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Volume 29 Number 1
FEBRUARY / MARCH 2022

Food Quality & Safety

FARM TO FORK SAFETY

UNDER PRESSURE

Why the Food Supply Chain Is Strained, and What the Food Industry Can Do About It

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FEBRUARY / MARCH 2022 • VOLUME 29 NUMBER 1 • www.foodqualityandsafety.com

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Food Quality & Safety (ISSN 2572-8644) is published 6 times a year in Feb/Mar, Apr/May, Jun/July, Aug/Sept, Oct/Nov, Dec/Jan by Wiley Subscription Services, Inc., a Wiley Company, 111 River St., Hoboken, NJ 07030-5774. 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 €164, U.K. readers at £133, and rest of the world readers at $248.
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.

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 Editor

The State of Food Safety in 2022

The beginning of 2022 brings renewed hope to the world and, in particular, to the food safety community. It looks as if things will return to a more normal routine and, as such, this seems a fitting place to start my first column as the new Executive Industry Editor for *Food Quality & Safety*. As cases from the Omicron variant begin to dwindle across the U.S., there's hope that this will be one of the last major waves of the pandemic. And there is my hope that, as we begin rebuilding the foundations of our food safety systems, we can do far more than return to what was before, and instead build what "should be."

Since early 2020, food safety has been operating somewhat on autopilot. Inspections have been limited to those for cause, and third-party audits have suffered seriously due to travel limitations. Training events have fallen off as well. Early on, COVID-19 spread rapidly in food manufacturing plants, most notably among the workers in the meat industry. Food safety teams struggled to assess these new risks and implement the unfamiliar measures designed to manage transmission in their densely packed production environments. We all learned the new language of the pandemic.

Now, ever-pressing production demands are yet another issue contributing to the problem. Line workers are in high demand but always scarce, and trained employees were hard to come by even before the pandemic. Fortunately, the bulk of the required PCQI classes were completed prior to the pandemic, but in-person meetings and travel are still real challenges to maintaining professional development needs. Supply chain interruptions are also wreaking havoc.

Before the pandemic, food safety folks were tired, often undertrained, and in short supply. Now, after nearly two years, they are in the same situation as frontline healthcare workers: burned out and perhaps even more short staffed than ever. This is the landscape facing the food safety sector in 2022. As we contemplate this return to normal, we should look hard at this "normal" we want so badly. What is it? Perhaps there are better ways to achieve these goals? Perhaps there are new goals to achieve? I think there are both, and I'll explore these ideas in this column in upcoming issues.

Hopefully, this is the beginning of a national and international dialogue on food safety, and I want to encourage everyone to participate in the discussion. Tell me, what bothers you most today? What are the most significant challenges you face? What are your top five food safety concerns? And, most of all, how can *Food Quality & Safety* better serve your food safety needs?

Please share your ideas and concerns with me at trish@pawesta.com. Let's really kickstart 2022!

Patricia A. Wester
Executive Industry Editor

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Food Quality & Safety
FARM TO FORK SAFETY

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WINNER 2021 APEX AWARDS FOR PUBLICATION EXCELLENCE

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

NEWS & NOTES

FDA Issues Recommendations for Increased Food Safety at Indoor Farming Facilities

BY KEITH LORIA

FDA has released a report on its investigation of the Salmonella Typhimurium outbreak that caused 31 reported illnesses and four hospitalizations in the U.S. between June and August 2021. Although a conclusive root cause was not identified, based on its findings, FDA has issued recommendations for the indoor farming community to help identify and control conditions and practices that could result in contamination.

The requirements and recommendations provided are just a few examples to remind indoor farming operators that controlled environment agriculture (CEA) is increasing globally, and all types of food production must continue to address basic food safety concerns, including potential sources and routes of contamination.

One of the key recommendations is for indoor farmers to develop a strong understanding of potential sources and routes of contamination for their product, including the raw materials and inputs used, as well as possible sources of contamination throughout their operations.

A spokesperson for FDA tells *Food Quality & Safety* that another recommendation is for growers to implement effective sanitation procedures and sampling plans, while paying strict attention to hygienic operations and equipment design to ensure that cleaning procedures don't contribute to the dispersion of any microbial contaminants that may be present. Additionally, FDA plans to assess growing operations to ensure implementation of appropriate science- and risk-based preventive measures, including applicable required provisions of the FDA Food Safety Modernization Act, Produce Safety Rule, and good agricultural practices.

Another recommendation is for the CEA operators to implement procedures that are effective in rapidly cooling and cold holding harvested leafy greens after harvest and verify the effectiveness of the cooling and cold holding procedures, including the routine monitoring of processing and storage environments and product temperatures to prevent pathogen growth in harvested leafy greens, the agency spokesperson adds.

If employing tools such as pre-harvest and post-harvest sampling and testing of food, water, and the physical environment, growers will need to seek to identify and inform sampling plans, limits of detection, and mitigation measures that control potential sources and routes of bacterial contamination in the growing and harvesting environment.

Pond water is another challenge that impacts indoor farming, and the recommendations include ensuing that all water is safe and of adequate sanitary quality for any water treatment involved.

Study: Online Food Retailers Don't Always Adhere to Labeling Regulations

BY KEITH LORIA

Online food retailers do not regularly present nutrition information on their websites, and laws requiring them to do so are lagging behind the rules and regulations that brick-and-mortar retailers must follow, according to a new study conducted by the New York University School of Global Public Health and the Friedman School of Nutrition Science and Policy at Tufts University.

Lead author Jennifer L. Pomeranz, MPH, assistant professor in the department of public health policy and management at New York University, fell upon the genesis of the paper by accident, and says that she was looking for food labels of products for a different study, and searched online retailers to find them. "I noticed that the labels I found were inconsistent across retailers and sometimes were mock-ups of the products rather than the real food packaging you'd find in the store," she tells *Food Quality & Safety*.

The study examined whether 10 popular products across nine national online food retailers disclosed the information panel, which includes the nutrition facts label, ingredient list, common allergens, and the percentage of juice for fruit drinks. The investigators discovered that the required information was present, visible, and legible for only 36% of the products. What's more, potential allergens were only disclosed on 11% of the items. Failure to disclose this information may present safety concerns for consumers who depend on the labeling, as in the case of allergens, sodium, or sugar, the researchers noted.

"Although, arguably, the FDA's regulations for food labeling already apply to online food retailers, the FDA has not issued a clear statement confirming this to be the case," Pomeranz says.

The team also conducted legal research using LexisNexis to analyze federal regulatory agencies' authority. The researchers believe online food retailers should voluntarily disclose the full information panel conspicuously and legibly. "The FDA could issue guidance documents explaining that their labeling requirements apply in the online food retail environment," Pomeranz says. "Congress could pass a law requiring the same. The USDA could also issue regulations requiring that online SNAP [Supplemental Nutrition Assistance Program] retailers disclose the full information panel conspicuously and legibly. We hope our study will bring to light the issues consumers face when shopping online and urge the federal agencies to act to protect consumers and ensure an efficient and transparent marketplace."

Washington Report

FDA's Whole Genome Sequencing Network

A new study evaluates the costs and benefits of the program

BY **MARY BETH NIERENGARTEN**

Since 2012, FDA's GenomeTrakr Whole Genome Sequencing (WGS) Network has compiled a database that contains the genomes of a number of foodborne pathogens, accessible to public and private entities via the National Center for Biotechnology Information Pathogen Detection (NCBI PD) web portal. It is hoped that the network, currently comprising more than 50 national and international laboratories that contribute to the database, will grow to include more public and private laboratories to further speed up the sequencing of pathogens.

"We anticipate that WGS will help us identify the true scope of outbreaks, making clear that some illnesses we now see as sporadic—which research shows is about 95% of foodborne infections—are, in fact, part of an outbreak," says Brad Brown, PhD, senior scientific advisor for FDA's Center for Food Safety and Applied Nutrition (CFSAN), adding that the improvements seen with WGS technology can help detect more outbreaks through small clusters, thereby informing both how to respond to an outbreak and how to prevent one.

Data support the improvements already seen with the NCBI PD program and its component, the GenomeTrakr network. A study conducted by Dr. Brown and some of his colleagues at the CFSAN and published in PLOS ONE, performed an economic analysis of the program and concluded that the NCBI PD portal has been successful in reducing the number of total illnesses due to WGS source tracking, and projects the overall cost-effectiveness of the program over time.

A Faster Way to Detect and Stop Foodborne Outbreaks

To examine the benefits and costs of the WGS NCBI PD program to date, Dr. Brown and his team used an economic model to estimate the reduction in foodborne illnesses from three common pathogens (*Listeria*, *Salmonella*, and *E. coli*) by using WSG tracking. Estimates from the model were tested against empirical data. A final analysis was conducted to assess the benefits and costs of implementing the program.

The study estimated that. by 2019, the WGS tracking program had effectively helped reduce the number of people who got sick from foodborne illnesses to 210 illnesses annually (13% reduction) for *Listeria*, the most heavily sequenced pathogen tracked by the program to date, to 19,800 illnesses annually (1.5% reduction) for *Salmonella*, a relatively less sequenced pathogen; a 6% reduction in *E. coli* illnesses was also achieved.

According to Dr. Brown, lead author of the study, even accounting for uncertainty

in the model used to estimate these numbers, the total burden of illness reduction, or gross estimated benefit of the program, was nearly $150 to $500 million in 2019. This represents between 0.5% and 1.5% of the total burden of illness caused by food regulated by FDA, he says.

"The study provides strong evidence for significant improvement in food safety anywhere WGS source tracking is implemented," says Marc Allard, PhD, a research microbiologist with CFSAN and coauthor of the study.

Renato Hohl Orsi, PhD, a senior research associate in the department of food science at Cornell University in Ithaca, N.Y., underscored the extreme value of the program and expects that it will generate even better results in the coming years as more isolates are added to the database.

Dr. Orsi also pointed to the range of benefits offered by WSG data, such as specific information on isolates (e.g., the presence of antimicrobial resistance gene, serotypes for some pathogens such as *Salmonella*, and the presence of certain virulence genes), as well as the ability to better differentiate isolates to identify any that are closely related genetically, which can help to identify the source of an outbreak during an outbreak investigation.

> The study provides strong evidence for significant improvement in food safety anywhere WGS source tracking is implemented.
>
> —Marc Allard, PhD

A key benefit for industry is that the NCBI PD portal's database is available for public access. "This can benefit the food industry as a whole to improve their own safety processes and investigations," he adds.

Dr. Allard emphasizes that the food industry can use the publicly available genomic data for real-time comparison and analysis. "This can speed foodborne illness outbreak investigations and reduce foodborne illnesses and deaths," he says.

Other benefits to industry, he adds, include using the database to monitor ingredient supplies and to develop new rapid method and culture independent tests, as well as an effective tool for preventive and sanitary controls. Additionally, industry can use the database "to determine the persistence of pathogens in the environment, to monitor emerging pathogens, and as a possible indicator of antimicrobial resistance," he says.

Sound Investment

Using a model to generate an estimate of the annual benefits and costs of the WGS NCBI PD program to date, the PLOS ONE study investigators found that the upfront investment dollars needed to establish the program and maintain it are easily predicted to be offset by large gains from averting human health costs. When factoring in lab set-up costs, collection and testing costs, and internal costs to run the program, the study found that the program costs approximately $21.3 million per year to run.

By 2019, the estimated net benefits of the program were approximately $475 million, with conservative estimates at nearly $125 million. "The WGS program has generated a return on investment of as much as $10 in averted human health costs for every $1 invested in the program," says Travis Minor, PhD, senior policy advisor for the CFSAN and also a coauthor of the study.

Their research found that the program was likely cost effective in its second year of implementation. "These estimated benefits of the WGS source tracking program easily outweigh the estimated implementation costs after the second year," says Dr. Brown. "Once the program is fully implemented, we may see net benefits measure in billions of dollars."

Going Forward

The researchers expect that the applications of WGS source tracking will expand rapidly, and adoption of WGS surveillance globally will facilitate a greater capacity for public and private entities to detect, track, conduct root cause analysis of, and potentially predict future pandemics, outbreaks, and contamination events. "We envision a global food shield and pathogen surveillance system with many countries sequencing and sharing the genomes of human, animal, and plant pathogens," says Dr. Allard.

> The WGS program has generated a return on investment of as much as $10 in averted human health costs for every $1 invested in the program.
>
> —Travis Minor, PhD

The importance of this global sharing of pathogen surveillance is underscored by the significant value that WGS source tracking has had in the battle against COVID-19, he adds. He also emphasizes that the benefits of the program apply to the full range of infectious disease control agents, such as in hospitals, nursing homes, medical manufacturing, waste management, composting, agricultural water use, and reuse.

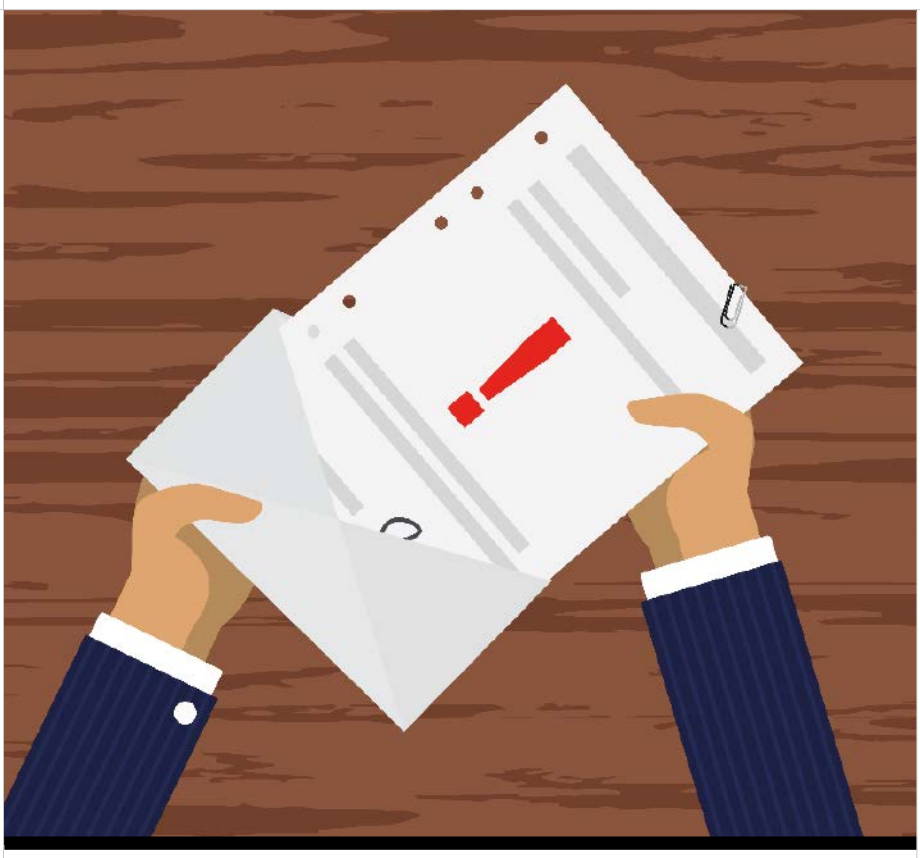
Dr. Orsi adds that adoption of WGS source tracking by other countries is critical for an increasingly international food supply. Particularly important is the use of WGS in countries that produce and supply ingredients. "For example, a country that uses ingredients from different suppliers in different countries could use WGS data to investigate a pathogenic isolate found in its final product by comparing these isolates against the database," he says. "If the database is thorough, the chances of finding a match to a closely related isolate in the database increases and can indicate from which of the suppliers or countries the isolate originated from."

Currently, members of the program include the Centers for Disease Control and Prevention and USDA's Food Safety and Inspection Service, as well as some U.S. state departments of health and agriculture. Internationally, several large laboratories, such as Public Health England, are planning to conduct surveillance.

For more information about the GenomeTrakr Network and a list of all the current contributing laboratories, visit FDA.gov/food and click on "science and research" in the menu bar. ■

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

Legal Update



FSMA Preventive Controls Final Rule Enforcement

While the rule is here to stay, how is FDA judging compliance?

BY **SHAWN K. STEVENS, ESQ.,** AND **ELIZABETH PRESNELL**

Believe it or not, it's been 10 years since President Obama signed the Food Safety Modernization Act (FSMA) into law. In the years that followed, FDA worked tirelessly to draft enabling regulations to help facilitate the congressional goals of making the U.S. food supply safer. One of the new FSMA rules developed by FDA was the Final Rule for Preventive Controls for Human Food.

The final rule, which went into effect in 2016 and required compliance from all covered facilities in 2018, called for nearly all FDA-regulated facilities to develop a written food safety plan designed to ensure that the risks associated with the production of certain food products were identified and addressed. The rule required food companies to conduct a hazard analysis designed to identify those hazards that were reasonably likely to occur in the food at issue, to identify effective controls to eliminate or reduce any such hazards, and to effectively implement those controls to accomplish the stated goals (see 21 C.F.R. § 117.16). The rule also required companies to develop written monitoring procedures, verification procedures, and corrective action procedures (in the event of a deviation or failure), as well as a written supply chain program and written recall plan.

In addition to requiring companies to develop written food safety plans, FSMA also established a mandated inspection frequency that is based on overall risk for food facilities and the specific products they manufacture (FSMA, 124 Stat. 3885, Sec. 201). Pursuant to the mandated inspection frequency, FDA is now required to inspect domestic food facilities at least every five years for non-high-risk facilities and at least every three years for high-risk facilities. With that said, in many cases, processors will find that the inspections are actually more frequent than the mandated minimums.

Initially, from an enforcement standpoint, FDA stated that the agency's primary focus would be on education and technical assistance. More recently, however, now that the final rule has been in place for almost five years, the agency has stated it will begin taking a more aggressive enforcement approach, focusing less on education and more on compliance and enforcement.

In October 2020, FDA issued guidance that provides direction to FDA inspectors who are conducting assessments under the Final Rule (See Compliance Program Guidance (CPG) Manual 7303.040. FDA confirmed that high-risk facilities will be prioritized for inspections, and inspectors are directed to select the highest-risk food or process within the facility for review during the inspection to target FDA resources on the most significant risks present. The CPG directs inspectors to use FDA Form 483 as the primary, though not exclusive, method of agency follow-up for critical and major preventive controls violations that are identified. The goal of FDA's Form 483's inspection and enforcement methodology as identified in the CPG is "to obtain high rates of industry

compliance," while, at the same time, encouraging voluntary corrective actions.

When a facility violates FDA regulations, FDA considers those violations to be very serious and, if they not corrected immediately by the facility under scrutiny, FDA can and will issue warning letters to the offending company. An FDA warning letter is the mechanism the agency uses to threaten the removal of a food company's registration (in essence, threatening to shut the company down) for uncorrected food safety violations that the agency deems to be very serious. While the issuance of an FDA Form 483 to a company is not widely publicized by the agency, FDA warning letters get much more attention and are, thus, more "public." Therefore, warning letters should be avoided at all costs.

We examine three recent warning letters identifying instances where FDA has found violations of the Preventive Controls Final Rule.

The Warning Letters

On October 25, 2021, Maribel's Sweets (a company that manufactures ready-to-eat chocolate products) was issued a warning letter because the facility did not have a written food safety plan, as required by the Preventive Controls Final Rule. The facility had not completed a hazard analysis as required by the final rule and, thus, failed to consider any allergen, biological, and mycotoxin hazards that were known or reasonably likely to occur in the ingredients and products at issue.

According to the letter, in addition to failing to complete a satisfactory hazard analysis, the company also failed to implement needed controls for those hazards that were foreseeable or likely to occur. The company was initially issued an FDA Form 483 following an FDA inspection in June 2021, and although Maribel's responded to the FDA Form 483 stating that it was in the process of creating and implementing a food safety plan, the company failed to provide a timeline that included a date by which the written food safety plan would be completed and, as a result, FDA issued the October 25th warning letter.

Only a month later, on November 22, 2021, FDA issued Sarita's Tortilla Factory a warning letter because the company had, similarly, not yet implemented a satisfactory written food safety plan as required by the final rule. The facility had, reportedly, not conducted a hazard analysis for the foods it manufactured (to include biological and allergen hazards) and had not implemented sufficient preventive controls for those hazards reasonably likely to occur in the products at issue. The agency also stated that the company had failed to implement appropriate monitoring procedures, verification procedures, and corrective action procedures as required by the final rule. Although the facility responded to FDA's initial Form 483, the agency was not satisfied with the company's response and, in November 2021, elevated its enforcement approach from the FDA Form 483 to a warning letter.

More recently, on December 1, 2021, FDA issued Sabra Dipping Company a warning letter because the facility's food safety plan reportedly did not "appropriately identify and evaluate known or reasonably foreseeable hazards" as required by the final rule. Specifically, as reported by FDA, although Sabra had created a written food safety plan, which did in fact identify certain hazards, the written plan did not clearly identify whether or to what extent those hazards required a corresponding preventive control. Additionally, the food safety plan, according to FDA, did not specifically address the hazard posed by *Salmonella* on certain incoming ingredients where *Salmonella* has been a hazard known to occur. Here, too, presumably not satisfied with Sabra's initial response, FDA issued a warning letter.

Compliance Lessons

Important lessons can be taken from the more recent waning letters issued by FDA. For those companies looking to ensure that they will be deemed by FDA to be in compliance following their next inspection, it will be important to do the following:

1. Create, document, and implement a satisfactory written food safety plan that addresses each required element. When FDA arrives for the next inspection, the agency will conduct an independent hazard analysis and risk assessment for your process. Take steps now to ensure that your food safety plan contains a thorough evaluation of all potential hazards (regardless of whether or not a preventive control is deemed necessary), and includes appropriate controls, adequate monitoring and verification procedures, and contains action procedures for when violations do occur.

2. Address all potential vehicles of microbiological and pathogenic contamination. Be sure to specifically consider and evaluate all ingredient and environmental pathogens in your food safety plan. Notably, each of the above warning letters included a specific indication by FDA that the food safety plan did not include a sufficient evaluation of environmental pathogens. These are known hazards and, when a ready-to-eat product is exposed to the environment post-lethality, the agency will expect to see an environmental monitoring plan that includes a written assessment of the hazards as well as appropriate controls.

3. Immediately perform and document corrective actions in response to any FDA observation. A timely and thorough response to any observations recorded by FDA in a Form 483 may prevent the issuance of a warning letter. When FDA receives satisfactory corrective actions to observations, warning letters are typically unnecessary.

When an FDA inspector visits a facility that does not have a written food safety plan or the controls identified in a food safety plan are inadequate to ensure public health, the inspector must classify the inspection as "official action indicated" (OAI) according to the CPG. Facilities that have received a classification of OAI are also prioritized for future inspections because the facility is then defined as high risk by the CPG.

By ensuring that your facility has a thorough, documented, and satisfactory food safety plan that considers all potential hazards and implements appropriate preventive controls, you can avoid the discomfort and pain of an FDA warning letter, and focus instead on producing a high quality, safe, and wholesome product for your customers. Indeed, keeping FDA happy will keep each of your customers (and consumers) happy as well. ■

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Cannabis Corner

Cannabis "Flavor" in Edibles

Cannabis can be a tough flavor to mask in edibles. We talked to several producers about what consumers want, and how to best meet demand

BY **JESSE STANIFORTH**

Even people who know nothing about cannabis know that it can have a strong smell. Cannabis flower is packed with aromatic terpenes, which give the plant its many strong and distinctive odors. The potency of terpenes carries over to the flavor of the plant, making it taste, as Canadian cannabis industry consultant Brandon Wright puts it, "very green."

This "green" flavor can be a challenge for edibles producers looking to add cannabis or cannabinoids to their products. Should they mask it? Should they lean into it? What do consumers want?

Wright opened his first company after the 2015 Supreme Court of Canada decision that the production and distribution of cannabis edibles for medical users was constitutionally protected. At the dawn of Canadian edibles, he says, the two main sources of cannabinoids were cannabutter (butter infused with cannabis) and Rick Simpson Oil (RSO), a high-concentration cannabis oil extract made with solvents such as naptha. "In the early days, a lot of things looked, tasted, and smelled 'green.'

That's just not the case anymore," he adds. Instead, edibles producers now often use tetrahydrocannabinol (THC) distillates or isolates, which eventually took over from RSO as the cheapest and strongest source of cannabinoids for edibles.

Wright also notes that, among regulated markets, THC distillates seem to be the most common cannabinoid additives due to the ease of masking their flavors. "Distillates in particular are a fairly well-refined product," he says, adding that the distillate process already takes out a lot of what you'd consider that green, "weedy" taste. "What you're left with isn't exactly a chemical taste; it would be akin to the alcohol taste in a rum ball. It doesn't taste like alcohol, but you know alcohol is in it. There's a sense there's something there underlying this that is more than just the flavor of the candy. That's how I know it's infused."

For some, the use of distillates has made edibles too easy to create. Christina Wong, a chef who develops cannabis-infused recipes, is tired of distillate in edibles. "My biggest pet peeve is people who have any edible or drink product [can just] add a [THC] distillate or isolate, and say 'Here we go, I have an edible,'" she says. "I know it's very hard to be a producer, to get a product to market, finding a co-packer and somebody who can create those products. Adding distillate and isolate is the 'easy' button. Anybody can add distillate/isolate to a product and call it an edible, and there are a lot of interesting ones. But personally, I'm on a mission to promote higher quality ingredients and educate the consumer about how they should buy quality."

While distillates and isolates have little flavor in lower doses, they can also be acrid; skill and practice are needed to incorporate them into a polished final edible product. Wright says that THC distillate between 85% and 95% potency is a plant-synthesized chemical so strong it's "akin to turpentine." Wong calls the taste of some distillates and isolates "bitter and horrible" and says that she'd rather work with the full plant and its many flavors instead of orienting her recipes around hiding the chemical taste of added cannabinoids.

Potency also influences distillate and isolate bitterness, which Wright says is one of the limits on the desirability of distillate-based edibles. "In the regulated market, almost exclusively, you'll see more distillates being used," he says, "because then people don't have to think about the problem of masking the greenness. But [as potency increases], some of the bitterness will remain." He adds that a trained food scientist is an important component of your R&D process.

> Instead of masking flavors, we're trying to bring out a different line of product. We have our regular product that's made with distillate or isolate, and then we also do this line of products for people who want to taste the cannabinoids and the terpenes.
>
> —Dave Maggio

Trial and Error

New edible products must meet strict regulatory requirements for cannabinoid content, a concern that must also be addressed during the product development stage. Rachel King, a founding partner and culinary director of edibles company Kaneh Co., agrees that R&D plays an important role in edibles product development. "We have done lots of R&D and have had a ton of trial and error," she says. "We have the system ironed out now, but we rely heavily on lab results, proper scaling of ingredients, and recipe ratios. Data has been our best friend in this." Once the potency content has been established, the art of masking the chemical taste becomes paramount.

Wright says the taste of distillate can generally be masked. "It's easier with savory things that are more complex—things like peanut butter cups," he says. "Gummies and things made purely out of sugars or basic products are tougher to mask it in."

At Kaneh Co., King has found chocolate the easiest flavor with which to mask cannabis, followed by coffee. "Fruit flavors don't always mask the taste," she says, "but the stronger the fruit flavor the better. Depending on the cannabis material used, fruit flavors or even vanilla can enhance certain notes in the cannabis flavor profile to create a pleasant synergistic effect. The stronger the food flavor, the better it will mask the cannabis flavor."

Dave Maggio, co-founder of multistate edibles operator Cheeba Chews, says his go-to cannabis masking flavor is mint. He agrees that "fruity" as a flavor isn't very effective, unless it's the kind of precise citrus flavor calibrated to the terpene profiles of particular strains. "There's a lot of R&D, but you can't just pick a strain and decide you're going to mix it with strawberry."

His company initially launched as a line of taffy products, and Maggio says that taffy is a rich medium in which to mask the flavor of pure distillate. "With chocolate and caramel, you can mask the flavor much easier." In their newer gummy products with more delicate flavors, Maggio hires a double distiller to make the distillate even more pure.

Maggio has little use for chemical flavor fixes such as bitter blockers, which he says don't work with cannabis. "A lot of it has been trial and error, and we find some of the higher-end flavor extracts are what have helped us, rather than bitter blockers or other chemical-type materials that are made for [masking]," he says. "What we found the most success with was using high-end [cannabis] when it comes to flavoring."

To Mask or Not to Mask?

One quirk of cannabis is its range of flavors and odors, which can be dominated by notes ranging widely from skunk or pine, to citrusy or lavender, to earth, spice, cheese, or turkey dinner. Wong sees this array of flavor possibility as a gold mine.

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For some of his company's new products, however, Maggio says that masking the flavor is no longer the goal. The company is joining the wave of higher-end edibles makers releasing flavors made with full-flavor rosins and solventless extracts like ice-water hashish. "Instead of masking flavors, we're trying to bring out a different line of product," Maggio says. "We have our regular product that's made with distillate or isolate, and then we also do this line of products for people who want to taste the cannabinoids and the terpenes."

That's the sort of thing Wong has been seeing more and more of in California, and she's overjoyed about it. "I would like to see more edibles made with ice-water hash, solventless rosin, and other high-quality cannabis," she says. "It's not about masking. I make cannabutter or infused oils at home, and I like to cook and bake using strain-specific pairings. Certain edibles companies are still using cannabutter and solventless rosin for edibles, and it's delicious. When you can get the true flavor of a strain paired with ingredients, from a culinary point of view, I love that. It elevates the edible experience."

Using products like rosin or ice-water hash over distillate can be more expensive, but it also can attract a certain segment of cannabis lovers who want a bit of "green" flavor. "That's not necessarily a bad thing," Wright says. "From a marketing perspective, people will tell you [that] when the brain doesn't get what it's expecting to get, it's [confusing]. A lot of people expect that taste now, and if they don't get it, they wonder whether they're really getting [the cannabis]."

The emerging consumer demand for cannabis-flavored edibles also means more R&D, says Maggio. "We spent so many years on trying to get the flavor to be better, with less cannabis flavor, and taking that flavor to build on," he says. "But [using rosin offers] a totally different type of flavor perspective. It's much more natural and really a full flavoring; it amazes me how the strains make a difference, where with distillate, you could put 300 strains in the mix and a kilo of oil, and it really doesn't matter. It all comes out the same. Every distillate ends up being the same."

Consumer Expectations

Maggio says his company, like everyone else's, is trying to figure out what cannabis consumers will want next in an industry that continues to discover itself. "With a country as large as ours, it makes it hard to jump into every little fad that's out there," he says. Yet the calling for unmasked, full-flavor edibles is real. "It's a little bit higher end, and it's a little more costly to put this product out. You don't get as much good, usable product out of it. It's more of a connoisseur kind of product, so it won't be for everybody. But is it going to be 10% of the industry? Fifty percent of the industry?"

One thing, however, is clear, according to Maggio: "I think we're going to see a lot more of it." ■

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Under Pressure

WHY THE FOOD SUPPLY CHAIN IS STRAINED, AND WHAT THE FOOD INDUSTRY CAN DO ABOUT IT

BY **KAREN APPOLD**

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The COVID-19 pandemic has taken a toll on many U.S. industries, and the food industry is no exception. In particular, food supply chain and safety issues have mounted as the pandemic has worn on.

"Food manufacturers have had to juggle a lot, including maintaining a sufficient number of qualified workers, having raw materials available, and meeting increasing demand for products," says Martin Bucknavage, MS, MBA, CFS, senior food safety extension associate and program team leader of industrial food safety and quality in the department of food science at Penn State University in University Park.

Workforce availability has been among the biggest challenges. "Initially, there were worker absences as well as facility shutdowns related to COVID illnesses or prevention," Bucknavage says. "Now, facilities are facing worker shortages due to hiring difficulties along with higher turnover levels."

Raw material availability is another huge challenge for many companies, because specific ingredients can be difficult to obtain. "Again, workforce availability is the driver," Bucknavage says. "This impacts a company's production scheduling and forecasting."

Many logistical issues also exist, whether it's delays of imported goods getting unloaded at shipping ports or trucking issues impacting the movement of raw materials or finished products, Bucknavage says.

Consequences

As a result of the pandemic, labor shortages have occurred at many stages of the farm-to-table process, including at production, food safety, quality assurance, and supervisory/management levels. "This could result in a regression or de-prioritization of food safety culture, which inevitably results in more product contamination events and product recalls," says Steve Kluting, Esq., national director of product recall for food and agribusiness at Gallagher, a commercial insurance and risk management firm in Grand Rapids, Mich.

Food manufacturing facilities have had to increase wages to retain and attract workers, says Glenn Drees, CSP, CPCU, managing director of food and agribusiness at Gallagher in Cincinnati, Ohio. Shipping and logistics costs are expected to keep rising in 2022. In some instances, certain products are unavailable or are in short supply. All of these costs are passed down throughout the supply chain, resulting in higher consumer prices.

John L. Kent, PhD, clinical professor of supply chain management at Walton College of Business at the University of Arkansas in Fayetteville, anticipates a lack of consistency. "Order size variation from anywhere in the supply chain, including purchases by end consumers, creates a bullwhip effect, with peaks and valleys of inventory," he says. "Prior to 2020, supply chain professionals had almost perfected most of the farm-to-fork food supply chains. Other than weather, a strike, or food safety recall, not much variation occurred because well-managed supply chains with trusted partners were established."

Another effect of the pandemic has been that many food companies have had to reformulate certain foods and haven't been able to produce certain SKUs because they couldn't obtain some ingredients from international sources, says David Acheson, MD, former associate commissioner for foods and current CEO and president of The Acheson Group, a global food safety and public health consulting team based in Bigfork, Mont. In particular, China, a significant supplier, experienced many logistical issues and labor challenges due to COVID-19.

Furthermore, many ships outside of major ports such as Los Angeles and Long Beach, Calif., were unable to get to port and unload due to pandemic-related issues, Dr. Acheson says.

Ensuring Product Availability

So how can a food manufacturer guarantee that there's a sufficient supply of their product? According to Dr. Acheson, food companies should avoid having a sole source supplier whenever possible. "If a sole supplier has a problem such as a labor shortage or breakdown at their facility, a manufacturer that needs that product will be in a pickle," Dr. Acheson says.

To prevent this from occurring, Dr. Acheson recommends having at least two suppliers for any critical ingredient. "But that is easier said than done," he says. "A food company needs to vet and qualify suppliers."

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> Initially, there were worker absences as well as facility shutdowns related to COVID illnesses or prevention. Now, facilities are facing worker shortages due to hiring difficulties along with higher turnover levels.
>
> —Martin Bucknavage, MS, MBA, CFS

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Some companies are choosing to act as their own suppliers by sourcing their own needs, says Bob Grote, CEO of Grote Company, a food equipment manufacturer in Columbus, Ohio, who adds that vertical integration, which was prevalent a century ago, may be rising again. "Serving as your own supplier helps reduce the unpredictability of relying on outside suppliers, which is what some are experiencing now," he says.

Another strategy to avoid limited inventory is to stockpile critical ingredients; however, this can only be done if a product is shelf stable and the manufacturer has sufficient warehouse storage. "This can be problematic because it can tie up substantial capital in ingredients just sitting there," Dr. Acheson says. Thus, for economic reasons, many food companies have done the opposite—they've shifted to a just-in-time kind of approach in which they don't carry a lot of ingredient inventory, making them vulnerable to any delivery delays.

Having a nimble supply chain is the key to ensuring product availability, Bucknavage says. This includes establishing secondary suppliers, obtaining assurances for supply availability and stability, having back-up production schedules, and communicating with customers on product availability. An important part of this is recognizing the limitations of internal resources, specifically labor.

By planning ahead and thinking through what inventory they may need, Grote says processors can keep up with product demand. "Conventional wisdom may be to keep inventory lower, but in our current business climate, it can be better to buy more," he says. "Without inventory to sell, processors can't count on revenue. Buying what's needed from suppliers means production can continue."

Success Stories

Some companies tout success in ensuring product availability. Ryan Hanan, chief operating officer at Hanan Products in Hicksville, N.Y., has employed several strategies, many of which were in place long before the pandemic. "As a family company, we've developed deep relationships with customers who trust we're doing the best for them; they have remained loyal even during pressing times," he says. "We're nimble and can take actions such as overstocking, which helps eliminate dependence on incoming materials in real time."

Hanan has also been successful in securing future contracts, which locks in a price for a set period—granting a time of stability. Even future contracts have been slapped with additional increases, however, for arbitrary costs such as trucking fees, pallet costs, and gas fees, which Hanan Products must pay.

Being a smaller company has its advantages, Hanan says. For example, it's much easier for a smaller company to receive one pallet of raw materials when an ingredient is in short supply than it is for a big company to receive 20 pallets in that situation.

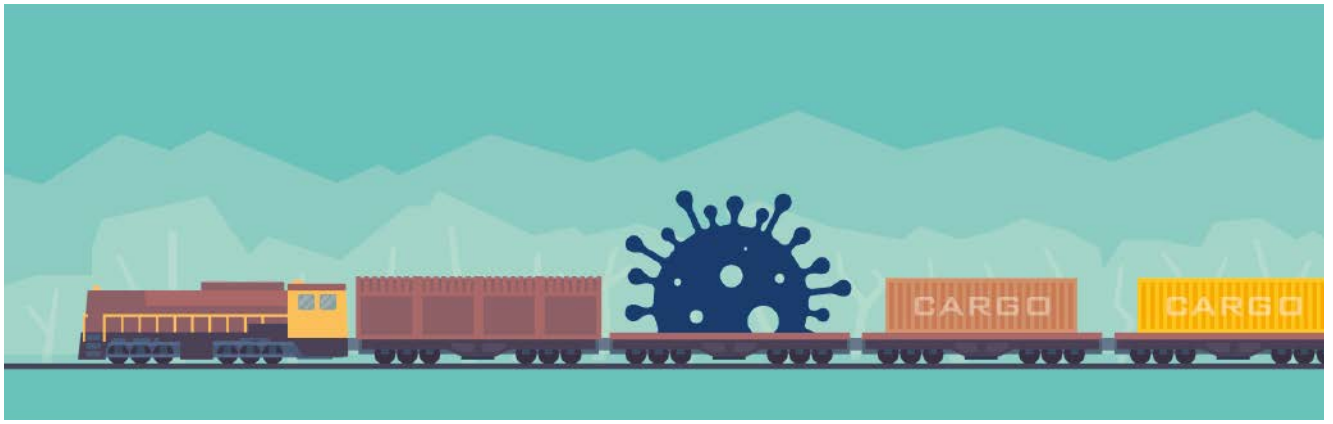
Some measures that Pat Schwartz, vice president of product and operations at Perfect Keto, a food manufacturer in Austin, Texas, has taken to mitigate supply chain risk include placing larger blanket purchase orders to ensure proper stock and raw material procurement and providing six to 12-month rolling forecasts to its suppliers and manufacturers to ensure proper supply and production planning.

Schwartz has carried more inventory than what's ideal and has reformulated certain products with more stable supply chain ingredients. "We've put more emphasis on looking upstream into our supply chain to understand where things come from, what ports they go through, how quickly we can re-supply, and how stable the supply chain is for future needs," he says.

Food Safety Concerns

Along with food supply shortages, food safety concerns have also increased during the pandemic. Producing food safely requires individuals who work in food lines to perform their jobs well. "Labor shortages forced a greater reliance on inexperienced temp workers, who can increase food safety risk," Dr. Acheson says. "New workers don't know what they don't know. They aren't necessarily careless, but an experienced employee may see something that doesn't look or feel right and bring it to their supervisor's attention, whereas a new employee may not."

Proper sanitation at a food production plant also plays an integral role in food safety. "There are often labor challenges with sanitation, because it's such a tough job," Dr. Acheson says. "Cleanliness is one of the first things that gets squeezed when there



are labor shortages." For example, the amount of time spent on cleaning may be shortened, or there may be a greater number of days between cleanings.

Along these lines, Grote says that labor safety and sanitation standards are at risk with new employees consistently cycling through a plant. "Training and, in some cases, retraining, is of greater importance," he says. "Increasing the use of robotics may result in more sanitary processing conditions overall."

Shortages can result in desperate measures being taken. "If you can't meet a customer's requests, it can be tempting to take shortcuts—such as substituting ingredients for lower quality ingredients or something that looks the same but isn't," Dr. Acheson says. "That may be done without any thought to causing harm, but it could occur."

Schwartz saw a decline in in-person regulatory visits and onsite audits and an increase in virtual audits in 2020 and 2021, a situation that may continue well into 2022. "This can raise concerns about an audit's quality and information being collected," he says. "Manufacturers might only show you what they want to show you."

Impact on the Food and Beverage Industries

The food supply chain crisis during the pandemic brought numerous issues to the forefront, including increased prices, increased demand for food, and a lack of inventory for necessary essential items. "E-commerce will not slow down; the industry has been forced to transform out of necessity, with technology supporting greater safety and convenience, contactless shopping, and de-

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FDA, USDA Respond to the Pandemic

As the pandemic affected many aspects of the food industry, FDA and USDA took measures to specifically address crises surrounding food supplies and safety.

According to an FDA spokesperson, the agency has assisted the food industry during the pandemic in a variety of ways. Early on, FDA issued resources and guidance to help keep the food production process moving when production and delivery were impacted by the pandemic. This guidance will remain in place for the duration of the public health emergency.

In May 2020, the Defense Production Act was issued and signed by FDA and USDA to address supply chain issues. Further into the pandemic, FDA issued guidance, "Reporting a Temporary Closure or Significantly Reduced Production by a Human Food Establishment and Requesting FDA Assistance During the COVID-19 Public Health Emergency." Food facilities and farms can continue to report a closure or a reduction in operations and/or request assistance for a human food establishment regulated by the FDA, excluding restaurants, retail food establishments, and animal food operations.

21 FORWARD was an initiative developed jointly by FDA's Office of Food Policy and Response, Center for Food Safety and Applied Nutrition, Office of Regulatory Affairs, and Center for Veterinary Medicine to help FDA identify where risks for interruptions in the continuity of the food supply may be the greatest because of the pandemic.

Early in the pandemic, FDA and USDA supported the food industry by modifying some rules to allow companies to migrate products to different channels—primarily providing a means to move from foodservice to retail, says Bucknavage.

CDC worked with the World Health Organization to help identify COVID-19–related risks and mitigation measures to reduce the disease transmission within the densely packed production facilities, which was useful during the early stages of the pandemic

"The FDA and USDA have maintained necessary activities with a focus on food safety," Bucknavage says. "Moving forward, it is important for the agencies to continue to monitor issues and address concerns as they arise."

Primarily, the agencies have offered expertise and guidance throughout the food chain to help companies adapt to safety and supply issues as well as provided grants and loans to help offset the monetary effects of the pandemic, says Grote.—*KA*

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livery options—which all depend on high-quality interoperable, standardized data," says Liz Sertl, senior director of retail grocery community engagement at GS1 US in Ewing Township, N.J. The information standards organization brings industry communities together to solve supply chain problems through the adoption and implementation of GS1 Standards.

Due to COVID-19, Daniel Hooker, MBA, senior lecturer and director of applied economics and management/food industry management at Cornell University in Ithaca, N.Y., says lower velocity brands and products have been discontinued to focus on higher velocity products. "This will be short term, and then innovation will return," he says. In addition, he expects larger and more financially stable retailers and manufacturers to thrive and grow—potentially squeezing out smaller players.

Grote expects less of a demand for traditional dining-in at restaurants, while the demand for food-to-go may continue to increase. He also foresees an increase in prices, a reduction in SKUs, an increase in preservatives used to keep food fresh longer, and a continued move toward automation.

Greater Impacts on Certain Sectors

The meat industry and produce sectors have had the greatest disruptions from the pandemic. "Long supply chains for cattle and pig slaughter take longer to work out," Drees says. "It can take years to recover from reduced herds. A lack of workers for produce harvest has led to some crops rotting in fields."

Dr. Acheson says that the meat and poultry industries were hit hard early in the pandemic because they were more reliant on manual labor. "These manufacturing facilities are designed deliberately for people to work in close proximity on a processing line; people can work very efficiently that way." This led to some meat and poultry plants closing due to COVID-19—more than any other supplier—and labor shortages remain a big challenge for many large manufacturers.

Meanwhile, longer shelf-life items such as frozen foods have become more popular, most likely because they can be stored longer than perishable foods. Hooker expects this trend to continue and grow in the near term.

The pandemic also led more people to cook at home, which resulted in increased grocery store purchases. "Behaviors changed because restaurants closed down or were operating under restrictions," Grote says. Behavior changes such as these mean that processors have to consider how they package what they sell; it may mean packaging meat in smaller or different portions, for example.

The Outlook

In the short term, worker shortages and turnover are expected to continue. "This will push companies to place greater attention on training, especially on aspects that affect food safety," Bucknavage says. "Hiring practices will continue to evolve as competition for workers, especially skilled workers, becomes more intense." Without well-trained, capable employees, particularly those who oversee and manage food safety, the risk of issues is higher.

Along with this concern, Bucknavage says that raw material supply issues will continue as these suppliers face ongoing logistical and workforce issues. Companies have learned to adapt to a less-stable supply chain; newer procedures will likely become part of normal operations. Companies have refined their product mixes with a focus on simplification in an effort to avoid empty slots on store shelves.

Finally, Bucknavage says inflationary pressures will impact customer purchases as prices rise due to increasing ingredient prices, operational costs (e.g., employee wages, energy), and logistical costs. As consumer buying power is impacted by inflation, demand for certain products will change, impacting long-term forecasting and scheduling.

Grote believes that inflation could affect the food industry more than supply chain issues, as it may remain a factor for a longer term. "We could expect prices to rise for a few more years," he says. Inflation affects everything. If processors need to spend more to manufacture products, those costs are passed on to consumers."

Coming full circle, if the pandemic has caused workers to leave their jobs, might inflation cause them to return to those jobs? "We'll have to wait and see," Grote says. ■

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Environmental Monitoring Under COVID-19

Four ways the pandemic has changed EMPs for the better

BY **MARGARET VIETH**

The COVID-19 pandemic has had far-reaching effects on all aspects of the food manufacturing industry, including environmental monitoring programs (EMPs), an essential element to any food safety and quality regimen.

According to Sedgwick's 2021 Recall Index, during the second quarter of 2021, the U.S. saw 106 food recalls, which affected 7.9 million units and were attributed to undeclared allergens, product quality, lack of inspection, bacterial contamination, and foreign material contamination. As a result of the pandemic, consumers are more aware of food safety than ever before. Even though the overall number of recalls is still lower than pre-pandemic levels, there are numerous lessons the food industry can take away from the heightened expectations consumers have today for safe, quality food products. Each player within the industry has a role in ensuring food quality and safety, and establishing and maintaining an efficient and effective EMP can help increase the likelihood of delivering a safe finished product.

During the pandemic, labor shortages and the need for social distancing caused food processors and labs to adjust the way they operate. Weak points in processes and opportunities to improve facilities became apparent as manufacturers struggled to keep up with demand and experienced a lack of resources.

Here are four critical trends processors should embrace as they continue working to strengthen their EMPs.

1. Food Safety Education and Cross Training

QA technicians have had to take on new responsibilities due to the increased labor turnover industry wide and the challenges posed by COVID-19. With new responsibilities and the need for speedy onboarding, continuous education is instrumental in keeping up with testing needs. Manufacturers can meet demand without sacrificing product quality or safety by creating a continuous learning program and establishing a streamlined onboarding and training process.

Similarly, in the wake of pandemic turnover, it has become clear that the best EMPs are those that involve a cross-functional group from their organization. Not only does this allow organizations to use wider expertise on the product and process, but it also ensures that the whole team knows the value of environmental monitoring and preserves an institutional focus on safety, even in the face of high turnover. Many of the food safety controls in place at a plant rely on people, so ensuring that the whole team understands the goals and importance of the program can provide the "why" behind day-to-day tasks. Cross-functional teams can also define areas of potential failure so that when things go wrong, they can be corrected swiftly and efficiently.

2. Virtual Training

The need for virtual versus in-person training to help stop the spread of COVID-19 resulted in more comprehensive and technology-based virtual training programs in the industry. Where training used to be mainly in person and slide-based, the majority of programs now incorporate virtual reality to increase the level of detail and understanding among trainees.

3. Regularly Review EMPs and Historical Trends

One of the best ways to proactively approach environmental monitoring is to

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Industrial Freezing

What food manufacturers should look for in freezing equipment

BY **DAVID HALLIFAX**

Frozen food aisles in supermarkets contain nearly every type of food. The frozen food sector is an incredibly huge market, and it's not surprising that these foods are popular with American consumers: They offer food preservation, reduced waste, and convenience, not to mention the fact that freshly frozen foods are just as nutritious as when they were plucked from the field or bush, or freshly made as in the case of meals, breads, and other prepared foods.

The global frozen food sector is growing at a rate of approximately 5% per year, according to a 2021 report from Mordor Intelligence. In fact, the industry has been on an upward curve since the advent of commerical food freezing in the late 1950s; it's a worldwide phenomenon. As emerging countries continue to develop economically, they tend to transition to frozen food because it not only preserves vital resources, but it also maintains the consistency of a product for a long time. The range of food types that can be frozen is quite staggering.

Industrial freezing equipment has also evolved over the decades to help food processors produce quality frozen products. The industry has the capability to continuously monitor the frozen environment and automatically adjust freezer conditions to ensure that products leave the freezer in optimum condition. This way, customers can be confident of the highest quality output, whether freezing meat cuts or baked goods.

Industrial freezing isn't the same as taking a fresh food and putting it in a domestic freezer, which people do all the time. The issue with this is that you can lose quality, as the process causes cellular damage and leads to drip loss. There's a a lot of science behind industrial frozen food production—as there must be when you could be dealing with up to 30 tons an hour of frozen food. However, we also need to understand how the food was made and how it's presented for freezing.

Freezing Systems

Freezing systems cater to any type of food, from chicken nuggets to French fries to croissants, pain au chocolat, and other niche pastries. Freezing joints of pork, beef, or poultry requires very different handling than freezing raspberries. Understanding how food freezes and how it

should be handled correctly allows for an efficient solution that delivers a high quality frozen product, with maximum product yield.

Let's take pizzas: This convenience food goes down well with Americans due to its versatility. Whether it is topped with meat, vegetables, or seafood, pizza offers something for almost everyone. You can say the same about the freezing systems on the market that keep freshness, flavor, and shape, regardless of the topping. Whatever the pizza variations are in a product portfolio, there is a corresponding cooling and freezing technology.

For example, best practices for the the harvesting of broccoli for a pizza topping require the vegetable to be cooled while still in the field, because its great metabolic activity would otherwise quickly make it appear wilted. Once harvested and cooled, freezing tunnels with individually quick freezing (IQF) technology can guarantee the individual freezing of fruits and vegetables, so that toppings such as broccoli can be easily weighed and distributed over a pizza. Before this stage, of course, the yeast dough must be kneaded, formed, pre-baked, and cooled again to prevent the frozen vegetables or ground meat from immediately thawing.

Because of the constantly growing demand, industrial freezer design changes from year to year. The machinery continually gets larger, faster, and stronger and has to be more efficient in operation. Freezers can't have too wide a physical footprint, however, so they don't exceed the general width of processing lines. If you're replacing old models, the best solutions will closely match their predecessors in size, while also remaining compatible with the rest of the line equipment such as fryers, ovens, and packaging machines. Of course, size for size, the newer models are far more efficient and productive than older ones.

So, what should food manufacturers be looking for from freezing equipment? Well, I see the key decision criteria being stringent hygienic requirements, high product quality and yield, minimum energy consumption, and effective frost management for long operating times. New and innovative food products, like vegan alternatives, demand new process lines, which create engineering challenges, especially in aging factories with limited space.

Off the Scale

Typically, a French fry freezer will handle 20 tons per hour, 24 hours a day, 21 days in succession before the process line stands down for maintenance and regular cleaning. That's approximately 10 million 1 kg bags of fries destined for supermarkets in one production run. The scale and size of this type of freezer is quite a common sight around the world in the temperate potato growing and processing zone.

As mentioned, freezing systems can freeze any type of food; however, a very different freezing regimen and a different freezer design are required for joints of pork, beef, or poultry than for other bulk foods such as ice cream. So, in essence, there are three main parameters for food freezing: temperature difference, air velocity, and freeer dwell time. Adjusting those three parameters to suit whatever product it is that has to have the heat efficiently extracted from it will result in a range of machinery that suits very different applications.

Technological developments include minimizing the use of refrigerants through automated valve control systems to extract optimum levels of heat exchange within the freezer. This process leads to intelligent control systems that automatically monitor frozen food discharge temperatures and control the refrigeration and freezer operating parameters autonomously.

A very different freezing regimen and a different freezer design are required for joints of pork, beef, or poultry than for other bulk foods such as ice cream.

Energy Costs

Food can be frozen very quickly or slowly, depending on how fast the heat (or energy) is extracted from the food. This is dependent upon the temperature difference between the cooling medium (usually refrigerated air), the amount of time the product is exposed to the colder air (dwell time), and the velocity of the air passed over the product. The velocity is used to help break down the boundary layer surrounding the food in order to allow efficient heat extraction. This freezing time costs energy—in other words, money. Thus, energy management is just as important in freezing food as it is for the rest of the production line. To put the energy demand in context, a 20,000 kg/hr French fry freezer extracts approximately 3,400 kW of heat every hour.

Cooling a product once it has already reached the required degree of freezing, however, isn't only unnecessary; it is also a waste of energy. Some products need to be 100% frozen, while for others, an 80% level of frozenness at freezer discharge is acceptable. Sensing technology measures the level of frozenness inline, at the freezer exit, without coming into direct contact with the food. The system then automatically adjusts the freezer parameters to maintain perfect freezing conditions according to customer and product requirements.

The current demand for freezing food equipment is just the tip of the iceberg. As more nations develop economically, there will be an increasing demand for frozen food because it offers convenience and reduces waste, and the range of foods it offers caters to everyone's needs—whether it's vegan, vegetarian, dairy, meat, bakery, fruits and vegetables, or prepared foods.

Factories are becoming increasingly streamlined to remain economically viable in a very competitive marketplace. That means looking for optimum efficiency and quality, and that, in turn, usually means specialization with dedicated production lines. ■

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Sustainable Poultry Processing

Four ways to save water and chemicals

BY **BOB OGREN**

Both water and chemicals are critical for food safety in poultry processing and are needed in large amounts. Poultry processors rely heavily on water, using it during processing and for sanitation, with some steps using 80 gallons of water per minute. According to Food Northwest, the entire process uses approximately 3.5 to 7.0 gallons of water for every four-pound average weight bird processed.

Heavy water usage is not only harmful to the environment, but it's also costly for poultry processing facilities. Facilities must pay for the water and subsequent wastewater treatment before it is discharged from their facilities. The current rate at which processors are using water is unfeasible for the long term when considering challenges such as water shortages, tightening government regulations, and labor struggles. Add the overuse of chemicals and energy to the mix, and processors face a perfect storm of challenges.

How can facilities mitigate some of these concerns? From small, consistent efforts like audits to more significant investments in automated equipment, there are several opportunities to save resources in poultry processing without compromising food safety.

1. Analyze Equipment and Processes to Locate Potential Savings

The first step processors can take in these efforts is to evaluate the main processes and equipment that use the most water. Scalding, de-feathering, eviscerating, washing, cleaning, and conveying require large amounts of water, as do inside/outside washers, chillers, and dip tanks.

At these stages, processors can create significant water and chemical savings using water reclamation and reconditioning, automation, or other efforts. Processing facilities can recoup this water and recirculate it to other equipment upstream, such as eviscerating equipment or scalders. Recuperation can potentially save hundreds of gallons of water from going down the drain.

Additionally, processors can conduct extended runs on equipment like chillers to avoid dumping large amounts of water and chemicals as often, since some facilities are running fewer shifts, thereby using more water for less product. Efforts like restricting water nozzles to higher pressure and lower flow can also add incremental water savings over time. Note that higher pressures can create splash back, which is a food safety concern in RTE areas.

2. Conduct Routine Maintenance on Small Pieces of Equipment

Water nozzles, spray heads, distribution piping, and even heat exchangers are areas where processors may be losing water, chemicals, and energy; they're also places that are easy to overlook. Specifically, water nozzles can wear down quickly and use much more water than they did when originally installed. Checking water nozzles monthly and replacing them every six months can help processors avoid losing up to several gallons of water per minute. Leaks in the plant distribution system should also be identified and repaired promptly.

3. Automate Sanitation and Intervention Practices

Automating processes and equipment can create the most significant savings throughout a plant and can offset water usage in areas where water is difficult to recoup, such as evisceration. Centralized cleaning systems and low water pressure sanitation units can be particularly effective at reducing water and chemical usage by supplying the correct pressure, flow, and chemical concentration to belts, rotating equipment, and other places requiring sanitation. Some automated

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Elanco™ Poultry

The Challenges of Salt Reduction

How to protect your product's taste, quality, and shelf life while preserving food safety under the new FDA reduced sodium guidance

BY **JOY VIMALARAJAH**

If fire was humankind's first flavor enhancer, salt emerged as its second. In fact, salt is one of the most amazing workhorse food ingredients ever discovered, not only in terms of enhancing flavor but also for delivering texture, taste, and appealing mouthfeel. It's been an important preservative and food protection agent for thousands of years. The question now facing the industry, however, given the undeniable reality that too much salt can also be harmful, is whether the ingredient is functionally irreplaceable.

Consider salt's provenance: Throughout history, the availability and use of this remarkable mineral was pivotal in the rise of civilizations all around the world. At the same time, medical science has taught us that excess salt is too much of a good thing—so much that it becomes a very bad thing indeed. Too much sodium can cause cardiovascular health problems—hypertension, stroke and kidney disease, to name a few—and most of the sodium in the typical Western diet comes from high added salt content.

From a taste viewpoint, salt has an impressive track record. It's one of the main "basic" flavors and improves the taste of many foodstuffs by suppressing bitterness, making food more palatable and also relatively sweeter. Today it's used liberally to add flavor to a plethora of different manufactured and processed foods and restaurant menu items—too liberally, according to many global health authorities.

In October 2021, FDA issued a final guidance with voluntary targets and recommendations for salt over the next two and a half years. The agency's goal is to persuade the food industry to voluntarily reduce sodium content from an average of 3,400 mg per person per day to 3,000 mg. While this goal is still well above the generally recommended sodium daily target of 2,300 mg per day, the objective is to foster a gradual reduction in sodium content, such that technical and market constraints around sodium reduction can be overcome over time.

Reducing sodium content is certainly achievable; that bears stating. However, there are limits on stealth reduction using the simplified strategy of just using less salt. In practice, formulators can't go beyond a 10% to 15% reduction of sodium content without running into significant taste, texture, and shelf-life challenges—changes consumers notice immediately, and not in a positive way. The very large challenge lies in naturally protecting (or enhancing) taste while also preserving food safety at a reduced sodium level.

In this article, we identify ways to successfully achieve these objectives.

Industry Change

Although the FDA sodium guidance is voluntary and a way to signal to industry that mandated sodium reduction may be on

the way, the current heightened consumer focus on health and wellness, especially amid the COVID-19 pandemic, already demands that the industry make changes. Voluntary guidance also tends to work its way into federal nutrition policy and food-assistance programs, such as school meal initiatives, and "recommendations" from FDA are often also integrated into state and local policies around food procurement, supplemental assistance, and education.

For the food industry, the reformulation race has already started to find solutions that will replace salt's role in the protection, preservation, and flavor of food. Although meat sits near the top of the list (meat applications are notoriously difficult in terms of meeting sodium targets), with dairy applications such as processed cheese close behind, plant-based meat substitutes, perhaps counterintuitively, often carry significantly higher salt content than their animal counterparts.

Let's not forget to mention processed meats, cheeses, plant proteins, sauces, marinades, salty snacks, etc. These are all challenging categories for formulators facing multiple concurrent problems involving taste, texture, and shelf life when seeking to reduce salt content. On the practicality side, reducing sodium can also create shelf-life challenges: Many preservative solutions currently on the market, both clean label and conventional, are sodium based, so they can actually end up contributing more sodium to the final product.

The challenges, taken together, are substantial, so food product developers must consider all variables while simultaneously balancing consumer concerns around taste and food safety when they decide to join the salt-reduction game.

Preserving Quality and Safety

For thousands of years, sodium's critical role has been to preserve food quality and safety. Today, many preservatives are based on organic acids that also contribute sodium to the final product.

One notable modern sodium application is curing meat with nitrite salts. While sodium tends to be naturally present in very small quantities in meat, nitrite salt preservatives can add substantially more. Pork, for example, generally contains 63 mg of sodium per 100 mg, while bacon has 1,480 mg. Herring containes 67 mg but, in its preserved form (kipper) it has 990 mg.

One way of addressing safety and quality solutions is by using the Leistner hurdle concept, which postulates that pathogens in food products can be eliminated or controlled by enacting a number of "hurdles" as building blocks in the foodstuff protection plan, strategies that ensure a product's safety and avoid wastage by extending shelf life. Some of these hurdles include high or low temperatures, increased acidity, reduced redox potential, the use of biopreservatives, and reduced water activity through the addition of salt, sodium, drying, curing, or conserving. Each hurdle seeks to at least inhibit unwanted microorganisms, and salt is the oldest and most common of these methods.

> Salt reduction is vastly more complex than just removing salt and sodium. In reformulating, it's crucial to use a "total concept" approach that involves making improvements to address shelf life, texture, and taste, and using preservation solutions that contribute little or no sodium to the final product.

Viewed from the hurdle standpoint, what occurs when you simply remove sodium? For one, safety can be compromised as resistance to contamination from threats such as *Listeria* is diminished. Quality can also be put at risk through diminished resilience to spoilage. Furthermore, a shorter shelf life leads to higher food waste, as well as increased supply chain and transportation costs, given that products must be consumed faster and distributed more frequently.

Reducing salt content presents preservative challenges that can also lead to increased sodium content through the use of added preservatives. Fortunately, there are natural, non-sodium-based preservatives that can protect product quality during the reformulation process.

Protecting Taste and Texture

When sodium is reduced, several things happen as the physiological response to the five basic tastes is disrupted: Saltiness is reduced, sourness increases, bitter or "off" tastes become noticeable, and sweetness and umami lose balance. Overall, reducing sodium throws disequilibrium into the organoleptic harmony of foods, allowing bitterness to stand out more and decreasing sweetness. After just a small reduction in salt content, the consumer begins to notice. Therefore, in taste, it's vital to consider sodium's overall contribution in terms of temporal taste perception—be it upfront, in the middle, or in terms of aftertaste—and apply solutions that will close the taste gaps or simply mask the previously disguised off tastes.

To complicate matters, salt has many roles in texture and functionality through water binding, in terms of "slice-ability" (enabling protein denaturation or gelation), or in dough rheology to tighten gluten strands. Processed meat is one key category in which salt contributes to mouthfeel and texture—weighty challenges that occur over and above taste and preservation. Whereas taste can be added back in using natural means, such as stocks and broths, as well as many different spices and seasonings, mouthfeel and flavor require a wide variety of natural solutions. A "tool-box" approach that offers many possible solutions is the best way to harmonize and rebalance sodium-reduced products. Whether the challenge is meat, snacks, meat alternatives, dairy, meals or sauces, it is vital to break down the challenges across taste, texture, and shelf life.

Replacing salt and sodium in foods requires a systems approach by a knowledgeable ingredient supplier that combines solutions that work together to build back taste, shelf life and texture. Here are some solutions that might work to reduce sodium:

- Given the current industry challenges in securing sodium lactate supplies, buffered vinegar liquid and dry, low-

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and no-sodium preservation solutions must be considered.

- Using texture in meat applications as an example, you can source highly functional stabilizers, texturants, and brines tailored to perform in reduced-salt applications. These can be combined into a taste and preservation portfolio that delivers a fully integrated solution.
- Other sodium-reduction solutions revolve around accessing science in its many forms: flavor creation, modulation, fermentation, dairy, and smoke, grill, and other preparation processes. For example, it's possible to develop natural flavor solutions in salty snacks that allow for a sodium reduction of up to 250 mg per serving.
- To rebuild the taste sensation, late-lingering flavor, juiciness, continuity, and succulence provided by salt, manufacturers need to leverage a variety of ingredient and flavor solutions. Umami stock can help build middle impact and the perception of sodium, complete with a natural, pantry-friendly ingredient statement. Natural stocks and broths are also excellent flavor enhancers produced through traditional kitchen cooking methods. Natural barbecue cooking is another key strategy.
- Natural salt replacement solutions are derived from fermentation, extraction, and flavor expertise to deliver on salt and umami taste while reducing the amount of sodium in a given product. Solutions can be applied to prepared meals, soups, sauces, snack seasonings, savory spreads, and vegetarian, white meat, and tomato-based products. These can lower salt content by up to 50% depending on the application, deliver salty and umami taste perception, ensure a balanced taste with a clean aftertaste, provide a natural, clean taste experience not based on potassium chloride, allow for declarations of "natural flavoring" or "yeast extract" on package labels, and optimize frozen, chilled, and ambient applications (pasteurized, sterilized).

Reformulating for Success

Clearly, salt reduction is vastly more complex than just removing salt and sodium. In reformulating, it's crucial to use a "total concept" approach that involves making improvements to address shelf life, texture, and taste, and using preservation solutions that contribute little or no sodium to the final product. Food manufacturers also need to consider practical implications; items such as packaging inventories (i.e., ingredient declarations and nutrition fact panels will change) are also part of the agenda.

Within the next 18 to 24 months, it is highly likely that consumers will begin to notice shifts in the marketplace based directly on the FDA voluntary guidance; starting early is key. Experience tells us that it takes food manufacturers six months to one year to reformulate and validate consumer safety and taste acceptance of food products. This lengthy process can be hastened through partnering with ingredient suppliers to address changes simultaneously and holistically—a "complete formula" strategy versus just tackling the sodium aspect.

For the food manufacturing industry, the drive to reduce sodium should be viewed as an opportunity to regroup, reimagine, and repackage, not only to reduce sodium but also to build on clean labeling and enhanced preservation/natural flavor innovations. Fortunately, the targeted solutions needed are already available. ■

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▼ Low-sodium bacon

Sodium Reduction Solutions

- Potassium acetate and diacetate blends come in free-flowing dry formats and are great replacements for liquid and powdered potassium/sodium lactate, which is in short supply.
- Potassium-buffered vinegars for meat are available in liquid and dry forms to replace sodium preservatives such as lactates and sodium-buffered vinegar.
- Calcium-buffered vinegar for baked goods is an innovation to replace sodium-buffered vinegar and propionate-based salts.
- Umami and kokumi provide natural options in which to build in non-sodium-based flavors.
- Natural barbecue, stocks, and broth flavorings can help add taste and flavor back.
- Some herbs such as parsley and coriander have a slight saltiness to them and build in a salty taste.
- Combination solutions for dairy, plant protein, and beverage will leverage multiple preservation and taste technologies to deliver shelf life with a no- or low-sodium contribution to the final product. Examples of proprietary sodium-free building blocks include plant extracts and smoke distillates.

Java Jive

How to achieve quality and safety in coffee roasting

BY **JASON SANDERS** AND **STEPHAN RUEEGG**

Many of us start our days on an early schedule, and morning routines can vary from one person to the next. Some like to start by exercising before heading off to work, while others may choose to sleep until the last minute. Morning activities vary, but a morning beverage is common for most. One of those go-to selections is coffee. While choosing coffee sounds simple, the process of producing coffee can be complicated.

Think about a trip to the grocery store to view the coffee choices available. You might see options such as light roast or dark roast, flavors such as French vanilla or cinnamon, and even a difference in the amount of caffeine. Some like to brew coffee at home, and others choose to hit the local coffee shop for a medium-sized, light-flavored coffee with steamed almond milk and a package of sweetener. While these choices are based on individual preferences, the path that coffee takes to get from raw beans to grocery store shelves or to a coffee shop is similar: The beans must be roasted to get to the final product.

Coffee roasting starts with green coffee beans, which are processed to change the properties of the bean. The roasting process is what defines the aroma and flavor. To achieve the desired product, a coffee roaster must decide on the type of coffee they will produce (i.e., light, medium, or dark roast), which will dictate the roasting method. Most of the traditional methods rely upon drum roasting, which uses gas burners to heat the air. This method requires a coffee roaster who not only has a good eye for bean quality but also has a fundamental understanding of the proper gas mixture for the process. While the gas burner method is proven, it can be labor intensive and present safety concerns. Another option for drum roasting would be incorporating electric heaters.

The method of electric heating has evolved over time. In the beginning, electric heaters struggled in various stages of the process to produce the desired results for both the roaster and the consumer. Other types of heaters that were used during the drum roasting process were the open heating coil or heating rods. While the installation and operation were easy, the heaters could not deliver efficient tem-

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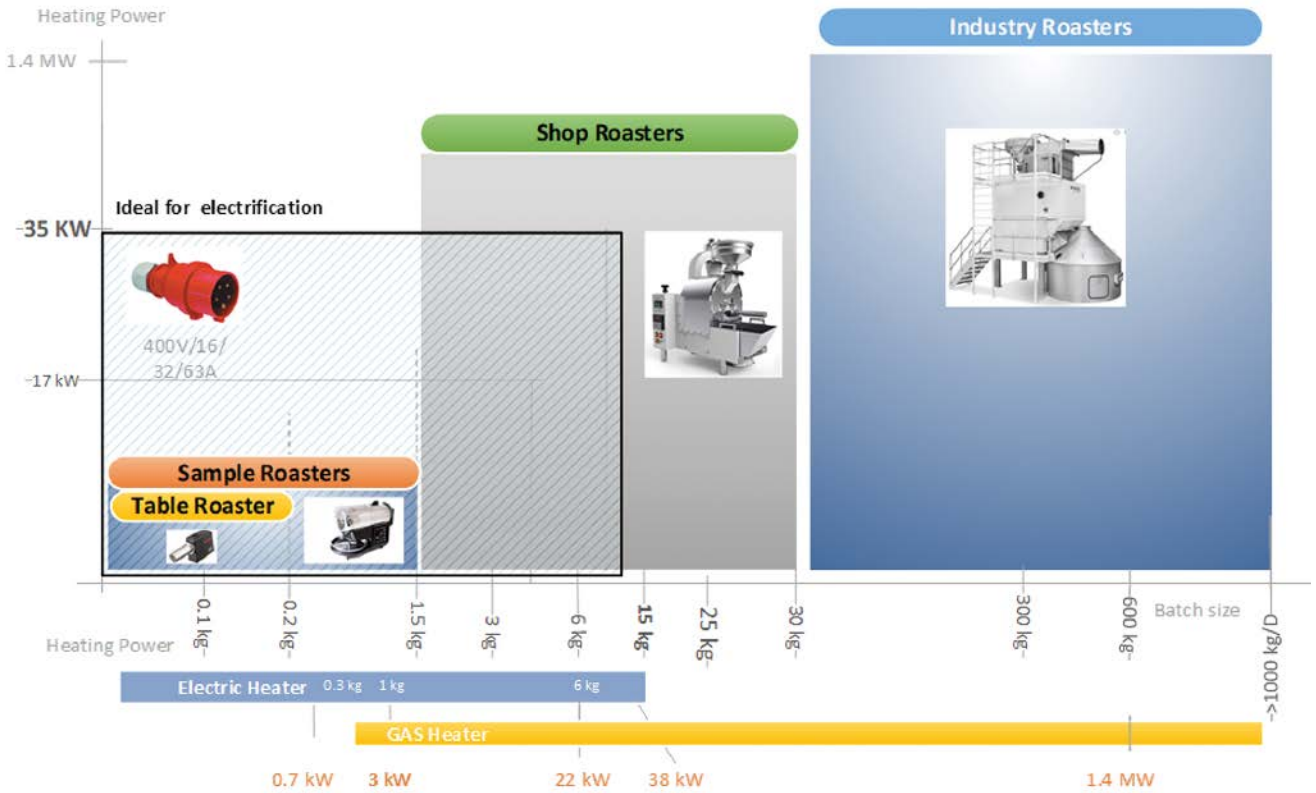

Figure 1: Drum roaster range and power requirements.

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peratures, desired batch volume, and consistent quality compared to gas roasters.

With improvements made through R&D, along with improved materials, a new generation of electric heaters have been implemented in roasting machines and are achieving similar results to gas-powered roasters. Innovations such as ceramic heating elements, paired with an actively controlled blower, allow roasters to achieve temperatures up to 1,100°F, which can be controlled in a precise manner. This results in higher quality coffee, which can be roasted continuously and precisely to build and support a strong brand image.

Drum Roasting

Coffee roasting can be accomplished in various machines such as packed bed and centrifugal roasters. One of the more common types of roasters on the market is the drum roaster. This type of machine consists of rotating drums that tumble the beans in a heated environment. Heat can be applied indirectly to the drum or, in some cases, the roaster uses direct fire, a process in which the heat is applied to the product inside the drum. The heat for the process can be supplied by natural gas, wood, or electricity.

Drum roasters are segmented according to their batch size (kg of beans per roasting batch). Industrial roasting machines, which process batches of more than one ton per pass, range in power from 50 kW to 1.4 MW. They roast for popular coffee brands and are installed in an industrial environment where safety and sustainability are constant areas of improvement. The very small sample or laboratory roasters are used by industrial roasters to create their roasting programs to refine the process. Lab roasters can operate at up to a few kW.

The next segment is the shop roaster. They process in small to medium roasting shops with batches ranging between 1.5 kg and 30 kg. The roast master develops coffee recipes that vary in aroma. Performance-wise, they operate at around the 50 kW range. For this segment, electric roasting is ideal because it enables operators to use the machine in their working environment.

For drum roasters with a batch size of up to 12 kg to 15 kg, i.e., an electrical connected load of around 43 kW, it makes sense to use electric roasters. More power is only made available in an industrial environment. A 5 kg roasting batch needs around 17 kW. This is an ideal size to place the roaster almost anywhere, even on cruise ships.

Electric roasting can be most efficient for shop roasters with a batch size of 12 kg to 15 kg. In other words, it's ideal for the segment of roast masters who want to inspire a very specific coffee-loving clientele with their unique brand. Electric roasting machines are easy and safe to install and operate. This type of electric heating in drum roasting machines offers many advantages and can deliver identical roasting results to those that are achieved using gas-operated machines (see Figure 1, above).

Advantages of Using Electric Air Heaters

The use of electric heaters in drum roasters presents an opportunity to provide consistent and continuous quality product. Environmental changes such as line voltage

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and ambient temperature changes can have an impact on the roasting process.

Coffee roasters can improve the roasting process by incorporating electric heaters. One benefit that is gained from incorporating electric heaters is process repeatability. By incorporating electric heaters and controllers to regulate the temperature, roasters can establish process recipes that allow them to apply the same parameters from one roasting batch to the next. This allows for consistency in the quality of the product. Another benefit that is gained is process safety. Electrical air heaters can easily be controlled by a small control system, allowing the end user to turn on/off the heaters when needed, especially when emergency situations arise. The electric heaters can be wired into an emergency circuit, allowing operators to shut down the heaters if problems arise in the process. One coffee roasting method that is gaining popularity is hot air drum roasting using electric heaters.

Figure 2: Leister electric air heater blower installation on large roasting machine.

The use of electric heaters in drum roasters presents an opportunity to consistently provide a quality product.

The use of electric air heaters for the drum roasting process provides an opportunity for recipe optimization. The air heaters and blowers can be integrated into roasting equipment with ease by simply sending a signal to obtain the desired output temperature. When paired with the proper control components, this method can overcome manual operation hurdles while providing automatic adjustments for the process, removing combustion residue, and not have a negative impact on quality. These added benefits give roasters the confidence to consistantly deliver quality products to the consumer.

The integration of an electric drum roaster provides ease of installation where gas is prohibited. Combustion installations require approvals and permits, along with inspections at regular intervals. In some environments such as shopping malls and cruise ships, proper combustion and safety measures for the roasting process may be difficult to run or may even be restricted. With the electric roaster, a standard power plug is all that is required, depending on heater output.

While a new installation can benefit from electric heaters for roasting, the possibility of retrofitting existing equipment exists as well. Older roasters have the potential for increased maintenance over time in addition to outdated safety measures. Electric air heaters can be integrated, mechanically and electrically, into existing roasters to easily replace the combustion equipment, eliminating the need for costly combustion safety equipment and downtime (see Figure 2, above).

Reduced emissions are another advantage of using an electric heater. During traditional gas roasting, the process can potentially release pollutants such as carbon dioxide, hydrocarbons, and sulphur oxide. The introduction of pollutants during roasting can have an impact on taste and pose a threat to consumers. With the use of electric heaters, the pollutant levels are decreased, which means fewer residues and improved quality of product for the consumer.

Electric air heaters can provide many benefits for coffee roasting. They can be easily incorporated into new and existing drum roasters, which allows for recipe repeatability and improved product quality. With these added benefits incorporated into the recipe, roasters can be confident that they will be able to consistently provide high quality products to consumers.

Before roasting can begin, it is essential to understand what type of product you are aiming for and the process required to produce those results. Whether it's a dark roast or light roast, hot air can be used in the process to deliver a quality, consumer-friendly product that is produced in a safe and efficient manner. ■

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In The Lab

Honey Fingerprinting

Ensure honey purity through mass spectrometry

BY **STÉPHANE BAYEN, PHD**

Food fraud is a significant concern for both consumers and producers. The scale of the problem is significant: 2016 research by Fera Science indicates that fraud accounts for up to 25% of all globally reported food safety incidents. Additionally, growing public demand for food authenticity means that consumers regularly pay a premium price for organic and sustainably produced goods, which is why unprincipled producers and distributors are flooding markets with adulterated, low quality, or mislabeled foodstuffs. This is not only damaging the livelihoods of legitimate businesses, but it's also risking the health of consumers.

To make matters worse, the potential number of adulterants and the millions of different foodstuffs require a similarly wide range of test methods if food fraud is to be effectively detected and prevented. The rapid growth of global e-commerce also increasingly places food sales outside of regulatory oversight. To catch the food fraudsters, you first need to quickly and efficiently identify their handiwork, which requires special tools.

Assessing Food Authenticity

Analytical testing is an essential technology for assessing food authenticity, which is critical to protect the health of consumers, the food brand, and producer income. Testing is, therefore, a necessary part of an overall strategy to mitigate fraud risk. The techniques and reference databases used for authenticity testing are rapidly evolving, but more still needs to be done, not least in terms of consistency.

There is a lack of adequate testing and test uniformity across the globe. Additionally, many of the test methods reported in the literature either lack applicability to emerging frauds or are simply not deployed in an enforcement framework; however, in recent years, pressure has grown to improve traceability and accountability across the global supply chain, especially for the more commonly adulterated products.

Natural Sweeteners

Current demand for natural sweeteners is high. When consumers purchase a product, they want to be able to recognize the listed ingredients, and know that those ingredients are as natural as possible. This is one of the reasons for increased interest in honey, which has been a natural sweetener for thousands of years. Consumers want more of these natural sweeteners, so the production and sales of honey, particularly organic honey, are experiencing a hefty growth. We're also seeing that consumers want natural product organic honey, called monofloral honey or unifloral honey, which is basically a honey that comes primarily from a specific type of flower. Consumers are willing to pay more for these products; therefore, we need to protect these consumers by making sure they get what they are paying for.

Creating a Buzz around Honey

One of the most widely adulterated products is the organic variety of honey, a high-value item prized for its unique properties. According to the U.S. Pharmacopeial Convention Food Fraud Database, it's the third most targeted food for adulteration, after milk and olive oil. It's also financially significant; a report by Grand View Research valued the global honey market at USD $9.21 billion in 2020 and expects it grow at a compound annual growth rate of 8.2%.

According to data from the United Nations Food and Agriculture Organization, China, Mexico, Russia, Turkey, and the United States are among the major honey-producing countries, accounting for approximately 55% of world production. The most common form of adulteration involves extending or diluting honey with other, less expensive sweeteners, such as corn, cane, and beet syrups. Any form of ingredient addition or substitution that creates a food safety hazard, such as the addition of an unlabelled allergen, must be addressed in the food safety plan.

Therefore, the ability to identify these substances quickly, efficiently, and consistently is essential to tackle fraudulent practices. What the food industry needs is analytical instruments and techniques that can consistently and rapidly fingerprint food and identify trace chemicals.

Setting the Standard

The good news is that liquid chromatography coupled with mass spectrometry (LC-MS) has emerged as the gold standard for analyzing trace constituents in food. The process enables food safety experts to map food components in an unprecedented fashion and will revolutionize how we manage and regulate the quality, safety, and authenticity of food.

While there has been work on developing ways to fingerprint foodstuffs, including honey, approaches among laboratories have varied in terms of sample preparation and analytical methods. There are also differences in terms of data processing. As a result, two laboratories analyzing the same sample could obtain slightly different results. To prevent the problems that may result from these variances, we should be looking at a standardized approach to fingerprinting and analysis.

Refining the Approach

Of course, we are trying to address two issues here: food safety and the quality and authenticity of the product. Each area is governed by separate sets of regulations. If we look at residues of contaminants in honey, such as pesticides, there also are differences between locations. For example, countries can have their own set of restrictions for the maximum limit for specific compounds. When we think about fingerprinting for honey, contaminants are a part of the picture, but the permitted levels vary between countries.

Food authenticity testing utilizing chemical fingerprinting strategies is emerging as a practical approach to tracking food fraud, as chemical fingerprints are virtually impossible to imitate due to their complexity. Regarded as the next-generation surveillance approach for chemicals in food, non-targeted analysis using high-resolution mass spectrometry coupled with innovative software enables the rapid characterization of thousands of chemicals in complex food matrices such as honey.

Currently, samples come from the field to the lab for testing; however, there is interest in potentially reversing this by bringing the lab out into the field. This interesting, but not yet recognized, capability would enable regulators and the food industry to rapidly respond more quickly to honey contamination—and to food fraud in general. By deploying the results of recent fingerprinting research in this way, we will be better equipped to protect consumers and producers alike.

LC-MS has emerged as the gold standard for analyzing trace constituents in food. The process enables food safety experts to map food components in an unprecedented fashion and will revolutionize how we manage and regulate the quality, safety, and authenticity of food.

A Global Perspective

The increasing globalization of our food supply chain raises the opportunity for food fraud. Experts predict that testing using methods such as those described above, will become more accessible, increasingly automated, and easier to perform. Fingerprinting methods—in which the entire molecular profile of a food can be obtained—will be a major feature of fraud prevention and identification systems in the future.

The good news is that current testing requirements have led to a rise in rapid, broad-coverage testing methods and technology to enable remote testing of food, in addition to improved testing within laboratory settings. Food testing laboratories can confidently measure contaminants that threaten the global food chain and supply and identify food fraud using these new approaches. ■

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Manufacturing & Distribution

First-In-First-Out Systems

Enhance your inventory system with the IoT to keep food safe

BY **BRIAN RUHAAK**

Whether you're raising livestock, cultivating crops in the field or grove, processing fresh food into consumer and industry saleable products, or bringing product to market and stocking shelves, some part of your operation is dependent on inventory being used or sold prior to an expiration date. Failure to effectively manage your inventory results in waste and loss and can impact the safety of the products. To combat the challenges of adhering to date-coded inventory, organizations will implement first-in-first-out (FIFO) systems that assure the proper material or product is used at the proper time.

What Is FIFO?

So, what actually is a FIFO warehousing system? It's an inventory control method designed to properly rotate stock so that older products are distributed first, and newer products remain in inventory. It is widely used across all types of industries—including food, retail, pharmaceuticals, and manufacturing—and applicable whether materials are stored on the shelf, in a dynamic warehouse, or in a refrigerator. It's even more important in environments where there is a high volume of inventory with limited shelf life.

Challenge: Food in FIFO

The FIFO inventory control method is designed to be the simplest inventory valuation method, specifically designed for perishable products and widely used within the food production industry. Significant consequences can impact food manufacturers as a result of poor inventory management and noncompliance to a FIFO system. Specifically, poor adherence to your FIFO system can result in food spoilage, disease, product recalls, and—ultimately—increased costs.

Food recalls in the U.S. have increased more than 10% from 2013 to 2018, according to a study by the Public Interest Research Group. The average food recall has a significant impact on an organization; a recall will damage a brand's reputation, affect sales performance, and carry with it direct costs associated with the recall process itself. Additionally, an organization could also be hit with lawsuits and litigation and compliance-related penalties. According to the Consumer Brands Association, the average cost of a recall in the food manufacturing industry is north of $10 million.

Where Industry Has Failed

Today's reality is that even the organizations that have a system in place struggle to control their FIFO operation. Organizations that have implemented a FIFO system sometimes exhibit challenges related to manual scanning and verification processes, a heavy reliance on employee intervention that can result in human errors, and antiquated systems that lack the flexibility or logic to successfully manage a complex inventory strategy.

Then there are the organizations that have no FIFO system all together. This could be due to the overall complexities of implementing a system and technology

to manage inventory. It could also be the scale of the operation that creates a significant challenge with FIFO compliance; large warehouse spaces, a diversified product catalog, and high inventory turnover all add complexity to inventory management. Additionally, some companies are generally challenged when it comes to gathering highly accurate data, and they struggle to turn the data they do have into actionable insights.

The Solution

While there are significant challenges to managing FIFO within the food manufacturing industry, organizations can leverage new developments in internet of things (IoT) technology to capture high-fidelity data capable of ensuring that a product can travel safely from field to fork.

Here are some ways in which organizations can digitally transform their inventory process:

- **Serialized Asset Identification**: The foundational building block of an effective FIFO system is identifying the data attributes of a specific asset. Traditional tagging methodologies limit the ability to do this. To enhance FIFO controls, organizations can introduce a serialized asset identification strategy through the implementation of ultra-high frequency (UHF) passive radio frequency identification (RFID) technology, which allows each asset to be identified with a unique serial number while preserving specific human readable label elements required in production. This serial identifier can be tied to various elements of master data, including date and time codes that drive FIFO logic. Once date and time codes are actualized, food manufacturers can begin planning production, inventory, and shipment at an individual asset level. In addition to UHF passive RFID, other types of serialized asset tagging technology are available including, ultra-wideband (UWB), Bluetooth, active RFID, and GPS. It's important to qualify and select the right technology to match an organization's individual objectives and business case.
- **IoT Smart Sensors**: To gather FIFO data, it's important to deploy the IoT technology necessary to capture the serialized assets. Historically, organizations have relied on their employees and a manual scanning process to capture inventory data. Yet, at scale, this becomes difficult to manage and can result in either increased time and labor or a significant decrease in accuracy. To enhance inventory control, numerous forms of IoT technology are available that will automate the data collection process while maintaining or, in many cases, increasing the accuracy of data collection. Types of technology commonly deployed are UHF passive RFID antennas, including dock door and choke point portals, overhead antennas and handheld devices, UWB beacons, vision systems, and active RFID beacons. All are designed to be autonomous and require minimal process change or human intervention.
- **Temperature and Control Monitoring:** In addition to serialized assets and smart sensing technology, companies are beginning to monitor the temperature of perishable assets, either through shipment or upon receipt into refrigerated warehouses. This has become one of the most important tools in the perishable food market due to the sensitivity to high temperatures and relative humidity of some products. Until now, this has been an incredible manual process and receiving data in real time was challenging. Now, it's possible to capture this data through reporting systems that allow retailers and manufacturers to access insights quickly.
- **Cloud-Based Software Technologies:** Through the introduction of serialized asset identification and IoT Smart sensors to capture data, organizations have the data necessary to control the FIFO system; however, this data can quickly become irrelevant if organizations don't transform it into insights and then into action. Cloud-based software technology can help to manage the vast amounts of data captured and use backend logic to actualize that data in a way that allows users to quickly identify the proper inventory to use. SaaS applications will do the heavy lifting and present the needed action to users through a user interface on a smartphone, handheld tablet, or other device with access to internet connection. Backend logic will pull back the oldest serialized inventory of a specific type indicated by a user; then the user interface will display the oldest three assets in descending order. The employee can then select the oldest inventory available for use.

Impact

By implementing IoT technology to enhance a FIFO inventory system, a food manufacturer can significantly impact the supply chain as well as the overall performance of the organization. A major positive impact of effectively managing FIFO inventory controls using IoT is quality control improvement, which can be seen throughout a food production process. Food manufacturers can realize an overall reduction in foodborne illness by shipping or consuming inventory based on the most appropriate date. As we know, this type of reduction can have a positive impact on brand perception and limit additional direct costs and lost sales. Organizations reduce the chance of product recalls, which also preserve their overall brand loyalty. Additionally, implementing a smart FIFO system can significantly reduce waste due to food spoilage. This can be one of the most costly and unnecessary challenges that impacts an organization; however, by enhancing visibility and increasing FIFO control using IoT, organizations can keep their warehouses from becoming cost centers.

A technology-driven FIFO system using serialized asset identification and high-fidelity data also allows food manufacturers to schedule workforce based on pack out. Through this, a workforce can be right-sized and specific shifts can be accurately staffed based on actual production demand. Gone are the days of idle shifts, employees waiting for mature product to ship, and manufacturers wasting product because they don't have employees available to ship it.

Through effective inventory control methods, manufacturers can meet customer requirements. Retailers desire manufacturing partners with a reputation of quality product, on-time delivery, and high brand recognition. ■

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The Cottage Food Industry

More state-level legislation is allowing for more home-based foods—how safe are they?

BY **MARY BETH NIERENGARTEN**

Like many industries, the cottage foods industry is experiencing the effects of COVID-19, as more and more people turn to home-based solutions to earn money or to learn or expand on a passion for cooking and baking. The cottage foods industry refers to individuals who use their home kitchens to make food, and then sell the products either out of their homes, online, or at farmers' markets or other events. While not legal in every state, these home-based businesses continue to grow as many states push for more ways to deregulate the industry, a trend that began before the pandemic and is now further fueled by it.

In 2021 alone, 55 new bills were introduced across the U.S. seeking to loosen restrictions on cottage foods, according to Emily M. Broad Leib, JD, clinical professor of law and faculty director of the Harvard Law School Food Law and Policy Clinic and deputy director of the Harvard Law School Center for Health Law and Policy Innovation in Boston. Among the restrictions these bills hope to ease are those directed at raising the annual sales caps on what cottage food producers can earn, increasing the types of foods that can be produced, and expanding the method of permitted sales (e.g., permit selling products online, by phone, through mail, via third-party delivery services).

Other legislative trends are laws permitting microenterprise kitchens, which means those who sell fully prepared meals from home-based kitchens.

Given the growing interest in, proliferation of, and expanding legislation for home-based products, what are the safety concerns with these products? In part, this question is answered by the level of risk they pose with regard to pathogens, and the subsequent risk of foodborne illness.

Pathogen Risk

Leib, along with law students Regina Paparo and Patrick Montgomery, describes cottage food as "value-added food products" made at home and offered for sale. These products include baked goods, jams, granola, popcorn, candy, coffee, tea, and other home-based goods. When a larger variety of foods or home-based businesses that offer fully prepared meals are included, other labels such as "home kitchens" or "microenterprise home kitchens" are sometimes used, they say.

To date, all 50 states allow the sale of cottage food in some form. While states vary in terms of the foods they allow to be produced from home for sale, most limit the products to those considered low risk. "Many cottage foods that can be made without a permit are non-temperature control for safety (non-TCS) foods that are categorically very low risk," says Leib. For states that allow a broader set of foods, ad-

ditional permitting, training, and inspection for home cooks is often required.

TCS is the newer term used for perishable foods or food products that require time and temperature to control safety. Both these factors affect the rate at which pathogens grow in foods.

Explaining the difference between low and higher risk foods, Peggy Kirk Hall, JD, director of The Ohio State University Agricultural and Resource Law Program in Marysville, says that processed foods are an example of higher risk foods in terms of safety. Processing, she says, can mean different things, from simply cooking something to make it edible (e.g., rhubarb jam), to drying, chopping, or repacking something (e.g., dried fruits), to—at the far end—heating and sealing to preserve over the long-term (e.g., salsa).

Although jams and jellies are examples of processed foods, Hall says that these are on the lower end of safety risk compared to products such as canned vegetables or salsas that have a higher pH and water activity value. Foods with a higher water activity value pose a higher safety risk, as they can support bacterial, yeast, or mold growth. "In most states, jams and jellies are fine, but in other states, like Ohio, no processed foods, like acidifying foods or those with a higher water activity level, fall under cottage food," she adds.

The safest products are those that are not processed and don't require time and temperature control to hold them, notably baked goods such as cakes, cupcakes, and cookies. One safety concern with these products, she says, would be any time and temperature-controlled ingredient added on top or inside, such as cream cheese or egg-based fillings.

The danger to individual and public health from these higher risk foods, in the form of foodborne illness, has not been shown in the research conducted by Leib and her colleagues, however. "The risk of foodborne illness varies with the type of cottage food we're talking about, but our research has not revealed any reported outbreaks of foodborne illness associated with any products made in home kitchens," says Leib.

Steven Mandernach, JD, executive director of the Association of Food and Drug Officials (AFDO), speaks with more caution about the safety risk potential of cottage food products and the decreasing regulation across states. He thinks states with more restrictions, such as those that only allow non-TCS products for sale from home-based kitchens, have the better approach to safety versus states that allow, for example, the sale of home-cooked meals. "The trend is moving to regulate cottage food less and less, and this is becoming a bigger issue over time as we see a lot of traditional restrictions go away," he says. In such an environment, he uses the term "buyer beware" to highlight the responsibility consumers face when buying these products.

> The trend is moving to regulate cottage food less and less, and this is becoming a bigger issue over time as we see a lot of traditional restrictions go away.
>
> —Steven Mandernach

Currently, he says that the most common point of sale for these products are local farmers' markets, where he describes the cottage food industry as "the front porch to the farmers' market." Products that may find a market in grocery stores or restaurants will more likely be foods with less safety risk, such as baked goods.

Know Your State Laws

For those who want to start a cottage food industry, or for larger food processors who may want to help a home-based entrepreneur scale up their food production for a broader customer base, it is critical to know the state laws regarding the production of these foods. "It is really important to stay focused on your state first, and to understand what your state requires," Hall says. "A lot of people go to the federal level first, but [cottage food industry regulations] are largely driven by state law."

For example, in Minnesota, each person producing cottage food needs to be registered with the Minnesota Department of Agriculture, says Carrie Rigdon, operations manager for the Minnesota Department of Agriculture Food and Feed Safety Division in St. Paul, and must complete a training session on issues within the cottage food law. "All cottage food producers in Minnesota need to complete a training session that describes the cottage food law, its requirements, and its limitations, as well as instructions on food safety, allergen control, and hygienic practices," she adds.

In addition, the Minnesota law requires food to be labeled to include ingredients and declare any allergens, as well as to inform customers that the product has not been subject to state inspection. Rigdon also says that her agency investigates any complaints, including foodborne illness complaints, related to cottage food products.

Although state law governs nearly all regulation in the cottage food industry, Leib and her colleagues point out that states generally base their retail food safety regulations on a model code called the FDA Food Code. "While the FDA Food Code model language does not allow for food made in a home kitchen to be offered for sale, the language does suggest that states allow non-TCS foods made in a home kitchen to be sold at religious events or charity bake sales," she says, adding that "many states have broadened this provision of the FDA Food Code to allow these products to be sold in more diverse venues."

A comprehensive list of cottage food laws by state, as of 2018, created by Harvard's Food Law and Policy Clinic, can be found at chlpi.org. ■

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Environmental Monitoring ... (Continued from p. 21)

have those employees most familiar with the data and facility regularly analyze trends of quantitative data. It can be difficult to keep up with production needs and still find time to analyze data trends throughout the course of the year. As manufacturers strive to keep up with the short-term goal of releasing product or releasing zones, many only look at whether a point passes or fails rather than how it's trending over time and what the long-term implications of those trends could be. By regularly analyzing the trending data, manufacturers can identify a problem in a caution zone and anticipate a failure before it happens, identify vulnerable areas of the plant, and work toward continuous improvement.

Another good practice is implementing caution zones. Rather than having pass or fail cutoffs for EMP test results, establishing caution zones can help alert the plant to a potential upcoming failure before it happens in the hygiene zone or on a product contact surface. This can help bring attention to problems such as the need for a additional training, a sanitizer changeover, replacement of out-of-date equipment, or a growth niche before they become bigger problems.

4. Creating a "Food Safety Culture"

As a result of the pandemic, some organizations have experienced a renewed sense of purpose; as a result, we have seen an increased emphasis on food safety culture and the creation of guidelines around what this entails. While not a direct result of COVID-19, one example of this renewed interest in food safety culture is the most recent update of the Safe Quality Food (SQF) Institute's Food Safety Code. At the end of 2020, SQF shared a number of updates for its guidelines for food manufacturing, including adding the need to "establish and maintain a food safety culture within the site" and training requirements around "sampling and test methods, environmental monitoring and allergen management, food defense, and food fraud for all relevant staff."

Management should work to create a culture in the plant that encourages finding a positive or identifying a vulnerable area of the plant. Testing programs should emphasize sampling locations most likely to find the target organism and require aggressive response to positive samples. Educational resources should be readily accessible, as well.

Though the pandemic has presented challenges in establishing and maintaining EMPs, it's also helped shed light on the critical role of education, the usefulness of virtual training, the need to continually review EMPs and the importance of establishing a food safety culture. ■

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Sustainable Poultry Processing (Continued from p. 24)

sanitation systems have been proven to reduce water usage by 50% and save on wastewater treatment costs. In addition to water savings, automated sanitation systems can help offset the labor shortage issue. Of course, changes to sanitation procedures designed to reduce water consumption should always be verified as effective.

While automated sanitation equipment has been available for some time now, new intervention technologies are revolutionizing how antimicrobials are applied to meat and poultry. Traditional antimicrobial application in poultry processing has been limited to dip tanks or unfocused sprays, using large amounts of water and chemical to ensure efficacy. However, with innovations in electrostatic technology (the same technology used to apply spray paint to cars), poultry processors can now realize significant savings in water and chemistry usage while achieving log increased reductions to aid compliance with new USDA Food Safety and Inspection Service regulations for *Salmonella*.

4. Talk to a Food Safety and Sanitation Expert

The best way to create a holistic sustainability plan is to consult with suppliers. The right equipment, chemical, and sanitation provider can audit a facility and provide recommendations on ways to create efficiencies and determine which processes could be automated. Ultimately, implementing sustainable practices without compromising food safety takes a commitment to innovation and a collaborative effort between food safety partners.

> The current rate at which processors are using water is unfeasible for the long term when considering challenges such as water shortages, tightening government regulations, and labor struggles.

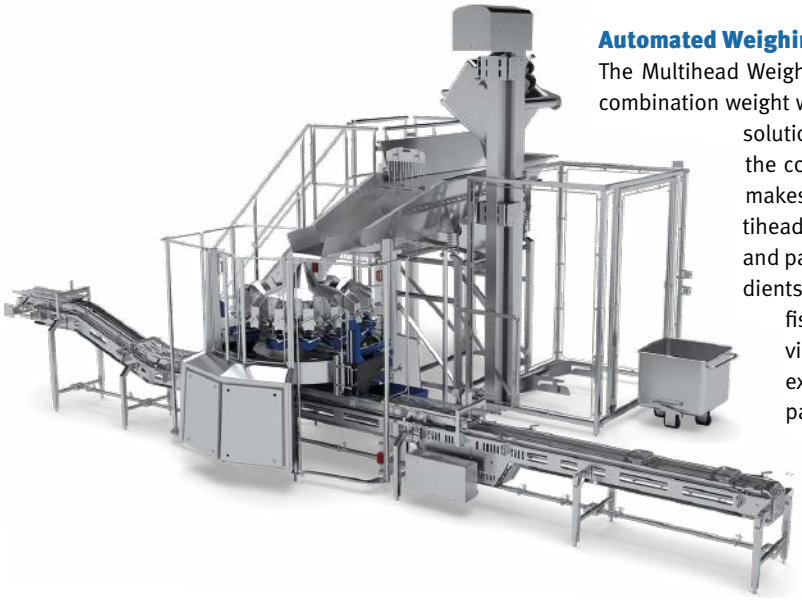
Sustainability: The Future of Poultry Processing

Federal, state, and local regulations on water usage and wastewater are only going to become more stringent, and the water supply becomes more limited by the day. That means poultry processors—along with the food processing industry as a whole—will need to evaluate their processes and equipment for ways to save, and the sooner the better. The good news is that the industry now has more technology and strategies for overcoming these challenges than ever before.

With the right sustainability efforts and food safety experts at their disposal, sustainable poultry production is in reach for processing facilities. ■

Ogren is president of Birko's equipment division. Reach him at bogren@birkocorp.com.

NEW PRODUCTS



Automated Weighing and Packaging System for Sticky Products

The Multihead Weigher Extreme from Cabinplant combines a screw-feeder combination weight with new scraper/weighing pans and a new processing solution, which ensures that the food is packed into trays on the conveyor belt. The system has a compact design, which makes it easy to fit into existing production areas. The new multihead weigher makes it possible to fully automate the dosing and packaging of ready-to-eat meals that include sticky ingredients such as diced vegetables, onion rings, rice, pasta, tuna fish, mayonnaise, and yogurt. These processes were previously performed manually or partially manually, without exact weighing. The end-product can be ready-to-eat meals packed in plastic trays, standing bags, etc. The cassettes can be replaced, which reduces the time for cleaning and changing to five to 10 minutes and allows for frequent changes in recipes and packaging sizes. **Cabinplant A/S. cabinplant.com.**

Linerless Labels for Food Delivery

Iconex has released lightweight linerless labels. The Sticky Media G2 combines lightweight paper with twice the adhesive grip of the original Sticky Media product line to target delivery operations and reduced environmental impact. The product blends a traditional receipt paper with a linerless pressure-sensitive label. The solution can label, identify, and track items all in one product. Iconex subjected labels to rigorous testing to ensure the adhesives lay flat, form to a wide array of shapes and materials, and hold up under a variety of environmental conditions. **Iconex. iconex.com.**

High Temperature Oven Lubricant

The Renewable Lubricants new food-grade Bio-Extreme High Temperature Oven Lubricants perform at extreme high temperatures up to and higher than 1,000°C, with protection up to 2,000°C. These biobased lubricants are enhanced with white graphite. Systems lubricated with white graphite require less product application, making for cleaner equipment. The lubricants are formulated from renewable carbon-negative resources and are available in 1-gallon jugs, 5-gallon pails, drums, totes, and in bulk. They are ideal for roller chains on oven conveyors, bakery oven chains, beverage can lines, and other food processing applications. The lubricants are NSF H1 and Kosher certified. **Renewable Lubricants, Inc., info@renewablelube.com, renewablelube.com.**

Tubular Chain Conveying and Cooling System

The THERMOLuxme Tubular Chain Conveying and Cooling System is comprised of an enclosed, sealed pipe assembly. Any gases or moisture emitted from the hot material during transfer are contained and vented through the internal pipework using either vacuum, forced air, or inert gases, protecting the food and the workforce. As a result, the system can safely convey and cool up to 1,100 cubic feet of hot food products per hour, such as high-fat content organic powders and mixes, roasted nuts and snacks, pet food kibble, and pre-cooked potato cubes/foods, while ensuring that work areas remain clean, dry, and dust-free. Available in 4-, 5-, 6-, 8-, and 10-inch diameter options, the system preserves product integrity by smoothly gliding food powders through the chain and disc conveyor without pinching or crushing. With carbon steel, stainless steel 304, or 316L low-carbon stainless steel construction, the system also comes with the option to specify glycol cooling chillers for applications with high inlet-to-outlet temperature differentiation over short transfer distances. **Luxme. luxme.com.**

All-In-One Metal Detection, Checkweighing, and Vision Unit

WIPOTEC-OCS has released an all-in-one inspection unit that combines X-ray foreign objects detection and checkweighing with a vision system capable of verifying label placement, barcode legitimacy, film detection, and validation of expiration. The unit, which also includes a reject system that sorts rejected products by pre-set categories, is controlled by a single HMI and is a space- and cost-saving option for food and beverage manufacturers. The unit's X-Rray scanner can identify foreign objects made of metal and other materials and has filters available to track for certain other abnormalities. The machine's vision system can flag errors such as an incorrect film, label placement or missing labels, or other aesthetic-driven quality control issues. **WIPOTEC-OCS, wipotec-ocs.com/us.**

Microfiber Cleaning Towels

Take microfiber cleaning and detailing on the go with Hospeco Brands Group's Shopserve microfiber towels, now available in a dispensing box. These thin 12" x 12" towels are perfect for quickly removing dirt, dust, and bacteria from surfaces requiring little or no chemicals and can be kept in areas where cleaning up or wiping down surfaces is a more constant undertaking. The towels are economical enough to be use as a disposable towel or can be laundered for limited reuse. The cloths are made of polyester and polyamide, and the fibers are more than 100 times smaller than a human hair, creating a larger volume of fibers touching a surface when compared with traditional cotton cloths. Further, they are non-linting, making them ideal for cleaning and polishing applications. They also excel at absorbing grease and oil and are available in a variety of colors to help prevent cross contamination and to indicate different chemical use. These machine washable, colorfast, edgeless towels are non-abrasive and won't scratch surfaces. **Hospeco Brands Group, hospeco.com.**

Chilled Mirror Dewpoint Sensor

The Edgetech Instruments Inc. COM.AIR dewpoint monitor is now available with the company's X3 high performance primary method chilled mirror sensor. The sensor is specifically designed to measure the dew/frost point under demanding conditions, and its minimized sample cavity results in rapid dry-down times, fast response, and quick detection of upset conditions. Its chamber design and heat exchanger result in the ability to measure very low frost points. The COM.AIR is a complete dewpoint monitoring system. Its aluminum NEMA-12 enclosure houses the sensor control circuitry as well as flow control, and can be wall mounted. Only a sample line and power connections are needed for the system to be made operational. **Edgetech Instruments Inc., edgetechinstruments.com.**

Chlorinated Alkaline Foaming Cleaner

Madison Chemical has introduced the Pro-Clean Foam Safe, a chlorinated, alkaline, general purpose foaming cleaner that performs well in most water conditions. When used in a "foam generator" as a one-package cleaner, it produces thick, stable, wet foam necessary for cleaning without dry-out or run-off. The product cleans stainless, aluminum, and zinc alloys, and vertical and overhead surfaces. It can be used as a general cleaner on all surfaces in and around food and beverage processing areas. It is not intended for food contact. It rinses easily with potable water and without streaking. When used according to manufacturer's instructions, no

residue or odor is noticeable after use. Product is generally used at ambient temperatures to 140°F, with exact dilutions dependent on specific application requirements. **Madison Chemical Co., Inc., madchem.com.**

Wireless pH Testers

Hanna Instruments, Inc. has introduced HALO2 Wireless pH Testers, which combines a professional pH electrode and Bluetooth 5.0 wireless technology. This pairing enables users to turn a phone or tablet into a laboratory-grade pH meter. With the HALO2 product line, testing with a professional electrode is no longer limited to just a laboratory setting. Its compact design and data logging capabilities helps users achieve results in any testing environment. These testers can be used for collecting pH measurements as part of the food production process. **Hanna Instruments, Inc., hannainst.com.**

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Food Processing Expo
Sacramento, Calif.
Visit foodprocessingexpo.org.

MARCH 2022

9-10
International Conference on Food Safety and Hygiene
Edinburgh, Scotland
Visit foodsafety-hygiene.alliedacademies.com.

22-24
SIAL America
Las Vegas, Nev.
Visit sialamerica.com.

29-30
Ice Cream Technology Conference
Bonita Springs, Fla.
Visit ifda.org/events.

MAY 2022

4-6
European Symposium on Food Safety
Munich, Germany
Visit foodprotection.org/europeansymposium.

9-12
Food Safety Summit
Rosemont, Ill.
Visit food-safety.com/food-safety-summit.

18-19
DairyTech Conference
Austin, Texas
Visit ifda.org/events.

JUNE 2022

6-7
Mexico Association for Food Protection Annual Meeting
Virtual Event
Visit amepal.com.

9-10
Turkish Food Safety Congress
Istanbul, Turkey
Visit foodsafetycongress.org

JULY 2022

10-13
FIRST Annual Expo and Virtual Experience
Chicago, Ill.
Visit ift.org/events.

July 31-Aug. 3
IAFP
Pittsburgh, Penn.
Visit foodprotection.org or email info@foodprotection.org.

AUGUST 2022

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

OCTOBER 2022

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

NOVEMBER 2022

2-4
Dairy Practices Council Annual Conference
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SCIENTIFIC FINDINGS

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

Shrinkage in Frozen Desserts

Shrinkage is a well-documented defect in frozen desserts, yet the root causes and mechanisms remain unknown. Characterized by the loss of volume during storage, shrinkage arose during the mid-20th century as production of frozen desserts grew to accommodate a larger market. Early research found that shrinkage was promoted by high protein, solids, and overrun, as well as post-production factors such as fluctuations in external

temperature and pressure. Rather than approaching shrinkage as a cause-and-effect defect as previous approaches have, these authors employ a physicochemical approach to characterize and understand shrinkage as collapse of the frozen foam caused by destabilization of the dispersed air phase. The interfacial composition and physical properties, as well as the kinetic stability of air cells within the frozen matrix, ultimately affect product susceptibility to shrinkage. The mechanism of shrinkage remains unknown, as frozen desserts are highly complex, but is rooted in the physicochemical properties of the frozen foam. Functional ingredients and processing methods that optimize the formation and stabilization of the frozen foam are essential to preventing shrinkage in frozen desserts. ***Comprehensive Reviews in Food Science and Food Safety*. 2022;21:780-808.**

Non-Thermal Processing for Seafood and Seafood Products

Seafood and seafood products (SSPs) are highly perishable foods due to their chemical composition (high moisture content and nutrients). They are regarded as highly sensitive to different processing technologies. SSPs are subjected to various processing conditions with intent to extend their shelf life, raise their quality, and minimize nutritional degradation. Recently developed non-thermal technologies (NTTs) have proven their efficacy in inactivation of microorganisms and enzymatic activities, enhancing the product shelf life while maintaining its nutritional quality. Considering the significant impacts of NTTs on shelf-life extension and maintaining quality parameters, they have attracted considerable interest among scientific communities and have resulted in commercial applications in some cases. This article focuses on recent developments in the application of NTTs—namely, cold plasma, pulsed electric field, and high hydrostatic pressure—as well as their advantages and limitations. In addition, their impacts on the microbiological and physicochemical characteristics, as well as the quality and safety, of SSPs are elucidated. ***International Journal of Food Science and Technology*. 2022; 57:774-790.**

Recent Advances in Halal Food Authentication

Increasing public awareness of food quality and safety has prompted a rapid increase in the authentication of halal food, which covers the production method for, technical processing of, identification of undeclared components in, and species substitution in halal food products. This situation calls for extensive research into analytical methods to obtain accurate and reliable results for monitoring and controlling the authenticity of halal food. Nonetheless, authentication of halal food is often challenging because of the complex nature of food and the increasing number of food adulterants that cause detection difficulties. This review provides a comprehensive and impartial overview of recent studies on the analytical techniques used in the analysis of halal food authenticity (from 1980 to the present, but there has been no significant trend in the choice of techniques for authentication of halal food during this period). Additionally, this review highlights the classification of different methodologies based on validity measures that provide valuable information for future developments in advanced technology. In addition, methodological developments and novel emerging techniques, as well as their implementations, have been explored in the evaluation of halal food authentication. This includes food categories that require halal authentication, illustrating the advantages and disadvantages as well as shortcomings of all approaches. ***Journal of Food Science*. 2022;87:8-35**.

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