid-May 2024, FDA announced that one in five samples of retail milk taken from grocery store shelves tested positive for highly pathogenic avian influenza (HPAI) H5N1; however, the agency stated that dairy products remain safe for consumption.

Results of egg inoculation tests from milk and dairy products that had previously tested positive for traces of the virus or virus fragments by polymerase chain reaction (PCR) testing showed that 96 milk samples and 201 dairy product samples, including cottage cheese and sour cream, were negative for live virus. Additionally, the agency says that no impacted samples were found in any infant formula tested and that there has not been any uptick in human cases of H5N1 as of April 2024.

FDA stated that there was limited research and information on whether HPAI viruses can be transmitted through raw milk or raw milk products, so the agency recommends that the industry refrain from manufacturing or selling raw milk or raw/unpasteurized milk cheese products made with milk from cows showing symptoms of illness. "While our initial assessment of the milk safety system continues to be affirmed by sampling and testing of retail dairy products, there remain a number of collective activities being undertaken to ensure the continued effectiveness of the federal-state milk safety system," the agency said in a May 10 statement. "The FDA will continue to follow a sound scientific process to inform the agency's public health decisions related to food safety."

FDA is committing approximately $8 million to ensure that the commercial milk supply in the country is safe, and USDA will pay up to $28,000 per farm to help mitigate the spread of the disease, totaling approximately $98 million in funds.

Cause for Alarm

Lee-Ann Jaykus, PhD, a food microbiologist, virologist, and professor at North Carolina State University in Raleigh, says the initial sample size FDA tested was small, and they found remnants of viral nucleic acid, not the actual virus. "Most people who know the science behind this really feel strongly that this virus is actually inactivated in the pasteurization process, and there's no evidence to the contrary," she says. "Even though specific studies haven't been done in the milk matrix, there's every reason to believe that."

So even though viral nucleic acid was found in the milk, it only means that perhaps the raw milk had the virus at some point but was likely inactivated by heat. "From a public health perspective, it's probably non-infective virus and likely killed during the pasteurization process, so there's no public health risk," Dr. Jaykus adds. "There's also no evidence that this virus is transmitted by consumption of food or even by the oral ingestion route."

Therefore, even if humans eat food containing the virus, it's highly unlikely that they would become sick from it.

Measures for Dairy Farms

Overall, bird flu has been detected in 36 dairy herds across nine states. Reports from affected dairy farms indicate that between 10% and 20% of the milking cows show clinical signs of infection with avian influenza. "Most of these affected cows tend to be older cows, and young stock (calves and heifers) have not displayed much evidence of clinical illness," says Noelia Silva-del-Rio, associate specialist in cooperative extension for the University of California, Davis, veterinarian medicine. "Affected cows may develop fevers, become lethargic, dehydrated, have reduced feed intake, have diminished or irregular rumination activity, and may have abnormal milk that is noticeably thicker or more concentrated."

No specific therapies are available for cows with clinical illness due to avian

influenza, but with supportive care, which includes fluids and fever reducers, cows typically recover in 10 to 20 days. Cow deaths are not associated with this outbreak of avian influenza in dairy herds.

"Affected herds have reported that milk production returns to normal or near-normal levels within about two or three weeks after ill cows are detected," Silva-del-Rio says. "The number of affected herds is expected to grow over time, but we don't know by how much. At the current time, most experts think that there could be some limited short-term effects, but the long-term impacts on milk production on an annual basis would likely be small—maybe about a tenth of a percent."

Terry Lehenbauer, professor of veterinary medicine at U.C. Davis, notes that dairy farmers should follow good biosecurity practices for their herds. This would include restricting or minimizing the introduction of dairy cattle into their herds from outside sources, isolating any cows that may develop clinical signs that are compatible with avian influenza infection, and practicing good hygiene, especially in the milking parlor. "Current evidence suggests that most of the transmission of avian influenza among cows within an infected herd is most likely occurring during milking procedures due to contamination of milking equipment because infected cows shed the virus in their milk during the acute phase of their illness," Lehenbauer says. "Cows with clinical illness or abnormal milk should be segregated or milked last."

Federal and state public health regulations require that milk from affected cows must be discarded and cannot enter the food supply. For affected herds, discarded milk should be pasteurized if it will be fed to calves. "We're basing our concerns about transmission of the virus from cows to humans on just one case," Dr. Jaykus says. "That's very consistent with the science, which says these viruses don't jump species very easily."

Transporting Issues

USDA issued new rules in late April for testing lactating cows before transporting them across state lines, aimed at reducing the chances that infected cows would be transported to join existing herds and possibly transmit infections. "This new testing requirement is especially important to prevent the movement of asymptomatic cattle that could potentially carry the virus and spread the disease," Lehenbauer says. "Compared to other classes of dairy cattle, such as dairy calves or dairy replacement heifers, relatively few lactating cows are routinely transported between states."

Money Matters

Patrick Wilson, DVM, a veterinarian at Well Pet Coach, explains that cow-to-cow disease transmission can present significant challenges in managing herd health. "Diseases such as mastitis, bovine respiratory diseases, and Johne's disease can spread rapidly within a herd as these can lead to reduced milk production, reproductive issues, and increased mortality rates," he says. "These disease outbreaks can result in substantial economic losses

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HPAI *(Cont. from p. 11)*

for farmers. Reduced milk yields, treatment costs, and potential culling of infected animals can impact farm profitability and sustainability."

Furthermore, if a farmer has consistently operated with the intent of disregarding potential contamination and cow diseases, USDA could issue civil penalties, including fines. Aside from that, if there's a serious disease threat, the USDA may order the seizure or condemnation of affected animals to prevent disease spread or revoke credentials, licenses, or permits. "Noncompliance with USDA regulations can result in the loss of eligibility for federal programs or subsidies related to agriculture or animal health," Dr. Wilson says. "Biosecurity measures are a sustainable practice but would be quite costly, and strenuous tasks can be ignored by small dairy farmers. They must implement stringent biosecurity measures to minimize disease transmission. This includes quarantine protocols for incoming animals, maintaining clean facilities, and controlling visitors' access to the farm."

The good news is that most believe the bird flu outbreak will have little to no effect on milk prices and market demand.

Andy Bhatt, a dairy industry lobbyist and executive director of SW and Associates, notes that this can play out in a variety of ways, most of them being harmless or having little to no impact. "If there is a temporary drop in supply, depending on what the current production yield and prices are, it could actually provide some benefit, as there are times where supply is too high and overage milk that can't be put to good use elsewhere has to be dumped," he says. "It could also lead to a very short-term lack of milk on the shelves that might not be a problem since media coverage of bird flu might cause consumers to buy less milk for a short period. But by the time any low inventory issues might show up, consumers may have forgotten about this and returned to previous demand."

Reassuring Consumers

The Centers for Disease Control and Prevention confirmed that a single individual in Texas who worked directly with cows in the herd tested positive for H5N1 after being exposed to infected dairy cattle. Symptoms were mild, it wasn't respiratory-based, and he didn't pass it on to anyone else, so most believe it wasn't the result of tainted milk. "Proper pasteurization of milk has consistently shown over time that milk and dairy products made from pasteurized milk are safe and healthy for consumers regarding the concern about bacteria or other pathogens of public health concern," Lehenbauer says.

Although the occurrence of HPAI in dairy herds raises concerns, it's anticipated that the milk supply will be minimally affected. This is attributed to the efficacy of pasteurization and the limited number of herds affected. Nonetheless, it's imperative for all stakeholders in the dairy industry to stay vigilant and implement proactive measures to curb the spread of this disease. ■

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Career Development

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Unlock Your Potential

Career growth tips for food safety professionals

BY **KEITH LORIA**

Food safety has always been crucial, but with the rise of pathogens and challenges from pests and chemicals, it's vital for food and beverage manufacturers to have strong food safety leaders. This has led to a strong emphasis on developing the food safety leaders of the future.

Jill Stuber, co-founder of Catalyst, a coaching and leadership development company for the food industry, and vice chair of the Developing Food Safety Professionals Group of the International Association of Food Protection (IAFP), says that possessing solid technical skills is essential in the food safety space. "We've seen people improve their work outcomes and get promoted when they practice and adopt soft skills such as [having] self-awareness, creating safe spaces, and leading with curiosity," she says. "Leaders who empower team members and invest in personal and professional growth are more likely to enhance their career growth prospects, as they will be known for growing competent, dynamic, and innovative teams."

Takashi Nakamura, PhD, MBA, vice president of food safety for Fresh Del Monte, highlights three areas of focus in building any career: attitude, aptitude, and attendance. All are necessary to become a strong food safety leader. "Resiliency is key when it comes to food safety, since the next outbreak or recall is just around the corner," he adds. "This world is that of pathogens, and it's important to know that we inhabit their world, and not the other way around. There will be more tough days than easy days in our business and function."

Aptitude should be a top characteristic in a food safety leader, and candidates should build themselves up as subject matter experts. "Establishing credibility and empowering others in this type of job function requires constant vigilance in developing your skill sets and competencies," Dr. Nakamura says. "Don't settle for what you have achieved, but rather look for the opportunity to build via a disciplined and rigorous program—regardless of the degrees you have or the training you've achieved. The world is constantly evolving and adapting, and as stewards of critical functions in an organization, we as professionals need to do the same."

He also notes the importance of regular on-site visits that include visiting the floor, walking the fields, and touring the facilities. "This function is not one where you stay behind a desk in an office," Dr. Nakamura says. "You will need to see, touch, and hear what is going on in your operations. Be present to those other functions and engage. Be engaged in associations, stay in touch with universities and

(Continued on p. 14)

Unlock Your Potential *(Cont. from p. 13)*

institutes, and establish and expand your network."

Food safety is a rapidly evolving field, so professionals must stay ahead of emerging trends and technologies to enhance their career growth. Continuous education and training are critical. "Professionals can stay ahead of emerging trends by regularly reading industry publications, research studies, and reports related to food safety issues and events," says Jorge Hernandez, vice president of quality assurance for the Wendy's Company, who has over three decades of experience as a food safety leader. "They can also pursue additional training, certifications, attend workshops, webinars, conferences, and/or taking online courses related to food safety. This will help them enhance their knowledge and skills in the field."

Key Skills

Jennifer McEntire, PhD, founder of Food Safety Strategy and former chief food safety and regulatory officer at the International Fresh Produce Association, shares her belief that future food leaders should possess strong foundational knowledge of food safety hazards and critical thinking skills to determine when these hazards become risks. "Knowing how to do the research to gather this information to make data-driven decisions is critical," she says. "It's not just analytical skills though; it's important to listen and learn from others. Leaders also have a natural curiosity."

Hernandez says that essential skills for aspiring food safety leaders start with building credibility. "This is a non-negotiable for aspiring leaders," he adds. "Your credibility is the bedrock of leadership and essential to your success in any organization. You must have a deep knowledge and understanding of food safety science that drives the food safety standards and regulations. It is the foundation on which trust is built, and it is what allows any aspiring food safety leader to influence others to engage in the pursuit of common goals."

Effective communication is another key skill that helps people advance in the field. "From gaining management support for budgets, programs, or changes to the status quo, to being able to educate and train staff on the importance of food safety, food safety protocols, and communicating with regulatory agencies, an aspiring food safety leader must seek to be an effective communicator who can clearly and concisely communicate the food safety vision, ideas, changes, and the benefits those bring," Hernandez says.

Dr. Nakamura advises workers to be results-oriented early in their careers and continuously develop their skills, thinking of themselves as a brand and taking stock to determine how to succeed. "Get solid, external certified basic trainings in HACCP, GMP, traceability (FSMA 204), [and the] produce safety rule (and its requirements such as PCQI) if going into the produce field," he says. "Sanitation should be one of your key areas of focus, as we don't have enough great sanitation-trained individuals. Commercial food sanitation has very well-respected and world-renowned training certification courses. Going back to being a subject matter expert, develop yourself to be a specialist in an area such as sanitation, microbiology, etc."

Critical thinking is another important trait of an aspiring leader: Be able to seek the proper information, analyze data to identify potential food safety risks, and develop preventive solutions to ensure the safety of the food supply chain. "They must also have courage," Hernandez adds. "This can be one of the hardest things for any leader, yet it is essential for any aspiring food safety leader. As an old friend once told me, 'If you want everyone to like you, do not go into food safety; go sell ice cream.' Having the courage to speak up, make difficult decisions, take responsibility for results, apologizing for mistakes, or giving bad news is not easy, but it's a defining characteristic of true food safety leaders."

Dr. Nakamura recommends initiating and driving research programs with universities and institutes for your organization. "External engagement with key educational and research universities will foster you and your team's ecosystem and network," he says. "This activity will drive two areas—it will keep you in touch [with] and abreast of new technologies and how the next generation is looking at current and future state problems and issues; and it will allow you to develop a network of like-minded professionals that can assist you in finding a solution to

(Continued on p. 27)

Interview Tips

The interview process can be the difference between landing a lead job or not. "Read up on the company, any relevant outbreaks/recalls the company or related industry has gone through, and how has the organization managed through this," Dr. Nakamura says. "Do your research beforehand, and then ask pointed questions."

Remember, an interview should be a two-way endeavor where both the organization and the interviewee seek to find the right fit for long-term success. "When seeking a job in the food safety field, professionals should ask interviewers questions that can help them gain a better understanding of the company, its food safety practices, and the role they will be taking on," Hernandez says.

Some questions for interviewees to ask include:

1. Can you provide an overview of the company's food safety culture?
2. How does the company ensure compliance with food safety regulations and standards?
3. Can you describe the company's approach to training and educating employees on food safety?
4. How does the company stay updated on emerging food safety trends and best practices?
5. What opportunities are available for professional development and advancement within the food safety department?

By asking these questions, food safety professionals can demonstrate their interest in food safety practices and gain insight into a company's commitment to a food safety culture, assessing whether an organization aligns with their values and career goals.—KL

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Rising Risk

Food safety in an uncertain climate

BY **MARY BETH NIERENGARTEN**

The planet is warming, and extreme weather events are becoming more frequent and severe. Across the globe, changes in climate are placing enormous pressures on entire ecosystems. Years-long droughts, severe rains and flooding, and frequent wildfires are among the increasingly disruptive weather events that are having cascading effects on perhaps the most essential ecosystem for humans—the food ecosystem.

While cyclical weather events such as El Niño and La Niña play a vital role in shifting weather patterns and events, it's the long-term trend in climate changes wrought by human activity that most experts believe, and science supports, exacerbate these cyclical patterns to a degree by which the health of ecosystems cannot be maintained or, if unimpeded, reversed. From depleting the soil of nutrients to interfering with the proper storage of foods for human consumption, climate change holds the potential to disrupt all aspects of the food chain. Ensuring food safety in this climate is an ever-growing concern.

For food producers and processors already tasked with the continuous, difficult mandate to ensure the safety of their food products, the task may feel Sisyphean amid new and uncertain

challenges all along the food chain caused by the warming planet. "Predicting the most significant impacts of climate change on food safety is challenging given the dynamic nature of climate change," says Sara Bratager, senior food safety and traceability scientist at the Institute of Food Technologies (IFT). Rather than one dominant impact of climate change on food safety, she thinks it more likely that there will be a collection of emerging risks whose impacts will vary regionally.

For Bratager, the problem presented by climate change to food safety is one that carries opportunity. "Climate change is encouraging us to think differently and more comprehensively about food safety practices," she says.

Brenda Zai, a PhD candidate in the department of population medicine at the University of Guelph in Ontario, Canada, put a stronger note on a similar message. "It is not necessarily the impacts of climate change on food safety risks that are the major concern; it is how solutions and resources are developed," she said.

She'd like to see more of a focus on mitigating and adapting to climate change rather than the current focus on preventing it. "Ultimately, climate change impacts are inevitable; therefore, a shift in mindset is central to adapting to these impacts to lessen their burden," she says. Without this shift, she thinks "the agri-food industry and public health will continue to be vulnerable to climate-sensitive food safety risks."

Focusing on climate change as a catalyst for improving food safety solutions, there remain several big questions. What are the effects of climate change on food safety that can spur more comprehensive food safety practices? How can food producers and processors position themselves to best handle these effects and strengthen their food safety protocols?

Risks to Food Safety

Rising temperatures across the globe, with 2023 as the hottest year on record according to a 2024 report from the World Meteorological Organization, are exacerbating a range of food safety concerns. Water and crop contamination are major concerns, as detailed in a 2020 report by the Food and Agriculture Organization (FAO) of the United Nations, "Climate Change: Unpacking the Burden on Food Safety." From worsening algae blooms along coastlines and

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lakes that harm marine plants and animals, to higher incidences of foodborne pathogens caused by heavy precipitation events and flooding, to increases in and expanded geographical areas with mycotoxin contamination in staple crops, the incremental but impactful heating up of the earth's water and land is presenting new challenges to keeping food safe all along the food chain.

And the risks are spreading globally. "Some of the greatest food safety risks caused by climate lie in the emergence of previously not regionally known threats," says Markus Lipp, PhD, senior food safety officer, Agrifood Systems and Food Safety Division, FAO, Rome.

Dr. Lipp points to many regions of the world, for example, that have not previously been affected by food safety risks related to mycotoxins in various crops or marine biotoxins in seafood. Unlike the many tropical countries for whom these risks are well known and who have learned to manage these risks, Dr. Lipp says these newer regions of the world have less practice and know-how on how to manage such food safety risks. "This is a particular concern as the rate of climate change is rather fast and results therefore in an immediate concern," he says.

> It is not necessarily the impacts of climate change on food safety risks that are the major concern; it is how solutions and resources are developed.
>
> —BRENDA ZAI

Bratager also underscores the particular threat of mycotoxin contamination of crops in non-tropical areas, in which warming temperatures and extreme weather events such as drought and flood are creating ideal conditions for certain mycotoxins to proliferate. She cited the rise in aflatoxin contamination in maize in South and Central Europe over the past decade, particularly in Italy, Serbia, and Hungary. "This shift highlights the expanding geographical range of food safety risks driven by climate change," she adds.

The risks to food safety go well beyond the pre-harvest stage. Other, less direct effects of climate change include disruptions in food processing and production as well as consumption. Extreme weather events can "disrupt food safety processes and interfere with protocols related to food processing, transport, and storage," says Elena N. Naumova, PhD, a professor in the nutrition epidemiology and data science division at the Friedman School of Nutrition Science and Policy at Tufts University in Boston. Power outages caused by extreme weather, for example, can impair refrigeration of perishable products of high nutritional value such as meat, poultry, fish, dairy, and eggs across the food supply chain, from production and distribution sites to retail stores to consumers' homes. Microbial, physical, and chemical spoilage of foods will incur high costs for food producers and processors, including more food recalls. "The environmental and climate changes may be incremental, but the overall effects, both direct and indirect, are likely to be substantial enough to trigger foodborne outbreaks," says Dr. Naumova.

Collaboration Needed to Mitigate Risk

Although climate-sensitive food safety risks are garnering more research attention, Zai notes that significant knowledge gaps remain. "Consequently, mitigation and adaptation strategies are under-developed and require further efforts and resources," she says.

She cautioned against tunnel vision in addressing the impacts of climate change on food safety and instead emphasized a collaborative approach among experts across multiple disciplines (agri-food, public health, climate science, and policymaking) to provide holistic solutions akin to the Centers for Disease Control and Prevention's One Health framework approach.

What this means in practice is taking a stronger, proactive approach to mitigating food safety risks. For food producers, this may mean increasing current efforts to introduce new methods to adapt to the increased risk of crop contamination. Zai pointed to several methods that could be employed: integration of climate-resilient crop varieties that are able to withstand extreme weather conditions, and plant pathogens that can pose a risk to consumers after harvesting, diligent water management and testing to prevent waterborne pathogens from contaminating crops, and pest management.

For governments, public health, and policymakers, it means undertaking more data and research-driven activities such as developing reliable surveillance systems that integrate climate data and environmental sampling data to project the likelihood of contamination through modeling methods, which could also be applied to developing early warning systems, according to Zai.

Essential for strong collaboration among all stakeholders is a willingness to share knowledge and best practices. For example, regions newly experiencing mycotoxin risks can learn from tropical areas with long-standing experience managing these contaminants, says Bratager. "Data sharing is equally important," she said. "It enhances our ability to predict and prevent foodborne illness outbreaks by improving the identification of food safety risks and enabling more targeted mitigation strategies."

For experts who use data analytical tools to track food-borne outbreaks, access to data that is more streamlined across agencies is critical but difficult. Dr. Naumova, who is an expert in developing analytical tools for spatio-temporal and longitudinal

data analysis applied to disease surveillance, emphasized the severe fragmentation of data across various agencies that makes it difficult to get the needed precise data on where, when, and how food contamination and exposure to pathogens occur, spread, and manifest. "Our task is to assemble all records into an analyzable form, considering the potential delayed or cascading effects of extreme weather events and health responses," she says. "This data preparation and sophisticated analysis is a tedious, time-consuming process requiring internal checks and controls and proper expertise."

According to Dr. Naumova, developing a tool that can mitigate the food safety risks caused by climate change requires an investment in dollars, time, and commitment that would have an impact akin to creating a national infrastructure. "We need integrated early warning systems to mitigate the risks," she said. These would include assessing the potential for an extreme weather event at a given time and location; assessing the extent of food safety risks, including population vulnerability; providing projections for health officials and relevant stakeholders for different stages of risk (anticipation, alert, and alarm); developing, testing, and providing tailored mitigation strategies and monitoring their implementation; and assessing the aftermath and adjusting for further preparedness and learning.

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Climate change is encouraging us to think differently and more comprehensively about food safety practices.

—SARA BRATAGER

Dr. Naumova emphasizes the need to keep the focus on targeted mitigation strategies. "The effects of climate change are global, but the solutions have to be local and well-tailored to local needs and challenges," she says.

Thinking Globally and Acting Locally in an Uncertain Climate

One key challenge when talking about food safety risks linked to climate change is the unpredictability and variability of the effects of climate change at any given time in any given place. New thinking and new tools can help transition to acting more proactively to mitigate risks to food safety under the uncertainties of climate trends.

New thinking may mean a shift to a more proactive way of thinking about food safety issues affected by the changing climate. The FAO advocates integrating what it calls a structured foresight system to get people thinking about what climate-related scenarios could occur in the medium-to-long term that could impact food safety. In its 2022 report, "Thinking About the Future of Food Safety: A Foresight Report," the FAO describes foresight as a structured futures-thinking approach involving multidisciplinary collaboration aimed at understanding trends and uncertainties and guiding decision-making processes towards achieving desired goals. Such proactive thinking goes beyond the traditional early warning food safety systems that are aimed at rapid response to outbreaks or seasonal or annual climate conditions predictive of food safety risks.

"When we are prepared, when we have the foresight to understand how the world and its climate will change and what the consequences for food safety are, we can avoid disruption," says Dr. Lipp. Acknowledging that this mindset will not work for everything, he thinks it will work for a great many things and allow for a planned approach to deal with unforeseen events. "Without foresight, too many issues turn into an emergency that will overwhelm our systems," he adds.

New tools, especially at the local level, can help foresee and anticipate regional and local climate trends. A new tool recently launched by the University of Minnesota Climate Adaptation Partnership (MCAP) is one such tool. Called MN CliMAT, the interactive online tool offers highly localized climate projections for Minnesota by providing detailed information on future climate variabilities.

Katie Black, an extension educator focusing on climate resilience and adaptation at MCAP, says the tool fills a needed gap in providing highly localized climate information. "Many reports discuss the expected changes to our climate across the globe, but to make decisions at the regional, city, or farm scale, we need information at that same scale," she adds. "MN CliMAT's data are more relevant and useful for the many climate change adaptation efforts happening within the state."

For food producers, processors, and manufacturers, the tool can be used to create plans for what areas of their operations are expected to be most at risk from the changing climate, she said. For farmers, the tool can be used to help rethink where to grow crops based on models showing, for example, expected increases in big rainstorms or average spring precipitation in their local area. For larger-scale food processors or manufacturers, the tool can help prioritize infrastructure and investment based on expected temperature, humidity, and precipitation over the next 15, 20, and 50 years across the various counties in Minnesota.

Black and her colleagues see the tool as part of a suite of tools that will generate more interest from food industry stakeholders in steps they can take to begin creating or advancing an adaptation plan to meet the changes in climate. "We also hope that more awareness of our tool across the country will help to demonstrate the need for other states to have access to downscaled climate data for climate planning," she says. ■

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Safety & Sanitation

The Clear Contaminant

Water can pose a big risk to food safety throughout the food production process

BY **STEVE FUNK**

According to USDA, more than 4,000,000 pounds of food were recalled in the U.S. in 2023. Food manufacturers can decrease food safety risk with a single—and often overlooked—factor: water. Water looks clean and clear coming from the tap, but the truth is that potable water is not actually pure. There's a regulatory tolerance for organisms and pathogens in tap water that may be unnoticed in a single glass of drinking water, but these same organisms can wreak havoc in a food manufacturing plant. Properly purifying the "clear contaminant" and understanding the impact of water throughout the food production process are keys to maintaining the highest standards of food quality and safety.

Water, Water Everywhere

The effects of water on safety are especially pronounced in the dairy industry. Water is used in starter cultures to kick off the cheesemaking process. During cheese production, wash curd cheeses, including Colby and Monterey Jack, are cooled with water. Cheeses like Gouda are produced by removing a percentage of the whey and replacing it with hot water, which essentially cooks the curds. Fresh cheeses like mozzarella can spend months bathing in a water brine, and aging cheeses provide an ideal environment for bacteria from unpurified water to flourish.

Beyond production, water comes into contact with every type of equipment in a food plant. Incoming water can contain all types of pseudomonades, bacilli, mitochondria, psychotropic bacteria, yeasts, and molds. Some of these bacteria, organisms, and exopolysaccharides can cling to surfaces in a plant—from a pasteurizer to a separator to the miles and miles of stainless-steel tubing dairy plants contain. If biofilms are not taken care of in the cleaning process, they can release in the manufacturing process and cause problems in the dairy product. The four basic steps in equipment cleaning are pre-rinse, wash, rinse, and sanitize. Because water is used throughout this process, any impurity could be reintroduced to the equipment over and over.

The More Beloved the Ingredient, the Wider the Safety Concern

There's no question that Americans love cheese; 2022 USDA data indicate that Americans consumed close to 42 pounds of cheese per capita that year. While fluid milk sales have been softening for years, cheese consumption continues to grow. It's a staple grocery item in tens of millions of households and a component of prepared foods ranging from prepackaged salads to frozen pizzas.

It's not just the U.S. that has a love affair with cheese. *Fortune Business*

Insights reports that the global cheese market is expected to grow from $191.94 billion in 2024 to $287.12 billion in 2032. It's a key ingredient in a variety of global cuisines, including Italian, Mexican, French, American, and many Latin American recipes. Demand for and interest in cheese is even growing in countries that don't typically use the product in traditional recipes, such as China. The popularity and wide-spread use of cheese means that a food safety issue with this product can have an extensive reach.

Traceable Safety

To keep consumers safe and minimize the extent of recalls, FDA's Food Safety Modernization Act (FSMA) of 2011 and the New Era of Food Safety in 2020 were enacted to implement a more pro-active approach to food safety, primarily through traceability. The tracking requirements in the FSMA are designed to isolate a source of contamination more quickly, limiting the size of recalls and potentially saving lives.

UV-based water disinfection systems can be custom built to the size of the plant and de-signed to purify a specific type of water.

In November 2022, FDA published a final rule called "Requirements for Additional Traceability Records for Certain Foods" with 600 pages of detail. Entities affected by the rule include farms, manufacturers, distributors, retail food establishments, and restaurants. These covered entities are required to provide traceability-related tracking to FDA within 24 hours of an official request. While only certain cheeses are included on the Food Traceability List (FTL) in the final rule, the same facilities and equipment are typically used for a wider range of products than those appearing on the FTL. In addition to supporting public safety and preventing food waste, eliminating water as a potential source of contamination can streamline FDA compliance with any official request.

What's more, covered farms are required to conduct pre-harvest agricultural water assessments once a year and whenever there is any change that could introduce a food safety concern. These assessments include location and nature of the water source, the type of water distribution system, and the type of application method. While limited to produce farms at this time, the heightened focus on water in FSMA illustrates the importance of its role in food safety.

Ultra Purity with UV Disinfection

The obvious question is how food manufacturers across the supply chain can protect and purify its water sources. The most effective and reliable form of water purification is ultraviolet (UV) dis-

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Researchers examine milk samples.

Environmental Sampling: Is It Enough?

Within the realm of environmental monitoring, a good pathogen EMP may not sufficiently ensure product safety

BY **CLARENCE JOHNSON**

In October 2019, the Food Safety Committee of the Innovation Center for U.S. Dairy published its updated environmental pathogen control guidance, a comprehensive document intended to help the U.S. dairy industry control pathogens in wet and dry dairy processing environments (available at usdairy.com/foodsafety). In its guidance document, the Innovation Center details five principles that should be followed to ensure effective pathogen control. These include:

1. Separate raw from ready-to-eat (RTE);
2. Follow good manufacturing practices (GMPs);
3. Institute sanitary facility and equipment design;
4. Implement effective cleaning and sanitation procedures and controls; and
5. Initiate environmental pathogen monitoring.

These principles are in keeping with a 2022 systematic literature review showing that 10 of the 12 (83%) foodborne illness outbreaks involving pasteurized dairy products from 2007 to 2021 were due to contamination with *Listeria*, an environmental pathogen (*Can J Public Health*. 2022;113:569-578). A similar study that looked at reported outbreaks from 1998 to 2011, coming from both pasteurized and unpasteurized cheese, and showed that, in 44 outbreaks stemming from cheese made with pasteurized milk, 24% were attributed to *Listeria* and the remainder were a mix of *Salmonella*, *Campylobacter*, *Bacillus*, *E. coli*, and others, all considered environmental contaminants (*Foodborne Pathog Dis*. 2014;11:545-551). The importance of focusing on the five principles of pathogen control is clear.

One Step Further

But within the realm of environmental monitoring, is the vitally important task of environmental sampling enough to control pathogens? Will a good pathogen environmental monitoring program (PEMP) sufficiently and consistently ensure product safety and a high level of product quality? According to Neil Bogart, a highly regarded expert in dairy safety and the president of Bogart Food Safety and Sanitation Associates, Inc., an Alabaster, Ala.-based food safety and sanitation advisory firm with a primary focus on dairy processing, the answer is, "Perhaps not."

"While swabbing, [adenosine triphosphate] ATP surface monitoring, and other environmental sampling methods are crucial steps for controlling widespread pathogens," says Bogart, "they do not provide the complete picture in wet milk processing. Thermoduric organisms, for instance, can carry over from the raw milk supply, or pockets of contamination can become established in processing equipment where swabbing is impractical. This underscores the necessity of a robust process monitoring program to fully validate sanitation procedures and pinpoint contamination hot spots that can significantly impact quality and safety."

When considering a process monitoring program for cheese and dairy powder processing, for example, emphasis must be placed on spore-forming bacteria due to their ability to survive extreme processing conditions, their potential pathogenicity, and their strong spoilage capacities, which could lead to proteolysis, lipolysis, gas formation, and other quality defects. These bacteria can originate in the soil, feces, bedding, feed, or milking equipment but can also enter the milk via contaminated teats, milking cups, bulk tanks, or transport tankers. Pockets of contamination can also develop within the processing plant due to failures in milk handling, sanitation, or preventive maintenance. Extended production run times exacerbate the problem. Endospores formed by these organisms may survive pasteurization and subsequently germinate into vegetative cells that may be psychrotolerant but prefer to grow in warm conditions, giving them an even greater chance to contami-

nate many dairy processing environments (*Front Microbiol*. 2017;8:1-15).

Sporeformers of primary concern to dairy processors are members of the genera *Bacillus* and *Clostridium*; however, except in some cheese processing, concern over the anaerobic *Clostridium* often causes less concern than its aerobic counterparts. While many sporeformers are not pathogenic and are seen primarily as indicators of hygiene during milk collection, transport, or processing, certain members of these genera are well-known pathogens and are, therefore, troubling from a food safety standpoint.

The formation of homogeneous or heterogeneous bacterial biofilm communities on the internal surface of processing equipment is of particular concern to dairy processors because, when present, biofilms can lead to persistent problems of microbial contamination that are often intermittent and hard to pin down. Heat exchangers, pipelines, tanks, gaskets, seals, and other stainless steel processing equipment are primary sites for biofilm formation, especially once a conditioning layer of milk protein is laid down on the surface of the equipment during processing (*Comp Rev Food Sci Food Saf*. 2012;11:133-147). Biofilm formation is also a leading cause of fouling of reverse osmosis and microfiltration membranes and is a frequent concern in the continuous step of evaporation before spray drying, making these processes especially critical in controlling contaminant outgrowth (*Food Res Int*. 2021;150:110754; *Comp Rev Food Sci Food Saf*. 2014; 13:18-33).

Real-World Example

The importance of process monitoring was exemplified in a 2007 research study published in the *International Journal of Dairy Technology* (2007;60:109-117.). In this study, a team of New Zealand researchers monitored a process stream during five whole milk powder manufacturing runs, each approximately 18 hours in length. The plant was operating at the rate of 40,000 liters per hour. A clean-in-place (CIP) cleaning occurred after every run, and after every five runs the evaporator and direct steam injection unit were manually cleaned to remove foulant build-up. Samples were collected every two hours during processing from 16 sampling locations: raw milk ahead of pasteurization, after pasteurization, following each of five evaporator passes, and through to the finished product. In addition to vegetative cells, samples were tested for the presence of endospores.

> It's imperative for food processing facilities to prioritize proactive measures in maintaining the hard-to-reach, or sometimes forgotten about, areas.

The study found low or no spore counts in samples taken from the end of raw milk treatment, although vegetative cells were found in low numbers. The researchers concluded that in this study, raw milk treatment had very little influence on the thermophile numbers of milk destined for powder manufacture.

Conversely, beginning with samples taken from between the plate heat exchanger and evaporator and carrying on through two stages of evaporation, there was a consistent increase in both vegetative cell growth and spore formation. Spores and vegetative cells were initially detected after about nine hours of production, and by 18 hours, counts exceeded 10,000 colony-forming units per milliliter (cfu/mL). Vegetative growth and sporulation did not increase during evaporator stages three through five. In some production runs, vegetative cell and spore levels decreased during processing after the second evaporation stage, but in other runs, the contamination levels remained relatively consistent.

The authors concluded that the study "confirms that spores were forming within the milk powder manufacturing process and were not a result of external contamination." They further noted that low levels of contamination could come in from the raw milk, but the contamination found in later stages of production predominately arose from sporulation occurring within the plant, notably from bacteria trapped in foulant (from the evaporator or separator, for example) that remains in the equipment between CIP runs and may be only partially removed during manual cleaning. In this case, the heat exchanger, the preheat section of the evaporator, and the evaporator itself appeared to be the predominant sites of biofilm formation.

Every Situation Is Different, but Some Things Remain the Same

Maintaining microbiological quality and safety in dairy processing presents a considerable challenge to dairy processors. In dairy operations where controlling thermoduric, thermophilic, and post-pasteurization contamination is requisite for ensuring consistent quality and safety, wet process monitoring is an essential adjunct to environmental surface monitoring. Microbiological sampling of wet process critical control points helps quality assurance professionals control contamination, validate cleaning and sanitation procedures, and identify sources of milk contamination coming from the raw milk supply, processing equipment, or the surrounding environment.

Every dairy processing operation is different, and processes determined to be "critical" will vary from process to process or plant to plant; however, some processes or plant operations require careful monitoring in every milk processing environment. These include raw milk, both at the time of receipt in the plant receiving bay and immediately before pasteurization; plate heat exchangers; microfiltration or reverse osmosis filtration equipment; any open vats or vessels, including cheese vats and blending or mixing vats; evaporators; scraped surface heat exchangers; filling equipment in wet milk filling operations; and other specialty equipment that may run for extended periods between cleaning cycles. In each case, biofilm formation is a threat, and it is critical to sample both upstream and downstream of the equipment to afford the ability to determine if biofilms are developing on internal surfaces.

Thermoduric and thermophilic vegetative organisms and their endospores are found frequently in dairy products, including milk powders. Single-species and multi-species biofilms formed on milk contact equipment surfaces are a primary contributor to pathogenic and spoilage organism bioburden. These biofilms are difficult to remove from milk processing environments and, if allowed to mature,

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Beyond the Basics

Five commonly overlooked areas in food processing facilities that can attract pests

BY **MARC POTZLER**

"Pest infestations" are words likely to cause angst among quality assurance (QA) managers and food and beverage processing operators. Due to the nature of their operations, food and beverage processing facilities are viewed as "sweet spots" for pests, making them vulnerable to pest introductions and infestations. While this unavoidable truth is unfortunate, managers and operators can be better prepared for infestations and better protect their facilities against these pesky pests.

If left undetected and untreated, pest infestations can lead to significant health and safety issues for employees, financial losses from structural damage, production disruptions, and fines, as well as brand and reputational harm from negative backlash. QA and quality control (QC) managers work tirelessly to ensure that food and beverage plants set up and maintain proper sanitation policies to prevent pest infestations. Yet, if those policies do not cover commonly overlooked areas within the plant, it may only be a matter of time before an unwelcome guest seeks harborage inside the facility.

To better protect facilities from pest infestations, food processing operators should be educated on some of the commonly overlooked areas that can attract pests. To start, facility managers should think through these questions for their specific facility:

- Where is there potential for spilled food to accumulate?
- Where is it difficult to clean up these spills?
- What areas might the sanitation crew miss during their regular cleaning procedures?

Food processing areas and equipment sometimes have design flaws that can allow for pest infiltration and breeding; however, some solutions counter these design flaws using different sanitation techniques, tools, and structural changes. Understanding this, plant managers should look at these five commonly overlooked areas that can lead to health risks and potential pest infestations and consider the solutions for each.

1. Tile Floors

Tile floors have the potential to harbor numerous pests and microbes due to the possibility of loose grout and broken tiles. Often, when a tile comes loose or grout gets eroded by cleaning compounds, moisture, and food debris build up. These areas can be difficult to clean and treat, making them common places for small flies to breed.

Floor tiles are also areas that are typically heavily cleaned and tend to remain wet for long periods of time. If a surface treatment is applied to the floor during the cleaning process, but the floor is left to air dry, or is not dried per the application instructions, then it can negatively impact the efficiency of the pest application.

Several solutions can help with these concerns. First, it is recommended to immediately repair any spots or areas that have broken or loose tiles or missing grout. Additionally, ensure that the floor staff and cleaning team are properly trained and are following the label

and application instructions for any products used on the floors.

Second, if within budget, plant owners may consider replacing tile flooring with a poured epoxy floor that extends partway up the walls to prevent many insect and pathogen development sites. This easy-to-clean solution comes with less repair and lower maintenance costs than tiles, which often need to be replaced and regrouted. If a facility decides on this option, make sure to prevent any equipment that is brought into the area from damaging the floor. If it needs to be mounted in place, make sure any penetrations are waterproofed so that water cannot seep into the flooring.

2. Cleaning Equipment

It might not be something that comes to mind when cleaning a food facility, but it is crucial to ensure that the cleaning staff is also cleaning—and replacing as needed—the cleaning equipment. Insects and pests can develop in an unkept broom, and flies will breed in Zambonis if they're not flushed out thoroughly.

Most cleaning equipment can be cleaned and reused until it wears out. Things that may wear out after many uses include brooms, mop heads, drain brushes, and web brushes. All of these should be cleaned and dried after every use. Mops may be stored with the mop side up, or hung up to dry after being rinsed. Mop buckets and Zambonis need to be emptied after each use and flushed with clean water. Broom butlers should also be cleaned and dried after each use.

3. Motor Housings and Compressors

Areas at risk of food dust buildup are also commonly overlooked when it comes to popular pest infestation sites. For processing plants with flour handling areas, any mounted devices in the vicinity of those areas will often have food dust buildup in and on them as they are typically hard to reach or not fully visible from the plant floor.

As flour becomes airborne, Hammermills—and all of the joints associated with the flour transport pipes—can accumulate dust and buildup. It's good practice to inspect these regularly and promptly repair any joints that are allowing food dust to escape and accumulate where pests may access it.

It's imperative for food processing facilities to prioritize proactive measures in maintaining the hard-to-reach, or sometimes forgotten about, areas.

A common quick fix is to use compressed air to blow dust away from these hard-to-reach areas. This is not sufficient to properly clean this type of equipment. Guards around motor housings may trap airborne food dust and need to be cleaned at a more frequent rate than the insect with the shortest life cycle that may infest that product (plan on six weeks or less).

Although convenient, compressed air often just moves food dust from one surface to another, harder-to-reach area. Placing a dust-proof cover over the motors is also not recommended as the motors need ventilation to avoid overheating. A good vacuum system is recommended to clean the space. The housings should be easy to remove for efficiency of cleaning, and a central vacuum system with long-reach extension tubes is a good investment.

4. Support Struts and Horizontal and Diagonal Surfaces

The support struts for the equipment should be designed with no voids or at least with no openings that can lead into the hollow parts of the machinery. Any spilled food that enters such a hollow area will be next to impossible to clean thoroughly, leaving room for insects to develop in that area. A similar situation applies around structural support beams: The bolts that hold the I-beam in place are not only difficult to inspect; they are also difficult to clean, allowing for food buildup.

Horizontal and diagonal surfaces can develop accumulations of food dust or pest evidence, which can contaminate surfaces below and even surfaces far to the side, depending on airflow. Regular cleaning schedules will depend on what the plant is processing and the likelihood of it becoming airborne during mixing or processing.

Clean overhead surfaces at least quarterly, but if food dust is in the air, plan on cleaning at least monthly. It is imperative to stay ahead of the development cycle of whatever pests may infest the products. Another helpful solution could be installing a hanging guard over sensitive areas or under potential contamination sources. This will help prevent contamination from conveyor systems and pipes that may sweat and motors that may drip grease, among other problems.

5. Conveyor Belts

Conveyor systems may have a buildup of organic material on the underside of the conveyor, providing a food source for fruit flies and cockroaches. Whether the conveyor is moving food or dishes, there has to be an easy and accessible way to clean and sanitize it. A less complex belt system would make for fewer areas to accumulate debris; however, this may not be feasible. A more realistic solution may be an access space that allows for power washing the belt as it runs its course.

Spots like this come down to routine inspection, cleaning, and maintenance to keep them from developing into pest feeding sites. Since small flies can complete a life cycle in a week or so in ideal conditions, so it's important to schedule downtime for cleaning these spots to stay ahead of that pest cycle.

It's imperative for food processing facilities to prioritize proactive measures in maintaining the hard-to-reach, or sometimes forgotten about, areas. If left unchecked, these surfaces can serve as breeding grounds for pests and other bacteria and viruses. Rigorous cleaning of equipment and thorough inspection of critical areas such as motor housings and conveyor systems are fundamental aspects of effective pest management strategies. By implementing preventive measures and adhering to consistent upkeep, food businesses can strengthen their defenses against pest infestations and uphold strict hygienic standards throughout their facilities.■

Potzler is a technical service manager and board-certified entomologist for Rentokil.

Draft a Compliant Food Safety Plan

HACCP has evolved, and so too have manufacturing processes, the supply chain, inspection systems, and documentation requirements

BY **ERIC GARR**

In late 2022, the World Health Organization (WHO) released its Global Strategy for Food Safety 2022–2030. The publication's underlying theme draws attention to a commendable vision: Try to ensure that all people, wherever they are in the world, can consume safe and healthy food. The WHO repeatedly refers to this goal as being a "basic human right."

Following this publication, the topic for the WHO World Food Safety Day 2024 was "Food safety: prepare for the unexpected." How prepared do processors need to be? What role do modern inspection systems, technology, and software features play in protecting consumers worldwide?

Several decades ago, food safety management programs were generally reserved for the very largest food manufacturers. Many recognized just how far news of a recall can spread and how extensive the brand damage can be. Today, retailers, legislation, and prolific consumer awareness drive the food safety agenda.

HACCP Safety Takes Off

The earliest conception of a food safety management system came about in 1960s America. A team of food scientists, Pillsbury engineers and the U.S. Army collaborated with NASA to build quality checks that would ensure that the food on space expeditions was safe and pathogen-free. During the 1980s, WHO published their first report on hazard analysis and critical control points (HACCP) systems, recommending their implementation in food manufacturing. This food safety mindset slowly began to infiltrate food production plants and, by 2006, HACCP became a legal requirement.

During this time, some of the largest superstores began to exert their influence, starting a snowball effect that saw the profile of contaminant detection increase significantly. With retailers now insisting on frequent food safety audits, manufacturers are required to demonstrate their constant adherence to food safety principles.

Today, consumers expect contaminant-free food. Over the years, work has been diligently going on to document, plan, and ensure that food safety is not compromised. Consistently high standards of food safety must be kept throughout the entire food supply chain. The industry is not relying on simple quality checks anymore. Preemptive, preventive measure controls, corrective actioning, accurate and regularly updated documentation, and inspection systems all play their part in this new era of food safety.

The Who's Who of Food Safety

Although many retailers and auditing and inspection standards refer to HACCP planning, USDA and FDA only mandate these in meat, seafood, and juice production. Hazard analysis and risk-based preventive controls (HARPC) planning was introduced in 2015 to meet part of the Food Safety Modernization Act (FSMA) Preventive Controls for Human Food rule. Generally, all food facilities in the U.S., by law, must adhere to the Preventive Controls rule. This means that they need to have a HARPC plan.

So where does this leave HACCP plans? Do they connect? Is HARPC more robust than HACCP? What does the law recognize? Where does the WHO Global Food Safety Strategy 2022–2030 fit in?

HARPC planning presents a comprehensive food safety management system. It also aligns with WHO's food safety goals, placing greater emphasis on science-backed, risk-based preventive controls, and promotes the idea of food safety being a shared responsibility throughout the entire supply chain. Its primary aim is to significantly reduce, prevent, or eliminate identified hazards that are either previously acknowledged or reasonably foreseeable.

Similarly, the WHO Strategy outlines five key interconnected, scientific-backed priorities: implementing stronger national food safety control systems; utilizing food safety systems to identify and respond to food safety challenges; increasing use of scientific evidence and risk assessments in decision making; involving stakeholder engagement in risk communication; and promoting food safety as an essential component of trade.

Rate Your Risks

Traceability is a key element in WHO's global food safety initiative. Inspection systems such as metal detection and X-ray mitigate the risk of physical contaminants while simultaneously increasing traceability and reducing the likelihood of a recall.

HACCP planning focuses on critical control points (CCPs), of which inspection systems play a large and very essential role; however, in HARPC planning, risk prevention in North America now extends beyond CCPs; food manufacturers are required to rate the risk of their identified and reasonably foreseeable hazards by severity and likelihood. From this, control measures should be implemented to prevent, eliminate, or reduce the hazards to an acceptable level. This can include the addition of an inspection system.

To illustrate this point, most food production lines use metal in their equipment, tools, and processes. This presents a high probability of metal contaminants entering the production line. An end-of-line metal detector can be used as a preventive control measure in this instance.

Traceable Documentation

A well-established documentation system forms an integral part of food safety. Documents must be maintained and stored safely to comply with the Preventive Controls rule.

FDA and FSMA require that food manufacturers keep a written record of their entire HARPC plan, including the process, proof, and problems. Preventive control monitoring records, corrective actions, inspection system performance validation tests, auditing and inspection results, the recall plan, supply chain program, and certificates relating to food safety must be documented and up to date.

Digitizing record-keeping eliminates many of the cumbersome functionality concerns food manufacturers usually encounter with paper records. Processes that have largely been paper-based can utilize digital record keeping as a fundamental step toward building a sturdier supply chain and reporting process.

Defining the Future

Just as history has shaped and enshrined today's food safety rules, the unprecedented combination of processing pressures, trends, and supply chains has the potential to enhance or disrupt the safety of our foods. Processing and planning systems need to keep pace.

Changes to food safety concepts, including the WHO food safety plans, are largely driven by U.S. legislation. Most countries' legislative frameworks are now merging into things that look very similar to FDA and FSMA standards, creating a road map that modernizes farm-to-fork food safety systems, pursues continuous improvements, and bolsters collaboration.

HACCP has evolved, and so too have manufacturing processes, the supply chain, inspection systems, and documentation requirements. By continuing to work closely together, food manufacturers, machinery suppliers, production staff, retailers, and consumers can shape how modern businesses cater to food safety demands. Future food safety improvements are largely dependent on this level of cross collaboration.■

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Unlock Your Potential *(Cont. from p. 14)*

your organization's problems, potentially being an active resource and toolbox for future talent needs."

Ambitious food safety leaders must also embrace continuous learning and improvement. As foodborne pathogens evolve and the environment changes, science provides new insights. It is imperative for future food safety leaders to stay current on the latest trends, technologies, tools, and best practices to continuously improve their knowledge and skills.

The Power of Networking

A key strategy for career advancement is networking. Building a strong network of industry professionals and participating in professional organizations will help you stay informed of emerging trends and opportunities.

Networking allows professionals to connect with industry peers, experts, and potential employers, expanding their professional contacts and career advancement opportunities. By attending industry events, conferences, and networking functions, professionals can build relationships, exchange ideas, and stay informed about emerging trends and opportunities in the food safety sector. "Networking can also help professionals access hidden job opportunities, referrals, and recommendations from within their professional network," Hernandez says. "By building strong relationships with industry, academia, and regulatory contacts, professionals can increase their visibility, credibility, and chances of securing job interviews and career advancement opportunities."

Hernandez also suggests that aspiring leaders seek mentorships with seasoned professionals. "Mentors can offer career advice, feedback, and support to help professionals set goals, make informed decisions, and navigate career transitions in the food safety sector," he says. "They can also provide valuable insights into industry trends, job opportunities, and professional development pathways."

When deciding on the perfect job in food safety, Dr. McEntire suggests talking with many people in food safety and adjacent fields to learn about their career paths and current roles to determine what's most interesting.

Ultimately, food safety professionals should carefully assess these factors and conduct thorough research to select a food sector that aligns with their interests, goals, and values, setting the stage for a rewarding and satisfying career in the food safety industry. ■

Quality

Cannabis-Infused Foods

How F&B processors meet food safety guidelines and quality indicators for these increasingly popular products

BY **KEITH LORIA**

While cannabis-infused foods are not yet legal at the federal level, an increasing number of states allow for edibles, beverages, and other foods that contain THC and CBD as ingredients.

As cannabis becomes legal in more and more states across the U.S. and as the U.S. Drug Enforcement Agency (DEA) moves to reclassify it as a schedule 3 substance—a move that would make it a less dangerous drug but would not legalize it for recreational use—food manufacturers need to ensure that their production practices are sound and validated. It's vital for these companies to meet food safety guidelines and focus on quality when creating new products.

Kathy Knutson, PhD, a food microbiologist, chair emeritus of the education committee for the National Cannabis Industry Association, and president of Kathy Knutson Food Safety Consulting, is seeing more cannabis beverages in the market as consumers grow more comfortable with drinking those products. However, edibles remain the primary focus for most manufacturers. "Really, any food could be an edible," she says. "In Canada, meat products are now allowed. I've heard about ice cream, taffy, popcorn, chocolate, and many savory bakery products. There's a lot of work being done on the food side."

While she appreciates the entrepreneurial spirit in the industry, she notes that food safety may not be the first thing manufacturers think about when creating and releasing their products. "My colleagues and I are always pushing those in the cannabis industry to have a dedicated quality manager and for the company to recognize how important it is to implement quality management systems and build a savvy food safety plan," Dr. Knutson says. "Everything that's expected of the food industry should be expected in the cannabis industry."

Roberta Wilson, co-founder of California-based cannabis edible company Dr. Norm's, which manufactures brownies, cereal treats, and cookies sold at more than 300 compliant California dispensaries, understands the importance of adhering to all food safety regulations. "Being a cannabis-infused food company does not in any way alter the way we operate compared to a traditional food company," she says. "All of our employees have to go through food safety training and adhere to all applicable regulations."

She explains that cannabis-infused food products have food safety standards and regulations that are even more stringent and challenging to comply with than traditional food safety regulations.

Chad Frey, owner of a Washington D.C.-based cannabis-derived consumer goods company, notes that he takes food safety very seriously. "We're constantly staying at the forefront of R&D, new scientific developments, and leading studies with universities to explore adverse effects," he says. "We utilize existing food safety regulations and third-party analytical testing with DEA-registered labs. This ensures that the labeling of products matches the accuracy in potency and packaging."

Compliance Challenges

Pat Bird, cannabis lead for bioMérieux, a diagnostics company that provides food quality and safety testing solutions for the cannabis food and beverage industries, notes that one of the most concerning issues with the cannabis industry is the lack of consistent and standardized measures for ensuring compliance with food safety regulations. "Good manufacturing procedures, risk analysis, and hazard controls have been a part of food testing for over two decades, and these principles are not universally adopted within the cannabis industry," he says. "This can lead to products produced in facilities without proper environmental monitoring programs and using production practices that are not sufficient to protect consumers from contaminants."

He says that infused product testing is often performed by compliance laboratories that lack the experience and expertise to fully analyze food products. "The expertise required to navigate inherent challenges associated with commonly infused food matrices (chocolate, gummies, beverages) is not always present in compliance testing, as labs are built quickly with a focus on flower analysis," Bird says. "As more complex matrices are introduced, methods must be further validated to obtain accurate results."

Different Protocols

There are several differences in food safety protocols between traditional food processing and cannabis-infused food production. "The biggest difference with cannabis versus traditional food manufacturing is that weight would not affect food safety in traditional manufacturing," Wilson says. "In cannabis, since weight determines the dosage of the product, we have to be meticulous about weighing every single piece of edible we manufacture to ensure that it is the stated dosage, making it 'safe' for consumption."

The law provides for a 10% variance in dosing, which requires adherence to very rigid manufacturing practices involving weighing every piece of product before it gets packaged for distribution. In traditional food manufacturing, only package weight needs to be adhered to.

Another main difference is that within the food industry, testing is performed from farm to fork. "Raw materials, environmental monitoring, and finished products are all evaluated in a risk-based approach to minimize the chance that hazards may be present," Bird says. "For cannabis-infused products, only the minimal required compliance testing on finished product is performed, which can increase public health risks associated with contamination from the environment or in the raw materials of the product."

Lab testing required by law in cannabis also screens for pesticides, heavy metals, and other harmful substances that traditional food testing is not subjected to. If products fail lab testing, the entire batch becomes unusable.

While regulations differ among states, manufacturers need to understand the basics to ensure they are compliant. "It is very challenging to navigate the regulatory landscape in the cannabis business," Wilson says. "The regulations are different in every state, making it like setting up an entirely new business in every state. I can't think of a single other industry where this is the case."

Navigating the patchwork regulatory landscape can be very difficult for food manufacturers. "Multi-state operators—producers active in more than one state—often implement separate QA programs at each facility, which adds complexity to managing from a corporate standpoint," Bird says. "These groups often rely on a senior regulatory advisor to help with navigation, but these individuals traditionally have a cannabis background, not a food safety background. This process helps ensure compliance with regulations but can result in less focus on implementing traditional food safety procedures."

> Everything that's expected of the food industry should be expected in the cannabis industry.
>
> —KATHY KNUTSON, PHD

Thankfully, in many states, cannabis commissions will directly engage with manufacturers to proactively work toward better production and quality procedures.

Working with Suppliers

It isn't uncommon for manufacturers to find issues working with suppliers because cannabis is still federally illegal. "We have had issues with being able to buy directly from large suppliers through wholesale accounts, as they don't want to sell to cannabis companies," Wilson says. "As such, we are forced to buy most products at retail. This is a huge issue with COGS, as they could be much lower if purchased through wholesale agreements."

Dr. Knutson notes that while a few big players deal with everything in the supply chain the same way as normal food companies, the majority of cannabis manufacturers are still very small, operating more on the level of a restaurant kitchen or a pilot plant with small production. "So it's a different scenario, and these companies are more likely to go to big box stores to get their ingredients," she says. "That's more common. Every cannabis company is still doing their product development and fine-tuning recipes, and flavors are evolving. They don't have the consistency of purchasing, but that will change as the companies grow."

What's Ahead

Cannabis-infused producers that fail to invest in a strong QA plan often have the most difficulty producing consistent and safe products.

Bird notes three goals that can help producers overcome pitfalls: identifying a manufacturing director with experience in food production; increasing quality control testing of raw materials and finished products beyond the bare minimum compliance requirements; and establishing robust environmental monitoring programs.

He believes a singular standardized approach that incorporates many of the GMPs from pertinent industries (dietary supplements, food, pharma), while establishing guidance specific to the cannabis industry, will help streamline how companies can manufacture safer products for consumers in the future.

Even with the potential for federal legalization of cannabis-infused foods in the future, many predict food safety regulations won't change for what will become a larger market. "It would just mean much greater ease of manufacturing product in one central location with the ability to sell it across state lines," Wilson says. "Scaling up in a central manufacturing facility would pose the same issues as any traditional food manufacturing facility in adhering to food safety regulations."

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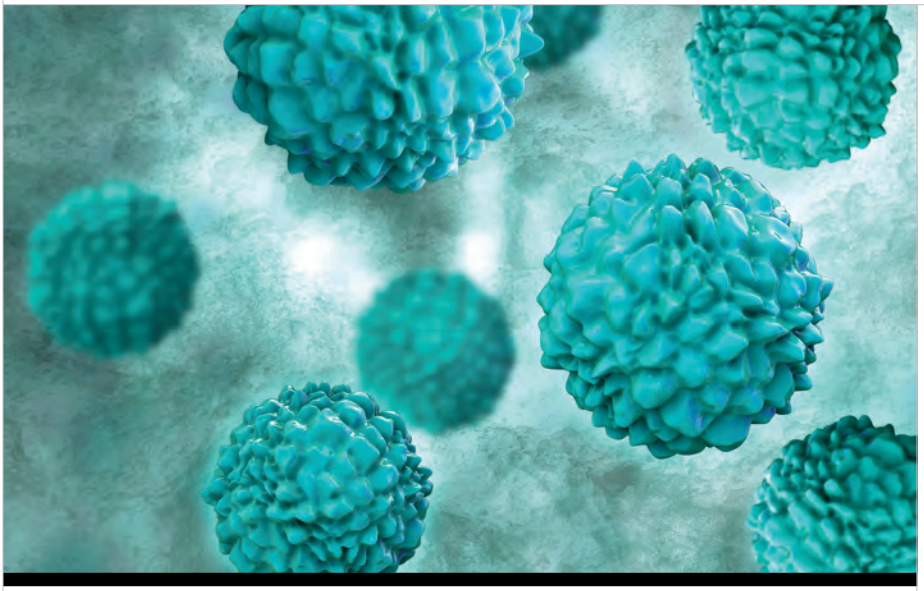
In the Lab



Gone Viral

Foodborne viruses pose unique challenges for prevention, mitigation

BY LORI VALIGRA

Foodborne viruses can be tough to prevent and mitigate. Some can't be cultured, so they are difficult to analyze. Others aren't affected even by strong disinfectants, so intervention is ineffective. In the past decade, an additional virus, hepatitis E, joined norovirus and hepatitis A as a top three concern for human food safety.

To tackle these challenging foodborne viruses that can cause serious human illnesses, the Food and Agriculture Organization of the United Nations and the World Health Organization (FAO/WHO) are holding a series of meetings focused on microbial risk. The first Joint FAO/WHO Meeting on Microbiological Risk Assessment (JEMRA) convened in September 2023 in Rome and focused on foodborne viruses of top concern for public health, analytical methods, and contamination indicators. The second meeting, which took place in February 2024 in Geneva, discussed prevention and intervention measures for these viruses. A third meeting is planned for later in 2024 and will focus on evaluating risk.

The final reports for the first two meetings are still in progress, with only summaries released so far. Experts involved in the meetings said significant advances have been made in the study of foodborne viruses; these have helped researchers understand the science of viral mitigation since the inaugural JEMRA meeting 16 years ago, a milestone event that was the first time the issue of viruses in foods was brought to international attention.

"We have improved norovirus surrogates and ways to study human norovirus, and we have better detection methods, like digital PCR," says Kalmia Kniel, PhD, associate chair of the department of animal and food sciences at the University of Delaware in Newark. She adds that thermal treatments are often relied on to inactivate viruses, but there are promising non-thermal technologies being studied, including cold plasma, chlorine dioxide, and some chemical disinfectant combinations.

The Biggest Threats

Dr. Kniel chaired the 2023 meeting and was a member of the expert committee that reviewed recent scientific developments, data, and evidence associated with foodborne viruses. JEMRA will update and provide scientific advice to the Codex Committee on Food Hygiene, which requested the series of meetings. The Codex committee will use the information for its international recommendations and standards. The expert committee also considered trade implications of possible standards to ensure that food safety does not become a trade barrier.

In reviewing viruses associated with human foodborne illness, the expert committee identified human norovirus as the leading cause of viral foodborne illnesses, followed by hepatitis A and hepatitis E. The ranking considered the frequency of illness, the clinical severity of the disease, and the food most often linked to the virus; however, while hepatitis A and hepatitis E were ranked equally behind norovirus in terms of frequency, they were higher than norovirus in terms of clinical severity. The committee lacked sufficient data to rank other viruses, including rotavirus and sapovirus.

In terms of the foods most associated with the viruses as a potential public health threat, prepared food, frozen berries, and shellfish—in that order—are associated with norovirus. For hepatitis A, linked foods are shellfish, frozen berries, and prepared foods. Those two viruses are transmitted via contamination by feces exposure. For hepatitis E, a zoonotic virus, pork and wild game are associated, and the virus is transmitted from animal to human.

The committee considered only water used in food production, in processing,

in preparation, or as an ingredient, not water intended only for drinking, in its assessments.

Viral foodborne disease has a substantial impact on morbidity and mortality globally, but surveillance data is sparse, and there is the potential for asymptomatic shedding, so it is difficult to craft prevention and control strategies.

Norovirus causes about 125 million cases of foodborne illness and 35,000 deaths worldwide annually, according to the committee's summary, including severe outcomes such as hospitalization and death, especially in children younger than five years old, the elderly, and immunosuppressed people, who may shed the virus for extended periods. Hepatitis A causes about 14 million cases of foodborne illness and 28,000 deaths each year globally, but there are significant regional differences attributable to endemic prevalence, vaccine use, and international food trade. There are no global estimates for hepatitis E, which can damage the liver, the meeting summary said.

"The JEMRA committees discuss foodborne viruses in a global context," Dr. Kniel said. "We need to keep in mind that our food system is global in nature, which means we need better surveillance of viruses in all countries in order to help each other."

Dr. Kniel said that since the 2008 JEMRA report, international and national standard methods have been developed and validated to detect and quantify human norovirus and hepatitis A virus in foods. Methods released since that report include the International Standards Organization's ISO-15216-1:2017 and ISO-15216-2-2019. These are used widely to detect norovirus and hepatitis A in leafy greens, soft fruits, and shellfish, and as a benchmark to validate new methods, the committee's summary said. There is no ISO method for prepared foods. Methods to detect hepatitis E in meats are under development.

The committee said infectivity assays are needed for wild-type viruses, as there still is no definitive way to tell infectious from noninfectious viruses using molecular amplification.

It recommended that countries consider building capacity to help with adopting and training in methods for detecting viruses in foods and the environment. "Appropriate global actions will help alleviate the anticipated increase in public health risk from viral foodborne illness arising from population growth, the climate crisis, and globalization of food supply chains," the summary from the 2023 meeting said.

Table 1: Foodborne viruses and foods of highest public health concern

Norovirus	Hepatitis A	Hepatitis E
1. Prepared food	**1.** Shellfish	**1.** Pork
2. Frozen berries	**2.** Frozen berries	**2.** Wild game
3. Shellfish	**3.** Prepared foods	

Source: FAO/WHO.

Prevention and Mitigation

Prevention is the preferred focus now, given the difficulty and expense of mitigating infected foods, says Lee-Ann Jaykus, PhD, rapporteur of the March 2024 meeting and a member of its expert committee. She says the viruses are not culturable organisms and cannot be grown in a lab like bacteria can, nor can they be culturally enriched. There is no host cell in a culture with which to propagate them. It's necessary to concentrate and purify them from a sample and use reverse transcription polymerase chain reaction to detect the viruses. "We have standardized methods to detect these viruses in selected commodities, but they have some inherent disadvantages because of the limitations of not having a culture," Dr. Jaykus says.

Limitations include the fact that even when a viral nucleic acid is detected, it doesn't necessarily mean there is an infectious virus, she said. Real-time polymer chain reaction (RT-PCR) is a complicated method, and it is easy to lose viruses in the first steps, so it is not as sensitive as needed. "These are limitations not because the science is bad," she says. "The science is the best it can be as it currently stands. There are limitations because we can't grow these things."

One focus of the second meeting was contamination routes for the virus to humans. Fecal matter and vomit from infected humans are the primary sources of contamination for norovirus and hepatitis A to get to humans through affected waters, food handlers carrying the viruses, and surfaces, because the viruses can live for weeks on surfaces, Dr. Jaykus says. The zoonotic hepatitis E virus is present in the meat, organs, tissues, and excretions of infected swine and game animals and gets transmitted through exposure.

Because the viruses persist in the environment for long periods and are resistant to many treatments, prevention is the key strategy to control foodborne viruses, Dr. Jaykus says. One example of prevention is reducing the viral load in shellfish by treating wastewater, but that requires infrastructure investment. Another is using production-related strategies to reduce contamination of fresh and frozen produce. Virus inactivation methods also are under investigation.

The committee recommended some directions for future research and development, including early identification of contamination hot spots using wastewater surveillance, for example, and technologies such as satellite imagery and hydrographic dye studies to predict virus dispersion. It also recommended using emerging scientific data to develop surface disinfectants and hand sanitizer formulations with greater efficacy against environmentally stable viruses. After all, hand sanitizers were effective in reducing transmission during the COVID-19 pandemic.

"Following up on the COVID-19 pandemic, it is critical that we launch surveillance studying the health of animals, humans, and the environment to identify important zoonotic viruses before the next pandemic," says Dr. Kniel, who, like Dr. Jaykus, was surprised to see the hepatitis E virus added to the list of top foodborne virus concerns since the inaugural JEMRA meeting 16 years ago. "It is frustrating to continually talk about the need for better surveillance to better understand foodborne virus transmission and the attribution of disease to a specific virus." ■

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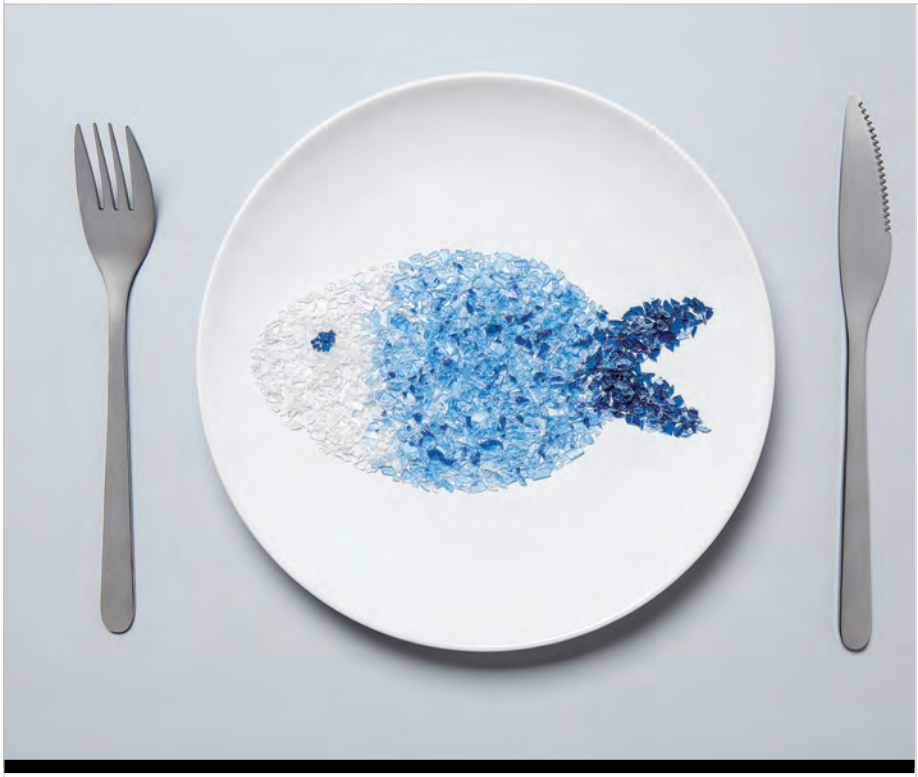


Microplastics In Food

The research on microplastics contamination in food and its toxicity in humans is relatively new. What do we know?

BY **ANDREA TOLU**

In February 2024, a group of Canadian and American researchers published a study in the journal *Environmental Pollution* that analyzed the presence of microplastics in 16 protein-based foods commonly found in supermarkets (*Environ Pollut*. 2024;343:123233). The products included plant and animal proteins from both marine and terrestrial animals and with different levels of processing, such as breaded shrimp, Pollock fillets, chicken nuggets, pork loin chops, plant-based nuggets, and tofu.

The analysis found microplastics contamination in all sampled foods, with no significant difference between animal and plant-based proteins. Another takeaway was that more processed products, such as chicken nuggets and tofu, contained more microplastics particles than those with minimal processing, such as Pollock fillet or pork chops.

The correlation between levels of processing and microplastics contamination is not surprising. As Madeleine Milne, PhD, a researcher at the University of Manitoba and co-author of the study says, "as food goes through additional processing steps, there might be more opportunities for contamination from microfibers of synthetic polymers used for workers' clothing or rubber pieces from conveyor belts."

This study is not the first one indicating microplastics contamination generated in food processing environments. In 2001, in Japan, a research study found that the levels of phthalates in retail packed lunch meals substantially decreased after PVC (polyvinyl chloride) gloves containing DEHP (a common phthalate plasticizer) were banned during production and cooking processes (*Food Addit Contam*. 2001;18:569-579). In 2020, researchers from the Instituto Politécnico Nacional in Mexico analyzed milk samples and found microparticles of sulfone polymers, which are commonly used for membrane materials in dairy processes (*Sci Total Environ*. 2020;714:136823).

Microplastics contamination in food products creates a potential new food safety risk for manufacturers, especially when one of the pathways is the very processing environment they are responsible for; exactly how to manage that risk is something researchers are still trying to determine.

Worrying Signs

One of the main questions about microplastics is their actual toxicity. "Humans have been exposed to different types of particles for thousands of years; they ingest them and digest them without anything bad happening. We don't know yet whether microplastics are any different," says Mohamed A. Abdallah, PhD, associate professor in persistent organic pollutants and emerging contaminants at the University of Birmingham in the U.K. and a member of the Birmingham Plastics Network, an interdisciplinary team of experts aiming to address the global plastics waste problem. "We still don't have a full understanding of the toxic implications of human exposure to microplastics, and we haven't been able to establish a toxic dose level (TDL), which is the lowest dosage known to have produced signs of toxicity. We have reasons to worry, though."

One of those reasons is the small size of microplastics, which allows them to potentially reach any corner of the human body. Most microplastics are the product of the breakdown of plastics into smaller particles. Their size ranges from one micrometer (one thousandth of a millimeter) up to five millimeters. "Current findings are focusing on microplastics in the smaller size range, less than 50 micrometers, which can be carried around by blood and accumulate in organs," says Dr. Abdallah. "Microplastics were found in tissues, bones, genitals, and there are even indications that

they can cross the cerebral spinal barrier and reach the brain."

The very presence of these extraneous particles in the human body may be reason for concern: "There have been studies on mice pointing to microplastics as a cause of myocardial toxicity," says Susanne Brander, PhD, an associate professor in the College of Agricultural Sciences at Oregon State University in Corvallis, who focuses on endocrine disrupting compounds and microplastics in aquatic organisms. "The hypothesis is that these particles could interfere with cell function and cause muscle tissue inflammation."

Another potential source of toxicity are the additives used to give plastic certain attributes, such as color, texture, or flexibility: "A lot of those chemicals, bisphenol A for example, have been shown to be endocrine disruptors, which means they can bind to hormone receptors on cells and disrupt the messaging that happens between them and organs," says Dr. Brander.

The damage that these plastic additives cause to human health are well known. In 2022, a research study published in the US was able to quantify the societal costs of cardiovascular mortality associated with phthalate exposures to at least $39 billion per year (*Environ Pollut*. 2022;292:118021).

Growing Pains

In fact, the research on microplastics contamination in food and its toxicity in humans is relatively new. It evolved from the study of plastic pollution in marine environments and then in fish. "Up until a few years ago, most of the studies were focused on the occurrence of microplastics in oceans and in waterways. Funding sources for research focused on humans have just started to materialize. If you got a grant, and it's a three-year or five-year grant, you're probably still working on it," says Dr. Brander.

A significant issue confronting research on microplastics in food is measurement techniques. Measuring the content of microplastics typically goes through three stages: chemically digesting the sample, removing the food part, and using microscopy and spectroscopy to identify and count the particles. Currently, however, there is no standard method for measuring microplastics. "The protocol is well established, the problem is, it takes a lot of time and it's a very intensive and expensive process due to the labor that's required. One sample has been estimated to take up to 60 hours from start to finish," says Dr. Brander.

"A lot of labs are trying to figure out how to reduce the manual labor of having to look under a microscope at samples and pick particles. But until then, it will definitely be a challenge, because each measuring method has its benefits and limitations. Some techniques can only measure larger microplastics, while others can examine smaller particles," says Dr. Milne.

Because not all techniques are available to all researchers, the size range of microplastics they investigate might be limited by the instrumentation they have access to. These limitations make it difficult to compare results of different studies: "If a hypothetical study on fish found 50 particles of microplastics in a sample and another one found 100 particles, you couldn't simply say the second one was more contaminated, because they may be measuring completely different size ranges," says Dr. Abdallah.

Once these issues are resolved, however, the progress on microplastic detection will pave the way to the study of nanoplastics, whose size can be as small as a nanometer, which is the thousandth part of a micrometer. Nanoplastics are still a largely unexplored side of plastics contamination: "They're the next frontier and one of the biggest challenges," says Dr. Brander. "We know that they're there, and the technology to quantify them is improving, but it's still expensive and it's not available to most labs that work on microplastics."

Reducing Microplastics in Food

Food safety regulations and standards don't yet have any specific requirements around microplastics—this may change in the future. "Microplastics in food products is a rising concern among both food manufacturers and the public," says Bosco Ramirez, senior director of the North American Laboratory Division of NSF International, a global certification body for food safety schemes. "Hopefully, as research progresses and methodologies improve, specific requirements for microplastics will be introduced to existing food safety standards. It's also possible that new standards or government regulations will be developed. Collaboration among experts, industry stakeholders and regulatory agencies will be key in deriving robust methodologies to detect and quantify microplastics."

Right now, there's not a lot that food companies can do to tackle the issue of microplastics contamination directly: "A lot of food and non-food companies are concerned about whether they're inadvertently generating microplastics or are using materials that contain microplastics," says Caroline Potter, VP of sustainability at Sagentia Innovation, an R&D consultancy based in the U.K. "But if you find microplastics contamination in a food processing environment, it would be very difficult to understand how much of it came from the processing line, from water, from air pollution, or from the people working in the facility. And without knowing that, it would be very difficult to take precautionary measures."

The best strategy for food manufacturers is to reduce the use of plastics across the board: "Part of the problem is coming from plastic packaging and the way it's mismanaged after use, which leads to the breakdown that generates microplastics," says Potter. "Food companies should definitely look at using alternative materials or use plastic packaging designed in a way that it can be easily recycled, so that it won't make its way into the environment."

The problem, however, is more nuanced, Potter adds. "Sustainability isn't just one thing. Plastic leakage is an important aspect, but companies are also looking at their carbon footprint, and with plastic being a very lightweight material, it can be the lower carbon footprint packaging option in some cases. When evaluating the alternatives, our advice is to try and balance all the different sustainability trade offs, whether it's carbon footprint, water usage, or impact on biodiversity. There's no point in finding a solution that has a better impact in one area of sustainability, just to have a worse impact on another."■

Tolu is a freelance writer based in Barcelona, Spain.

Supply Chain Instability

How software can help tackle continued disruptions to the global food supply chain

BY **ERIC LINXWILER**

Disruptions and instability are becoming the new norm for the food and beverage supply chain. The supply chain has been rocked by recent geopolitical tensions, most notably the Russian invasion of Ukraine, which has led to a dramatic reduction in the availability and affordability of essential commodities such as wheat and sunflower oil.

The situation is further compounded by ongoing attacks by Houthi rebels in the Red Sea, which have disrupted one of the world's most crucial shipping lanes, exacerbating the challenges posed by the Ukraine conflict and recent shipping disruptions in the Panama Canal, where cargo has been limited by low water levels. All of this has caused a notable increase in delivery times and transportation costs.

These disruptions underscore the urgent need for a more agile and resilient approach to supply chain management. To mitigate these risks, food and beverage retailers should diversify their sourcing and logistics strategies, reducing dependence on volatile regions. Digital supply chain solutions, such as real-time tracking and predictive analytics, have become essential for proactive risk management. These technologies enable companies to anticipate disruptions and reconfigure their supply chains dynamically, enhancing transparency and resilience in their operations. Additionally, building stronger relationships with a diverse range of suppliers and logistics partners can provide alternative options when usual channels are disrupted.

With real-time data sharing capabilities and predictive analytics, multi-enterprise supply chain platforms allow companies to swiftly respond to these challenges. The right platform can enable companies to quickly adapt to changing circumstances, such as finding alternative suppliers or rerouting shipments in response to geopolitical sanctions or natural disasters. These capabilities are important for all businesses, but given the delicate nature of the global food supply chain, having a centralized system that provides complete, real-time information is even more critical for food and beverage retailers.

This technology helps food and beverage retailers mitigate disruptions by enhancing visibility and control throughout the supply chain, enabling companies to quickly adapt to and manage disruptions and ensuring minimal impact on operations. A multi-enterprise platform acts as a control tower, providing supply chain managers with real-time insights and analytics that empower them to understand, assess, and swiftly respond to any disruption and limit its impact.

Resilience Amid Turbulence

In addition to gearing up to make the supply chain more resilient and agile, retailers and manufacturers must also consider evolving consumer expectations regarding sustainability and ethical sourcing. Consumers are increasingly aware of and concerned with the environmental impact of their food choices.

Additionally, regulatory changes aimed at both food safety and environmental impact are demanding increased vigilance and adaptability from companies. For instance, the European Union's new deforestation regulation requires manufacturers to prove that commodities such as coffee, palm oil, and cocoa are not linked to deforestation. These changing consumer preferences and regulations have introduced additional complexity to supply chains, necessitating that food and beverage retailers invest in robust traceability solutions.

This heightened focus on sustainability is particularly consequential for food and beverage retailers, where confirming the nth-tier origins of ingredients like spices is especially demanding. Any required changes, such as addressing deforestation, reducing carbon footprint, or complying with regulations concerning specific regions like China's Uygur region, necessitate a thorough validation of all downstream suppliers. Efficient digital tools are required to conduct all necessary audits and certifications to ensure that a company's standards of social and environmental sustainability are met at every stage in the supply chain.

(Continued on p. 35)

Supply Chain Instability (Cont. from p. 34)

A robust supply chain management platform with traceability tools allows businesses to map their supply chains down to the nth-tier and track and document chain of custody, ensuring compliance with global environmental, social, and governance (ESG) laws and consumer expectations. Moreover, a comprehensive approach to supply chain management helps companies maintain quality and sustainability standards even amid rapid market changes and supply chain disruptions. This approach ensures that companies can adapt to evolving market demands while maintaining their commitment to sustainability and ethical practices.

If recent disruptions have taught supply chain managers anything, it's to expect the unexpected. Disruptions in the Red Sea shipping lane are predicted to continue well into 2024, with no signs of the attacks abating, further emphasizing the need for agile, technology-driven strategies that can adapt to the unforeseen. Multi-enterprise platforms offer invaluable resources in this volatile environment, providing companies with the means to effectively manage uncertainty, maintain sustainability efforts, and guarantee the continuous delivery of staple foods that consumers depend on. ■

Linxwiler is senior vice president of TradeBeyond, a software company based in Hong Kong. He has more than 30 years of experience in enterprise software and cloud-based service companies, with a specialty in supply chain optimization and workflow management..

Environmental Sampling (Cont. from p. 23)

can cause immeasurable damage to product safety, quality, and reputation, leading to disastrous economic consequences.

As Neil Bogart concludes, "From a practical viewpoint, a carefully conceived and well-implemented process monitoring program that allows managers to optimize and validate sanitation procedures and safely regulate plant operations is about the cheapest insurance money can buy." ■

Johnson is a biotech innovator with a 25-year tenure founding and developing companies to advance health technology. A trailblazer in HACCP application in the dairy industry, his early career focused on enhancing dairy safety and quality assurance. He holds advanced degrees in microbiology and biochemistry and serves on the board of directors of QualiTru Sampling Systems. Reach him at clarence@qualitru.com.

News (Cont. from p. 9)

old appeal to Congress for a framework enabling the sale of cannabidiol (CBD) as a dietary supplement and as a food ingredient. Currently, FDA believes it lacks the authority to pursue this course of action within its existing structure.

Califf addressed a U.S. House of Representatives oversight committee earlier this month and noted that FDA deemed hemp-derived CBD not sufficiently safe for lawful sale as a dietary supplement. He urged Congress to establish a pathway for regulating the substance.

Based on a recent report from the World Health Organization (WHO), CBD shows promising therapeutic potential in various trials, both controlled and open label, demonstrating good tolerance and a favorable safety profile.

The regulation of hemp derivatives, including CBD, has been a matter of concern since the legalization of its cultivation in the 2018 Farm Bill, predominantly crafted by USDA and ratified by Congress. Since then, the product has become widespread as a supplement and has also found its way into certain food and beverage items, despite FDA never officially declaring it safe as a food ingredient. "It's Congress's decision to make, so we would really look forward to work with you all as quickly as possible to come up with a regulatory pathway that you think is reasonable and enables us to take action," Califf said during his address.

James Comer, chairman of the House Committee on Oversight and Accountability, sent a letter to Califf on Wednesday in reply, stating it is imperative that FDA engages in this regulation quickly, safely, and efficiently to provide proper guidance to consumers about the safety of CBD products. "Without allowing for therapeutic CBD products to be regulated as dietary supplements such as melatonin or fish oils, the good faith actors in the industry are unable to enter the market and provide people with helpful products because they are currently not distinguished under the FDA from the intoxicating products containing Delta-8," he wrote, asking FDA for documents and information to enable oversight of the agency's actions.

Another issue gaining steam revolves around the national legalization of tetrahydrocannabinol (THC), the intoxicating component of marijuana, and its potential integration into food and beverage items. While some states where the drug is already legalized have incorporated it into food products, interstate transportation of such products remains prohibited.

Califf has gone on record declaring there is no justification for the Drug Enforcement Administration (DEA) to prolong its decision regarding the rescheduling of marijuana from a Schedule I to a Schedule III substance, thereby aligning it with medications such as acetaminophen and ketamine, rather than with substances like heroin and LSD.

"This is an area where I believe we would be better off if we had guidance from Congress about how to proceed," Califf said. ■

The Clear Contaminant *(Cont. from p. 21)*

infection. Alternative methods, such as carbon filter beds, work well temporarily, and then build up residue that needs to be cleaned. The unpurified water that is used to clean the residue can add new unwanted organisms, and chemical cleaning will not eliminate all of the bacteria. A plant can purify the water with UV disinfection to clean the residue, but then the question becomes why not eliminate redundancy and use UV disinfection to purify all water in the first place.

UV light purification systems are sophisticated mechanisms that remove all unwanted organisms from incoming water. In tubing, since UV can't hit water directly, a scraper can use a UV light to clean off any residue that builds up on the sleeve with a UV light. The systems last two years and are not prohibitively expensive; the cost of even just a few lost vats of cheese due contamination is higher than the cost of an entire system.

UV-based water disinfection systems can be custom-built to the size of the plant and designed to purify a specific type of water (i.e., water from the specific municipality or a well). Some plants use thousands of gallons of water per hour, allowing new contaminants to be introduced over and over. This systemic approach to purification is more consistent and reliable, even with large volumes of water.

Higher Rigor than Regulations

While FDA and other regulatory bodies have food safety standards in place, higher rigor is re-quired to prevent contamination from water. Water regulations are designed for potable water, and these standards don't translate perfectly to food production. What's more, manufacturers can take shortcuts—knowingly or unknowingly—and even regulations can't prevent a food safety issue when protocols aren't followed. To decrease the likelihood of missed protocols, UV light purification systems provide transmission numbers which take the guesswork out of water safety. Customers can obtain a UV transmittance (UVT) number to represent the purity of the water. A transmission number of 97 or 98 is excellent, whereas 92 or 93 indicates unsafe water with minerals and/or bacteria present.

Plants may use caustic sanitizer rinses to reduce contamination risks, install advanced air filter systems to prevent airborne contaminants, and follow all safe food handling procedures to the letter. Still, if water purification is forgotten, the facility is at risk for safety issues. Investing in the highest form of water purification can protect the integrity of the food supply, a producer's bottom line, and a company's reputation while giving consumers the benefit of safely enjoying the foods they love. ■

Funk is senior cheese technologist at Nelson-Jameson. As a dairy industry veteran with more than 40 years of experience, he provides customers with advice on ingredients, production processes, and manufacturing improvements to enhance cheese and fermented dairy product results. Reach him at s.funk@nelsonjameson.com.

NEW PRODUCTS

Custom Mixing System

Custom mixing systems from Indco are engineered to optimize processing projects including batch size, material properties, and agitation levels to achieve desired process results. The company can develop a mixing system that includes mixers and tanks from open-top designs to ASME jacketed vessels. Whether temperature is controlled to ensure viscosity of materials, to utilize heat as a catalyst, or for other reasons, jacketed tanks are often a crucial element of custom mixing system designs. The company can provide a fully integrated mixing tank and mixer design that includes tank jackets and other features such as polished and electropolished surfaces and dip tubes and drain valve designs. **Indco, indco.com**.

Industrial Camera

Opticom Tech is offering a CC04-IP5MV3 camera, an upgrade to the CC04-IP3MV camera. The new CC04 camera offers a higher resolution than its predecessor—5 megapixel compared to 3 MP. It also supports artificial intelligence functions such as object detection, intrusion detection, line crossing, and object counting. The camera is NDAA compliant, uses the ONVIF protocol and can withstand high-vibration, hazardous, and controlled environments. It can also withstand direct hits by logs, boards, rocks, and other objects, making it compatible for industrial facilities. **Opticom Tech, opticomtech.com**.

CO_2 Compressor

The HGX56 CO_2 T, provides a solution for industrial and commercial refrigeration, including cold storage, as well as for large industrial heat pumps. With a 6-cylinder capacity, customers can reduce the number of compressors in their system, resulting in lower system complexity and investment costs. With the approaching HFC phasedown and transition to natural refrigerants, the HGX56 CO_2 T transcritical compressor range is designed for demanding conditions with natural refrigerant R744 in commercial and industrial applications. The expansion to 6-cylinder capacity allows for a wider spread and faster uptake of large CO_2 heat pumps and industrial refrigeration systems. Additional benefits are low noise and vibration, a compact and lightweight design, and a minimal oil carry-over rate. **Danfoss, danfoss.com**.

COURTESY OF INDCO / OPTICOM / DANFOSS

X-Ray Inspection System

Eagle Product Inspection has launched a hygienically constructed inspection system designed to maximize product throughput while ensuring that safety standards are met. The machine is equipped with image analysis software, SimulTask PRO, and enhanced dual energy detector, PXT, to deliver bone and metal detection, reduce false rejects, and minimize operational challenges related to manual labor. Its dual lanes can run up to 120 pieces per lane per minute. **Eagle Product Inspection, eaglepi.com**.

Optical Sorter

Key Technology has introduced the Compass family of food optical sorters. The product helps processors automate and improve quality management of their food products. The system can sort processed, frozen, and pre-processed vegetables and fruits, nuts, leafy greens, potato chips, and other food products and can identify and separate plastic, glass, paper, and other organic and inorganic foreign material from the line. It can also sort specific product defects. The sorter is offered in a configurable range of system types and sizes and can be installed in line at the start of the process to sort incoming product, after critical transformational processes on the line, or at the end of the food processing. **Key Technology, key.net.**

COURTESY OF EAGLEPRODUCT/ KEYTECHNOLOGY / KHRONE

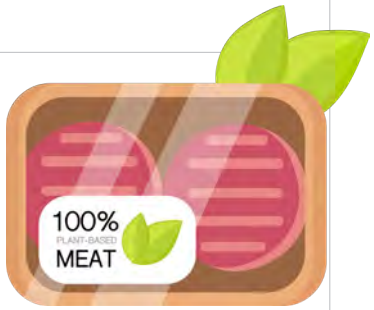
Capacitance Level Switch

The Optiswitch 6500 capacitance level switch from Krohne provides a minimally invasive solution for point level detection of liquids, liquid-liquid interfaces, and solids. One feature of the switch is its variety of available hygienic process connections. Unaffected by foam, condensate, or build-up, the product can be set to detect foam or even changes in media characteristics of the same liquid. The product is also resistant to CIP and SIP agents. The switch can be installed in any position and is fully compliant with FDA and EC1935/2004, in addition to being EHEDG and 3A certified. Typical applications range from small tanks in hygienic applications to tanks with tough, pasty, or strongly adhesive media. The product can also provide block prevention, overflow protection, dry-run, and pump protection in tanks. A range of detections, from interface detection to high and low-level detection to detection of foam, are all achievable with this hygienic switch. **Krohne, us.krone.com.**

SCIENTIFIC FINDINGS

For access to the complete journal articles mentioned below, go to "Food Science Research" in the June/July 2024 issue at foodqualityandsafety.com, or type the headline of the article into the website's search box.

Processing Technologies for Novel Synthetic Foods



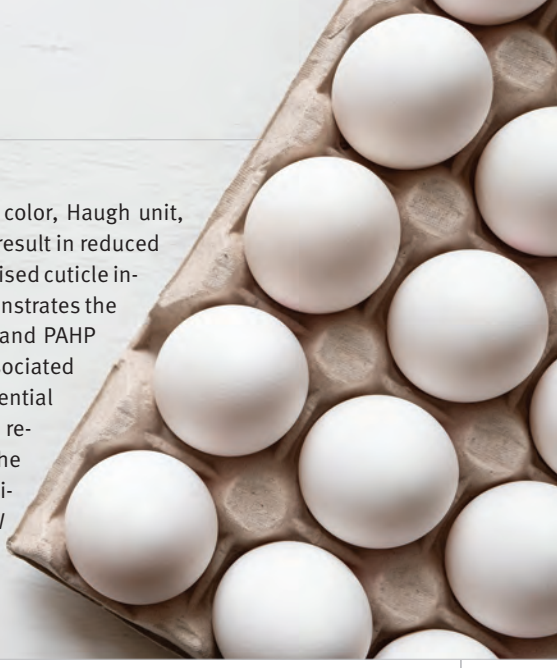
Nowadays, the food industry is facing challenges due to the simultaneous rise in global warming, population, and food consumption. As the integration of synthetic biology and food science, novel synthetic foods have obtained high attention to address these issues. However, these novel foods may cause potential risks related to human health. Four types of novel synthetic foods, including plant-based foods, cultured meat, fermented foods, and microalgae-based foods, were reviewed in the study. The original food sources, consumer acceptance, advantages and disadvantages of these foods were discussed. Furthermore, potential risk factors, such as nutritional, biological, and chemical risk factors, associated with these foods were described and analyzed. Additionally, the current detection methods (e.g., enzyme-linked immunosorbent assay, biosensors, chromatography, polymerase chain reaction, isothermal amplification, and microfluidic technology) and processing technologies (e.g., microwave treatment, ohmic heating, steam explosion, high hydrostatic pressure, ultrasound, cold plasma, and supercritical carbon dioxide) were reviewed and discussed critically. Nonetheless, it's crucial to continue innovating and developing new detection and processing technologies to effectively evaluate these novel synthetic foods and ensure their safety. Finally, approaches to enhance the quality of these foods were briefly presented. The research aims to provide insights into the development and management of novel synthetic foods for the food industry. ***Comprehensive Reviews in Food Science and Food Safety.*** **2024.23:e13371.**

Cultivated Meat Production: Safety and Growth Factors

Growth factors are commonly added to cell culture media in cellular agriculture to mimic the endogenous process of proliferation and differentiation of cells. Many of these growth factors are endogenous to humans and known to be present in the edible tissues and milk of food animals. However, there is little or no information on the use of growth factors intentionally added in food production before the advent of cultivated meat. Ten commonly used growth factors have been reviewed to include information on their mode of action, bioavailability, occurrence in food and food animals, endogenous levels in humans, as well as exposure and toxicological information drawn from relevant animal studies and human clinical trials with a focus on oral exposure. In addition, a comparison of homology of growth factors was done to compare the sequence homology of growth factors from humans and domestic animal species commonly consumed as food, such as bovine, porcine, and poultry. This information has been gathered as the starting point to determine the safety of use of growth factors in cultivated meat meant for human consumption. The change in levels of growth factors measured in human milk and bovine milk after pasteurization and high-temperature treatment is discussed to give an indication of how commercial food processing can affect the levels of growth factors in food. The concept of substantial equivalence is also discussed together with a conservative exposure estimation. ***Comprehensive Reviews in Food Science and Food Safety.*** **2024;23:e13350.**

Challenges and Analytical Techniques for Food Authentication

Food authentication and contamination are significant concerns, especially for consumers with unique nutritional, cultural, lifestyle, and religious needs. Food authenticity involves identifying food contamination for many purposes, such as adherence to religious beliefs, safeguarding health, and consuming sanitary and organic food products. This review article examines the issues related to food authentication and food fraud in recent periods. The development and innovations in analytical techniques employed to authenticate various food products are comprehensively focused. Food products derived from animals are susceptible to deceptive practices, which can undermine customer confidence and pose potential health hazards. Therefore, it is necessary to employ suitable and robust analytical techniques for complex and high-risk animal-derived goods, in which molecular biomarker-based techniques are covered. Various analytical methods have been employed to ascertain the geographical provenance of food items that exhibit rapid response times, low cost, nondestructiveness, and condensability. ***Comprehensive Reviews in Food Science and Food Safety.*** **2024;23:e13360.**



Decontaminating Egg-Associated Pathogens by Plasma-Activated Water

This study investigated the effectiveness of plasma-activated water (PAW) and plasma-activated hydrogen peroxide (PAHP) in reducing egg-associated pathogens. The antimicrobial activity of these solutions against *Salmonella Enteritidis*, *Campylobacter jejuni*, and *Staphylococcus aureus* on eggs was evaluated at different plasma treatment durations. The results demonstrated that increasing the duration of plasma treatment enhanced the antimicrobial efficacy of both PAW and PAHP. The bacterial counts of the egg-associated pathogens significantly decreased from 7.61, 7.59, and 7.54 log (CFU/egg) to 5.4 and 3.09, 5.36 and 3.11, and 5.08 and 3.73 log (CFU/egg) for PAW and PAHP, respectively. The storage study revealed that PAHP treatment had no adverse effects on the egg pH, albumen and yolk color, Haugh unit, and yolk index. However, it did result in reduced eggshell strength and compromised cuticle integrity. Overall, this study demonstrates the successful application of PAW and PAHP in effectively inhibiting egg-associated pathogens while preserving essential egg quality attributes. Further research is needed to optimize the treatment conditions and investigate the long-term effects of PAW and PAHP on eggs in larger-scale applications. ***Journal of Food Safety.*** **2024;44:e13136.**

Produce Safety Training for Growers

The Produce Safety Alliance grower training has been offered since 2016. Prior to the pandemic, the course was offered exclusively in-person. During the pandemic, trainers were allowed to offer the course remotely. The effectiveness of in-person and remote delivery options was compared utilizing four methods: course evaluations completed at the training; a pre- and post-training knowledge assessment; a one-year follow-up survey; and focus groups with course trainers. All methods, except the focus groups, were used as evaluation tools starting before and continuing during the pandemic. On the course evaluations, remote delivery and in-person participants rated their satisfaction with the training and their confidence in their ability to make changes at the same high rate. The knowledge assessment found remote delivery participants scored higher on the post-test than in-person participants when controlling for pretest score; the effect size was between low and medium. On the follow-up survey, remote delivery participants reported making changes to food safety practices or infrastructure at a higher rate than in-person. There were demographic differences in educational level, job description, and number of years farming between the two populations. The focus group revealed advantages and disadvantages of both delivery methods, including internet availability, engagement activity, and course logistics and planning. Because no practical differences in outcome were measured between delivery methods and each had unique strengths, researchers recommend that educators should utilize both methods in the future. ***Journal of Food Science.*** **Published May 30, 2024. doi: 10.1111/1750-3841.17100.**

Non-Enzymatic Oxidation of Wine

Non-enzymatic oxidation is a primary factor affecting wine quality during bottling or aging. Although red and white wines exhibit distinct responses to oxidation over time, the fundamental mechanisms driving this transformation remain remarkably uniform. Non-enzymatic oxidation of wine commences with the intricate interplay between polyphenols and oxygen, orchestrating a delicate redox dance with iron and copper. Notably, copper emerges as an accelerant in this process. To safeguard wine integrity, sulfur dioxide (SO_2) is routinely introduced to counteract the pernicious effects of oxidation by neutralizing hydrogen peroxide and quinone. In this comprehensive review, the initial stages of non-enzymatic wine oxidation are examined. The pivotal roles played by polyphenols, oxygen, iron, copper, and SO_2 in this complex oxidative process are systematically explored. Additionally, the effect of quinone formation on wine characteristics and the intricate dynamics governing oxygen availability are elucidated. The potential synergistic or additive effects of iron and copper are probed, and the precise balance between SO_2 and oxygen is scrutinized. This review summarizes the mechanisms involved in the initial stages of non-enzymatic oxidation of wine and anticipates the potential for further research. ***Journal of Food Science.*** **2024;89:2530-2545.**

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Events

JUNE 2024

9-11
International Dairy-Deli-Bakery Association Show
Houston, Texas
iddba.org

20-21
Food Sure Summit Europe
Madrid, Spain
foodsureeurope.com

23-25
Summer Fancy Food Show
New York, N.Y.
specialtyfood.com

JULY 2024

10-11
Organic Produce Summit
Monterey, Calif.
organicproducesummit.com

10-13
American Cheese Society Conference
Buffalo, N.Y.
cheesesociety.org

14-17
IFT First Annual Event and Expo
Chicago, Ill.
iftevent.org

14-17
International Association for Food Protection
Long Beach, Calif.
foodprotection.org

AUGUST 2024

17-20
World Brewing Congress
Minneapolis, Minn.
asbcnet.org

SEPTEMBER 2024

11-12
Plant Based World Expo
New York, N.Y.
plantbasedworldexpo.com

OCTOBER 2024

8-9
Transform Food & Agriculture USA
Minneapolis, Minn.
events.reutersevents.com

NOVEMBER 2024

3-6
Pack Expo
Chicago, Ill.
packexpointernational.com

7-8
American Food Manufacturing Summit
Chicago, Ill.
foodmansummit.com

DECEMBER 2024

3-5
Midwest Food Products Association Annual Convention & Expo
Wisconsin Dells, Wisc.
mwfpa.org

Profiles

IN FOOD SAFETY

Virginia Holsinger Develops Enzyme Treatment for Lactose Intolerance

BY **MARY BETH NIERENGARTEN**

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It is now common when grocery shopping to find an array of products labeled lactose free. For people unable to metabolize lactose, these products are a food lifeline, enabling them to enjoy cheeses, ice creams, yogurts, and other foods and drinks without the intestinal discomforts brought on by their inability to break down lactose found in dairy-based products.

One food scientist is responsible for this enjoyment. Virginia Harris Holsinger, PhD, joined USDA's Agricultural Research Service (ARS) as an analytic chemist in the dairy products laboratory in Washington, D.C., after completing her bachelor's degree in chemistry from the College of William and Mary in 1958. In 1974, she transferred to the Eastern Regional Research Center in Pennsylvania, where she worked until her 1999 retirement. During those years, she earned her doctorate in food science and nutrition from Ohio State University and authored or coauthored more than 100 scientific papers.

As the former head of the dairy products research unit of ARS in Wyndmoor, Penn., Dr. Holsinger led a program on the chemistry and technology of milk and dairy foods from 1974 to 1999. Within those years, her research spawned the development of a range of products including a low-lactose milk product, a nutritious and shelf-stable whey–soy drink mix, a reduced-fat mozzarella, and a modified version of dehydrated milk powder. All of these products were based on the development of an enzyme treatment to make milk digestible for people missing the enzyme lactase.

Dr. Holsinger examines a sample of spray-dried butter.

COURTESY OF USDA ARS.

One of the most recognized brands that her work helped to launch is Lactaid. Asked in the early 1980s by a family dairy farmer named Alan Kligerman to create a milk substitute for people with lactose intolerance, Dr. Holsinger developed a way for a lactase from fungi, instead of humans, to break down a significant portion of the lactose in milk into sugars; products developed via this process were easier for lactose-intolerant people to digest. Lactaid is based on this formula. Launched by Kligerman in the mid-1980s and later bought by Johnson and Johnson in 1991, the brand now includes other products based on modifications of Dr. Holsinger's research such as yogurt and ice cream.

Beyond the Retail Shelf

Many consumers who enjoy the lactose-free products that ensued from this research may not appreciate the breadth and scope of the public health effects of Dr. Holsinger's research, which allowed for the development of nutritional, safe modified dairy products for use in a range of situations. For children in developing countries, the whey–soy drink mix she produced brought a needed nutritional milk substitute into their diets. The shelf-stable drink was among a number of formulated foods that she and her colleagues developed for emergency use as part of the U.S. Agency for International Development's Food for Peace program. She also developed a porridge based on a grain blend mixed with water that can be used to feed people in situations in which food is unavailable or hard to access, such as during famines and wars.

For the military, she developed a modified version of dehydrated milk powder with a long shelf life to be used for field rations consumed by lactose-intolerant soldiers.

In 2000, Dr. Holsinger was inducted into the ARS Hall of Fame. Prior awards include the Distinguished Service Award of the ACS Division of Agricultural and Food Chemistry in 1986 and the Lifetime Achievement Award for Women in Science and Engineering in 1995

Dr. Holsinger died at age 72 in 2009. ■

Nierengarten is a freelance writer based in Minnesota. Reach her at mbeth@mnmedcom.com.

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