

7 WAYS

ANTIMICROBIAL LIGHT DELIVERS

A CLEANER
BOTTOM LINE

**THE FOOD & BEVERAGE MANUFACTURERS'
ROI GUIDE TO SAVING TIME AND MONEY**

vital vio

THE CONTAMINATION CHALLENGE

Maintaining clean production lines is one of the most critical challenges facing food and beverage manufacturers. Tight regulations ensure that production processes and manufacturing environments meet stringent safety guidelines. If products or equipment are found to be contaminated, lines are shut down while everything is thoroughly cleaned. The impact to the bottom line can be significant in some very direct ways:

- Specialized contamination clean-up is very costly (chemicals plus labor).
- The financial opportunity cost of a temporary shut-down increases by the minute.
- Already-processed goods must be discarded at a total loss, while raw materials are discarded or safely stored for future use.
- The sum of these and other associated costs can be staggering and deeply regrettable.

Depending on its complexity, cleaning a production line and getting it running again can take hours or days. Specific protocols must be followed to properly clean the impacted environment. Often manufacturers bring in third-party contractors that may cost thousands of dollars per hour.

The larger or more complicated the contamination is, the longer it takes—and the more it costs—to remediate. And when contamination is not caught in time—and a product ships—a costly and time-consuming product recall may become necessary. Product recalls are not only financially expensive, they can have a material impact on a company's standing with suppliers, distributors and consumers. Recalls can also cause a backlash in the stock market, causing a company's value to plummet once news of a contamination breaks. Damage to a brand's reputation can take years to overcome, depending on the scope of the contamination and resulting media coverage. Most U.S. consumers can probably name at least one brand or product category associated with a food recall caused by contamination.

Beyond the financial costs of food contamination, there is a very real human toll. According to data from the U.S. Centers for Disease Control and Prevention, each year approximately 48 million people in the United States (about 1 in 6) become sick from food-borne illnesses; 128,000 are hospitalized; and 3,000 die from these (largely preventable) illnesses. Other CDC data show that there are thirty-one major pathogens acquired in the United States (versus from foreign travel) that are responsible for these illnesses. Nontyphoidal *Salmonella* was found to be the leading bacterial cause of illness (11%), and the top cause of hospitalizations (35%) and death (28%). Another common food-borne bacterium, *Listeria monocytogenes*, is estimated to be the third-leading bacterial cause of death (19%). What's even more troubling is that the actual numbers are likely much higher, with public health experts believing that cases are under-reported because only a small proportion of these illnesses are confirmed by laboratory testing and reported to public health agencies.*

* Source: Centers for Disease Control and Prevention, 2011 annual data

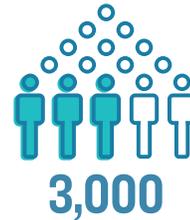
** Source: Grocery Manufacturers Association



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\$10 MILLION
average direct cost
per food recall due
to contamination**

ANTIMICROBIAL LIGHT: A NEW WAY TO CLEAN IN THE 21ST CENTURY

Until recently, the choices to combat microbial contamination within food and beverage manufacturing environments were typically limited to:

- Wiping and mopping with strong chemicals
- Power-washing and deep cleaning by specialized cleaning services
- Disassembling equipment, cleaning it and rebuilding it, typically using outside services

Now there is a new approach to mitigate contamination: antimicrobial light, a light wave frequency between 400 and 420nm that specifically targets bacteria, fungi, yeast and mold by creating an inhospitable environment that prevents further growth of microbes on surfaces within the production environment.

Originally discovered in England in 1892 using filters and sunlight, this light technology has evolved to become flexible and highly efficient using the digital tuning capability of LED. The breadth and depth of use cases are phenomenal: chief among them, food safety. In the case of food and beverage manufacturing, Vital Vio's lights can be configured precisely to target specific areas (throughout all Production Zones) where bacteria are present, likely to grow or likely to be transmitted to other Zones. The key benefit of Vital Vio's antimicrobial lighting solutions is the fact that Vital Vio has patented a single LED diode to emit this specialized light, enabling it to both illuminate large places such as manufacturing environments, while also providing continuous protection inside very small and hard-to-reach spaces, such as directly within the processing line itself, or underneath equipment.

Vital Vio antimicrobial light is unlike UV light, which is inherently dangerous because it attacks DNA to destroy the cellular structure in all living things (including people). Vital Vio's technology uses a selected light wave that meets the international standard for continuous and unrestricted use around humans (IEC24, 2019). There are countless advantages to antimicrobial light as an ideal complement to more traditional ways of cleaning. Studies show that Vital Vio's antimicrobial LED light technology can be used on materials like stainless steel, glass or plastic surfaces, whereas UV is known to degrade materials found in food and beverage manufacturing environments. This new class of antimicrobial lights cleans continuously, as part of a multi-layered defense system.

This new class of antimicrobial lights cleans continuously, as part of a multi-layered defense system.

A NEW FOUNDATION TO A LAYERED ANTIMICROBIAL DEFENSE SYSTEM

Food and beverage manufacturers can benefit from an enhanced layered approach to post-contamination cleaning by leveraging the continual cleaning power of Vital Vio's LED light technology. This technology is proven to be effective in defending against both the growth and the spread of microbes. Once in place, these lights work nonstop, keeping production environments at a significant reduction in microbe count. By using these lights, episodic spraying and wiping can potentially be reduced. Using less harsh chemicals and having a cleaner processing line and environment will also save time and money.

In a world where one bad headline can amount to millions of dollars in lost market capitalization, and the cost of a product recall averages \$10M, it's worth taking a look at how an investment in this new type of continuous antimicrobial light can reduce the impact of contamination; promote the company's commitment to the health and wellness of its employees and customers; and directly impact the bottom line.

7 WAYS ANTIMICROBIAL LIGHT DELIVERS A CLEANER BOTTOM LINE An ROI Guide for Food & Beverage Manufacturers

- 1 Less unexpected downtime. Reduces the need to hire expensive contamination clean-up crews on short notice. Also less financial opportunity cost of lost productivity.
- 2 Reduce strength of chemicals used for episodic cleaning and the expense of disposing of chemical waste.
- 3 Decreased potential for FDA fines or recalls (see Figure 2).
- 4 Less exposure for materials to corrosive chemicals that degrade the rubbers and plastics in production equipment. Therefore, potentially decreased demand and frequency for expensive replacement parts and labor.
- 5 Less damage from mold, and therefore, decreased need for mold remediation.
- 6 Less product loss (waste) due to microbial contamination.
- 7 Neutral or positive impact on the value of your brand integrity and ultimately, stock value by gaining a reputation as a meticulously clean manufacturer and corporation that is committed to hygiene, health and wellness.

Figure 1: **7 Ways Antimicrobial Light Technology Delivers a Cleaner Bottom Line** (Source: Vital Vio, 2020)

Vital Vio's new class of antimicrobial light provides significant benefits and payback in multiple ways:

- Increased up-time
- Greater protection for your brand's reputation and integrity
- Tangible proof of the company's investment in health and wellness for employees and customers
- Less time, money and effort spent on sanitation overall

THE IMPACT OF MICROBIAL CONTAMINATION

In 2019, the FDA issued approximately 350 recalls, market withdrawals and safety alerts. Of that number, 111 were attributed to potential or confirmed microbial contamination—data that demonstrate that the incidence of bacterial growth is the leading cause of market disruption for the food and beverage industry. Regardless of the resolution of each occurrence—whether a fine, forced or voluntary recall, quiet self-directed market withdrawal or alert—a few things are certain: production in each instance was stopped; products had to be discarded; and specialized cleaning needed to be hired quickly.

Nearly one-third (32%) of FDA recalls, market withdrawals and safety alerts for food and beverages are due to “potential for or confirmed microbial contamination.”

FDA RECALLS, MARKET WITHDRAWALS & SAFETY ALERTS (2019)

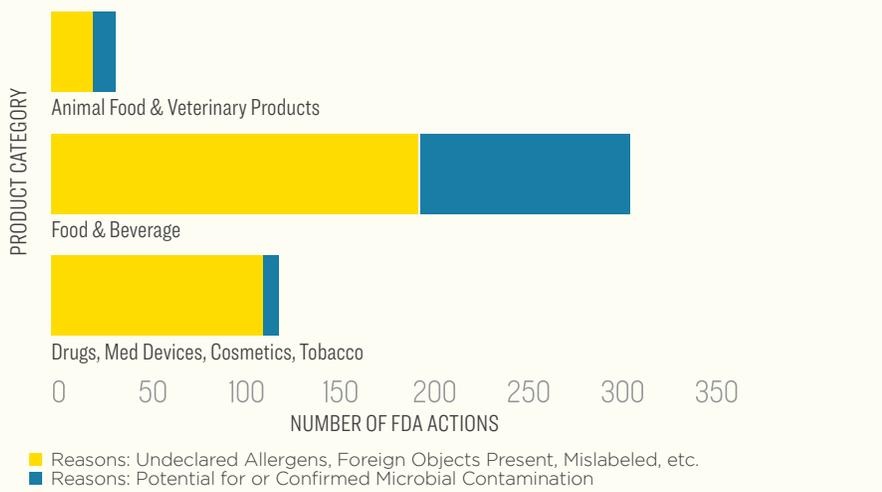


Figure 2: FDA Recalls, Market Withdrawals & Safety Alerts (Source: FDA, 2020)

APPLYING VITAL VIO'S CONTINUOUS CLEANING SOLUTION TO FOOD AND BEVERAGE PROCESSING

Vital Vio's antimicrobial LED light technology provides both illumination where and when light is needed and creates an inhospitable environment for pathogens and other microbes in manufacturing environments where bioburdens require tight control. Vital Vio works to attain the maximum dosage levels of antimicrobial action by tuning the power of these lights to specific lux levels, angles and distances from the targets. This comprehensive approach has been tested in many settings, all concluding that Vital Vio antimicrobial LED light technology is a powerful and highly sustainable way to reduce pathogens while at the same time having no negative impact on surfaces.

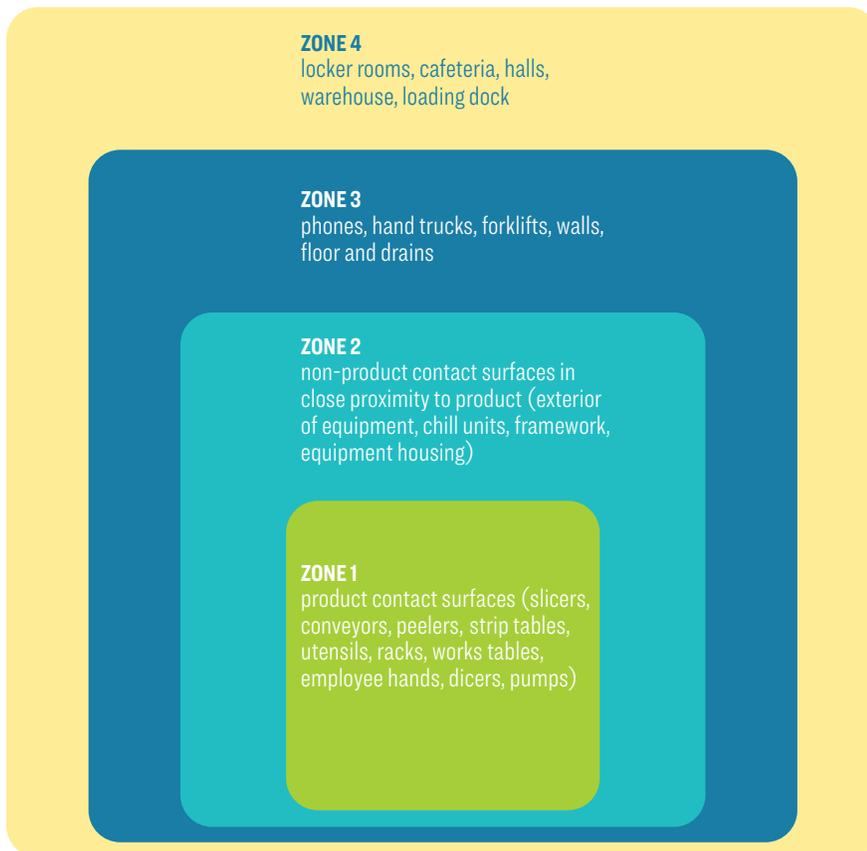
Consider a warm, humid processing environment where mold can easily grow unabated. Vital Vio's lighting technology is flexible enough to light the entire production line, as well as the hard-to-reach spaces, flipping that ideal environment for growing mold into a textbook case for the efficacy of VitalVio antimicrobial light.

ZEROING IN ON PRODUCTION ZONES

Of the three components of food production—raw ingredients, the manufacturing process itself and the processing environment—it is the processing environment that the FDA’s Food Safety Modernization Act (FSMA) looks at most closely. An environmental monitoring program is necessary for measuring the overall effectiveness of microbiological controls in food processing facilities, enabling companies to be proactive in preventing food-borne contamination.

The Environmental Monitoring Zone Concept is a framework that separates food and beverage production environments into four zones, each with specific propensities for bacterial growth. The highest risk is in Zone 1, with diminishing risk progressing to Zone 4. *Salmonella* and *Listeria* (and *E. coli* in meat processing) are the most common bacteria found in Zones 1 and 2, where there is a direct risk for contamination. Zones 3 and 4 are comprised of “infrastructure” including phones, computers, forklifts, hallways, floors, locker rooms and loading docks. The zones are interconnected by workers and machinery which create a risk of cross-contamination. All of the zones can benefit from antimicrobial lighting that is tuned and targeted to the surfaces in each one. Therefore, reducing the bioburden in any of the zones can have a positive impact on the sanitation of the entire production facility, as well as the health and wellness of employees, specifically in Zones 3 and 4.

FOOD PRODUCTION ZONES (FOR FSMA COMPLIANCE)



Source: Safe Food Alliance, 2020

Proof of the Efficacy of Vital Vio's Antimicrobial Light Technology in Relevant Environments

Case Study 1 | Office Environment Analogous to Zone 4

Vital Vio's results from an installation in an office environment are analogous to Zone 4. Results of a study conducted in a busy company break room showed that Vital Vio antimicrobial light was effective in reducing the bioburden on the surfaces in five key areas of the room: near the toaster, refrigerator, sink, water cooler and trash can. The same items and similar surfaces are found in Zone 4 of food production facilities—break rooms, locker rooms, cafeterias and hallways. Each of the five sites were swabbed once per day for 10 days at roughly the same time each day. Sites were sampled before the antimicrobial lights were installed to gather baseline values and again at 8 and 12 weeks post-installation.

The baseline (pre-install) counts were indexed as 100% of the total and the percent of bioburden remaining compared to that baseline was calculated for the two post-install time points. The addition of antibacterial light decreased the presence of bacteria in all areas:

- Average decrease of 1-log, or 90%, in surface bioburden after Vital Vio's antimicrobial technology was installed, compared to baseline
- 1.12-log decrease was reported at 12 weeks post-install
- An average of 89.8% and 92.4% decreases in surface bioburden across all sites were reported at 8 and 12 weeks post-installation respectively

After 12 weeks under Vital Vio antimicrobial lights, the average reduction in bioburden across all surfaces was **92.4%**.

Source: Vital Vio, 2020

PERCENT OF BIOBURDEN REMAINING COMPARED TO BASELINE

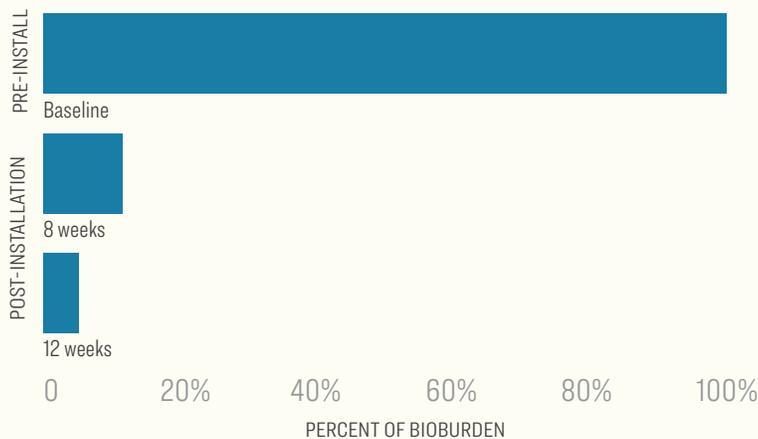


Figure 3: Results of Vital Vio antimicrobial lighting in an office environment (Source: Vital Vio, 2020)

Case Study 2 | SUNY/Stony Brook University Hospital: Nurses' Station Analogous to Zone 3

Another Vital Vio study, at New York's Stony Brook University Hospital, was conducted in and around the nurses' station adjacent to the Medical ICU, including the surrounding hallways and waiting room. The results showed reductions in bacteria on the office equipment in the station: phones, computers, mice, countertops, copy machines and keyboards. In all, twenty surfaces were tested and all showed dramatic decreases in bioburden, on average decreasing from a colony count of 55 CFU/Plate to 30. The testing took place over a 24-week period and the site was active non-stop (similar to many food production facilities). With no downtime, there was no opportunity to turn the Vital Vio lights on as "blue-violet lights" where they would be in cleaning mode only. Instead, they were constantly providing illumination as well as antimicrobial impact throughout the twenty-four weeks.

AVERAGE COLONY COUNTS BEFORE AND AFTER INSTALLATION OF VITAL VIO'S DISINFECTING TECHNOLOGY

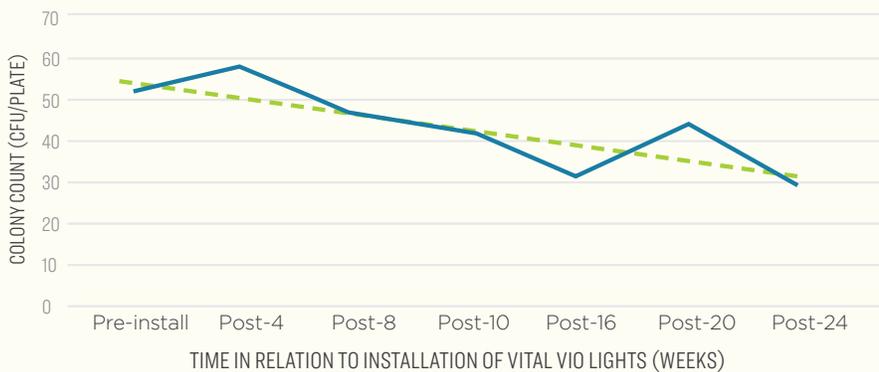


Figure 5. Average colony counts across 20 surfaces before and after the installation of Vital Vio lights. (Source: Vital Vio, 2020)

STONY BROOK UNIVERSITY

SITE #	LOCATION DESCRIPTION
1	Nursing Station 1 (NS1) Keyboard
2	NS1 Phone
3	NS1 Phone
4	NS1 Chair Arm
5	NS1 Crash Cart/Paper Disposal/COW
6	Nursing Station 2 (NS2) Keyboard
7	NS2 Phone
8	NS2 Copy Machine
9	NS2 Chair Arm
10	NS2 Crash Cart/Paper Disposal/COW
11	Nursing Station 3 (NS3) Keyboard
12	NS3 Phone
13	NS3 Mouse
14	NS3 Keyboard #3
15	NS3 Countertop
16	Core Fax Machine
17	Core Phone
18	Core Printer
19	Family Room Tabletop
20	Family Room Seat Cushion

Figure 4. Sampling sites adjacent to MICU nurses' station. (Source: Vital Vio, 2020)

Case Study 3 | HP Hood LLC: Food/Dairy Production Environment Analogous to Zones 1 and 2

A third study conducted with New England dairy HP Hood proved that Vital Vio's antimicrobial technology reduced 90-99% of each bacterial species found in the manufacturing process without harming the surrounding materials.

Vital Vio measured the presence of eleven microbial species—a wide range of dairy, spoilage, and pathogenic microbial strains in liquid conditions—and compared their growth under Vital Vio antimicrobial lighting to the same strains grown under ordinary fluorescent lights. The experiments were performed at higher lux intensities to accelerate results, but did not impact the results themselves—they were just delivered sooner.

Small samples were taken from the liquid cultures at a variety of time points and plated. Two of the species were specific to dairy processing, and therefore are not reported here. The results—across the board —of the nine remaining microbial species all showed 90% or 99% reductions in bacterial counts compared to the control cultures. The results clearly demonstrate the ability of Vital Vio's antimicrobial lighting technology to play a role in reducing the presence of pathogens and spoilage microbes that are found in food and dairy processing.

The second objective was to evaluate the degradation of manufacturing materials under Vital Vio antimicrobial lights vs normal LEDs. Materials testing consisted of exposing a variety of gaskets, tubing, wash-down hoses, bottles and finished packaged products to Vital Vio lights and comparing them to materials exposed to normal LEDs to check for material breakdown. The lights were set to at least 1000 lux (2x the more typical 500 lux) and materials were exposed for as long as seven days. At the conclusion of the testing period, the food processing materials showed no difference in quality after being exposed to the antimicrobial lights, compared to ordinary LED lights.

CONCLUSION

Vital Vio's antimicrobial lighting has been proven effective in use cases that occur in food and beverage manufacturing facilities. The technology's flexibility in its ability to cover large areas as well as tiny crevices makes it even more valuable in this environment, as the number of practical applications within each of the Production Zones are numerous. Companies that lead the way by investing in a multi-layered defense system that includes antimicrobial light will benefit from the hard and soft ROI described in this paper. Early adopters will be able to use this approach as a competitive differentiator and can portray themselves as innovators to their shareholders, employees and customers.

More about Vital Vio antimicrobial lighting at www.vitalvio.com

Antimicrobial technology was proven to eliminate 90-99% of each bacterial species found in the manufacturing process without harming the surrounding materials.