

# Food Quality & Safety

FARM TO FORK SAFETY

## A Delicate Balance

Protecting meat plant workers, food safety standards,  
and the supply chain during COVID-19



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*Food Quality & Safety* (ISSN 1092-7514) 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. Periodical postage paid at Hoboken, NJ, and additional mailing offices.

Print subscriptions are free for qualified recipients. Annual paid subscriptions are available to European readers at €152, U.K. readers at £123, and rest of the world readers at \$230. For subscription questions in the U.S., call 844-862-9286. For outside the U.S., call 856-255-5537. Or email customer services at [customerservice@d3data.net](mailto:customerservice@d3data.net).

*Food Quality & Safety* is a proud member of: United Fresh Produce Association  
APEX, Folio Ozzie, and ASBPE award winner for editorial and graphics excellence.

POSTMASTER: Returns and address changes to *Food Quality & Safety* magazine, PO Box 986, Levittown PA 19055-0986



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# From The Editors

## Keeping Up with the Regulators

**R**egulatory compliance is an integral part of the food processing industry, whether the operation is a meat and poultry processor operating under the aegis of USDA, a processor of food regulated by FDA, or a processor importing their products into the U.S. Each and every processor must adhere to the laws and regulations governing the safe production of foods, the labeling of those foods, and the many other aspects governing sourcing, receiving, shipping, hiring, firing, and ensuring that plant workers have a safe working environment. With all that food processors must do to comply with local, state, and federal regulations, and international issues for exporters, it's surprising how few food processors have a compliance officer in their plant, or even a documented policy to track and update the laws and regulations to which they must comply.



So, what might an operation do in this area to help them not only ensure regulatory compliance but also ensure that they are aware of these requirements? Remember, ignorance of a law or regulation is not an excuse.

The operations that most often have issues with regulatory compliance are small processors, but they certainly do not have a monopoly on the issue. One of the best means to help meet this goal is to join a quality trade association. The associations are especially useful in helping processors stay aware of regulations and in giving guidance on how to adhere to them. Areas where associations have developed guidance documents include recall programs, environmental monitoring, GMP compliance, HACCP compliance, validation of processes, and labeling issues.

It always helps to make sure that the essential laws and regulations are available to management and staff. There should be at least one person on site whose job is to ensure that updated copies of these documents are available to both management and the staff. These can be printed and placed in a manual or made available on the company intranet. It is imperative that these documents be properly updated, and it's also useful to include any guidance documents or updates generated by the regulators.

There is one more element to regulatory compliance: employee education. Make sure that your workforce understands the rules and their role in ensuring compliance. This should be done as part of the orientation for new employees and as part of yearly refresher sessions.

Oh, and one last thing: Your auditors like to see this kind of system, so think about that element, too.

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

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# NEWS & NOTES

## FDA Proposes New Rules on Food Traceability

BY KEITH LORIA

FDA has proposed a new rule that lays the foundation for end-to-end food traceability across the food industry as part of the New Era of Smarter Food Safety initiative. While limited to certain foods, the proposed rule is designed to create a first-of-its-kind stan-

dardized approach to traceability record keeping, paving the way for the food industry to adopt and leverage more digital, tech-enabled traceability systems in the future.

“At a high level, what this is really trying to achieve is to lay the foundation for a more standardized approach to food traceability by harmonizing and identifying what are the records that need to be there, and in turn, serving as a catalyst for greater end-to-end digital food transparency,” says Frank Yiannas, FDA deputy commissioner for food policy and response.

The proposed rule is looking to correct what he notes is often “one step up and one step back” with regard to other countries’ proposals for food traceability, where people are keeping records in different ways with no standardized data.

“What the FDA has done here is require people to ‘speak in the same or similar language,’ which will allow us to make those connections and show how food travels from farm to table,” he says. “This is a game changer in food traceability in that it identifies very appropriately and astutely in a 21st century fashion the key data elements and the critical tracking events that are needed.” Yiannas notes that the proposal is aimed at all food manufacturers, processors, packers, and those who hold foods on the Food Traceability List (FTL).

“Working together, we will advance food traceability and usher in a new era of smarter food safety that benefits producers and consumers,” he said. “Over the course of the next 100 days, you should expect significant announcements about our plan.”



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## Pre-Harvest Treatment Can Reduce Foodborne Pathogens

BY KEITH LORIA

New research from the Center for Food Safety at the University of Georgia suggests that farmers can reduce foodborne pathogens by applying sanitizers to produce while it is still in the ground. Modern practices for the reduction of foodborne pathogens on produce typically focus on post-harvest washing; despite tremendous efforts, however, outbreaks of foodborne pathogens in this produce still occur.

The researchers examined the bactericidal effects of a food-grade sanitizer and found that it could kill inoculated foodborne pathogens on tomato plants. Additionally, pre-harvest treatment reduced coliform and total bacterial population. “There was no *Listeria* detected on all collected tomatoes,” says Tong Zhao, PhD, an associate research scientist at the university and co-author of the study.

According to Dr. Zhao, pre-harvest application of bactericides is not a common practice among vegetable growers. Originally, the researchers planned to study the use of

a nonchlorine-based sanitizer made of two FDA-approved food additives—levulinic acid and sodium dodecyl sulfate—as a post-harvest wash solution. However, with advice from Bill Brim, president of Lewis Taylor Farms in Tifton, Ga., the researchers used the solution in a pre-harvest spray instead.

The researchers examined both laboratory and field tests, spraying tomato plants with a solution containing five strains of *E. coli*, five strains of *Salmonella*, and five strains of *Listeria* specially grown in a lab. The plants were then separated into three equal groups and sprayed with the bacteria solution composed of commercial product Fit-L. One group was treated with acidified chlorine as the positive control, another with a treatment solution containing levulinic acid and sodium dodecyl sulfate, and a third was treated with tap water only as the negative control.

The outcome of the study showed that the combination of levulinic acid and sodium dodecyl was effective in reducing foodborne pathogens on tomato plants contaminated

with *Salmonella*, Shiga toxin-producing *E. coli*, and *Listeria monocytogenes*.

“The results reveal that pre-harvest intervention by Fit-L is a practical, easy-to-use, labor-cost-effective, and environmentally friendly approach for control and reduction of foodborne pathogens that may contaminate the surface of the produce and total surface bacterial population at pre-harvest stage,” Dr. Zhao says. “Its application at pre-harvest, plus post-harvest washing will provide a warranty to secure the safety of fresh produce.”

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## FDA Sets Guidelines for Inorganic Arsenic in Infant Rice Cereal

BY KEITH LORIA

FDA has released new guidance on limiting the levels of inorganic arsenic found in infant rice cereal, capping the level of arsenic allowable at 100 parts per billion.

This guidance is intended to encourage manufacturers to reduce levels of inorganic arsenic in their rice products—white and brown rice, both organically and conventionally grown—thus reducing the possible risk for infants who are fed rice cereal. However, it does not establish legally enforceable responsibilities. “We have concluded that a level of 100 µg/kg or 100 ppb inorganic arsenic in infant rice cereals is achievable under current good manufacturing practices, based on evaluation of recent FDA data on inorganic arsenic levels in infant rice cereals,” the FDA noted in its report.

Janilyn Hutchings, a food scientist with StateFoodSafety, says that arsenic is a naturally occurring element that is toxic to humans. “FDA first proposed setting a limit on inorganic arsenic in infant rice cereals in 2016, after completing a risk assessment,” she says. “As part of the assessment, the agency analyzed several scientific studies that showed an association between inorganic arsenic and adverse pregnancy outcomes and neurological effects in children’s early lives.”

The limit proposed in 2016 was that inorganic arsenic should not exceed 100 parts per billion, or 100 micrograms per kilogram. This is the same limit enforced by the European Commission. Before the limit could be finalized in the U.S., FDA had to complete a review process that included accepting



public comments. It also tested the levels of inorganic arsenic in infant rice cereals that were then available on the market. Manufacturers could choose to meet the 100 ppb (100 µg/kg) requirement if they wanted. According to sampling data from 2018, about 76% of infant rice cereals currently meet that standard.

## Farmworkers Lack Federal Protections During COVID-19

BY LORI VALIGRA

The three million farmworkers in the U.S. who help feed the country are, understandably, deemed essential workers during the COVID-19 pandemic, but there are no federal regulations to keep them safe, and there have been virus outbreaks in fields across the nation.

It’s difficult to obtain accurate numbers on how many agricultural workers have tested positive for COVID-19 because of the widespread nature of farm work and the fear by workers of testing positive and being fired, advocates say. These same issues also make contract tracing challenging if there is an outbreak. “Right now there aren’t any federal requirements in place, so across the country we’re looking at a complete patchwork of different laws and regulations, whether it is mandatory or voluntary guidance,” says Jared Hayes, a policy analyst at the Environ-

mental Working Group, a Washington, D.C., consultancy.

In June, the U.S. Centers for Disease Control and Prevention and the U.S. Department of Labor issued joint guidance targeting worker safety for the agricultural sector that states can use, but the recommendations are not obligatory. Approximately 10 states have some kind of farmworker protections in place now, but it’s still mainly up to employers to set the safety standards.

U.S. farmworkers tend to be either seasonal workers with H-2A visas or migrant workers. Some stay in one state, but many travel from state to state, following the growing season, Hayes says. That can cause confusion among workers who don’t know their rights as they travel to states with different safety protections, he says. Living and working conditions can vary greatly, but many times, workers live together in cramped housing, commute to the fields in packed buses, and often work side by side, all of which can be conducive to spreading the virus, Hayes says. Some companies have started spacing out workers more in buses and in the field, giving them masks, and installing hand-sanitizing stations, he says.

Recent cases in California and Florida exemplify the risky conditions workers face.

An investigation by Cal Matters and The Salinas Californian newspaper found reports of six outbreaks at seven companies across four counties in California that sickened more than 350 guest workers. The companies didn’t always report the cases to public health officials, making it difficult to detect or contain outbreaks. “Due to their low wages and the cost of housing, farmworkers do tend to live either in multiple families in one unit or multiple workers in one unit,” says Alexis Guild, director of health policy and programs at Farmworker Justice, a Washington, D.C., advocacy group.

The 150,000 or so farmworkers in Florida are in the off season now, but there were rumors of earlier outbreaks at tomato and other farms in the state that were hard to confirm, says Jeannie Economos, coordinator of the pesticide safety and environmental health project at the Farmworker Association of Florida, a farmworker advocacy group in Apopka, Fla. Without federal regulations in place, she’s worried about the coming harvest this fall. “There are no OSHA requirements, there’s no enforcement, and there’s no carrot and stick for employers to do anything,” Economos says. “We don’t know what the season is going to look like. We’re very concerned about it.”



# Washington Report



## A Blueprint for Success

The importance of FDA's new smarter food safety initiative

BY KEITH LORIA

Despite advancements in food safety, the rates of foodborne disease in the U.S. have not changed significantly over the last decade. In an effort to bend the curve of foodborne illnesses, FDA has released new guidelines that are expected to offer more effective and modern approaches and processes to the food industry.

New Era of Smarter Food Safety: FDA's Blueprint for the Future is a 10-year road-map designed to create a more digital, more traceable, and safer food system

using technologies including, but not limited to, blockchain, sensor technology, the Internet of Things (IoT), and artificial intelligence (AI).

Angela Fernandez, a food traceability expert and vice president of community engagement for Ewing, N.J.-based GS1 US, collaborated with FDA to determine how GS1 standards would be essential for the blueprint. "The New Era blueprint is in many ways a response to the growing frustrations experienced by the industry and consumers over long, drawn-out investi-

gations into foodborne illness outbreaks and the considerable gaps in end-to-end traceability," she says. "It encourages the food system to prioritize food safety and enhance its tracking capabilities so that we don't grow accustomed to a world where romaine lettuce is missing from our Thanksgiving tables each year."

In announcing the blueprint through a video and press release, FDA Commissioner Stephen Hahn emphasized the need for tech-enabled food traceability that leverages data standards across the industry to "speak the same language."

Therese Myers, CEO of Infratab, Inc., Oxnard, Calif., which offers condition-intelligent radio frequency (RF)-sensor solutions for monitoring, tracking, and tracing perishables, notes that the imple-

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mentation of these tools is significant because it signals a mindset change toward assessing, quantifying, and immutably documenting both risk and quality, taking steps to ensure that the perishable will have the provenance, safety, and shelf life consumers expect. “For food manufacturers, this will mean a move to a traceability system that’s interoperable, not proprietary, allowing the same system to be used regardless of the channel,” she says. “Data security is paramount, of course, but as the plan broadens the scope of traceability, it will become untenable for food manufacturers to rely on one system for this customer and another for that customer—we need systems that can efficiently, accurately, and securely talk to each other.”

Sergei Beliaev, former CIO at Walmart and currently executive vice president and chief strategy officer of DLT Labs, based in Toronto, Ontario, Canada, which has delivered many of the largest enterprise blockchain projects globally, describes this as an important undertaking because human health and safety are primary concerns—any number of deaths is too many, particularly if the cause is preventable. “Blockchain enables connectivity of information from any input in one unified, shared ledger that’s traceable, immutable, auditable, and real time to ensure a more digital, [more] traceable, and safer food system,” he says. “The power of real-time visibility and early detection and alerts are our best technological hopes to support the food safety blueprint.”

### The Plan

Overall, the goal of the New Era blueprint is to curb foodborne illness by improving traceability, strengthening predictive analytic tools, and responding more quickly to outbreaks. Addressing new business models, reducing food contamination, and developing a stronger food safety culture across the industry are also important considerations.

The document calls for an increased level of information sharing, throughout the full life cycle of food and raw materials, to give manufacturers more reliable and complete information about how their products are transported, processed, and consumed. “This will allow for ongoing fact-based visibility and improvements to

the agriculture and processing processes,” Beliaev says. “Information sharing will also enable consumers to make informed real-time product choices. The goal is to be able to use the information to look both forward and backward.”

**For food manufacturers, this will mean a move to a traceability system that’s interoperable, not proprietary, allowing the same system to be used regardless of the channel.**

—THERESE MYERS, *Infratab, Inc.*



### Improved Food Safety

By creating a renewed sense of urgency around food safety, the New Era plan will help make recalls more efficient and stop potentially harmful foods from reaching consumers. “It will guide the industry toward a more agile supply chain and drive out manual practices that have plagued the food system for years,” Fernandez says. “This builds upon progress that has already been made over the last decade.”

Starting with the unique identification of product—one global number associated with a brand and product—manufacturers and their partners have a common foundation for traceability. Additional attributes, like batch and lot numbers that can be automatically captured at every step in the supply chain, are what enable additional levels of traceability.

End-to-end transparency of critical tracking events, coupled with clear provenance and certifiable manufacturing practices, will ensure that whenever food contamination is identified, its scope and location are quickly and easily identified, and it is traced back to its root source and causes.

“This will be a tremendous accelerator in responding to and containing the negative impacts,” Beliaev says. “Digitization of the key tracking events will also help create the necessary data to apply the predictive and analytical algorithms, which will be instrumental in taking the prevention capability to the next level, as well as defining the best course of action for containment activities.”

Moreover, the immutable and real-time nature of blockchain, together with automation via smart contracts, will ensure data quality, early alerts, and immediate response. “Blockchain is the glue that binds,” Beliaev says. “It establishes ubiquitous detection so that individuals can be fully integrated into an early warning and alert system, allowing information to flow from pallet to producer in real time.”

In the target state envisioned by the blueprint, any recall in the future should be able to generate a series of concurrent activities, starting with identification of affected batches and their removal and safe disposal. The potential outcome for a fully functional and integrated system is that manufacturers could save hundreds,



if not thousands, of lives with early alerts and early reporting.

“The plan brings traceability systems into the real world, leveraging technologies already at work in other industries to improve the speed and accuracy of critical supply chain data and making it faster to access and analyze to prevent a small issue from becoming a major outbreak,” Myers says. “The intent is that with sensors and radio frequency identifications, it will take much less time to find a recalled item and get it off the shelf.”

### Industry Reception

The response among those in the food industry has been mostly positive, with many praising the blueprint.

For example, Leslie Sarasin, president and CEO of the Food Marketing Institute, Arlington, Va., notes the importance of FDA bringing technology to the forefront with this plan. “Within the food industry, we continue to witness how rapidly business models are changing; any new frameworks should be broad in nature and be adaptable with evolving business practices,” she says. “It’s critical that this new plan focuses on outcomes, leverages existing tools, increases communications with and among stakeholders, accounts

for our variable resources and abilities, and provides uniformity that amplifies success.”

Still, there are some challenges to widespread adoption, especially among smaller food producers. “The obstacles to widespread adoption are legacy systems, such as temperature loggers,” Myers says. “Some companies will be reluctant to change due to the investment cost, which is why it’s even more important to adopt a new system that works with what you already have.”

Fernandez adds that small producers are a key part of uniting the food system and modernizing business processes for better traceability. “They can often act with greater agility than larger companies, but they need cost-effective solutions to do so,” she says. “Solution providers must be able to offer them scalable options that help them participate in end-to-end traceability. When smaller companies are able to see the shared value of an investment in technology, they are often more open to exploring emerging technology like blockchain.”

### Tech in Motion

The use of this technology is projected to accomplish a great deal across the food industry. Still, Fernandez notes that what’s right for one company may not be right for another. “The blueprint provides general guidance toward more digitization and automation, focused on the benefits of these kinds of changes,” she says. “The importance of standards-based collaboration is a key point that can apply to all types of manufacturers and all levels of supply chain participants. Regardless of whether you are using simple GS1-128 barcodes on your cases, or emerging technology like artificial intelligence, blockchain, or IoT, GS1 standards are foundational to making these technologies successful and help to ensure the industry speaks the same language when it comes to sharing product data.”

One example given by Hahn in a recent press release was the use of artificial intelligence and machine learning to screen imported seafood for safety. The release detailed a pilot program where FDA was able to create a screening tool that helped identify seafood that could be classified as unsafe by utilizing years of historical

data on seafood shipments that had been refused entry into the U.S. or that required additional examination.

The next phase of the pilot project involves applying a machine learning algorithm to assist FDA staff in identifying which shipments to examine and what food in a shipment should be sent to a lab for testing. “Imagine having a tool that expedites the clearance of legitimate, compliant shipments and improves by 300% our ability to know which shipping container to examine because that container is more likely to have violative products,” Hahn said in the blueprint introduction video. “It would save an immense amount of time, and potentially lives.”

### Looking Ahead

In the year ahead, Fernandez believes there will be more supply chain partners working together to bring along smaller partners in terms of education on advanced technologies, preparation for increased automation, and phasing out reliance on manual processes.

Manufacturers that are not already digitally collaborating with their suppliers, distributors, and retail partners using global data standards should take steps to prepare their systems and data for a new level of automation. Fernandez advises that they should evaluate the quality of their data and determine whether or not they are using globally unique product identifiers and standardized product information that can be widely accepted and processed consistently as technology use and process automation in the supply chain grows. “For manufacturers that have already begun their digital transformation, the New Era blueprint encourages them to bring small- and medium-size partners along on their journey to create true end-to-end visibility,” she says.

While the initial plan represents a baseline, the amount of information is dynamic, not static. Over time, through leveraging accurate data (blockchain) and combining with AI, manufacturers and every party in the supply chain can have both specific information on individual supply chains and also comparative information that enables best practices. ■

Loria is an award-winning journalist who writes on topics as diverse as food, sport, business, and government. Reach him at [freelancekeith@gmail.com](mailto:freelancekeith@gmail.com).

## New Era Core Principles

The structure of FDA’s New Era of Smarter Food Safety blueprint revolves around four core principles requiring the use of digital tools, including blockchain, end-to-end traceability, e-commerce, big data, and predictive analytics to modernize food safety:

- Tech-enabled traceability (using existing and emerging technology to identify and trace outbreaks in minutes or even seconds, rather than days or weeks);
- Smarter tools and approaches for prevention and outbreak response (leveraging data to mitigate risks);
- New business models and retail modernization (adapting oversight to new and emerging food distribution avenues and advancing food safety in retail venues); and
- Food safety culture (promoting food safety practices and influences locally and globally).

# Market Initiatives



## Say Cheese!

Quality and safety initiatives, regulatory challenges, and research opportunities abound in the U.S. cheese industry

BY LINDA L. LEAKE, MS

If Wisconsin were a country, it would rank [fourth](#) in the world in cheese production, after the rest of the U.S., Germany, and France. Ranking first in the U.S. for more than a century, Wisconsin produced 25.3% of the nation's cheese during the first six months of 2020—1,652,500,000 pounds—according to the USDA National Agricultural Statistics Service (NASS) and [Dairy Farmers of Wisconsin](#) (DFW).

DFW is a farmer-owned and farmer-directed nonprofit organization funded

entirely by Wisconsin's dairy farm families. It was created in 1983 as the Wisconsin Milk Marketing Board, Inc., to increase the sale and consumption of Wisconsin milk and dairy products. The organization's name was changed to DFW in 2018.

While Wisconsin makes more than [600](#) different varieties, types, and styles of cheese, mozzarella (33.1%) and cheddar (21.1%) accounted for 54.2% of the varieties produced in the state from January 2020 through June 2020, according to DFW and [USDA](#).

### U.S. Cheese Statistics

After Wisconsin, the leading cheese-producing states are California (18.9% of U.S. production, 1,234,300,000 pounds produced from January 2020 through June 2020), Idaho (7.7%, 501,600,000 pounds), New Mexico (7.4%, 485,700,000 pounds), New York (6.3%, 411,900,000 pounds), and Minnesota (5.6%, 369,000,000 pounds), according to USDA NASS. From January 2020 through June 2020, these six states produced 4,655,000,000 pounds of cheese, while total U.S. cheese production was 6,535,632 pounds, USDA NASS reports.

Cheese is the largest single category of specialty food in the U.S., according to [Dairy Reporter](#). U.S. retail cheese sales totaled 2,344,900,000 pounds, valued at \$11,726,200,000, from January 1, 2020 through July 12, 2020, according to custom

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Dairy Management, Inc. analysis of IRI data.

The U.S. exported 357,000 tons of cheese in 2019, ranking second in cheese exports after the European Union-28 (888,000 tons), as published by the USDA Foreign Agriculture Service.

Per capita consumption of natural cheese was 38.15 pounds in 2018, as per the USDA Economic Research Service.

### COVID-19 Leadership

Most recently, Wisconsin's cheese industry is focused on leadership relative to COVID-19, according to Adam Brock, CFS, DFW's director of food safety, quality, and regulatory compliance. "DFW has collaborated with industry partners to develop and house information on our COVID-19 resource hub," Brock says.

In April 2020, DFW published standard operating procedures (SOPs) titled COVID-19 Positive Worker and COVID-19 Positive Worker Return to Work. Brock co-wrote the SOPs with Marianne Smukowski, the dairy safety and quality coordinator at the University of Wisconsin-Madison Center for Dairy Research (CDR), which is partially funded through DFW. Among other responsibilities, Smukowski oversees the CDR's trademarked Wisconsin Master Cheesemaker Program, a rigorous cheese quality initiative.

Smukowski offers advice for cheese producers to deal with the pandemic as diligently as possible. "Keep explanations simple and clear when instructing employees and anyone visiting your plant about what special procedures and behavior are required and expected," she recommends. "Emphasize that face masks be worn according to the requirements and guidelines of your local health department. Facilitate proper physical distancing, and make sure you have systems in place to verify that distancing is maintained."

Smukowski advises that producers conduct a risk assessment relative to communicable illnesses and determine appropriate follow-up steps, should positive cases be identified among employees. She also stresses the importance of having a pandemic communication strategy, both internal and external. "The pandemic is a fluid situation, so be ready for change at any time," Smukowski says.

### Cheese Industry Collaborations

Not surprisingly, Wisconsin, which named cheese its official state dairy product in 2017, boasts myriad initiatives and organizations devoted to promoting cheese quality and safety.

Having consistent, science-based, and harmonized *Listeria* regulations between FDA and USDA would be extremely helpful for cheesemakers and would do much to advance food safety.

—CATHERINE DONNELLY, PHD,  
*University of Vermont in Burlington*



In June 2018, DFW launched a new Wisconsin cheese brand identity that includes the Proudly Wisconsin Cheese logo. "In order to carry the logo, cheese and dairy products must be made with milk purchased from Wisconsin dairy farmers," Brock says. "This logo demonstrates that consumers are getting a high-quality product, made by licensed cheesemakers in the place that wins more national and international awards for cheese than any other state or country."

Also established in 2018, the Dairy Food Safety Alliance is a collaboration of the CDR, the DFW, and the Wisconsin Cheese Makers Association. "Through the Alliance, we focus on regulatory activities that are tied to food safety," Brock says. "We host meetings on an annual basis around the state that provide opportunities for industry stakeholders to discuss food safety issues with the Wisconsin

Department of Agriculture, Trade and Consumer Protection (DATCP). Related to the Alliance, DFW participates with DATCP and other Wisconsin dairy industry partners as members of the state's Dairy Rules Advisory Committee."

Brock recently partnered with the American Cheese Society and other cheese industry stakeholders to develop a webinar focusing on food safety culture. The webinar debuted in September 2020. "The Wisconsin cheese industry is a leader in food safety and quality from farm to fork," Brock says. "We have a unique collaborative spirit in Wisconsin, featuring an excellent working relationship with our industry partners and our regulatory agencies."

### Listeria Concerns

*Listeria* control is a major issue relative to cheese safety, according to Catherine Donnelly, PhD, a professor of nutrition and food sciences at the University of Vermont in Burlington. "It is well documented scientifically that aggressive environmental testing and monitoring are key to achieving this control," she says. "Cheesemakers need to identify and eliminate niches of *Listeria* that may be constantly introduced into the cheesemaking environment. We know this is a problem for cheesemakers large and small."

In 2010 and 2011, FDA conducted environmental surveillance of 154 cheese plants in 27 states, including both artisan and industrial producers. "Thirty-one percent had positive environmental findings, confirming the widespread presence of *Listeria* in processing plants," Dr. Donnelly notes.

She contends that there are conflicting *Listeria*-related regulatory issues that create challenges for U.S. cheesemakers. In her opinion, there is a need for regulatory policy that helps incentivize cheesemakers with respect to testing dairy environments to facilitate *Listeria* control. "FDA's revised 2017 draft *Listeria* guidance is a step in the right direction, but there is a further need for consideration of alternative approaches to FDA's zero tolerance policy for low risk foods that do not support *Listeria* growth," Dr. Donnelly says.

"FDA's approach to inspections under the Food Safety and Modernization Act is viewed as punitive by many dairy proces-

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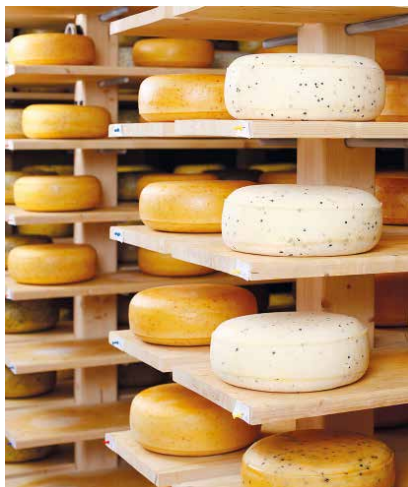
sors, as positive environmental findings for *Listeria* in plants trigger recalls in some cases and injunctions in others,” Dr. Donnelly says. “FDA has considered both the pathogen *L. monocytogenes* as well as the non-pathogenic *L. innocua* adulterants, whose presence indicates that cheeses have been prepared, packed, or held under insanitary conditions.”

In contrast, Dr. Donnelly says, USDA’s policies encourage aggressive environmental testing to protect post-lethality-exposed ready-to-eat meats and poultry products. Additionally, USDA considers products adulterated only when the pathogenic *L. monocytogenes* (and not *L. innocua*) is found on a food contact surface or in a product. “Having consistent, science-based, and harmonized *Listeria* regulations between FDA and USDA would be extremely helpful for cheesemakers and would do much to advance food safety,” Dr. Donnelly suggests. Aside from that, globally harmonized cheese regulations that are science-based and focused on promoting safety are needed, she advises.

### Research Needs

There is a need for research on new cheese cultures, Dr. Donnelly says. “Cheese is not, nor ever will be, a sterile food product, and we have so much to learn about the microbial communities that comprise cheeses,” she explains. “It would also be useful to know what health benefits might be associated with these microbial communities.”

“Previous [research](#) has revealed the complexities of the microbial consortia of cheese rinds, yet few, if any, of the more



Cheese is among the top-10 products that are adulterated all over the world. Establishing region-specific fingerprints of U.S. cheeses will facilitate their authentication, which will be especially useful for investigating situations where U.S.-made cheeses are implicated in food safety-related cases.

— MOSHE ROSENBERG, DSC, University of California, Davis

than 30 genera comprising these microbial communities have been fully characterized, and the role of some of these newly identified microbes is poorly understood,” Dr. Donnelly says. “We have so much to learn, particularly in the context of how these organisms interact with the human gut microbiome. From my perspective, there has never been a better time for cheese research than now.”

### Raw Milk Cheese

To pasteurize or not to pasteurize: This debate is an ongoing focus of heated discussions about cheese and food safety, according to Moshe Rosenberg, DSc, professor and specialist of dairy science and engineering in the department of food science and technology at the University of California, Davis. “Some wonder why it is important to manufacture raw milk cheese,” Dr. Rosenberg says. “Maybe it’s not. Those who consume raw milk cheese want to indulge in specific flavor notes. It’s possible to use secondary and adjunct starter cultures for introducing specific flavor notes of raw milk cheese into pasteurized milk.”

### Promising Technologies and Tools

Dr. Rosenberg highlights innovations he believes have potential to revolutionize U.S. cheesemaking. For starters, fully mechanized cheesemaking systems are commonly used; however, automated cheesemaking platforms have yet to be developed, he says. “Introducing automation requires developing a new generation of in-line probes and cheesemaking-specific artificial intelligence that can make decisions,” he adds. “Such systems will continuously assess and quantify the multitude of parameters that govern the transformation of milk into curd of desired

properties and optimize the process ‘on the fly.’ Such systems will improve cheesemaking yield, minimize batch-to-batch variations, and will allow better controlling [of] the development of desired cheese quality attributes.”

Dr. Rosenberg is a proponent of establishing the concept of protected designated origin (PDO) for cheeses in the U.S. “In the case of cheeses, PDO defines the place and way that milk is produced, the way it is collected, as well as the place and manner in which cheese is made and aged,” he says. “It allows highlighting cheese terroir, the flavor of place.” Dr. Rosenberg explains that introducing and protecting PDO for U.S.-made cheeses requires developing the region-specific physico-chemical, microbiological, and sensorial “fingerprints” of cheese. That said, the true meaning of cheese terroir has not been scientifically addressed in the United States yet, he notes.

“Cheese is among the top-10 products that are adulterated all over the world,” Dr. Rosenberg says. “Establishing region-specific fingerprints of U.S. cheeses will facilitate their authentication, which will be especially useful for investigating situations where U.S.-made cheeses are implicated in food safety-related cases.”

People are ready to pay more for local cheese, Dr. Rosenberg says. “However, without authentication, local is just a ZIP code,” he emphasizes. “And, regarding cheese labeled as organic, research has indicated fraud in many cases. Identifying unique cheese properties, such as fatty acid composition, elemental composition, and stable isotopes profile, can help protect against fraud.” ■

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# Legal Update



## FSMA's Sanitary Transportation of Human and Animal Food Rule

Food safety and sanitation requirements for shippers, loaders, carriers and receivers

BY JOEL S. CHAPPELLE, ESQ. AND SHAWN K. STEVENS, ESQ.

**F**DA has finalized seven major rules that collectively account for the majority of the Food Safety Modernization Act (FSMA). One of those rules, and the subject of this article, is the Sanitary Transportation of Human and Animal Food Rule. According to FDA, the rule is intended to prevent practices during transportation that create food safety risks, such as failure to properly refrigerate food, inadequate cleaning of vehicles between loads, and failure to properly protect food.

The Sanitary Transportation of Human and Animal Food Rule (also referred to as the Sanitary Transport Rule) establishes food safety and sanitation requirements for shippers, loaders, carriers by motor or rail vehicle, and receivers involved in transporting human and

animal food. Specifically, the rule establishes requirements for vehicles and transportation equipment, transportation operations, records, training, and waivers pertaining to the safety of food in transport. In essence, it's an enhanced version of the 2005 Sanitary Food Transportation Act, which was enacted to combat concerns arising from reports of unsanitary transportation practices and foodborne illness outbreaks caused by contamination that occurred while food was being transported.

Generally, the rule applies to shippers, receivers, loaders, and carriers who transfer food in the U.S. by motor or rail vehicle, whether or not the food is offered for or enters interstate commerce. This is somewhat unusual. The rule does not apply to transport by ship or air. Although,

as noted, the rule is applicable to various individuals and entities throughout the supply chain, it is the shippers who have the greatest degree of responsibility under the rule, including for the development and implementation of written procedures that address how the safety of the food will be assured.

The rule is focused on three major areas, which are:

1. Assurance that vehicles and equipment used in transportation operations are in appropriate sanitary condition;
2. Assurance that, for bulk cargo, a previous cargo does not make the food unsafe; and
3. Assurance that foods requiring refrigeration as a matter of safety are transported under adequate temperature control.

The rule allows the transportation industry to continue to use best practices, i.e., commercial or professional procedures that are accepted or prescribed as being correct or most effective, concerning cleaning, inspection, maintenance, loading and unloading, and operation of vehicles and transportation equipment that it has developed to ensure that food is transported under the conditions and controls necessary to prevent adulteration linked to food safety.

### Requirements Applicable to Vehicles and Transportation Equipment

The requirements applicable to equipment are stated in very general terms, which is ostensibly necessary given the breadth and variation among the types of equipment and modalities used for the transportation of food.

Under the rule, vehicles and transportation equipment used in transportation operations must be designed and constructed in a manner that is suitable and adequately cleanable for their intended use in order to prevent the food they transport from becoming unsafe, i.e., adulterated. FDA defines the term "adequate" to mean that which is needed to accomplish the intended purpose in keeping with good public health practice.

Ultimately, this will likely be interpreted from an engineering standpoint, meaning FDA will want independent



supporting information that is based on scientific data and that supports the adequacy of any measures. Although there are many ways to achieve the objectives, it will be important for stakeholders to ensure they are doing their due diligence with respect to ensuring that the equipment used to transport products is adequately constructed to ensure the safety of food. This means carefully working with carriers to ensure they are meeting their obligations.

### Requirements Applicable to Carriers Engaged in Transportation Operation

According to the rule, transportation operations must be conducted under such conditions and subject to any controls necessary to prevent the food from becoming unsafe during transportation operations. Although this is broadly stated, it means that all stakeholders must work together to ensure that food is being safely transported. This necessitates measures such as segregation, isolation, or the use of packaging to protect food from cross-contamination with other foods or nonfood items in the same load. Likewise, protective measures must be put in place to protect food transported in bulk vehicles or food not completely enclosed by a container from contamination and cross-contact during transport; it also requires ensuring that food requiring temperature control for safety is transported under adequate measures.

With respect to temperature, the rule only requires temperature control during transportation when it is necessary to prevent the food from becoming unsafe. That is, the rule does not establish requirements for temperature control during food transportation for any other purpose, such as for marketability purposes, or to preclude the spoilage of food subject to this rule. By way of example, whole, fresh apples, cherries, pears, and potatoes are all examples of foods that generally do not require temperature control for safety. FDA has stated it intends to ensure that inspectors understand which factors generally distinguish foods that require temperature control to prevent the food from becoming unsafe from other foods that are transported under temperature control for quality purposes. This is a gray area that

may cause some discord until further guidance and/or agreement is reached.

Shippers are responsible for determining whether a food is subject to the temperature control provisions of the rule. The rules do not specifically require any given type of monitoring, but it will be important to establish a means of showing that no temperature deviations occurred. This could include independently recording temperatures from time to time, or otherwise effectively showing, to the extent specific data is not available, that no deviations occurred. Put differently, this means that for food that requires temperature control for safety, the shipper must develop and implement written procedures, subject to the rule's recordkeeping requirements, to ensure that the food is transported under adequate temperature control. The recordkeeping requirements for transportation operations require shippers to retain records, for a period of 12 months, that demonstrate effective procedures to prevent the food from becoming unsafe during the transportation operation, to ensure that previous cargo does not make the food unsafe, and to ensure that the food is transported under adequate temperature control.

Deviations from the temperature control rules can render a shipment adulterated, but do not necessarily do so. To paraphrase FDA on this issue, inconsequential failures to maintain temperature controls will not necessarily render the affected food adulterated. However, if an individual subject to the rule is aware of an indication of a possible material failure of temperature control or other conditions that may render the food unsafe, the person must ensure the food is not sold or otherwise distributed, unless a qualified individual determines that the temperature deviation did not cause the food to become unsafe.

Importantly, these requirements apply to all shippers, carriers, loaders, and receivers engaged in transportation operations. A person may be subject to these requirements in multiple capacities, e.g., the shipper may also be the loader and the carrier, if the person also performs the functions.

Notwithstanding the previous provisions, parties can reassign their responsibilities to another party, provided that reassignment is set forth in a written

agreement. To the extent that such responsibilities are reassigned, there may be additional requirements that are triggered. For example, when the carrier and shipper have agreed in a written contract that the carrier is responsible, in whole or in part, for the sanitary conditions during transportation operations, the carrier must provide adequate training to personnel engaged in transportation operations. The training must provide instruction on the potential food safety problems that can occur during transportation and on basic sanitary transportation practices to address those potential problems, and must also specifically delineate the responsibilities of the carrier to ensure the transport of food in compliance with the Rule. Additionally, the training must be provided upon hiring and as needed thereafter. To ensure adequate compliance with the rule, carriers are required to create and maintain records documenting the training, including the date of the training, the type of training, and the person or people trained.

In the end, achieving compliance with the rule will require industry to focus on the three major areas:

1. Assurance that vehicles and equipment used in transportation operations are in appropriate sanitary condition;
2. Assurance that, for bulk cargo, a previous cargo does not make the food unsafe; and
3. Assurance that foods requiring refrigeration as a matter of safety are transported under adequate temperature control.

There are many ways to achieve these goals, depending on the type of food and manner of transport, and FDA will likely give industry significant leeway in developing its own ways to ensure compliance. The best practices, however, will be to continually communicate among shippers, carriers, and receivers; maintain clear and careful records; and set forth all parties' responsibilities in clear and precise contractual documents. Likewise, regular audits and reviews will ensure that once compliance is achieved, it is also maintained. ■

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# Cannabis Corner



## Potency Inflation in Testing

Why “friendly” labs frighten the cannabis industry

BY JESSE STANIFORTH

**J**im MacRae, PhD, founder and owner of Straight Line Analytics, a cannabis industry consulting and advisory firm in Seattle, doesn't like to use the words “bad,” or “fraudulent” when describing testing laboratories. Instead, he calls testing labs that deliberately inflate cannabis products to give producers whatever results they hope to get “friendly.”

This “friendliness” is a big problem in the cannabis sector. As more and more traditional food production companies consider chasing the hefty profits associated

with adding cannabinoids to their products, they must also be concerned with avoiding testing labs that report falsely sunny results or risking legal and insurance misery.

Since 2016, Dr. MacRae and his company have published reports about cannabis testing in his home state of Washington and in other states where cannabis is legal. From the beginning, he identified what he calls “potency inflation.” In the earliest years of legal cannabis use in the U.S., consumers tended to buy products with

the largest amount of intoxicating cannabinoid tetrahydrocannabinol (THC), or, in some cases, the non-intoxicating cannabinoid cannabidiol (CBD). Although these labs are best known for inflating the content of major cannabinoids like THC and CBD, as legalization speeds cannabis research and development and other emerging cannabinoids such as cannabitol (CBN) and cannabigerol (CBG) become desirable, Dr. MacRae expects to see some labs goose those numbers too.

In a series of studies performed since 2016, Dr. MacRae revealed some prominent Washington state labs that appeared willing to “fail virtually nothing,” he says. Some cannabis producers used the practice of “lab shopping,” in which they delivered samples from the same product batch to multiple labs, to choose the lab whose results would be most desirable to themselves and/or consumers.

For example, in one study, Dr. MacRae examined certain labs testing cannabis flower, which can contain no more than 15% moisture according to state regulations. “There were a couple of poll humps in the data distribution,” he tells Food Quality & Safety. “One of them was around ... 11%, which is ... an appropriately cured moisture level in the flower.” But, as products approached the brink of the failing 15% mark, result numbers began to stack up suspiciously.

“I did a chart at a resolution of a tenth of a percent,” he says, “and you could see a spike [of results] at 14.9%. Then I did one where it was a hundredth of a percent, and you could see a spike at 14.95% and 14.99%. And then I did one with a thousandth of a percent, and the spike was always just below where you'd fail.” These results can downplay readings on allowable limits such as moisture, pesticides, molds, and other pathogens.

### Shift toward Terpenes

As American legal markets have become more mature and sophisticated, consumers no longer just want high-cannabinoid

cannabis. Many buyers are also looking for cannabis featuring particular terpenes, the aromatic oils that give cannabis its distinct odors and flavors, such as skunk, diesel, citrus, pine, lavender, and spice. Terpenes are believed to contribute to both the psychoactive and therapeutic effects of cannabis, and many consumers like to buy with a particular terpene in mind, such as pine-scented pinene, believed to have anti-inflammatory qualities. As such factors become more desirable, Dr. MacRae expects to see the rise of friendly labs inflating terpene figures to give producers the results they want.

For Morgan Fox, director of media relations for the Washington, D.C.-based National Cannabis Industry Association (NCIA), this consumer shift away from high THC toward a consumer preference in flavors and odors offers an advantage: Consumers can smell and taste quality themselves, rather than rely on a lab result to determine how strong to expect a product to be. “Consumers are really looking for the qualitative experience,” Fox says. “Does it taste good? Does it smell good? The emphasis on having the strongest THC is really starting to diminish, particularly when people have time to get used to the wide variety of different products that are available now.”

### Where Edibles Come In

For companies that produce cannabis-infused foods and beverages, the challenges are similar, but with their own slant. To start with, cannabinoids in ingestibles are measured as doses in milligrams, rather than percentages of product weight. Infused food and drinks are mostly not made by cannabis producers or by extractors themselves; instead, ingestibles producers are very unlikely to work with whole cannabis flower; rather, they use its industrial by-products. And, while terpenes are a popular factor in choosing cannabis flower to smoke or vaporize, their powerful odors and flavors make them a challenge for industrial food producers to slip into popular infused-food formats such as gummies, baked goods, and chocolates.

Instead, food and beverage infusers generally buy bulk cannabinoids (often in the form of THC or CBD distillate), which they add directly to their products. Thus, an edibles producer that trusts its bulk cannabinoid supplier and the supplier’s lab is in a far more stable position than they would be as a grower bringing products to a testing lab and hoping to learn the thousand pounds of cannabis flower they produced this growing cycle is strong enough to sell. Yet, as always, trust is the issue: Can you trust the lab your supplier used?

Finding a lab you’re comfortable working with is much easier in a federally legal marketplace such as Canada. In the U.S., large multi-state cannabis operators (MSOs) are not allowed to move cannabis products outside the boundaries of individual legalized use states.

Brandon Wright, a pioneer in Canadian edibles, became an edibles producer following a 2015 Supreme Court of Canada decision that found that medical cannabis patients had the right to produce and possess cannabis-infused foods and beverages. When Canada green-lighted ingestible and topical cannabis products as well as cannabis extracts in its second wave of adult-use legalization last fall, Edmonton, Alberta-based Dynaleo, Wright’s company at the time, was among the first legal edibles producers in Canada and remains the country’s largest. Though Canadian cannabis producers are subject to a single national regulatory compliance standard, Health Canada’s demands are notoriously rigorous. For that reason, Wright counsels companies to implement their own high standards and be ready to do plenty of testing.

To avoid a discrepancy in THC percentage between your producer’s lab and your own, Wright says to try to use the same labs as your supplier. “Another way to avoid that kind of discrepancy is to have all of your inputs tested at your lab prior to using them,” says Wright. “This way, the same entity is measuring what goes in and what comes out.”

Wright tells producers to be conscious of this issue when drafting contracts and include language to account for discrepancies between a company’s lab and the lab of their cannabinoid supplier. This contract language can dramatically reduce the incentive to inflate, he says, and instead drives incentive for consistency among labs.

*(Continued on p. 49)*

## Standards for Accuracy?

In terms of objective measures of quality, no universal standards exist for cannabis. This problem is exacerbated in the U.S. thanks to the variety of different state-level approaches to cannabis quality, with testing demands that fluctuate from state to state. “There’s currently no regulatory structure set up at the federal level, although that’s something that [the NCIA is] working on through various forms of legislation over the next year,” says Fox.

Even federal regulations won’t unite the crazy quilt of varying state laboratory and testing demands, Fox adds. “Regulations will still be in place. You’re going to have to be compliant to whatever federal structure is there, as well as to the state in which you’re operating. That can get extremely complicated, because not every state regulates labs the same way. Some of them have a lot

more oversight; some of them have not very much at all.”

A new program put in place by the National Institute of Standards and Technology, part of the U.S. Department of Commerce, may help with accuracy in testing for key chemical compounds in marijuana, hemp, and other cannabis products and help ensure the quality of routine analysis throughout the cannabis industry. The Cannabis Quality Assurance (CannaQAP) program will help improve measurement consistency and product labeling. NIST will conduct various exercises with participating labs to determine an individual lab’s performance. All results from the exercises are evaluated by NIST and made publicly available as published internal reports, although individual labs are anonymous in the report. The first exercise will focus on the determination of cannabinoids in hemp oils.



# A Delicate Balance

Protecting  
meat plant workers,  
food safety standards,  
and the supply chain  
during COVID-19

BY AMANDA MCCORQUODALE



**T**his spring, as coronavirus cases in major metropolitan areas in the U.S. began to plateau, a spike in other areas of the country raised concern—both for loss of life and potential disruption of the food supply chain.

In 56 counties in the U.S., meatpacking accounts for more than 20% of all county employment. Starting in mid-April 2020, confirmed COVID-19 cases per 100,000 in these rural meatpacking-dependent counties grew rapidly, according to USDA's Economic Research Service, with infection rates as much as 10 times higher than those in other rural counties.

Meat processing plants proved to be far more susceptible to COVID-19 transmission than other sectors. As of September 2020, there have been 42,606 confirmed cases of COVID-19 among the 500,000 people who work in the meatpacking industry in the U.S., with 203 reported fatalities. That's in stark contrast to the 7,253 COVID-19 cases and 16 deaths in the farm sector and the 9,571 cases and 35 deaths in food processing plants, as cited in Food & Environment Reporting Network (FERN)'s dashboard tracking of COVID-19 outbreaks in the food system.

As more workers got sick or felt too unsafe to return to work, plants across the country shut down. Due to the production output of each of these plants, a single shutdown could affect as much as 5% of the supply chain.

The impact was sudden and unprecedented. By the end of April, weekly cattle slaughter was down 35% and hog slaughter by about 45%, according to Jim MacDonald, who was the acting chief of the Structure, Technology, and Productivity Branch at USDA's Economic Research Service before becoming a professor in the department of agricultural and resource economics at the University of Maryland in College Park.

The sharp decline in meat processing also forced hog farmers to euthanize their pigs, which have to be slaughtered at a specific weight, to avoid dangerous overcrowding. Cattle farms experienced an overabundance of livestock, causing prices to drop 18% in April and May.

Even as farmers faced a livestock surplus, fast food chains began running out of beef patties, and grocery stores had to tap into surpluses of frozen meat. John Tyson, chairman of the board with Tyson Foods, took out a full-page advertisement in numerous newspapers, stating that the crisis needed public and private sectors to work together to strengthen the supply chain and make sure employees can come to work "without fear, panic, or worry."

On April 28, President Trump signed an executive order classifying meat processing plants as "critical infrastructure" that could and should stay open during the pandemic. The companies that own the majority of meat processing plants—Tyson, Cargill, Smithfield, and JBS—began implementing personal protective equipment (PPE) requirements, social distancing protocols, test-

ing, and contact tracing. By June, there was a sharp reduction in the number of cases per 100,000 for these meatpacking-dependent counties, reports USDA. These counties now have only 1.25 times the two-week moving average number of cases per 100,000 compared to other rural counties.

Throughout the pandemic, we have had two priorities: First, keep our people healthy and safe, and second, keep our nation fed.

—KEIRA LOMBARDO, *Smithfield Foods*

Most researchers agree that the industry was able to quickly tamp down the flames of these hotspots to restore the stability of the meat supply chain. Yet, labor activists point to ways the industry still has to evolve to make sure workers are kept as safe as the supply chain.

### Unique Hotspots

Plants in other sectors, such as the automobile industry, often rely more on machines than on human labor; however, due to the carcass-specific cutting required in the packing industry, meat fabrication is still largely done by hand in the U.S. Workers typically stand very close together in these plants, which are typically very cold and very loud—all conditions that make transmission of aerosol diseases more likely. "It's not a good place to work if you're prone to respiratory diseases," says MacDonald. At press time, COVID-19 infections have impacted the operations of 496 U.S. meatpacking facilities, as reported by FERN.

There is also a correlation between how fast a plant's line speed is and the rate of coronavirus transmission. "In order to hit the line speed of 120 birds per minute in a poultry plant, [plants] have to put workers shoulder to shoulder," says Jose Oliva, campaigns director at HEAL Food Alliance, a nonprofit organization working to create food and farm systems that are healthy for farmers, consumers, and the economy. "Even if you have a mask on, at that speed, there's blood and other body fluid flying around, and you're much more likely to contaminate yourself and others."

(Continued on p. 22)

(Continued from p. 21)

Additionally, because some people who have COVID-19 are asymptomatic or have very mild cases, workers worried about lost wages may have chosen to show up to work even when sick. Some plants have a point system, says Oliva, which means that missing a day of work adds to accumulating infractions that could end in job termination.

Meatpacking plants also hire large groups of workers who often congregate in the same spaces multiple times a day, from where they live to how they commute. “We set a plant down someplace, and we bring in 900 workers. We’ve essentially set up a little cohort of people, and the opportunity for community spread is really amplified in that that type of setting,” says Edward Mills, PhD, associate professor of Meat Science at Penn State University in University Park. “From my experience, the guys that work in the plants tend to spend a significant amount of time together in the bars as well, where there is a lot of close contact.”

### Industry Response

To date, Tyson Foods has had the most COVID-19 cases by company (10,660, with 35 deaths, according to FERN), even though they formed a coronavirus task force in January 2020. “We were one of the first companies to start taking team member temperatures, and we began efforts to secure a supply of face masks before the CDC recommended using them,” says spokesperson Gary Mickelson. They also initiated comprehensive health screenings, including purchasing 150 infrared walkthrough temperature scanners and adding a new position of chief medical officer.

Tyson now also uses 500 social distancing monitors to ensure social distancing and confirm that PPE is worn properly. Tyson’s plants now include physical barriers between workstations and in break rooms, more break room space, such as in outdoor tents, and staggered start times to avoid large gatherings as team members enter the facilities. “About a third of our U.S. workforce have been tested,” says Mickelson. “Currently, less than 1% of Tyson Foods’ U.S. workforce has active COVID-19.”

Meanwhile, Smithfield, which lost eight workers to COVID-19, says the com-

pany has spent \$350 million to protect its team members as well as the food supply. This allowed them to expand employee benefits and remove all COVID-related limitations in their health plans; add pay premiums; hire private healthcare providers to supply free, on-site, on-demand COVID-19 testing to all employees; provide PPE and hand sanitizing stations; install mass thermal scanning systems and physical barriers; and slow line speed.

“Throughout the pandemic, we have had two priorities,” says Keira Lombardo, executive vice president of corporate affairs and compliance at Smithfield Foods. “First, keep our people healthy and safe, and second, keep our nation fed. These remain our sole priorities.”

JBS USA, which closed four production facilities due to the outbreaks, all of which are now open again, spent \$100 million to enhance safeguards for its workforce and nearly \$100 million to reward team members with thank you bonuses. “We also hired 1,000 team members to conduct additional, around-the-clock sanita-

tion and cleaning services and to provide education, training, and enforcement of COVID-19 preventive measures,” says a company spokesperson. To further ensure a safer work environment, JBS is also using ultraviolet germicidal air sanitation and plasma air technology to neutralize potential viruses in plant ventilation and air purification systems.

To encourage safe practices even when employees are not at work, Cargill, which has had 1,372 COVID-19 cases in its facilities, began providing buses with protective barriers to employees to discourage carpooling. Inside the plant, the company implemented standard prevention measures such as PPE, barriers, and social distancing, as well as a temporary wage increase. “If our employees see a practice that does not adhere to our values or these policies, we encourage them to speak with a manager or call our open ethics line,” says a spokesperson. “We adopted a ‘see something, say something’ safety culture many years ago to ensure our workplaces are safe for all who enter.”

### The Case for Legislation

Production may be back to near pre-pandemic levels, but do workers feel safe? Not really, says Oliva. “Just yesterday, workers were telling me they’re not so concerned about getting masks and face shields,” he says, adding that they’re more concerned about social distancing and being shoulder to shoulder on the production lines, which he says goes back to line speeds.

He notes that even if ample risk mitigation measures are recommended by corporate, it’s up to a plant’s manager to balance those with what needs to happen to meet target production rates. To ensure that companies are prioritizing worker health as much as profits, U.S. Senator Cory Booker recently introduced a bill that would limit increase of line speeds at meat plants during the pandemic.

“There are also a lot of companies that haven’t gotten rid of their point system,” adds Oliva. “So, it may be corporate policy to stay home if you feel sick, but missing work could also lead to a point against you. It’s a mixed message for workers who have

to choose between an income and the public health.”

Ultimately, until there is a mandated standard to implement CDC guidelines, workers will be at the mercy of their individual plant’s management. “In the HEROES (Health and Economic Recovery Omnibus Emergency Solutions) Act, which was passed in the House and has stalled in the Senate, there’s some very clear language around how OSHA should be implementing CDC guidelines in these facilities,” Oliva says. “If passed, it would literally take care of 90% of the problems.”

In a recent statement, Marc Perrone, president of United Food and Commercial Workers International Union, which represents the more than 250,000 meatpacking and food processing workers, wrote, “If we truly care about protecting workers and our nation’s food supply during this pandemic, the federal government must take action, beginning with an enforceable national safety standard, increased access to PPE and COVID-19 testing, and rigorous proactive inspections.”—AM



We set a plant down someplace, and we bring in 900 workers. We've essentially set up a little cohort of people, and the opportunity for community spread is really amplified in that type of setting.

—EDWARD MILLS, PHD, Penn State University

Most plants are back up and running at about 95% of typical production levels, says Keith Belk, head of the department of animal sciences at Colorado State University in Fort Collins, but with less staff on the floor, and with shifts spread out over more days. To keep production numbers up, plants may be opting not to fill custom orders. They also may be shipping more half or whole carcasses and producing fewer tray-ready cuts that go right onto supermarket shelves.

### Preventing Future Shutdowns

The coronavirus pandemic represents a shift for the meat processing industry, which will have to be as diligent about protecting human health as it is about food safety. "It took the 1993 E. coli outbreak at Jack in the Box to really figure out what we needed to do to prevent food safety outbreaks," says Belk. "I think the same will be true here."

Looking forward, researchers think that new meatpacking plants will be designed to avoid some of the pitfalls of the shutdowns in April and May. This could mean building more, but smaller, plants so that one shutdown doesn't have as sizable an impact on the supply chain. Future plants could be built with more square footage to enable better social distancing. They may also be designed with optimized personnel flow within the plant. "We did this years ago when we got more serious about eliminating pathogens in raw products, and we knew we couldn't have people go from raw areas in the plant to other areas," says Dr. Mills.

The most foolproof solution, however, would be to invest in more automation at the fabrication level. At Europe's largest pig slaughterhouse, which relies heavily on automated labor, only 10 of its 8,000

workers contracted coronavirus during the pandemic. The meat supply remained secure, and the workers overseeing the series of advanced robots that fabricate pig carcasses remained largely safe.

Automation in meat fabrication would be a significant investment, however, as artificial intelligence is needed in order for these robots to perform carcass-specific evaluation and cutting. Because meatpacking production in the U.S. has just about fully recovered, spending that kind of capital could be a tough sell. "I'm guessing that managers are thinking, 'You know, we've handled this pretty well,'" says MacDonald. "I'm not sure that we will see really major investments in the future of these plants unless they find themselves facing another wave and really getting dragged down."

Others note that if such an investment meant a much more stable food supply, consumers might be ready to pay more for meat at the register. "During the last two to four decades, Americans have only spent about 6% of our disposable income on food. That's the lowest of any country by far," says Belk. "Clearly, potential food shortages during the pandemic caused the entire U.S. population to instantly recognize the value of a secure supply chain."

In the rippling wake of the pandemic, it's easy to see how a secure supply chain starts with a healthy workforce. Even if the industry doesn't invest in a fleet of robot technology across the board, companies will have to invest in the health and wellness of their human workforce more than ever before to ensure that the shutdowns from the spring of 2020 never happen again. ■

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# Safety & Sanitation

PEST CONTROL



## Five Criteria to Help You Evaluate Your Pest Management Provider

The right provider should produce a plan that meets all applicable audit standards as well as your other specific company needs | BY SHARON DOBESH

Choosing the right pest management provider for a food manufacturing or processing plant is a necessity, because the presence of pests can be costly. Neglecting to contract with a trusted provider who can meet the needs of your company can affect your operations, reputation, and bottom line. A major pest problem, whether it is from a gap in preventive care or an inability to handle a situation that unexpectedly arises, can create numerous challenges. In some cases, your company could be responsible for expensive product recalls or other regulatory action.

With such stakes on the line, companies need knowledgeable and trusted pest management providers. Identifying whether a pest control provider fits the needs of your facility, however, can be a challenge in itself. With so many options to choose from, it can be daunting to choose the most qualified provider for the job. Needless to say, when you set out to find the best pest control fit for your company, it is easy to become overwhelmed.

As you balance myriad responsibilities at your company, the last thing you should have to worry about is whether the pest management provider you hired is

doing its job. Rather than wait to endure the potential consequences of a less-than-ideal partnership, consider orienting your decision process around the key qualities of a good pest management provider.

A good pest management provider should be able to offer you a comprehensive integrated pest management (IPM) program with preventive measures that can reduce the risk of a pest problem, but their program should not stop there. The right provider should produce a plan that meets all applicable audit standards, as well as your other specific company needs.

To better understand what to look for in your potential pest management provider, consider using these five key criteria as decision-making guidelines:

### 1. Extensive Food Industry Experience

The food manufacturing and processing industry is an incredibly specialized area of service, and the work is completely different than that of industries such as restaurants or multi-family services. When choosing a provider, note that their

expertise may not transfer across these industries, because the food manufacturing and processing industry has distinct and stringent protocols. Your provider should be well-versed in the food processing industry, including safety regulations, audit compliance, regulatory compliance, and more. This expertise can help mitigate the likelihood of costly mistakes that could stem from being less familiar with the industry's needs. Each niche of service proposes its own tasks and struggles, and hiring someone who either specializes in or has experience in food processing can directly influence the effectiveness of the pest management in your facility down the line.

## 2. Technical Knowledge

Your pest management provider should serve as your go-to source for up-to-date information. From rules and regulations to the latest technology, your provider should be a wealth of knowledge, not only for your organization, but for the food processing and manufacturing industry



as a whole. In fact, to utilize the best pest control practices for the food processing and manufacturing industry, they should follow industry updates. For a strong partnership, your provider should be able to communicate these ideas and updates to you and your employees. Your provider should also be readily available to answer questions and offer any other helpful insights related to pest prevention. Your provider's ability to share this knowledge and make it more accessible will further reinforce your IPM efforts. This mutual understanding and guidance, in all cases, will greatly bolster the preventative steps your facility takes.

From rules and regulations to the latest technology, your provider should be a wealth of knowledge, not only for your organization but for the food processing and manufacturing industry as a whole.

## 3. Geographic Coverage and Consistent Service

Consider the location of your facility when choosing a provider, because different providers treat different regions. With each region come different pests due to variances in landscape and climate. Should your company operate in multiple locations, as many food manufacturing and processing companies do, be sure to research whether your potential provider typically covers the scope of your locations. This will ensure that your provider knows the pest risks associated with the area and can address each location's needs. In fact, it is best to make sure potential providers have the ability to service all of your locations. By utilizing the same provider across locations, you can simplify operations at all of your facilities and always know exactly who to call when you have a question or need support. The result will be a timely response, which is necessary if a crisis arises. Continuity and rapid response can make a noticeable difference when it comes to pest management.

## 4. Applicable Credentials

In the same way your company needs proper certifications and licenses to operate in the food processing and manufacturing industry, pest control providers need proper credentials. These will vary depending on a person's role, but the correct credentials from everyone involved are crucial. From the technician who services your facility to the inspector who reviews the effectiveness of your IPM, each acting member from your pest management provider needs to be appropriately trained to complete their job effectively. Higher levels of management in pest control should hold certifications and, when applicable, additional certificates and degrees. Technicians and field workers should also hold appropriate certifications and should have completed the proper training. All providers must be certified and licensed by their state's appropriate regulatory agency. You

should ask your provider whether or not their licences are up to date.

## 5. Reporting and Trending

As the customer, you should be able to follow your site's pest management status at a glance whenever needed. This includes knowing when your provider last serviced your facility and what they accomplished during their visit. With access to these updates, you can have confidence in your provider, knowing there is an added layer of accountability. A reputable provider understands that readily accessible reports help to provide transparency, both strengthening your partnership and helping you monitor the status of your facility. This can prove crucial for your company in the event of an audit as well. During an audit, your providers must be able to offer detailed reporting to you for documentation purposes. Any pest management company that does not offer reports and access to your records and status when you request them should raise a red flag.

As a decision maker in charge of selecting your company's pest management provider, you have a great responsibility, and the choice you make could be crucial for the long-term success of your operations. From audit compliance to reputation to your company's bottom line, who you choose as a provider can affect your business positively or negatively for years to come.

Knowing what key factors to look for when choosing a provider can help narrow down your options to the one that meets all of the needs of your company. Utilizing these five tips as a roadmap and researching your options as you determine which companies could serve as your pest management provider will help simplify your decision and set you on the path to success. ■

**Dobesh** is a director of technical services at IFC. She has spent the last 16 years as an extension specialist at Kansas State University, and she holds an MS in entomology and a BS in crop protection-entomology. Reach her at [sdobesh@indfumco.com](mailto:sdobesh@indfumco.com).



# Quality



## Sustainability and Shelf Life

How enzymes support bakers to meet shelf-life challenges, reduce food waste, and cost-effectively deliver a clean label

BY RICHIE PIGGOTT

**A**lmost as soon as baked goods come out of the oven, they begin to degrade. For bakers, it's always a race against time to get their fantastic fresh products distributed and onto consumers' tables before quality starts to suffer.

To extend shelf life and maintain taste and flavor, manufacturers have traditionally used food additives to preserve the quality of their products, but

this practice is dropping off rapidly as increasingly health-conscious consumers adopt a clean-label mantra that rejects additives. When we add in the recent challenge of a global pandemic—during which widespread consumer stockpiling, supply-chain disruptions, and altered consumption patterns have become the norm—bakers have been under intense pressure to boost output, quality, and, most importantly, shelf life. The need for

consumer-friendly shelf-life extension solutions that uphold quality and taste standards over time has never been more acute than it is right now.

### Curbing Waste Along the Entire Bakery Process

Food waste is no small matter: Each year, it adds up to between a staggering one-third and one-half of all food produced globally, at an economic cost of \$940 billion to the world's economy. Within this figure, the U.S. represents approximately 40% of global food waste, accounting for the highest per capita quantity of food loss worldwide. Viewed by category, meat has the highest overall value of waste, while baking creates the largest volume of waste.

In a world in which one of every nine people is undernourished, it is a sad fact that more than a billion tons of food goes to waste annually. To assist with this alarming problem, the Food Loss and Waste (FLW) Accounting and Reporting Standard, the first-ever tool to measure food loss and waste, was introduced in 2016. Since then, many food and beverage manufacturers, including the leading global bakery companies, have committed to reducing food waste by 50% by 2025. This is no mean feat, and it highlights the need for effective, economically viable solutions.

To address the challenge within the bakery industry specifically, it is important to consider every stage of the production process, from the initial farming of wheat and grains right through to consumption by purchasers. The production stages ripe for improvement include manufacturing, distribution, and retail and at-home storage, with solutions constantly being sought to reduce spoilage at each level. At the same time, it is important to seek production efficiencies that will lower environmental footprints and improve sustainability profiles, all while delivering the additional benefits of less variance, lower yield loss, and faster output.

### The Rising Challenge of Clean-Label Bakery Products

These days, the most sought-after solutions are "clean-label," meaning they offer enhanced food protection benefits (e.g., longer shelf life) without the use of addi-

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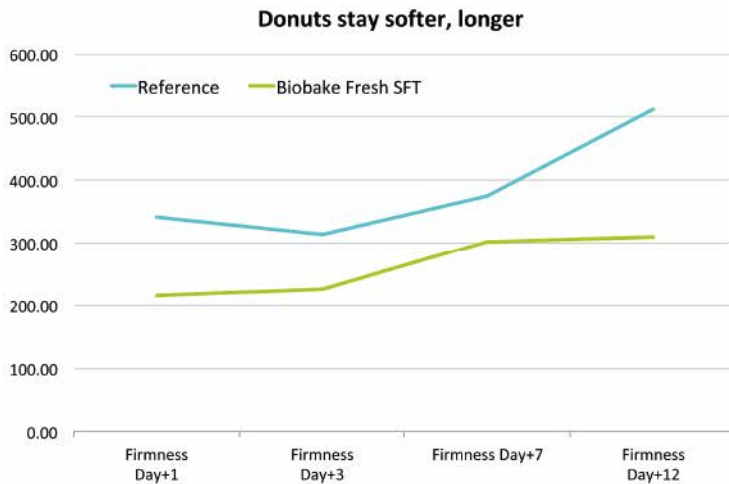


Figure 1: Day 12: Kerry Biobake Fresh SFT enzyme is proven to increase softness over shelf life in donuts. On day 1 the donuts with the enzyme were softer than the reference and by day 12 they still maintained this position. Shelf life was doubled while maintaining desired softness and texture.

tives. Today’s consumers are driving the trend with their demands for fresh, better-tasting products with more simplified labels that meet their expectations around health and sustainability. The Kerry *Future of Food* survey on consumer attitudes toward clean labeling found that 76% of food service consumers believe clean-label foods are healthier than their traditional counterparts. The same survey confirms that a significant majority (74%) frequently read product labels when purchasing food and beverages; when you look solely at younger millennial and Gen Z consumers, that number moves up to 80%.

### Consumers Care about Sustainability

A staggering 89% of global consumers expect companies to invest in sustainability, up from 65% in 2018, revealed by a 2019 Innova Market Insights report. By way of proof, over the last five years, according to research by NYU’s Stern’s Center for Sustainable Business on U.S. consumers, products branded as “sustainable” have experienced 5.6 times faster growth than their standard competitors’ items. Even during the COVID-19 pandemic, according to Stern’s research, products with a sustainability claim have continued to grow, enjoying a 17% market share during the first half of 2020. What’s exciting is that sustainable solutions in baking go across the entire production process, from manufacture to distribution to the store and the home.

Of note, while millennials are highly likely to buy products marketed as sustainable, the larger collective (Gen X and baby boomers) combines to purchase the highest volume of such items. For bakery products specifically, consumers want to know about the ingredients, processes, and companies behind the food they are eating. Their desire for convenient, freshly baked goods still predominates, but it is clear manufacturers must communicate to customers that their purchase was produced in an ethical manner. This requires bakery manufacturers to be forward thinking in their sustainability efforts in myriad areas, among them raw materials, production processes, energy efficiency, food waste, packaging, and distribution.

### Enzymes: The Right Solution at the Right Time

Enzymes are proteins produced by all living organisms, including microbes, plants, and humans, that act as catalysts to bring about specific biochemical reactions in nature. Their natural origins, proven safety, efficiency, and specificity make them extremely useful in a range of different industries.

Among many baking examples, specific amylase enzymes can release sugars from the starch in flour to generate sugars that the yeast can then utilize to optimize bread volume. Similarly, lipase enzymes can modify fats and lipids to form emulsifiers that help dough handling and bread texture. Maltogenic amylase, for

instance, is used to slow the loss of moisture and the recrystallization of starches in bread, thereby slowing down the “staling” process.

With attributes such as these, enzymes are sought after for their shelf-life extension abilities and specific product enhancement properties. Even further in their favor, enzymes are adept at speeding up reactions and are considered star performers in terms of sustainability improvements. When several processes are optimized, the benefits accrue: less water and energy used; dough retard and refrigeration time reduced; and shorter production time overall.

It is increasingly obvious that consumers want to know what goes into their food. Even before the COVID-19 pandemic changed consumer behavior, the clean-label food protection movement had shown little sign of slowing down. Kerry’s *Beyond the Label* report on consumer awareness of clean-label processes found that 75% of respondents are prepared to pay more for products they perceive to be natural. Consumers are also rejecting preservatives as a broad category, tending to vilify all unfamiliar or unpronounceable names equally.

This introduces another significant benefit of enzymes: their labeling requirements. Considered “processing aids,” enzymes do not require labeling in a majority of countries around the world. With “less is more” the mantra for consumers when it comes to ingredient labels, enzymes present a clean-label advantage.

### Fried Products: Enzymes Can Double Shelf Life and Improve Eating Quality

For producers of fried products such as donuts and Berliners, the challenges of maintaining product softness and moisture, along with consistent volume, dough tolerance, and uniformity of texture (in short, shelf life) are universal. Kerry has developed an enzyme that addresses these specific manufacturing challenges and can increase a product’s shelf life more than twofold—from seven to 15 days—while maintaining desired softness and texture.

A comparative analysis carried out at the Kerry Global Technology & Innovation Centre confirms that, on day 12, donuts

(Continued on p. 28)

(Continued from p. 27)

containing the enzyme were significantly softer to the touch, a quantifiable improvement of more than 40% for that one characteristic alone (see figure 1). Further, the enzyme solution has been shown to improve the eating quality, texture, and volume of fried products without increasing weight. A further key consideration for manufacturers of such products is the fact that this new formulation requires no changes to a product's label or nutritional profile. The cumulative benefits include reduced waste, a lower carbon footprint, and increased revenue at a lower manufacturing cost.

### Burger Buns: Enzymes Improve Quality, Durability, and Visual Appeal

As important as shelf life certainly is in baked products, strong visual appeal cannot be overlooked. When it comes to servicing demand in quick-service restaurant (QSR) chains, burger buns, for example, need to maintain visual appeal throughout the preparation process and up to and including the point of consumer consumption. Due to a lack of dough resiliency, damage can occur during the freeze-thaw process when stock is stacked.

Enzymes provide burger bun manufacturers with an effective, clean-label method with which to tackle and overcome these processing challenges. With the correct enzyme solution being applied, the resiliency of burger buns can be significantly improved. The benefits of improved resiliency

## Functions of Enzymes

- Enzymes are used as alternatives to traditional chemical-based technologies, allowing advantages in environmental performances by lowering energy consumption levels and the biodegradability of products.
- Enzymes are more specific in their actions than chemical reactants, with fewer by-products.
- Enzymes can catalyze reactions under mild conditions, allowing for processing without destroying valuable attributes of food and its components.
- Enzymes are cost effective and provide better food safety; using enzymes instead of food additives reduces overall manufacturing costs.

## Cracker Manufacturing: Quality Improvements, Cost Savings

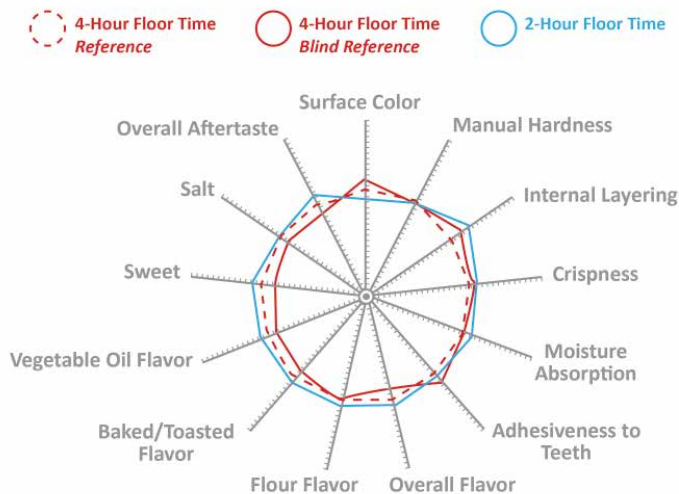


Figure 2: Reducing dough lay time by 50%: a comparative sensory analysis of four-hour versus two-hour dough lay time containing a Kerry enzyme for crackers. Enzymes can improve manufacturing efficiencies. One cracker manufacturer attained a number of efficiency improvements in line efficiency, waste, dough development, shrinkage, consistency of color and crispness, and reduced water consumption, worth an estimated \$220,000 annually.

continue further downstream along the supply chain where the burger buns can withstand the transition from frozen to thawed very well, holding their shape while being stacked, processed, and delivered. The end result: improved back-of-house efficiencies, longer shelf life, reduced waste, and increased consumer satisfaction.

### Crackers: Enzymes Improve Baking Manufacturing Efficiency

A cracker manufacturer was experiencing a less-than-optimal 68% plant throughput that was resulting in 30% food waste and inconsistencies in sensory appeal. The company wanted to improve plant efficiency, reduce waste, and produce consistent crackers that would feature a more appealing brown color and crispier texture.

By applying enzymes during the production process, the manufacturer was able to achieve an impressive cohort of results: an increase in line efficiency to a striking 90%; reduced food waste (-20%), dough development time (-50%) (see figure 3), and cracker shrinkage; improved product consistency; the desired color and crispier texture; and decreased water consumption.

Furthermore, utilizing enzymes in the process allowed for the elimination of the additive sodium metabisulfite, delivering the additional benefit of a cleaner product label. Along with these quality

and efficiency benefits, the enzyme solution lowered costs and mitigated food waste significantly, taking the company a giant step closer to its sustainability targets. Collectively, the financial benefit of enzyme utilization for this cracker manufacturer added up to savings of as much as \$220,000 annually.

At a time when global food manufacturing is in a state of deep flux, due largely to the pandemic and ensuing economic upheaval, bakers have the opportunity to improve shelf life, enhance quality, and streamline production processes, and all of this can occur while moving in the right direction in terms of consumers' clean-label and sustainability demands. As evidenced by the donut, burger bun, and cracker instances touched on above (a few of many examples), it is clear that enzymes are on an upward trajectory and are firmly here to stay.

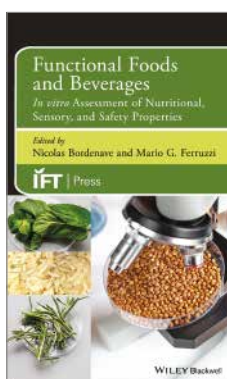
As the world copes with the tremendous challenges presented by the pandemic and moves in tandem with food consumption patterns as they evolve and eventually take root, manufacturers worldwide will need to continue to heed the call to increase production while decreasing waste. In response, the rise of the humble enzyme will no doubt accelerate. ■

**Piggott** is vice president-business development for enzymes in North America at Kerry Taste & Nutrition. Reach him at richie.piggott@kerry.com.

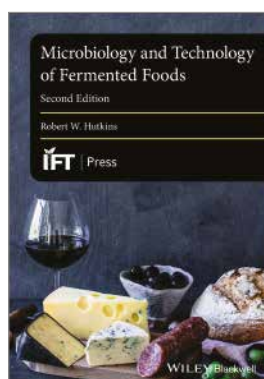


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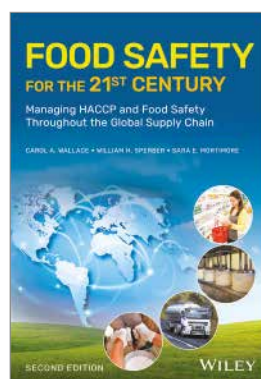
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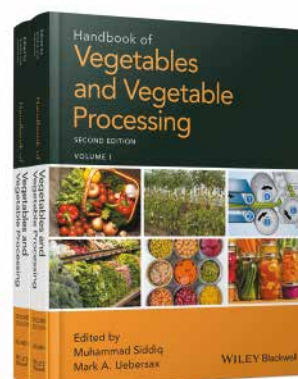
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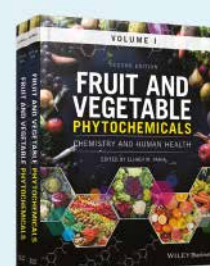
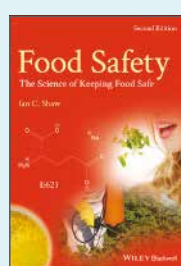
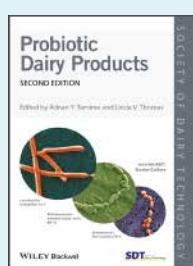
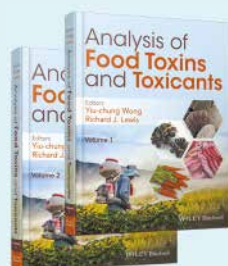
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## Oil Filtration: An Overview

Filtration varies in complexity depending upon the system and materials used

BY RICHARD F. STIER

**Editors' note:** This is the third in a series of three articles on frying. Part 1, "How to Ensure Quality in Fried Foods," was published in the June/July issue of FQ&S and Part 2, "Frying Studies," was published in the August/September issue.

In part 1 of this series on frying, we referenced the work of Dr. C.J. Robertson, who cited six elements for quality frying:

1. Proper design, construction, and maintenance of equipment;
2. Proper operation of equipment;
3. Proper cleaning of equipment;
4. Minimal exposure to ultraviolet (UV) light;
5. No salt and other metals sources in oil; and
6. Regular oil filtration.

Fryer operators at foodservice/restaurant or industrial operations should follow these criteria to better maintain and manage their frying oil and help ensure the production of quality fried foods. This means producing good tasting, high qual-

ity fried foods. Of these six criteria, perhaps the most effective and the one that can potentially yield the most benefits is the last: Filter oil regularly.

The following quote by Yates in 1996 supports this statement: "After the selection of the equipment itself, the most important aspect of frying oil filtration is the choice of the filter medium."

The efficacy of filtration is a function of many things, one of which is obviously the equipment. Oil filtration varies in complexity depending upon the system and materials that are utilized. More than 30 years ago, Michael Blumenthal, PhD, attempted to simplify the basics of oil filtration media or systems by defining two basic types of filtration:

**Passive Filtration Systems:** These systems simply remove particulate from the oil through sieving. Passive filtration has also been called simply "filtration" by some. Examples of passive systems are filter paper, diatomaceous earth, bag filters, and steel screens. McLeod expanded on this type of system, describing passive fil-

tration as the mechanical removal of solids by screening or fine filtration (2015). This is considered to be anything from 2 mm to 4 mm screens down to typically 50 microns. Other types of mechanical filtration, such as cake or depth filter pads, can go down to as low as 1  $\mu\text{m}$ .

**Active Filtration:** Active systems are much more complex. These systems not only remove particulates but will remove oil-soluble components from the frying oil. Active systems are also referred to as "treatments." These include powders, impregnated paper or pads, and paper with active powders. Gupta (1992) further stated that active filters are those where the oil impurities are reduced via physical as well as chemical reactions, in addition to the removal of the suspended materials in the oil.

Figure 1 shows how oil life may be extended through the use of a passive filter and an active system or treatment. Fryer operators must understand that once frying is initiated, the damage to the frying oil cannot be reversed. It can, however, be slowed, which is one of the principle benefits of oil filtration or treatment.

Chow and Gupta (1994) provide support for this statement. They have observed that, "in reality, it is never possible to take any kind of used oil, reprocess it, and turn it into a product as good as the original." They further note that "it is, however, possible to treat used oil in a specific manner to retard its degradation, and thereby prolong its useful life and reduce overall cost of the oil."

Figure 2 is an example of how an active depth filter system or treatment works. Looking at the figure, you can see sieving or filtering to remove particulates, plus entrapment, adsorption, and absorption—reactions with the soluble components of the oil—which means that the oil is actually treating the oil. The figure also provides additional detail on how sieving, entrapment, adsorption, and absorption function.

Jacobsen (1991) described the importance of filtration and the removal of particulates that move from the food into the oil. He recommended that operators filter regularly "to remove charred batter and breading materials because these materials can darken oil, contribute bitter flavors to foods, impede heat transfer, and ruin

the appearance of fried food.” Particles remaining in the oil continuously leach their components into the oil, chemically degrading the frying medium.

Blumenthal (1987) has observed that “food particles in an oil act as reactive sites for oil degradation.” A simple analogy to particulates in oil may be a starter crystal in a sugar solution in the production of rock candy. Without the starter, the desired crystallization will not occur. The same idea holds true with the chemistry of the frying oil: Remove the particulates, and reaction rates are slowed. Again, this may be seen in Figure 1.

### The Pros and Cons of Oil Filtration

In foodservice or restaurant operations, oil life extension is one of the most important elements to ensure profitability. There are other potential benefits, but people also need to understand that oil filtration or treatment is not a panacea. Table 1 lists both potential benefits and concerns.

Let’s take a look at some of these benefits of and concerns with oil filtration and treatment. Some of these issues are closely interrelated. For example, extending oil life, which, as noted, is of paramount importance not only to restaurant and foodservice operators, but also to industrial operators, will also result in reduced oil usage and improved food-to-oil ratios. The food-to-oil ratio is a calculation that shows the amount of food fried to pounds of oil used. This can result in significant savings for the operator and also means that the amount of oil that has to be discarded (waste oil) is reduced. Simply extending fry life from two to three days in a 50-pound fryer will save almost 3,000 pounds of oil per year. Extending the oil life to six days will save 5,800 pounds per year, as may be seen in Table 2. This also means less oil handling, fewer concerns with discard issues, and reduced operating costs.

Food quality is another potential benefit. Food quality is a characteristic that depends upon the operator. It could be improved shelf life, enhanced flavor, or improved overall appearance of the product. One industrial processor adopted an active treatment system, which improved the shelf life, flavor profile, and overall appearance of a fried pepper product. The product fried in oil that was subjected to the oil treatment had improved pepper flavor and aroma when evaluated by an expert sensory panel.

When evaluating any kind of system in a food processing environment, operators must look at both potential benefits and concerns. As an example, Europe discourages the use of pow-

Table 1: Oil Filtration Pros and Cons

Pros of Filtration	Cons of Filtration
<ul style="list-style-type: none"> <li>• Reduced energy usage</li> <li>• Reduced oil usage/ reduced waste oil</li> <li>• Improved food–oil ratio</li> <li>• Enhanced shelf life</li> <li>• Reduced down time</li> <li>• Oil life extension</li> <li>• Reduced cleanup time</li> <li>• “Healthier” cooking oil</li> <li>• Safer work place</li> </ul>	<ul style="list-style-type: none"> <li>• Leaching of powders</li> <li>• Leaching of metals</li> <li>• Lack of good equipment</li> <li>• Hard to use, especially in foodservice</li> <li>• Legal issues</li> <li>• Capital costs</li> <li>• Safety</li> </ul>

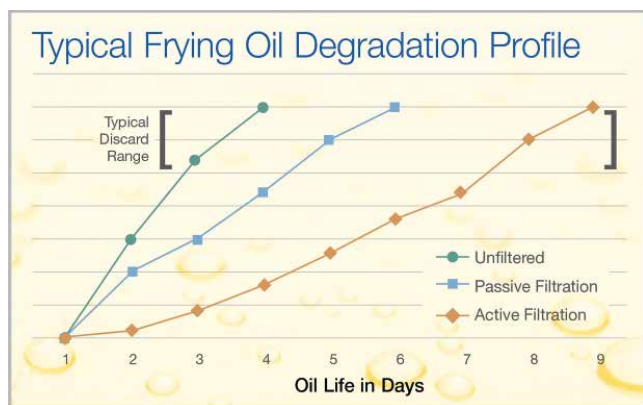
ders for oil treatments, whereas they are allowed in the United States. There have also been issues when it comes to handling powders. People should wear the appropriate personal protective equipment (PPE) when handling powders, which should include gloves and masks. This can be more difficult to manage and enforce at the restaurant level than in industrial operations. Lastly, there are products on the market that may seem beneficial but are, in reality, more damaging to the oil. There are treatment products on the market that will reduce free fatty acids in the oil by converting them to alkaline soaps. The soaps are very damaging to frying oil, enhancing the formation of free fatty acids and catalyzing oxidation reactions that will produce off flavors in fried food, in addition to significantly reducing oil life.

Perhaps the biggest concern with any kind of filtration system is blinding of the filter. Industrial operations often use indexing paper filters to continuously remove particulates from oil. A stationary system could blind very quickly, especially in an operation producing battered products, hence the indexing or moving paper. The type of product being fried has a direct influence on the potential for blinding a filter. By-products of frying that are slimy, pasty, or sticky will have a greater potential for blinding a filter. Examples of these products are meats, fish, and kettle-style potato chips. One might ask, “Why kettle style?” They are not rinsed prior to frying, so the potato starch ends up in the oil. Items like fried corn products, such as tortilla chips and breaded products, yield grainy by-products that are less likely to blind a filter and, in fact, can even build a filter cake on the filter medium.

### Selecting an Oil Filtration or Treatment System

There are many different products available to the fryer operator at both the foodservice/restaurant and industrial levels. Each and every fryer operator will probably utilize a passive filtration system of some sort, but the question is, “Would installing an active system be beneficial or not?” In industrial frying, there are many different systems available to remove particulates, some of which are not filters at all. There are drag bars that remove particulates that settle to the bottom of the fryer and are then dragged from the fryer by the bar. Some processors use centrifugal separators. Systems that filter oil include catch boxes, stainless steel screens, rotary drums, stainless steel baskets, continuous belt filters, bag

(Continued on p. 32)



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(Continued from p. 31)

Table 2: Oil Usage and Costs

Days of Oil Use	Cycles (days in year/ oil usage)	Oil Usage (cycles x oil used per cycle)*	Savings Oil = \$1.00/lb
2	182.5	12,593 lbs/yr	0
3	121	9,680 lbs/yr	\$2,913
4	91	8,281 lbs/yr	\$4,321
5	73	7,446 lbs/yr	\$5,147
6	61	6,771 lbs/yr	\$5,822

\* Assumes a 50-pound fryer.

filters, and filter presses. Heat and Control is one of the main producers of fryers and frying systems.

There are also active systems currently in use by industrial frying operations. Most of these are designed to treat oil at the end of the day's production. One example is a system where the used oil is mixed with an active treatment powder and allowed to react with the oil in a mix tank. The treated oil is then filtered to remove the powder and transferred to a holding tank or back into the fryer to be used in the future. The Dallas Group provides powders and the treatment system. Other systems, such as those from Filtercorp, utilize filter pads impregnated with active ingredients. The oil from the fryer is slipstreamed from the fryer and pumped to a filter vessel and through the filter pads on a continuous, real-time basis, before it is returned to the

fryer or a holding tank. Filtering/treating oil continuously would require a pre-filter to remove suspended solids to prevent blinding of the system.

Today, a significant percentage of the fryers used in restaurant or foodservice operations are manufactured with a built-in filter apparatus but may also have working relationships with one or more suppliers of filtration products and services. There are also fryers that do not come with a built-in filter. In these fryers, an operator must utilize a portable filter that can be hooked up to the fryer at the end of the work day. Years ago, some operators used cone filters. The user would place a filter in the metal cone, and the fryer operator had to ladle oil into the cone so it could flow through the filter via gravity. These units posed a significant risk to workers handling the hot oil, so it is good that they have been phased out.

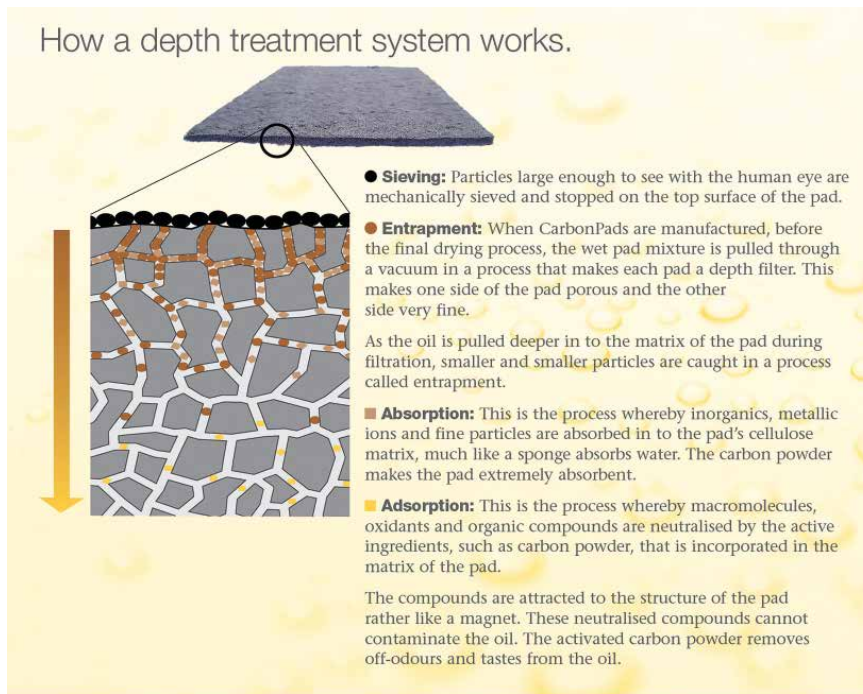
Both active and passive systems are used in foodservice and restaurant operations. The most common passive system is filter paper, which simply removes suspended solids from oil. Active systems include impregnated pads or papers, paper and powder, and powder. With paper and powder systems, the active treatment product is sprinkled on paper, and the oil is filtered over the powder and through the paper. In some cases, the powder is added to the oil and filtered out, but this type of system is losing favor as there are concerns about adulterating the oil and potentially the food.

If an industrial processor or foodservice/restaurant operator wishes to adopt a filtration system of any sort or make changes to what they are currently doing, they should conduct the necessary frying studies. These studies will not only allow them to gather baseline data on what they are currently doing but will provide them with information to properly evaluate the benefits, if any, of the new system. How to conduct frying studies and why these studies are so important was addressed in the last issue of *Food Quality & Safety* magazine in Part 2 of this series. As part of the decision process, a fryer operator should:

- Understand the chemistry of their oil;
- Understand what impurities they wish to remove from the oil;
- Understand the basic steps for treatment required in a given operation;
- Understand the limitations of the treatments being reviewed; and
- Understand their operations so that the benefits of the post-treatment will produce good results.

The frying study is the best tool to gather this necessary information for the decision-making process. It is also essential that all fryers who wish to evaluate any filtration or treatment system clearly establish goals and the indices that are to be used to determine endpoints; that is, will it be a chemical index of oil quality, a physical indicator, or a food quality attribute? All studies really should include the latter, since producing consistently high quality food is why people fry and why people enjoy fried foods so much. ■

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# Transparent Labeling for Gluten-Free Foods

Earn consumer trust and build brand loyalty with these labeling best practices

BY JEANNE REID AND LAURA K. ALLRED, PHD

due to a recent [FDA rule change](#) that allows manufacturers to make minor substitutions to ingredients without changing their packaging. While substitutions that can cause adverse health effects are prohibited—the rule specifically references gluten—the possibility now exists for companies to inadvertently substitute a gluten-containing ingredient and neglect to note it on the ingredient list.

The growth in online shopping due to COVID-19 is also creating additional demand for detailed ingredient information. Meanwhile, the pandemic is creating opportunities for businesses to slow down, reevaluate processes, and place renewed focus on quality. Now is an ideal time for manufacturers to introduce labeling practices that meet consumer demand for greater transparency in product information.

## Terminology, Logos, and Placement

However, initiatives to make product labels more informative can backfire unless manufacturers adopt best practices in terminology, logo design, and placement.

*(Continued on p. 34)*

**I**n the age of the internet, social media, and smart phones, consumers have become much savvier about the foods they eat. Whether for health reasons or medical necessity, many people are adopting special diets and are increasingly researching and choosing products based on the availability of reliable information. In fact, seven out of 10 of consumers say they want greater transparency in food labels, and 75% would switch products if another brand provided more in-depth information beyond the physical label.

Reliable information is especially important for products marketed as gluten-free. Approximately three million Americans have [celiac disease](#) and face serious health complications from con-

suming even a trace amount of gluten, and millions more (up to 13% of the population) choose carefully to avoid gluten due to gluten sensitivity or other health concerns. It is incumbent upon food manufacturers to provide accurate information about food products, and that starts with transparent labels. But, transparency in labeling isn't just a compliance or safety issue. Providing clear, accurate information about food—about everything from dietary claims to allergens to the manufacturer's processes—can generate consumer interest in your products and drive their purchasing decisions.

## The Age of COVID-19

The COVID-19 pandemic has put a finer point on the issue of transparent labels



(Continued from p. 33)

Despite best intentions, manufacturers can do more harm than good by providing unnecessary, inaccurate, or unclear information. For instance, statements that products “contain wheat” or “may contain wheat” are a common source of confusion for foods marketed as gluten-free. Manufacturers often include this phrasing to address labeling requirements for wheat allergens. But, for consumers with gluten intolerance, this wording can set off alarm bells, particularly if the product is marketed as gluten free. Manufacturers can eliminate confusion by explaining that products labeled as gluten free meet the FDA standard of containing less than 20 ppm of gluten. It is also an FDA requirement that products labeled gluten free clarify when wheat ingredients have been prepared or processed to remove gluten, such as wheat starch, wheat grass, or wheat grass juice.

Statements about gluten-free foods being processed on shared equipment are another frequent source of confusion. Manufacturers include these to reduce legal liability when gluten-free products are packaged in the same plant as products that contain wheat. In many cases, such statements trigger needless anxiety about the presence of gluten even when the prospect of cross-contamination is minimal. This problem is often compounded when consumers contact manufacturers for clarification and talk to an employee who doesn't understand procedures for preventing cross-contamination or meeting gluten-free standards. Conducting a thorough risk assessment of your plant's packaging environment, making sure employees understand manufacturing processes, and training your employees to explain labeling claims in clear language will eliminate many potential misunderstandings.

Manufacturers can instill even more confidence in their labeling by adhering to agreed-upon terminology. In most cases, employing the term “gluten free” is the safest bet because it is the wording used by FDA. Avoid potentially confusing terms like “gluten friendly” or “gluten free as defined by FDA,” because these terms raise more questions than they answer, and don't really tell you anything about what the product does or does not contain. Rather than reassuring consumers, using

this kind of imprecise, subjective wording is more likely to cast doubt on the reliability of your information.

It's also important to avoid designing and using your own gluten-free logo. Like

**Providing clear, accurate information about food—about everything from dietary claims to allergens to the manufacturer's processes—can generate consumer interest in your products and drive their purchasing decisions.**



creative uses of terminology, this can undermine confidence in your trustworthiness. Consumers who adopt a gluten-free diet are generally well acquainted with marks for gluten-free certification and can see right through copycat designs. In most cases, sticking with a mark from a recognized certification is the best way to go.

Transparency in labeling is especially important because consumers in the gluten-free community are extremely active on social media, and many of their interactions take place in private online groups. It's common practice for members to trade product recommendations (or warnings), and many consumers will only purchase products that have been certified as gluten free. Social media influencers also play a big role in shaping consumer opinion, whether they are doing a paid sponsorship for a gluten-free product or recommending a favorite brand out of personal preference.

To promote transparency, make sure any certification marks and “gluten-free” claims are placed prominently on your packaging. In general, it's best to place these elements on the front, top, and sides of packages and reserve the back for ingre-

redient lists and other information. For Millennial and Gen Z consumers, the ability to tell at a glance whether a product is gluten free is a selling point, while Gen Xers and Baby Boomers tend to gravitate toward and examine the back of the box for more detailed information about ingredients and manufacturing processes. By paying attention to placement of your logos, word choices, and ingredient lists, you can meet the needs of gluten-free consumers from all generations.

### Marketing

With more people using their phones to research products and shop online, your website has the potential to become a powerful marketing tool. Given the limited space available on food packaging, your website is an ideal place to provide details that don't fit on your labels and to give consumers conducting product research the information they need. Your website is also the perfect place to address frequently asked questions, provided you present information in clear, accurate, and accessible language, and understand and can support any gluten-free claims.

Third-party certifications like GFCO are another powerful tool for earning consumer trust and providing an added layer of protection. Again, consumers instantly recognize and trust the products that carry gluten-free marks from recognized organizations. When displayed prominently on your packaging, certification marks can provide persuasive validation that your products meet rigorous standards for preventing cross-contamination as well as FDA's threshold requirements for gluten-free foods.

If transparency is the foundation of trust and ultimately of brand loyalty, then adopting best practices in labeling will certainly enhance your reputation in the gluten-free community. For consumers with celiac disease and non-celiac gluten sensitivity, transparent, easy-to-find labeling is a vital resource for maintaining health—and may be the deciding factor that causes consumers to reach for your brand over other products. ■

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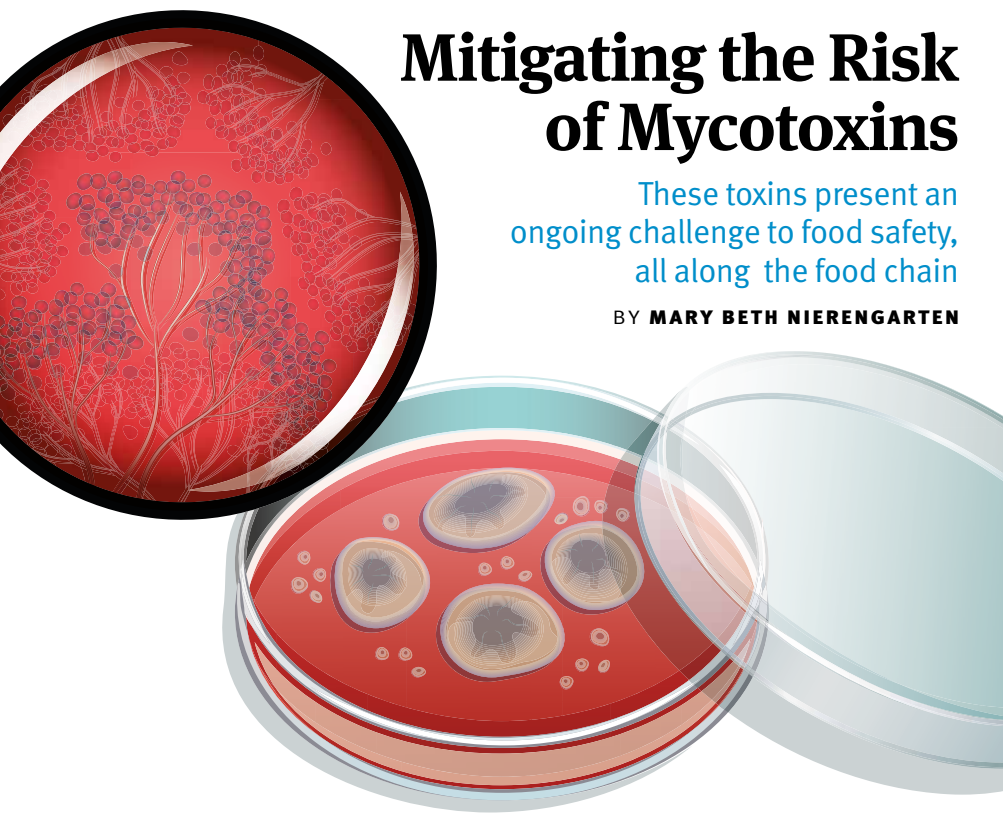
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# In The Lab

## Mitigating the Risk of Mycotoxins

These toxins present an ongoing challenge to food safety, all along the food chain

BY MARY BETH NIERENGARTEN



**M**ycotoxins pose a threat to food safety worldwide. Because they are considered among the most prominent and dangerous toxins that can affect any part of the food chain—from pre-harvest to food processing—prevention and mitigation of mycotoxin contamination is critical to protect consumers from the adverse health effects associated with these toxins.

“Mycotoxins, such as aflatoxins, are very toxic and present a significant health hazard to consumers,” says Hassan Gourama, PhD, associate professor of food science at Penn State Extension, College of Agricultural Sciences, at Pennsylvania State University in University Park.

With the potential to contaminate a variety of common foods, such as grains (corn, barley, wheat, rice, and oats), nuts, cocoa, and milk, mycotoxins present an

ongoing challenge to food safety all along the food chain. The ideal way to mitigate their risk to food safety is to prevent these toxins from entering the food chain at all, and a number of pre-harvest strategies based on good agricultural practices (GAPs) can help.

Even with the best prevention strategies, however, mycotoxins can end up in the food chain given that they are ubiquitous worldwide and that ever-changing environmental conditions preclude strict elimination. “Mycotoxins are naturally occurring toxins found globally and cannot be controlled completely,” says Ronald Niemeijer, MSc, director of global marketing food and feed diagnostics at R-Biopharm AG in Darmstadt, Germany. “The weather conditions prior to harvest play a major role in the risk of mycotoxin production, and globalization of trade

flows, as well as climate change, lead to the occurrence of unexpected mycotoxins in unusual products.”

Niemeijer stresses that once mycotoxins enter the food chain, it is nearly impossible to completely remove them during processing, as the toxins are chemically relatively stable. At this stage, detoxification is needed to reduce their level or to partially eliminate these toxins during the food processing stage.

This article describes what mycotoxins are, details the risk they pose to the food chain and human health, explains how to prevent these toxins from entering the food chain, and offers strategies to minimize their risk if they do.

### Mycotoxins: Ubiquitous and Challenging

“Mycotoxins are naturally occurring compounds that contaminate food and feed around the world,” says Rebeca Lopez-Garcia, PhD, principal at Logre International Food Science Consulting in Mexico City, adding that the toxins are produced by molds, the most common of which are *Aspergillus*, *Fusarium*, and *Penicillium*.

According to a 2020 review of mycotoxins by Agriopoulou and colleagues, there are currently approximately 400 compounds identified as mycotoxins, and about 30 of these receive the most attention with regard to their threat to human and animal health. Table 1 (p. 37) lists the compounds of most concern, along with the food commodity at risk of contamination with a specific compound.

Among these groups of mycotoxins, aflatoxins are considered the most harmful to human and animal health, says Dr. Gourama. “Aflatoxins have many toxic effects, including acute toxicity, liver cancer, liver cirrhosis, and growth retardation,” he says, adding that symptoms of acute toxicity include abdominal complications, jaundice, pulmonary edema, coma, and death.

Along with the significant health impact, mycotoxins also have a significant economic impact; for example, the value of contaminated crops decreases considerably. “Producers may face export limitations, or lots may be even impossible to sell and have to be destroyed,” says Niemeijer.

As highlighted in the 2020 review by Agriopoulou and colleagues, other sig-



Table 1. Important Mycotoxins and Food Commodities

Mycotoxin	Food Commodity
<b>Aflatoxins (B1, B2, G1, G2)</b>	Maize, wheat, rice, peanut, sorghum, pistachio, almond, ground nuts, tree nuts, figs, cottonseed, spices
<b>Aflatoxin M1</b>	Milk, milk products, meat
<b>Ochratoxin A</b>	Cereals, dried vine fruit, wine, grapes, coffee, cocoa, cheese
<b>Fumonisin B1, B2, B3</b>	Maize, maize products, sorghum, asparagus
<b>Zearalenone</b>	Cereals, cereal products, maize, wheat, barley
<b>Trichothecenes (type B: deoxynivalenol)</b>	Cereals, cereal products
<b>Patulin</b>	Apples, apple juice and concentrate, pears, peaches, grapes, apricots, olives, low acid fruit juices
<b>Trichothecenes (type A: HT-2) and (type A: T-2 toxin)</b>	Maize, wheat, barley, oat, rye
<b>Enniatins</b>	Corn
<b>Ergot alkaloids</b>	Rye, rye-containing commodities, wheat, triticale, barley, millet, oat
<b>Alternariol</b>	Grain and grain-based products, vegetables and vegetable products, fruits and fruit products, wine, beer, oilseeds, vegetable oils

SOURCE: FOODS. 2020;9:137.

nificant sources of economic loss include increases in production costs, lowered animal production, irregularity of production,

regulatory enforcements, and the need for testing and other quality control measures. Data show that mycotoxin contamination

of 25% of the world's harvested crops costs billions in dollars annually.

### Prevention: the First and Best Line of Defense

Once mycotoxins are in the food chain they are impossible to completely eradicate; therefore, prevention is critical. Pre-harvest practices can maintain the health of crops and reduce their susceptibility to fungal contaminants. Dr. Gourama cites several agronomic and management practices that can be applied to achieve this end, including reducing crop residues in the field from the previous harvest (as they can be the initial inoculum for the next crop), using proper irrigation and nutrition to keep crops healthy and less susceptible to fungal invasion, implementing crop rotation to reduce the level of fungal contamination in the field, and planting resistant crop varieties if possible.

Reducing mycotoxin risk at the harvesting stage, he says, includes harvesting grain and seed crops when their moisture content is at its lowest, removing damaged

*(Continued on p. 48)*



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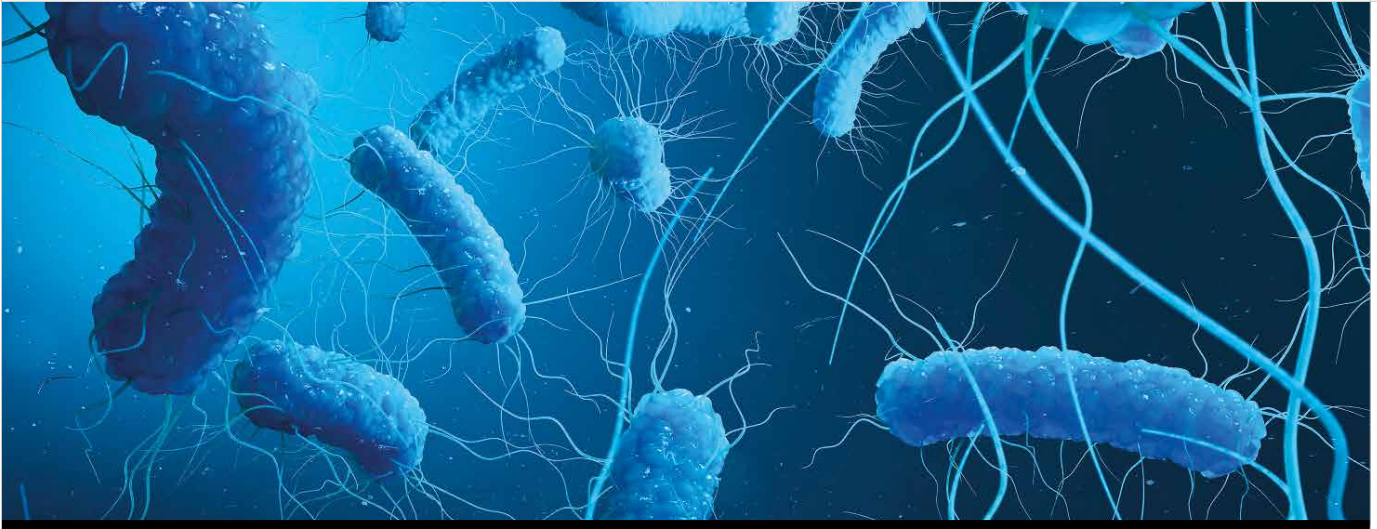
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# Hyperspectral Imaging, Food Pathogens, and Food Safety

HSI exists at the cutting edge of food safety technologies and may disrupt food pathogen detection as we know it

BY MICHAEL BARTHOLOMEUSZ, PHD

Consumers expect freshness, quality, consistency, and—most importantly—safety in their food products. However, delivering on this expectation has become increasingly difficult for food processors. Complicated supply chains and financial pressures to reduce processing costs can unfortunately and inadvertently lead to lapses in food processing and safety procedures, posing a major threat to consumer safety and the food industry at large.

In addition to issues of overall food quality, the food industry is faced with the liability and significant risk to consumers deriving from food pathogens, invisible foes that sicken millions of people each year. Failure to detect the presence of dangerous microorganisms, including *Salmonella*, *Listeria*, and *E. coli*, in foods results in severe outbreaks of foodborne illness. In fact, approximately 48 million episodes of foodborne illness occur in the U.S. every year, with 28,000 hospitalizations and 3,000 deaths. The economic burden of foodborne pathogens is thought to be as large as \$36 billion every year. And, the

problem seems to be getting worse, as incidents of foodborne infections continue to rise.

Recent technological advances in intelligent hyperspectral imaging (HSI) promise to disrupt the food industry's present state of detection and response, however, giving processors a new and more effective tool in combating the pathogen breakouts that cause these illnesses.

## Challenges in Maintaining Food Safety

The rising risk of infectious foodborne diseases is partly driven by the consolidation and industrialization of food production. As facilities become larger and more automated, the potential for the spread of pathogens increases.

Currently, most companies use nucleic acid-based polymerase chain reaction (PCR) techniques to detect pathogens, and this approach is widely accepted across the industry. However, this assay is costly, involves complicated sample preparation, and, most importantly, it is slow to yield results. The time from test to

result ranges from 12 to 36 hours in theory, but in practice may range from three to eight days. This creates bottlenecks in the supply chain that negatively impact operating cycles and increase inventory management costs. The impact is particularly significant with perishables, which have a short shelf life. In these industries, it is commonplace for products to already be in market by the time a pathogen is identified. That means customers could already be sick by the time a problem is discovered, resulting in significant liability and brand damage to processors.

These shortfalls point to the urgent need for better solutions in pathogen detection. New advances in HSI provide such a solution: a faster system that is capable of the early detection of foodborne bacteria at the cellular level before the product is shipped to market.

## How Hyperspectral Imaging Technology Works

In broad terms, HSI uses advanced hardware and software to help companies create improved quality assurance indicators. The hardware captures an image, and then the software processes it to provide actionable data by combining the power of conventional spectroscopy with digital imaging.

HSI technology utilizes superior capabilities in two areas: spectral and spatial resolution. Conversely, conventional machine vision systems lack the ability to capture and relay details and nuances to users effectively. That means HSI systems

provide a level of detail that far outpaces current industry-standard systems. For example, an RGB camera can only detect three colors (red, green, and blue), while HSI can detect between 300 and 600 real colors, a significant increase of 100 to 200 times.

HSI can also read the ultraviolet or infrared spectrum, providing chemical and structural details of food composition and microorganisms that are not observable within the visible spectrum. HSI cameras do this by generating “data cubes,” which are pixels collected within an image that display subtle reflected color differences not observable by humans or conventional cameras. That information is then processed through a machine-learning algorithm to render a “classified” image, which is labeled and optimized to more efficiently process information in the future.

The advent of widely accessible machine learning methods has also brought a new and powerful set of tools to HSI pathogen detection. To make use of the abundance of data rendered by HSI,

**HSI is built upon a set of machine learning tools specially trained to identify the dominant spectral and spatial signatures in harmful food pathogens and labels them for intuitive identification.**

a number of image processing algorithms have been developed over the years, with more created all the time. These mathematical techniques, combined with intelligent HSI microscopy, aid users in interpreting the data with speed and accuracy.

In comparison to HSI, other traditional quality assurance systems pose additional specific limitations in regard to food safety and pathogen detection. X-rays, which are prohibitively expensive and only focus on detecting foreign objects, can be difficult to maintain and calibrate. While metal detectors are more affordable, they generally only catch metals with strong magnetic fields like iron. Unfortunately, many materials, including copper, aluminum, plastics, wood, and feces, can slip through undetected.

Conventional quality assurance systems also rely on human subjectivity, which may shift subtly from day to day or even hour to hour. While those in charge of monitoring in-line quality and food safety are trying their best, the naked eye and human brain can be erratic. Tired or distracted people may judge quality in different ways, leading to inconsistent standards that can negatively affect both the food processor and consumers.

#### Using HSI for Pathogen Detection

Compared with current conventional techniques, HSI can immediately provide tangible benefits for the food industry, especially when it comes to quality assurance in the food supply chain. HSI solutions provide benefits across three specific elements.

First, the intelligent hyperspectral microscopy employed within HSI combines the analytical benefits of conventional

*(Continued on p. 49)*



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## Detecting Food Adulteration with Benchtop NMR

NMR analysis can rapidly create a molecular “fingerprint” of a product, identify any adulterants, and establish the true country of origin

BY VENITA DECKER, PHD

**F**ood authenticity is not a new concept, but it remains a ubiquitous issue across the globe. While it is difficult to quantify how prevalent food fraud is throughout the entire supply chain, experts estimate its impact on the food industry to be in excess of \$50 billion each year. Incidences of food fraud over the past decade have increased media attention on the issue of food authenticity, which has, subsequently, made it a hot topic in the food industry and regulatory agencies.

Over the last few years, nuclear magnetic resonance (NMR) technology has become an increasingly accessible technique for food safety laboratories, particularly for verifying food and beverage authenticity. NMR analysis can rapidly create a molecular “fingerprint” of a product,

identify any adulterants, and establish the true country of origin—a frequent target for fraud.

### The Demand for Accurate and Rapid Quality Control in Food Safety Labs

Traditionally, the food safety industry has utilized gas chromatography (GC) and polymerase chain reaction (PCR) testing to determine the chemical composition of products. However, these methods require large quantities of expensive reagents to operate effectively and can take hours, even days, to produce results.

Since its discovery in 1946, NMR spectroscopy has continued to grow as an indispensable analytical tool across a range of applications. NMR is an information rich, non-destructive analytical technique that

provides detailed information about molecular structure and dynamic processes. It is also a primary quantitative method that can determine the concentration of molecules, even in complex mixtures.

NMR is utilized in the food industry for a variety of applications, including the determination of the chemical composition of foods and the quantitative analysis of changes induced by processing, storage, and spoilage. NMR has become a particularly popular technique in the food safety sector over the last decade, primarily used for verifying the authenticity of food and beverages and detecting counterfeit products.

In NMR analysis, food or beverage samples are analyzed and compared to large databases of genuine products, generating a “fingerprint” that users can compare with the test sample in order to check for compliance. Information that can be gathered not only includes what components the sample contains, but also details such as geographical origin to confirm if the product is from the source claimed.

### The Shift Toward Benchtop NMR

The past 50 years of NMR spectroscopy innovation have, until recently, centered



around steadily increasing the magnetic field strength of instruments. Now, new benchtop NMR spectrometers offer the reproducibility and stability of NMR technology in a more accessible, smaller instrument that can be installed on the lab bench.

A benchtop NMR spectrometer is significantly more compact and portable than the conventional NMR instrument. It does not require dedicated infrastructure or an extensive installation process. Benchtop spectrometers offer improved workflow, even for novice users, as they are intuitive in use and do not require extensive user training.

Low-field benchtop NMR can provide a high value solution for the food sector by delivering the same answer as high-field NMR to an array of analytical questions. The advantages of benchtop NMR systems are paving the way for the introduction of this technology:

- No specialist NMR expertise required;
- Same direct quantification and deep structural information as high-field NMR;
- Compact benchtop size;
- No additional infrastructure needed;
- Cryogen-free permanent magnets—no need to refill liquid helium;

- Operates from a single standard power socket; and
- Easy maintenance and minimal cost of ownership.

The significantly reduced costs, low maintenance requirements, and simplicity of benchtop NMR spectrometers are leading this technology. Their advanced electronics and methodology make them ideally suited to high-throughput quality control.

### Supporting Food Quality and Authenticity

Olive oil is one of the top-10 most adulterated food products, so detecting its dilution with a lower quality substitute, such as sunflower oil, is critical to the industry. The edible oil industry is a prime target for adulteration, with high quality oil, such as olive oil, often adulterated with significant levels of other edible oils that have a lower market price or are of a lower quality, such as hazelnut oil, sunflower oil, soybean oil, rapeseed oil, or corn oil. The olive oil industry has been petitioning FDA for years for a standard.

Benchtop NMR can differentiate among saturated, mono-unsaturated, and poly-unsaturated fats (Figure 1) and, based on this, can differentiate among different types of oil (Figure 2).

Figure 3 shows a gradual increase of one of the signals by adulteration with increasing concentrations of sunflower oil. NMR as a benchtop tool allows

*(Continued on p. 50)*

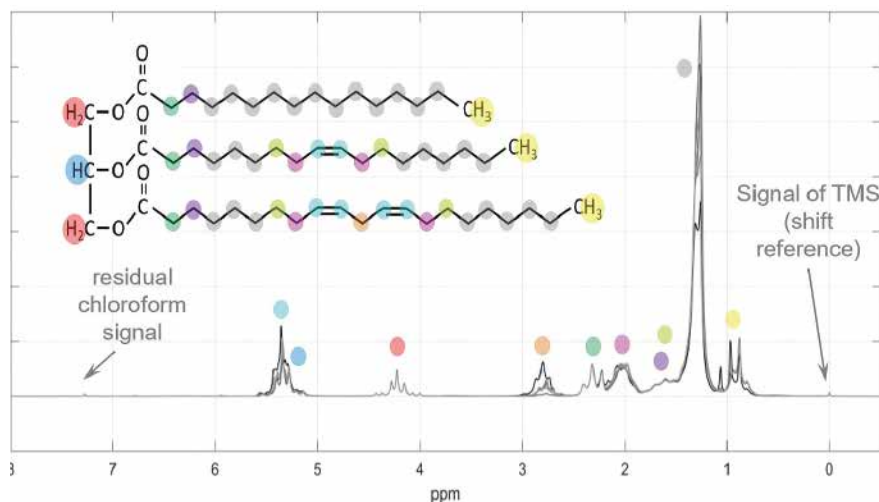


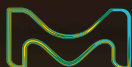
Figure 1: Hypothetical fat molecule (triglyceride) with saturated, mono-unsaturated and poly-unsaturated fats analyzed with 80 MHz benchtop NMR (Fourier 80, Bruker BioSpin). The spectra show where typical signals for the different types of fatty acid appear and can be used in analyzing edible oils.

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# Manufacturing & Distribution



## Biobased Material

An evolution in the food packaging industry

BY HALEY GERSON

**B**iobased alternatives for products ranging from household items to cosmetics to biofuels are popping up in the marketplace. The biobased trend is also evident within the food sector, specifically relevant to packaging material for food items. This article will explore the journey of food packaging and the steps that manufacturers are taking as the industry transitions from depending on petroleum-based material to opting for biobased alternatives instead.

During phases of product development, product formulators and manufacturers of food packaging are relying on third-party analysis for biobased content results. By employing carbon-14 analysis, manufacturers have a way to quantify and optimize biobased content in product ingredient formulations, while limiting or phasing out the use of petrochemical-

derived material. In addition, manufacturers can apply for biobased certifications for their finished products in order to receive eco-labels, allowing promotion of the use of plant-based packaging.

### Why Switch to Biobased?

Biobased products are composed fully or partially of biomass material; this includes material derived from biological renewable resources that are available on a recurring basis, such as plants, wood residues, crop residues, sugarcane, and other agricultural resources. Biobased products are increasingly sought after due to the eco-friendly nature of the materials. For example, as companies in the food industry explore ways to limit and reduce their contribution to the global carbon dioxide footprint, they are opting for alternatives to mainstream plastics.

This, in turn, is leading manufacturers to formulate packaging with biobased material, while at the same time driving distributors to sell and advertise these biomass-derived products.

According to surveys and studies, consumers are also interested in the transition to biobased. An international study conducted in April 2019 highlighted this preference, surveying 4,000 consumers in the United States, China, Finland, and Germany on food packaging preferences. The survey demonstrated that more than half of the respondents were willing to pay a higher price for renewable food packaging such as biobased packaging. In addition, out of the participants surveyed from the United States, 56% felt that food brands are mainly responsible for reducing the plastic waste that comes from food packaging. Such results are influencing manufacturers to transition to biobased material in an effort to address consumer demands.

On a global level, the biobased market throughout several sectors continues to grow. In 2017, the market was worth USD \$8.81 billion, which is expected to increase at a compound annual growth rate of

12.6% between 2018 and 2025. A growing preference for biobased material and packaging within the food industry is evident, and manufacturers are relying on testing methods such as carbon-14 to maximize the portion of biobased ingredients used in packaging formulations.

### Carbon-14 for Product Formulations

Manufacturers developing biobased products such as food packaging and containers opt for plant-based material that is chemically identical to conventional packaging and able to provide the same functional properties. Carbon-14 testing is a key step in the product formulation process, providing results on biobased content of product material and allowing manufacturers to re-work their formulations based on the results.

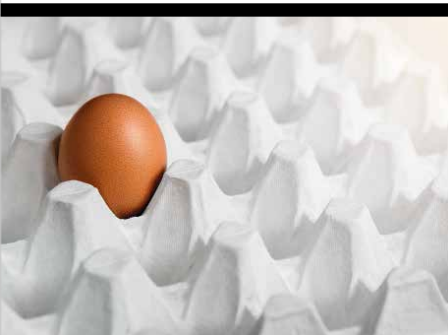
Carbon-14 analysis is used as a biobased verification tool, because the amount of carbon-14 present in a given sample represents the amount of biobased content. Carbon-14 is a weakly radioactive isotope that is present in all living organisms. Once a living organism dies, however, the carbon-14 begins to decay at a rate of approximately 5730 years, which is the half-life of carbon-14. Once the material is older than approximately 50,000 years, carbon-14 is absent in the fossil.

Manufacturers submit samples, which can be in solid, liquid, or gaseous form, to radiocarbon dating laboratories, such as ISO 17025-accredited Beta Analytic, in order to receive a percentage of biobased content in product ingredients. The analysis is performed in accordance with internationally developed standards such as ASTM D6866 and ISO 16620-2. ASTM D6866 is a standard developed to determine the percentage of biobased content as a fraction of the total organic carbon content in a sample. ISO 16620-2 measures the biobased carbon content as a fraction of total carbon content or total organic carbon content applicable to plastics, polymers, and other additives.

Once samples are received by the laboratory, they are prepped and pretreated as needed, and, once ready for analysis, they are inserted onto a wheel of an accelerator mass spectrometer instrument. This instrument is used to count the amount of carbon-14 present in the sample, yielding

a result that represents the percentage of biobased content. Results may range from 0% biobased to 100% biobased. A sample that is 0% biobased is completely petrochemical-derived, while 100% biobased indicates it is fully composed of biomass-based sources. Lastly, a result anywhere between 0% and 100% biobased means the sample is a mixture of fossil fuel and renewable sources. This result allows

**Biobased products are composed fully or partially of biomass material; this includes material derived from biological renewable resources that are available on a recurring basis, such as plants, wood residues, crop residues, sugarcane, and other agricultural resources.**



manufacturers and product formulators to make adjustments, depending on the percentage of biobased content they are aiming for, and redevelop product formulas as they continue to test ingredients with carbon-14 analysis to achieve their goals of optimizing biobased ingredients and moving away from fossil fuel ingredients.

### Certified Biobased

Once a biobased packaging formulation is finalized, manufacturers and product distributors opt to certify the packaging material so that the use of biobased ingredients is easily visible on the packaging. Within the bioproducts industry, the USDA BioPreferred Program includes a certification program to promote biobased

products. This program allows consumers to distinguish sustainable options in the marketplace.

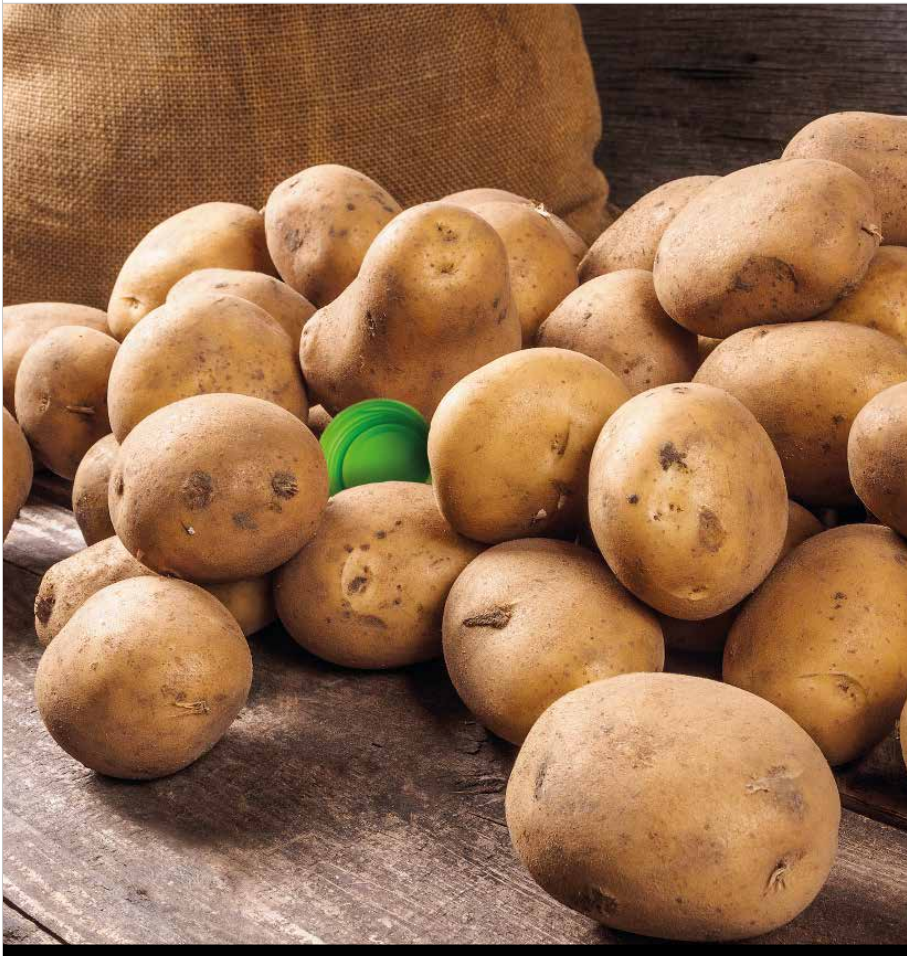
The USDA BioPreferred program includes a voluntary labeling initiative that enables companies with biobased products that have been tested by a third-party carbon-14 laboratory to apply for certification. In order to qualify for the certification, products must meet the standards and requirements of minimum biobased content, which varies based on the type of category the product falls under. The program includes a packaging category, which is broken down into more specific subcategories such as disposable containers, product packaging, non-durable films, semi-durable films, and shopping and trash bags. Each subcategory has a different requirement for minimum biobased content: 72%, 25%, 85%, 45%, and 22%, respectively. In addition, there is a category specifically for intermediates—plastic resins—which has a requirement of 22% biobased content for product eligibility.

If a product meets the requirements and certification is received, packaging products are sealed with a USDA Certified Biobased Product eco-label, which indicates the percentage of biobased content in a product. Biobased certifications and eco-labels act as verification that packaging material is derived from renewable biological material.

The preference for renewable and sustainable food packaging material is increasing over time among manufacturers, distributors, and consumers. To keep up with global demands for biobased food packaging material, manufacturers are working with carbon-14 laboratories to receive third-party verification of biobased content. This allows manufacturers to switch material formulations as needed in order to optimize the use of biobased material and limit dependence on fossil fuels, decreasing plastic waste and reducing the impact that the food packaging sector has on greenhouse gas levels. Once a product formulation is finalized, sustainability initiatives are demonstrated by applying for biobased certification schemes, allowing for greater transparency of product ingredients. ■

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# Top Technologies for Foreign Object Control

How to determine which detection technologies to choose, and how to use them

BY ANDREA TOLU

**I**n March 2019, USDA issued a best practice guideline for meat and poultry producers to reinforce the requirement of notifying the agency within 24 hours of shipping products that are potentially contaminated with foreign objects. As the agency explained, although the rule had been in place since 2012, cases of foreign materials found by consumers had increased in recent years.

Foreign objects are an insidious issue for all food producers, not just meat and poultry processors. Unlike with pathogens, there is no kill step to eradicate or minimize

the foreign object. Contaminations can occur at any point in the supply chain, with different materials and for various reasons: pieces of plastic from dough scrapers, bottle caps and golf balls, and broken metal from equipment or construction material are just a few examples from FDA's product recall list.

### Assessing Risk

The starting point to managing foreign objects in food production is to understand the hazards. "Risk is not a yes- or no-type question," says De Ann Davis, food safety

director at Commercial Food Sanitation in New Orleans. "Certain foreign materials present more of a health hazard than others. Some of them can be found readily through technology, while for others, like thin, clear plastics, it's going to be very difficult."

When you measure the likelihood of foreign object contamination, the quality of the information is important. "The best data comes from a strong near-miss program, which is a detailed library of materials found in partially or fully processed products before they end up on the shelf. Other important sources are your suppliers' history and the validation of your own controls. It's not just about how you can detect a piece of metal at the end of the line; it's important to look at risk from a holistic standpoint," adds Davis. The risk assessment will determine which foreign detection technologies to use and how to employ them.

### Sorters, Filters, and Magnets

Sorters, filters, and magnets are typically used with produce, powders, and liquids.

Produce is often washed first: "Water is a good segregation system because the produce usually floats, says Rob Kooijmans, CEO of the Food Strategy Institute in Amsterdam, Netherlands. "Wood floats on top and can be discarded later, soil dissolves, and stones sink." In some cases, using magnets first might be a better option, as open fields could hide all sorts of foreign materials. That's the case in the Netherlands and France, says Kooijmans, where it's very common to find hand grenades from World War I or II with the produce.

A second, more sophisticated sorting level uses cameras, lasers, and infrared and ultraviolet (UV) radiations. "Cameras look at color and potentially shape, while lasers, infrared, and UV analyze reflection," says Kooijmans. "By combining that information, you can detect foreign bodies that were not washed out in the beginning. A golf ball harvested with potatoes, for example, would float during the washing step and would probably deceive cameras and lasers too, but it will reflect UV light, while potatoes won't.

Sieves are typically used with liquids and powders, while magnets offer a useful support, especially to detect any metal

particles from grinding steel equipment left in dry powders, such as pepper and cocoa. “Sieves should be placed at the entry and exit of a processing step, because your process itself might introduce foreign objects. When only one option is possible for cost reasons, the best choice is the end of the line,” says Kooijmans.

### **X-Ray Systems and Metal Detectors**

Metal detectors and X-ray systems detect foreign objects by recognizing the disturbance that they can cause to signals. In metal detectors, metal objects will change the electromagnetic field, generating a voltage signal; in X-rays, foreign objects with higher density will attenuate more energy, producing a darker area in the image.

The detection capability of both systems is limited by the so-called “product effect,” which can cause false positives or negatives. “In metal detectors, product effect is the phenomenon whereby the product and the contaminant generate a similar signal at the same frequency,” says Mike Munnely, marketing manager of life sciences manufacturing at Thermo Fisher Scientific in Waltham, Mass.

The main cause of this product effect is the conductivity of the food, which can be increased by even the smallest variations in salt content, moisture, and temperature. Complex food matrixes make product effect even worse.

The most advanced metal detectors minimize the problem by using up to five frequencies at once. “Different metals respond better to different frequencies,” says Munnely. With multiple frequencies, we can offer optimal performance. With just one, there is always some compromise to be made, maybe reducing the sensitivity to a particular metal in order to avoid product effect.”

Complex matrixes are a problem for X-rays too, due to their density profile. “With meat skewers, for example, detecting light contaminants would be much more difficult, as the wooden stick, the meat, and the vegetable oil would have different densities,” says Alex Kinne, an applications engineer at Thermo Fisher Scientific.

One solution is scanning products from different angles. “Using multiple beams greatly improves the chances of finding the most difficult contaminants, like glass

**You need a strong preventive maintenance program that avoids foreign material that may come off of equipment, such as pieces of conveyor belts, metal shavings, screws, or pieces of plastic. When foreign material is found on the equipment or within the facility, you also need a sanitation and GMP program that prevents it from entering the food-making process.**

—**DE ANN DAVIS**, *Commercial Food Sanitation*

inside of glass jars, that can hide at the bottom or in corners or edges,” says Kinne.

Another area of improvement for X-rays is imaging software that can differentiate between subtle changes in darkness: “It’s quite a difficult software to do well, but it has become more advanced over time, improving the probability of detecting contaminants,” says Munnely.

### **Making Technologies Work Together**

In general, each of these technologies has its own natural place in the production line: sorting, filtering, and magnets only work with produce, liquids, or dry powders. Metal detectors and X-rays are better suited for constituted products. Their placement, however, is rather flexible.

“X-ray and metal detectors are used at different critical control points rather than in tandem,” says Kinne. “For example, in meat processing, metal detection may be used to inspect large oblong pieces of raw meat, and then X-ray after food is packaged.”

How you combine systems really depends on your risk, your food matrix, your line speed, and the capabilities of available technologies, says Davis.

For Munnely, using X-ray, metal detection, or a combination of both depends on how “safe” food manufacturers want to be. “They could be guided by brand protection, a particular local regulation, or the request of a customer to use one or both of them,” he adds.

### **Investigating Foreign Object Findings**

When a foreign object incident occurs, there are a few questions to answer as quickly as possible: What is it? Where does it come from? Why did it end up there?

How much product could potentially be contaminated?

Investigation always starts in the facility, but it doesn’t necessarily end there. In some cases, food companies will resort to a lab to continue it with more sophisticated technology. “Whether or not a lab is involved depends on the impact of the incident,” says David Wright, associate principal scientist at Reading Scientific Services Ltd. (RSSL) in the United Kingdom. “If [a contamination] has gained media or regulatory attention, they’re likely going to investigate. When that’s not the case, then investigation is still advisable, as it allows the prevention of future, and potentially more serious, contamination.”

One risk of not conducting a deep analysis is misidentifying the material completely. “We had a case where a piece of suspected glass came in, which turned out to be an extremely hard plastic type. This might be unusual, but just highlights the fact that you might see something that it really isn’t,” says Rene Friedrichs, RSSL’s microscopy lab manager.

Identifying the type of material in a contamination is just the first step. You can obtain more useful information from a lab. “If a piece of glass was found by a consumer, we would determine [if] it’s a heat-resistance glass type from chipped kitchen glassware. In that case, it could have been unintentionally introduced by the consumer,” says Friedrichs.

RSSL’s microscopy lab use five technologies in particular, says Friedrichs:

- **Light microscopy:** Used to look at the morphology of the foreign material and to see whether there are deposits on it.
- **X-ray microfluorescence:** The standard technology to help identify types of glass, steels, and other metal alloys.

*(Continued on p. 47)*



# Is the Food Supply Chain Really Breaking?

The food chain is fragile, and it's a problem we need to tackle

BY ARE TRAASDAHL

In April 2020, Tyson Foods took out full-page ads in *The New York Times* and *The Washington Post* warning that the food supply chain was breaking in the era of COVID-19. Experts pointed out that the ads were focused on COVID-19–related closures of meat processing plants, that Tyson was being alarmist, and that Americans were not going to run out of food anytime soon.

While the panic buying seen early on during the pandemic and concerns that the food supply chain was “breaking” have largely subsided, they did spark overdue conversations about the topic: The food chain is fragile—and it’s a problem we need to tackle.

Here are some of the weak links in our food supply chain and suggestions for how we can fix them to optimize the food industry—during COVID-19 and beyond.

## Too Many Data Silos

Let’s take a look at our food supply chain. We have more than 200,000 companies trading with one another, 3.7 million farms, and 45,000 grocery stores. If you’ve ever managed a handful of employees, or even tried to get a few friends to agree on a restaurant, you can imagine how difficult it is to get all of these moving parts to work together.

No matter how they order and receive products, supply chain managers must juggle multiple supply chains, third-party vendors, and more to ensure that the end customer gets what they want, when they want it. Storage, inventory control, and transportation also need to be perfectly orchestrated to make this happen. Crises, industry shifts, shifting weather patterns, changes in the environment, and store problems only add to the confusion.

Right now, all of this is precariously balanced on top of outdated or clunky communication systems such as email, phone, and paper purchase orders, all of which keep businesses from accessing valuable data about sales and consumer trends, among other information.

High complexity and low data are a mix that can hurt any business. In his book *The Complexity Crisis* (Platinum Press, 2008), John Mariotti says that more data is often accompanied by a “better granularity regarding the consequences of the amount and nature of the complexity, and its relative impact on profitability.”

## Increasing Cost

Higher costs amount to lower profits, and these costs disrupt entire food supply chains as they are passed to the next partner in the chain.

Higher fuel prices and labor costs are big cost drivers as well, but here are some of the more controllable expenses that can cut into profit margins for food manufacturers:

- Poor planning and inefficient routing, which lead to wasted fuel and product loss;
- Stocking or stockpiling inventory, which ties up capital and can lead to



food waste when the goods are not sold;

- Choosing the wrong suppliers due to lack of good data around supplier prices and reliability; and
- Overproduction due to the lack of visibility around consumer demand.

The complexity referenced earlier is a major culprit in each of these expenses. The less we know about what is happening with our partners, customers, and the market at large, the more we are reduced to making educated guesses about routing, stocking, and production.

### Slow Shipping, Unsafe Storage

Getting food where it needs to be in a timely manner, keeping it fresh during transportation and storage, and handling it efficiently are a challenging set of tasks, especially for smaller businesses. One misstep along this chain, and the end result can be ruined product and/or fines.

For example, keeping fresh food refrigerated during transport isn't cheap. Even if refrigerated trucks were inexpensive, the shortage of long-haul truckers drives up transportation costs, while also increasing the risk that products spend so much time

Right now, [the supply chain] is precariously balanced on top of outdated or clunky communication systems [that] keep businesses from accessing valuable data about sales and consumer trends.

in storage or transit that they lose their freshness.

Customers don't care about their supplier problems; they just want the products to arrive on time to satisfy their customers. Late or incomplete deliveries are a big problem, with the U.S. food industry losing \$15 to \$20 billion in sales annually due to out-of-stock or unsellable products.

For this reason, retailers require food producers to hit their "must arrive by" dates or incur a fee. Less-than-truckload shipping can help smaller producers hit these delivery deadlines, but the fact that

their products are loaded and unloaded more frequently, and that they're transported along with non-food items, leads to more breakage and contamination. This creates a vicious cycle.

These are only a few of the transportation challenges smaller food businesses face. Larger and international businesses have challenges of their own, such as port congestion, that can delay deliveries.

### Strengthening the Fragile Food Supply Chain

What do all of these issues—complexity, shipping and storage problems, and increasing costs—have in common? They can all be solved with more transparency among partners in the food supply chain.

We have the data that can help us streamline the entire food supply chain. Now, we need to implement the data-sharing, communication, and forecasting technologies that other industries have been using for years.

The food supply isn't at the breaking point yet. Let's put the tech in place to ensure it won't get there. ■

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Traasdtahl is the founder and CEO of Crisp.

## Top Technologies for ... *(Continued from p. 45)*

- **Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS):** This technology can provide morphological and elemental information for even the smallest foreign materials.
- **Fourier transform infrared spectrometer (FTIR):** This technology can help to identify organic materials, such as types of fibers and polymers, by investigating functional groups.

The majority of foreign materials can be identified using some or all of these techniques. What tool to use will depend on each specific case. "We have a triage type approach where we make an initial evaluation of a sample using microscopy and then decide which analysis we regard as appropriate to correctly identify and characterize a sample," says Wright. "If a foreign object is found in a packaged food,

we will want to analyze the packing, as well, to help establish how it may have entered the product. We try to gather all the information and then decide the critical path: If it's a piece of glass, it goes down one route; if it's plastic, it goes down another. It depends on how we can find out what's on the surface of something, what it's been in contact with, and what else is around it."

The benefit of engaging with a laboratory for further investigation is not just in the level of technology. "From our impartial, yet experienced, perspective, we will ask the right questions. When somebody is too close to a process, they might overlook what is actually quite obvious," says Wright.

### Prevention Is Always Better

In spite of the many technologies available, the best way to control foreign ob-

jects is to keep them out of the supply chain. "Before you think about the risk, you need a strong preventive maintenance program that avoids foreign material that may come off of equipment, such as pieces of conveyor belts, metal shavings, screws, or pieces of plastic. And when foreign material is found on the equipment or within the facility, you also need a sanitation and GMP program that prevents it from entering the food-making process," says Davis.

"Too many companies just rely on their systems as if they were foolproof, but they're not," says Kooijmans. All these detection methods are trying to cure something that you should prevent in the first place. Prevention is always better." ■

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Tolu is freelance writer who specializes in covering the food industry. Reach him at [andrea@andreatolu.com](mailto:andrea@andreatolu.com).

## Mitigating the Risk ... (Continued from p. 37)

grains/fruits/seeds, and drying grains and seeds quickly once harvested. At the storage stage, moisture and insects need to be controlled and antifungal agents used.

### Detoxification: Processing Level

Dr. Lopez-Garcia emphasizes that most mycotoxins are not destroyed or inactivated during processing, so the goal is to prevent highly contaminated products from entering the processing environment.

She recommends that food processors build adequate relationships with suppliers and develop specifications that address mycotoxins. "It's important to understand each commodity coming into the processing facility and develop specifications that will address the potential contamination," she says. "It is also important to have proper sampling and analytical methods in place, as sampling is extremely important to obtain reliable results, since some of the toxins may be present in hot spots." To be valid, she says that samples should represent the whole lot.

She also stresses the need for vigilance in mitigating the risk of mycotoxin exposure in products targeted at infants and children.

**It's important to understand each commodity coming into the processing facility and develop specifications that will address the potential contamination.**

—**REBECA LOPEZ-GARCIA, PHD,**  
*Logre International Food Science Consulting*

Niemeijer also emphasizes the need for sample testing with an appropriate method to get an early indication of the mycotoxin status so that the right decision can be made before the next step in the production chain. "Before accepting a lot, the product can be tested to prevent mycotoxins entering the production facilities," he says. "Also, testing before shipping or exporting a product is a good strategy to prevent financial losses."

Dr. Gourama underscores the need for food processors to obey all GMPs related to their products, particularly for products

or ingredients susceptible to mold growth such as peanuts and corn. "Raw material and any incoming products should be checked for any signs of damage, mold growth, and presence of mycotoxins," he says, adding that a proper cleaning and sanitizing program should always be followed throughout the processing facility to prevent food contamination with molds and potential production of mycotoxins.

### Global Effort

Given the enormous impact mycotoxins can have on the food chain, regulatory limits on their levels in food and feed have been established by governing bodies worldwide, including FDA, the European Food Safety Authority (EFSA), the Food Agricultural Organization, and the World Health Association.

Implementing a Hazard Analysis and Critical Control Points approach across the entire food chain and through all stages of food handling is another way to ensure the safety of foods and feed from mycotoxin contamination. ■

**Nierengarten** is a freelance writer based in Minnesota. Reach her at [mbeth@mnmedcom.com](mailto:mbeth@mnmedcom.com).

## Events

### OCTOBER 2020

19-22

#### Food Safety Summit

Virtual Event

Visit [foodsafetystrategies.com](http://foodsafetystrategies.com).

25-28

#### IAFP Annual Meeting

Virtual Event

Visit [foodprotection.org/annualmeeting](http://foodprotection.org/annualmeeting).

### NOVEMBER 2020

8-11

#### Pack Expo International

Chicago, Ill.

Visit [packexpointernational.com](http://packexpointernational.com).

10-11

#### European Food Sure Summit

Milan, Italy

Visit [foodsureeurope.com](http://foodsureeurope.com).

### JANUARY 2021

26-28

#### International Production & Processing Expo

Atlanta

Visit [ippexpo.org](http://ippexpo.org).

### FEBRUARY 2021

25-26

#### Food Packaging & Sustainability Summit

Clemson, S.C.

Visit [sonocofreshsummit.com](http://sonocofreshsummit.com).

25-March 3

#### Interpack

Dusseldorf, Germany

Visit [Interpack.com](http://Interpack.com).

### MARCH 2021

1-3

#### Beef Industry Safety Summit

Denver, Co.

Visit [bifsc.org](http://bifsc.org).

6-10

#### Pittcon

New Orleans, La.

Visit [pittcon.org](http://pittcon.org).

28-30

#### SNAXPO

Charlotte, N.C.

Visit [snaxpo.com](http://snaxpo.com).

### APRIL 2021

11-16

#### Conference for Food Protection

Denver, Co.

Visit [foodprotect.org](http://foodprotect.org).

26-28

#### IAFP European Symposium on Food Safety

Visit [foodprotection.org/europeansymposium](http://foodprotection.org/europeansymposium).

### Have an Upcoming Event to Promote?

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## Hyperspectral Imaging, Food Pathogens ... *(Continued from p. 39)*

spectroscopy with digital microscopy imaging to provide high resolution spectral and spatial information that enables the spectral identification of every pixel throughout bacterial cell images. Dark field illumination microscopy is also utilized to negate the need for staining or special reagent growth media. This vastly shortens the time needed to identify potentially harmful pathogens in line and enables them to be identified on premises.

Second, HSI utilizes machine learning to constantly improve its image processing capabilities, helping food processors better monitor and control the quality of their food products. As described above, the hyperspectral imager hardware returns a raw data cube, which represents the spectral information for each pixel in the image. By using special software analysis and calibration, HSI products continue to improve discernibility as larger sample sizes and additional data are processed. HSI is built upon a set of machine learning tools specially trained to identify the dominant spectral and spatial signatures in harmful food pathogens and label them for intuitive identification. This helps provide instant feedback for food processors,

who can then implement new systems with this instant data. For example, if a harmful pathogen is detected, lines will be stopped automatically so the issue can be resolved immediately.

Finally, HSI utilizes automated detection to identify pathogen cells. Traditional processes for correctly identifying pathogen cells can be involved and time-consuming. HSI can automate the capture of spectral data cubes from a sparsely populated field of view. In the case of low cell concentrations, the process automatically searches for cells using a targeting algorithm. The system can then enable the rapid identification of pathogens on site in less than four hours, thereby reducing testing time exponentially.

### Additional In-Line Applications

In addition to food pathogen detection, multiple food characteristics can be measured simultaneously with HSI, including color, moisture levels, fat content, and protein levels. This level of nuance gives details of chemical and structural composition not discernible to the naked eye, while providing added information that can be used by manufacturers for im-

proved safety and quality assurance in a number of areas.

For example, HSI can be used to ensure food freshness. By identifying spoilage before it becomes visible, it gives producers a tool to maintain product uniformity and quality throughout the supply chain. HSI can also assist meat and poultry companies with in-line detection of foreign objects, including metal, wood, plastic, bone, feces, and more. The same HSI unit can be used for pathogen detection, quality assurance, and packaging inspection.

HSI exists at the cutting edge of food safety technologies and will disrupt food pathogen detection as we know it. New advances in the relevant technologies have rendered HSI more affordable and capable than ever before, making it a viable alternative for older, outdated technologies and practices. Detecting foodborne pathogens in hours instead of days, with a clear path to take this down to minutes, HSI keeps dangerous food from reaching the market, protecting consumers, company bottom lines, and brands. ■

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**Dr. Bartholomeusz** is CEO of HinaLea Imaging, located in Emeryville, Calif. Reach him at [sales@hinaleaimaging.com](mailto:sales@hinaleaimaging.com).

## Potency Inflation in Testing *(Continued from p. 19)*

### Looking for a Lab

When selecting a lab, Wright suggests that manufacturers familiarize themselves with basic cannabinoid compounds and how they break down so that they're able to ask questions of potential laboratory suppliers. "I've seen lab analysis papers that say simply [percentages of] 'THC and CBD' as the only two cannabinoids or terpenes tested for—no testing for THC-A, THC-V, and so on," Wright says. "Understanding the chemical makeup of your inputs helps screen for good producers."

Additionally, there are more complex concerns to bear in mind. For example, overcooking CBD can lead to a high percentage of a different isomer of the compound, says Wright. The end product has the same molecular weight, but some

consumers believe its medical effects are slightly degraded. A lab that can't discuss such issues should be avoided.

Finding a lab you're comfortable working with is much easier in a federally legal marketplace such as Canada. In the U.S., large multi-state cannabis operators (MSOs) are not allowed to move cannabis products outside the boundaries of individual legalized use states.

Like Wright, Fox advises MSOs to find labs they can rely on rather than looking to another company's numbers. "In every market where you're operating, you work with several different labs. You figure out exactly which is the most reliable and go with them. Even if the lab result isn't necessarily a number that you want, that really doesn't matter. You have to go with the most accurate."

Yet different states have different standards—and not all have the same labs. If a producer operating in Colorado, Washington, and California finds a trustworthy lab to work with, that same lab might not operate in Maine, Illinois, or Michigan when the producer decides to expand into those states. "You would have to find a different lab to work with [in those states], and they might not have the same testing protocols or regulatory requirements that your other lab does," Fox says. "Even when you're using the exact same methodology and the same non-cannabinoid ingredients in all of your state markets, you still have to worry about issues with product uniformity in the final product." ■

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## Detecting Food Adulteration ... (Continued from p. 41)

manufacturers and food safety officials to rapidly test the authenticity of foods such as olive oil, to protect brand reputation and ensure consumer confidence in the product's authenticity.

Other features often analyzed with NMR that are now benefitting from benchtop systems are fat content of milk and species of coffee bean. The determination of the origin of these foods in the supply chain is vital to preserve the integrity of the manufacturer's product and protect the consumer.

### Mitigating the Risk of Food Fraud in the Future

Food fraud dents consumer confidence in the supply chain and causes distortions in markets that can lead to unfair competition, with legitimate producers undercut and potentially forced out of the market. If the whole supply chain is acting in accordance with a single standard, consumers can be confident in the seal of approval.

Benchtop NMR has a wide variety of potential applications in the fight against food fraud. Benchtop NMR systems can slot into any laboratory environment and begin providing accurate results quickly, without the need for expensive reagents or extensive user training.

For more information about how benchtop NMR is tackling food fraud, please visit [bruker.com/products/mr/nmr/benchtop-nmr.html](http://bruker.com/products/mr/nmr/benchtop-nmr.html). ■

**Dr. Decker** is product manager for compact NMR (TD/FT) for Bruker BioSpin.

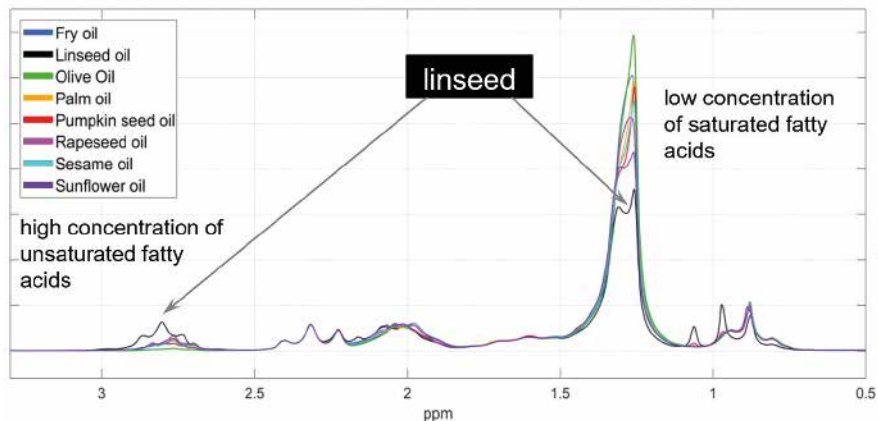


Figure 2: Overlay of 80 MHz benchtop NMR spectra (Fourier 80, Bruker BioSpin) of different edible oils, showing a typical indicator for linseed oil due to higher signal in 3 ppm region, and a clearly reduced signal in the chain lengths in the saturated fatty acid region.

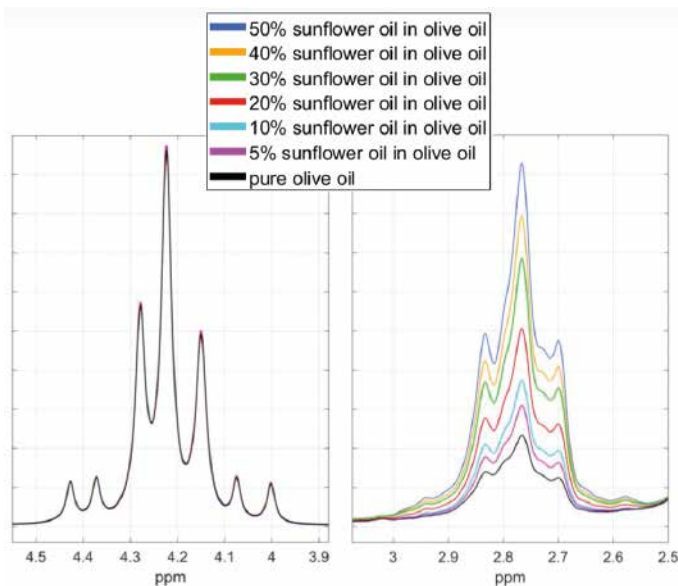


Figure 3: Detecting dilution of olive oil with increasing concentrations of sunflower oil, using 80 MHz benchtop spectroscopy (Fourier 80, Bruker BioSpin). While the glyceride part is the same (left), the main differentiator between the two oils is encoded in the number of double bonds in the fatty acid regions, leading to different signal intensities for different dilution factors (right).



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# NEW PRODUCTS



## Enterobacteriaceae Real-Time PCR Detection Kit

AOAC International has approved the Bio-Rad Laboratories iQ-Check Enterobacteriaceae Real-Time PCR Detection Kit, which is used to detect Enterobacteriaceae in dairy products. The kit method was validated against the ISO reference method using Bio-Rad's PIF Supplement, which facilitates a shorter enrichment time for sample sizes up to 375 grams. Bio-Rad offers a fully harmonized enrichment protocol for real-time PCR and cultural methods to individually detect Enterobacteriaceae, *Cronobacter*, and *Salmonella* from a single sample, helping to decrease the costs, labor, and time associated with testing dairy products. The method matches the accuracy of the ISO method while reducing labor requirements and testing time. **Bio-Rad Laboratories, Inc.**, [bio-rad.com/iqcheck](http://bio-rad.com/iqcheck).

## Liquid Cooling Unit

The new EB 2.0 ECO Chiller uses compressor inverter technology to reduce power consumption up to 65% and lower operating costs. Inverter technology in the compressor works to ensure a direct response to cooling demand, thus minimizing energy waste for more environmentally-friendly and lower cost operation. This responsiveness to cooling demand also increases the range of cooling capacity significantly—by 50% to 100%—and extends the product's lifespan. Designed for indoor and outdoor operation, the new chiller design is suited for heat dissipation in combination with passive indoor cooling systems. The new unit features a hot gas bypass refrigerant circuit, internal hydraulic bypass circuit, and non-ferrous hydraulic circuit. The electrical tank level switch and coolant flow switch simplify operation, along with the programmable smart controller and wired remote control. It uses R410<sup>a</sup> environmentally friendly refrigerant and features a micro-channel condenser for greater resistance to dirt and debris buildup in outdoor environments, and thus offers more efficient operation over time. **Pfannenberg**, [pfannenbergusa.com](http://pfannenbergusa.com).



## Reversible Pump Filtration Machine

When is a vegan dish not a vegan dish? When it's fried in the same oil as meat-based foods. Even if you regularly filter your cooking oil, standard filtration procedures send oil from all vats through a common plumbing system, where they become commingled. Once this pool of oil is filtered and pumped back into the vats, your vegan dishes become tainted with traces of meat from the other vats' oil. With the new Reversible Pump Filter Machine, the two-way pump both sucks out the oil from the individual vegan-designated vat and pumps it back in after filtering. There's no longer any need to use the fryer's common drain. Vegan stays vegan. The machine can also keep different oil types separate as well for restaurants that offer a range of oils for different dishes. **Frontline International**, [frontlineii.com](http://frontlineii.com).

## Listeria monocytogenes ELISA Assay

The PerkinElmer Solus *Listeria monocytogenes* ELISA Assay will help high throughput food processors and contract labs focus on *L. mono* testing for food samples. In sync with leading industry standards, the new solution is being introduced with Performance Tested Method SM (PTM) certification from AOAC International. The assay features the ability to employ a single protocol for food samples (such as unpasteurized cheeses, meats, shrimp, and vegetables) A 24-hour enrichment process leverages supplemented standard media and incubation parameters are shared across matrices. Users can choose to process samples manually or automate them with Dynex Technologies' DS-2 system. **PerkinElmer**, [perkinelmer.com/category/food-safety-quality](http://perkinelmer.com/category/food-safety-quality).



(Continued on p. 52)

(Continued from p. 51)

### Industrial Dust Collector

The Gold Series X-Flo (GSX) industrial dust collection system collects airborne dust particles to provide a clean work environment and prevent cross-contamination of food products. The system is ideal for dry food ingredients such as coarse grains, fine spices, and additives, as well as sticky dusts such as sugar and whey. It can collect toxic, nuisance, and combustible food dusts including fine, fibrous, and heavy dust loads. It can capture food dust at its source using stainless steel pickup hoods at each production station or by directly hooking to batch mixers or high-velocity slot hoods behind weigh stations. Capturing dusts at their



source prevents worker exposure to airborne contaminants and keeps dust from travelling throughout the facility. The GSX system also helps food processing and manufacturing facilities exceed OSHA indoor air quality standards. The system offers the highest combustible dust explosion protection in accordance with NFPA and ATEX standards. **Camfil Air Pollution Control, camfil.com.**

### Packaging Solution for Case Erecting and Bag Placing

The CombiPlast case/box erector with bag inserter combines box erecting and bag inserting technology in one compact solution with the ability to speed up to 15 boxes per minute.



The CombiPlast automatically takes charge of your packaging process by putting each box together and inserting bags each time, resulting in a much faster and safer process than manual production. The stainless steel frame has a small footprint that conserves floor space. **Niverplast, niverplast.com.**

### Supply Chain Integration Platform

RedwoodConnect 2.0, Redwood Logistics' supply chain integration platform-as-a-service (iPaaS) provides a platform for customers to design, deploy, monitor, support, and report on all the data moving across disparate modules within its supply chain operations. The platform's cloud-based integrations allow customers to determine and move data received through its existing TMS, ERP, WMS, carrier, and partner integrations. The platform allows customers to send and receive logistics data in any file format the way it exists from each partner and supply chain module, and automatically configures the data. **Redwood Logistics, redwoodlogistics.com.**

### Laboratory Casework

The UniLine Casework is constructed of welded 18-gauge steel. Base cabinets have a load capacity of 500 pounds per linear foot. It is tested independently to be SEFA 8 compliant. The drawers extend to 18" fully open, and include an interchangeable, interlocking drawer head, sound deadened for quiet operation. It also includes a one-piece drawer body with radiused bottom for easy cleaning. The interior is powder-coated steel, and a stainless steel interior is optional. The two-piece double wall construction is painted before assembly. Insulated door filler for added rigidity and quiet operation. **HEMCO, hemcocorp.com.**



### ELISA Rapid Gluten Test

The GlutenTox ELISA Rapid G12, an improved test for the most immunotoxic peptide in gluten, provides results in less time than either previous versions or competitors' ELISA tests for gluten. Test uses the G12 antibody to identify in food samples the 33-mer (part) peptide segment of the gliadin protein, which is part of the gluten protein complex. This "33-mer" peptide is the most immunotoxic part of the gluten protein and induces celiac disease in susceptible people. The 33-mer peptide also shows high resistance to complete digestion by human digestive enzymes. Focusing on this peptide fragment provides more objective information to help people with celiac disease and gluten intolerance to avoid foods that contain gluten. The test provides measurement of gluten down to 0.6 ppm (0.3 ppm of gliadin). **Hygenia, hygenia.com.**



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4. Issue Frequency: Bi-monthly Feb/Mar, Apr/May, Jun/Jul, Aug/Sep, Oct/Nov, Dec/Jan

5. Number of Issues Published Annually: 6

6. Annual Subscription Price (if any): \$ 230

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®): Wiley Periodicals LLC, 111 River St., Hoboken, NJ 07030

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13. Publication Title: Food Quality & Safety

14. Issue Date for Circulation Data Below: Aug/Sept 2020

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## The Impact of Different Hop Compounds on the Growth of Selected Beer Spoilage Bacteria

Beer-spoiling lactic acid bacteria are a major reason for quality complaints in breweries around the world. Spoilage by a variety of these bacteria can result in haze, sediment, slime, off flavors and acidity. Using certain hop products that inhibit the growth of these spoilers could be a solution. To investigate the impact of seven different hop compounds on the growth of six major beer spoilage bacteria, two concentrations (10 mg/L and 25 mg/L) of each hop substance were added to unhopped beer. The potential growth of the spoilage bacteria was investigated over 56 consecutive days. A comparison of the results shows a strong inhibition of growth of all spoilage bacteria at 25 mg/L of tetrahydroiso- $\alpha$ -acids, closely followed by  $\alpha$ -acids as the second most inhibitory substance. The results showed a high resistance of *L. brevis* to all hop compounds as well as an inhibition of *L. coryniformis* and *L. buchneri* at low concentrations of most hop components. In comparison with the control sample, *L. lindneri* showed increased growth in the presence of some hop compounds. *Journal of the Institute of Brewing*. Published September 11, 2020. DOI: 10.1002/jib.624.

## Cinnamon Essential Oil to Enhance the Stability and Safety of Fresh Apples

The core objective of this study was to enhance the storage stability of apples with cinnamon essential oil edible coating. Apples were coated with coating material containing different concentration of cinnamon essential oil. Coated apples were packed in polypropylene bags and stored at 5°C refrigeration for two months. The coated apples were subjected to physiochemical analysis (moisture loss percentage, weight loss, color, total soluble solids, ascorbic acid, titratable acidity, and pH), microbial analysis (antifungal activity and antimicrobial activity), and sensory evaluation during storage after intervals of 10 days for two months. During storage, a rapid decrease in all parameters was observed, except in the group with 5% cinnamon essential oil. The edible coating contained in this group showed the highest zone of inhibition against *P. expansum* and *E. coli* and prevented the spoilage and maintained the nutritional values of the apples. *Journal of Food Processing and Preservation*. 2020;e14926.



## Effect of Stretching Temperature on the Texture and Thermophysical Properties of Mozzarella

The stretching conditions adopted for mozzarella cheese production are important, as they have a direct effect on the texture and thermophysical properties of cheese. The aim of this study was to evaluate the effect of stretching temperature on the microstructure, texture,



and thermophysical properties of mozzarella cheese throughout the refrigerated storage period. The microstructure, apparent zeta potential, uniaxial compression, texture profile analysis, melting, and free oil of cheeses stretched with water at 75°C and 85°C were analyzed during 28 days of storage at 4°C. The results showed that the variation in the stretching temperature did not cause changes in the melting and oil release of the cheeses. The visual analysis of fat particles size showed changes throughout the refrigerated storage period, but with no impact in the free oil release from the cheeses. *Journal of Food Processing and Preservation*. 2020;e14703.



## Rapid Method Detection of *E. coli* and Coliforms in Dairy Products

This investigation’s goal was to develop colorimetric tests for rapid detection of *E. coli*/coliforms. These tests were developed using the modified *E. coli* selective medium (M-ECSM) and coliform selective medium, respectively. The selective media contain a combination of group-specific marker enzymes and selective agents. The marker enzymes were screened using chromogenic substrates wherein  $\beta$ -D-glucuronidase and glutamate decarboxylase were found specific for *E. coli*, with  $\beta$ -D-galactosidase specific for coliforms. The selectivity of the media was achieved using different concentrations of ampicillin and gentamicin. A field evaluation of the tests reported the prevalence of *E. coli*/coliforms as 57.29/88.54% in 96 raw milk samples and 16.28/51.16% in 43 pasteurized milk samples. Test components were vacuum dried in the form of miniaturized point-of-need tests for field application in dairy farms and industries with minimal infrastructural requirements. *Journal of Food Safety*. 2020;e12839.





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