

The Role of Manual Cleaning in Biofilm Prevention and Removal

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Biofilms are a serious food safety threat because they are capable of harboring pathogens and forming on many types of surfaces found throughout food manufacturing facilities. Biofilms also protect pathogens from chemicals and environmental stresses, allowing these microorganisms to survive for longer periods of time and to spread at unpredictable rates. Because of these factors, having an effective strategy to prevent and remove biofilms requires appropriate cleaning tools and methods.

Understanding Biofilms in the Food Industry

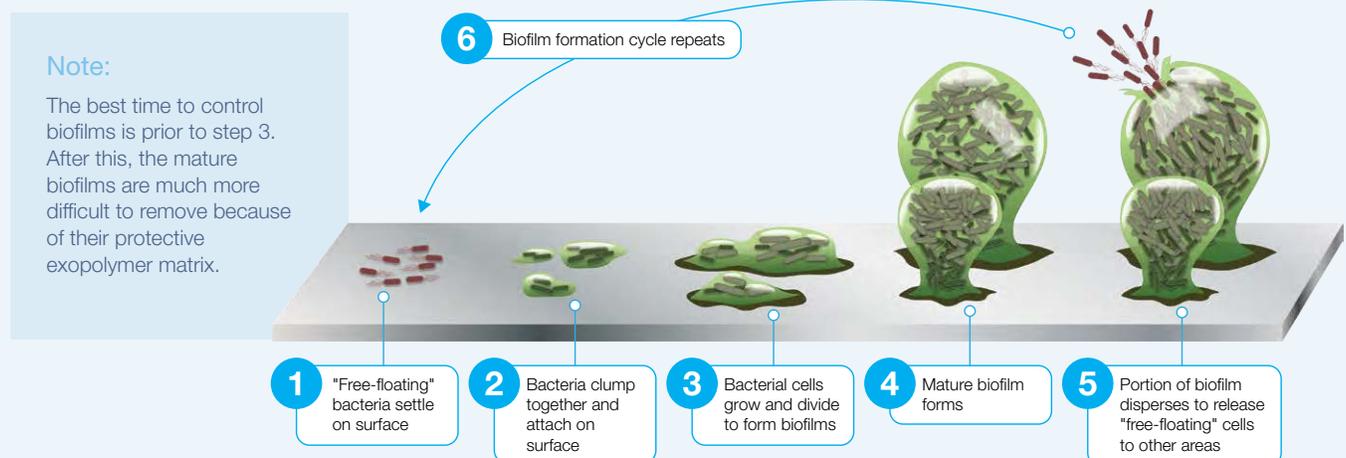
According to the CDC, each year 48 million people get sick from a foodborne illness, 128,000 are hospitalized, and about 3,000 die in the United States. *Listeria monocytogenes*, *Salmonella*, Shiga-toxin producing *E. coli*, *Campylobacter jejuni*, and *Staphylococcus aureus* are among the key causative agents behind those illnesses and deaths. The principal of these, *Listeria monocytogenes* and *Salmonella*, are responsible for over 40% of major FDA food recalls. Although the microbial composition of a biofilm will vary, dependent on the environmental conditions, the most common pathogens listed above are all known to create and thrive in biofilms.

Some biofilms are relatively simple and others more complex, but they are all composed of three basic elements – microorganisms, nutrients, and water. When these three elements are left undisturbed over time, the microorganisms secrete an extracellular polymeric substance (EPS), or “slime”, that is composed of

polysaccharides, nucleic acids, and glycoproteins. This slime coating helps protect microbes from chemicals and environmental stresses and further anchors the microbes to the surface. Microbes in a biofilm can be up to 3,000 times more resistant to disinfectants than ‘free floating’ cells and they are able to survive with limited nutrients, moisture, and oxygen, and in adverse pH conditions. The biofilm enables the microbial community to survive, colonize, and spread to contaminate other surfaces and food products via air, moisture, human contact, and other vectors.

Research on biofilms is still ongoing, and it has been found that microorganisms are able to communicate with each other to group themselves, share resources, and offer cross-protection through a molecular signaling technique called “quorum-sensing.”

These are the typical steps of biofilm formation:



Biofilm Prevention Strategies

An Integrated Sanitation Approach

Optimal biofilm control starts with prevention. As a proactive biofilm control strategy, it is necessary to consistently maintain the sanitary state of a food facility in order to ensure the production of safe and wholesome food. The following strategies can be implemented to mitigate risk in production facilities:

Regulatory and standard requirements or recommendations regarding biofilm control strategies:



Codex Food Hygiene: Basic Texts (4th ed.)

recommends proper design of facilities and equipment to prevent harborage sites from forming or cross-contamination and recontamination happening. They also recommend proper surface cleaning and sanitizing protocols.



According to the **Draft Guidance on 'Control of *Listeria monocytogenes* in RTE foods'**, selecting the right sanitizer (i.e. quaternary ammonium compounds, peroxyacetic acid, iodine, or chlorine), and routinely rotating them is critical to biofilm prevention.



FSIS Best Practices Guidance on Controlling *Listeria monocytogenes* in Retail Delicatessens (2015)

also recommends alternating sanitizers (e.g. quaternary ammonium and sodium hypochlorite solution), and clean-scrubbing surfaces to prevent biofilms formation.



According to **3A-SSI Standards**, if the food-contact components of equipment is not designed for CIP or other automated methods of cleaning, these parts should be cleaned and sanitized manually. Manual cleaning, in such cases, involves the use of tools such as brushes, scrapers, squeegees, etc., along with other sanitation aids to achieve the desired effect required to remove soils (e.g. biofilms) from a contact surface.

Risk-Based Environmental Monitoring of Facility Locations–

Facilities need to be on the lookout for hard-to-reach surfaces (food-contact or otherwise) that are generally difficult to clean, inspect, and maintain, along with the typical surfaces that also need to be cleaned regularly. The *FDA Listeria guidance for ready-to-eat (RTE) foods* can be a good reference for spotting the key locations in a food facility:

- **Contact surfaces for RTE foods:**
 - ✓ Fibrous and porous-type conveyor belts
 - ✓ Filling and packaging equipment
 - ✓ Belts, peelers, and collators
 - ✓ Containers, bins, tubs, and baskets
 - ✓ Slicers, dicers, shredders, and blenders
 - ✓ Utensils
 - ✓ Re-useable gloves
- **Surfaces that generally do not contact RTE Foods:**
 - ✓ In-floor weighing equipment
 - ✓ Cracked hoses
 - ✓ Hollow rollers for conveyances
 - ✓ Equipment framework
 - ✓ Wet, rusting, or hollow framework
 - ✓ Open bearings within equipment
 - ✓ Poorly maintained compressed air filters
 - ✓ Condensate drip pans
 - ✓ Motor housings
 - ✓ Maintenance tools like wrenches and screwdrivers
 - ✓ Forklifts, hand truck, trolleys, and racks
 - ✓ On/off switches
 - ✓ Vacuum cleaners and floor scrubbers
 - ✓ Trash cans and other such ancillary items
 - ✓ Tools for cleaning equipment
 - ✓ Spiral/blast freezers
 - ✓ Ice makers
 - ✓ Aprons
- **Plant environment:**
 - ✓ Floors, especially cracks and crevices
 - ✓ Walls
 - ✓ Drains
 - ✓ Ceiling, overhead structures, and catwalks
 - ✓ Wet insulation in walls or around pipes and cooling units
 - ✓ Rubber seals around doors, especially in coolers
 - ✓ Metal joints, especially welds and bolts
 - ✓ Contents of vacuum cleaners



With the implementation of FSMA regulations, the FDA is sampling multiple zones in plants (especially those processing ready-to-eat foods). Food-contact and non-food contact surfaces may be sampled for biofilm-producing pathogens such as *Listeria* and *Salmonella*. There is, therefore, an expectation from regulators that facilities will put appropriate sanitation preventive controls in place to manage biofilm formation.

Hygienic Zoning and the Use of Color-Coded Tools –



Vikan Hygienic Zoning Planner



Food-Contact Tools



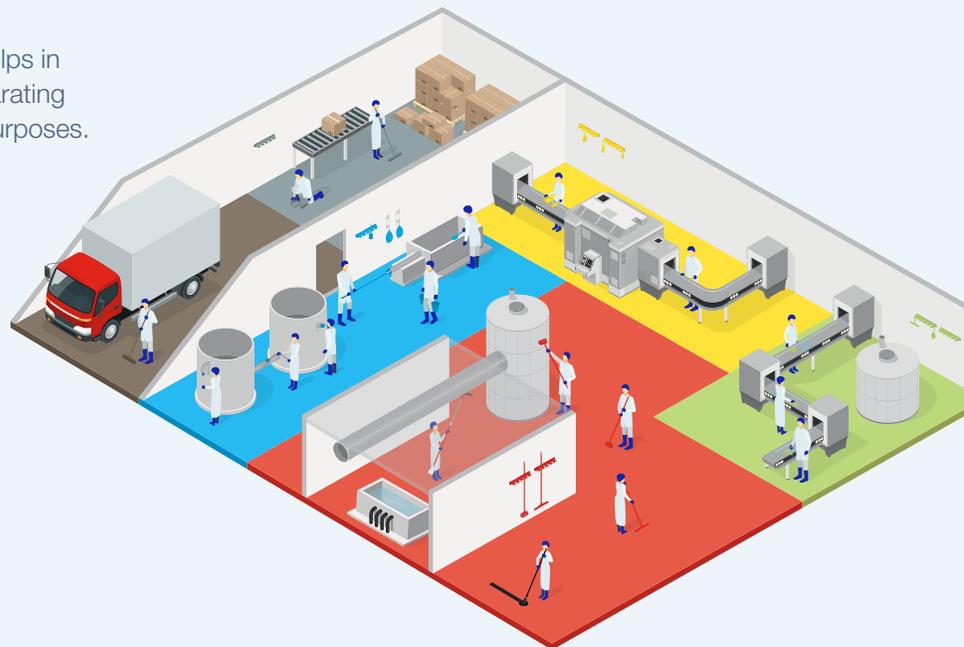
Non-Food Contact Tools

Effective hygienic zoning, as a risk-based means of separating facility areas and processes, can prevent or greatly minimize the spread of microbes that could lead to eventual biofilm formation. For example, an effective way would be by color-zoning and segregating people and equipment used in a raw meat handling area (low risk, high microbial contamination), from a ready-to-eat product handling area (high risk, low microbial contamination). Note that any uncontrolled cross-over from a low risk zone to a high risk one is a contamination threat. Additionally, all areas must go through scheduled decontamination based on the risk of biofilm formation and threat to food safety. With regard to biofilm formation, due to the high levels of microbes in low risk areas, decontamination may need to be more frequent.

Color-coding also acts as a visual cue that helps in segregating zones, process stages, and separating tools used in different zones or for different purposes.

For example, yellow pipe brushes may be used on food equipment surfaces and black brushes can be used on non-food contact surfaces like drains.

This prevents cross-contamination incidents that could pose a threat to food safety and escalate to biofilm formation.



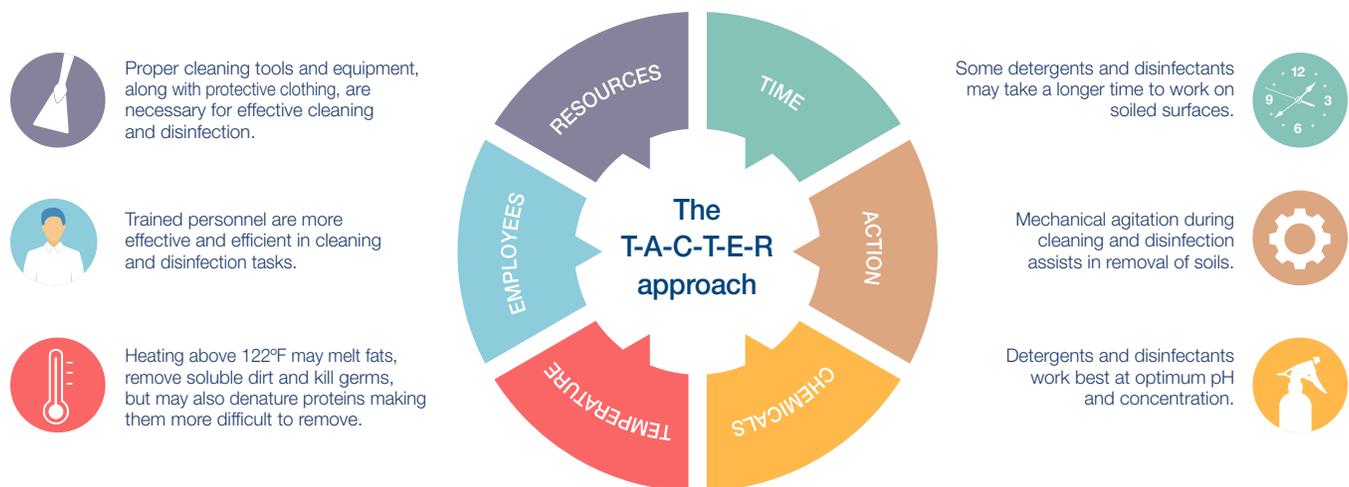
Biofilm Removal Strategies – A Six-Stage Approach with Emphasis on Manual Cleaning

According to Moorman and Jaykus (2019), manual cleaning is important because, “one just can’t sanitize one’s way out of a persistent biofilm problem within a facility. Biofilm eradication, therefore, generally requires equipment tear-down, deep-cleaning and sanitation, and a follow-up verification.”

The following six stage approach to cleaning and sanitation, with an emphasis on manual cleaning, is highly recommended:

(A) ASSESS YOUR TACTER PARAMETERS:

The TACT circle was originally developed by Dr. Herbert Sinner in 1960. The model lists the parameters needed to remove soil from a surface. Remco has added two parameters, “Employees” and “Resources,” to make it a holistic model for effective cleaning:



When biofilms build up, generally, the TACTER requirements are intensified, such as a worker needing to do intense manual scrubbing to remove the thick biofilms.

(B) DEVELOP A ROBUST CLEANING AND SANITATION PROGRAM

When considering a biofilm removal strategy, at least the soil, surface, and the conditions need to be evaluated. The Double SAVER model was developed by Remco to assist with understanding the considerations for a comprehensive cleaning and sanitation program:



1. What type of **Surface** is being decontaminated?
2. What is the nature of the **Soil** being removed or reduced to an acceptable level?
3. What is the **Aim** of the decontamination action?
4. What level of procedural decontamination **Activity** is being implemented?
5. Is the decontamination process well **Validated**?
6. Is the decontamination process adequately **Verified**?
7. How **Effective** is the decontamination process?
8. How **Efficient** is the decontamination activity?
9. Are the processes supported by valid scientific, technical, or credible **References**?
10. Are **Remedies** in place to correct or prevent anything significant that could go wrong?

(C) HAVE A RISK-BASED CLEANING SCHEDULE IN PLACE

A cleaning schedule for effective sanitation of facility areas, fixtures, equipment, utensils, and tools must be adopted. This schedule will assist in preventing biofilm formation.

WHAT TO CLEAN?	HOW TO CLEAN?	WHEN TO CLEAN?	WHO DOES THE ACTIVITY?	HOW ARE PARAMETERS CONFIRMED?	HOW TO VERIFY EFFECTIVENESS OF CLEANING
ITEM / AREA	PROCEDURE	FREQUENCY	FREQUENCY	FREQUENCY	FREQUENCY
Food Preparation Tables	Clear debris, wash and scrub with brush, rinse, and sanitize	- After production is completed - Before start of operations (sanitize only if clean)	Production Employee	- Confirm correct concentrations of detergents and sanitizers - Other resources provided	- Visual Check - ATP Test - Micro-swab
Floors at Production Zone	Sweep debris with broom and dustpan, and throw in bin	- After production is completed - Once every 2 hours on accumulation of wastes	Production Employee	- Supervisor checks floor cleanliness - Resources e.g. broom, dustpan and broom provided	Visual Check

Note: This is a test example. Program may be more detailed and ranges from site to site

(D) ENSURE THE CLEANING STEPS ARE WELL DEFINED AND UNDERSTOOD BY EMPLOYEES

1. Secure equipment, disassemble, and dry-clean to remove debris
2. Pre-rinse equipment surfaces with potable water, from top to bottom
3. Apply detergent and foam, and scrub from bottom to top
4. Post-rinse with potable water and conduct self-inspection (by operator)
5. Conduct a formal post-sanitation inspection (usually done by QC)
6. Sanitize (with approved sanitizer) and assemble the equipment
7. Dry equipment and let supervisor verify as part of pre-op inspection



(E) CREATE A MANUAL CLEANING PLAN AND SELECT THE RIGHT TOOLS FOR THE JOB

DIFFERENT TYPES OF CLEANING

HIGH-LEVEL CLEANING:

Tools with telescopic handles, such as condensation squeegees and hook brushes, help prevent biofilms on ceilings and overheads.



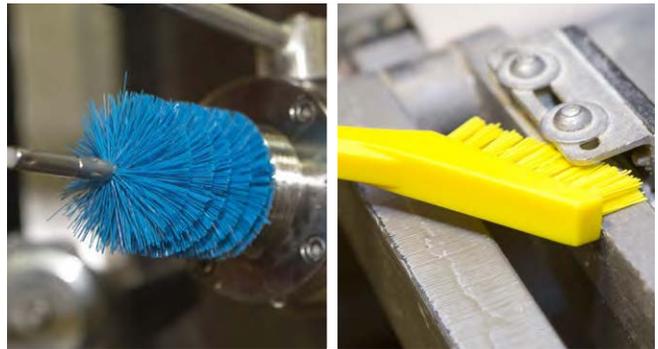
LOW-LEVEL CLEANING:

Angled brooms with long extension handles can reach relatively inaccessible surfaces like narrow junctions and corners.



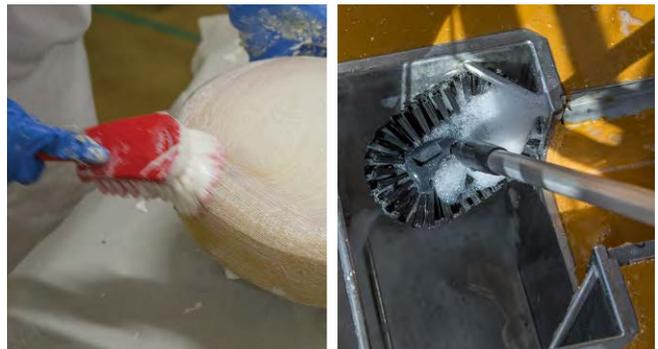
DETAILED CLEANING:

Narrow bristle blocks with ergonomic handles are used on hard-to-reach nooks and crannies of equipment surfaces.



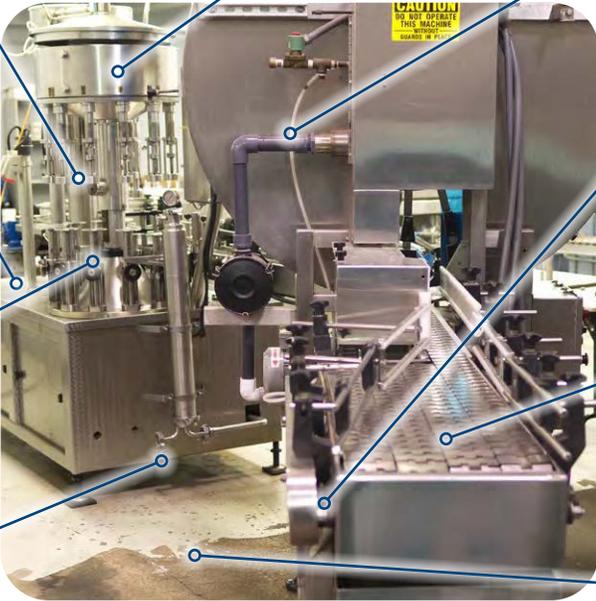
DEEP CLEANING:

Scrubbing tools, chemicals, and water can be used to remove mature biofilms.



Below is an example of a piece of equipment within a processing environment, and the tools used for cleaning the surfaces:

Filling Machine



Item number:
53763
Tube Brush
Ø0.9, Medium, Blue
●●●●●●●●

Item number:
55003/5525
Pad Holder
Blue Holder/White Pad
●●●●●

Item number:
53743/29753
Overhead Brush
Medium, Blue
●

Item number:
35873
Hand Brush
Medium, Blue
●●●●●

Item number:
44013
Detail Brush
Stiff, Blue
●●●●●●●●

Item number:
42873
Dish Brush
Medium, Blue
●●●●●●●●

Item number:
41903
Washing Brush
Medium, Blue
●●●●●●●●

Item number:
70473
High-Low Brush
Medium, Blue
●●●●●●●●●●●●

Item number:
77133/29623
Floor Squeegee
20", Double Blade, Blue
●●●●●●●●

When cleaning a piece of equipment using a set of tools, be on the lookout for nooks and crannies that might also be harder to reach, inspect, or clean, and where biofilms may develop. It definitely pays to invest in hygienically designed equipment. Equally important is the selection and use of tools such as Vikan's Ultra-Safe Technology range of brushes, Ultra-Hygiene Handles and Squeegees, hygienically designed buckets and scrapers, that are easy to decontaminate before and after use.



**Ultra-Safe
Technology (UST)
Brush Technology**

(F) FOLLOW TOOL CLEANING AND MAINTENANCE PROTOCOLS



It is important to clean and sanitize tools before and after use, as these can be potential biofilm habitats and vectors of bacterial cross-contamination. For instance, according to a UK government-funded study (Campden BRI), 47% of the cleaning equipment sampled in food production facilities tested positive for *L. monocytogenes*. Therefore, tools that are easy to clean and maintain are preferred.

It is also necessary to regularly inspect and replace damaged and worn-out tools.

Key Points:

- ✔ Prevention is the best control strategy because once biofilms mature, they can become more difficult to remove using conventional cleaning and sanitation methods.
- ✔ Mature biofilms are likely to form on surfaces that are difficult to clean, reach, inspect, or maintain. Common trouble spots are drains, the undersides of equipment, high-level pipework and ceilings, crevices, nooks, and rough welds.
- ✔ The best time to remove biofilms is before they mature and produce a thick extracellular protective layer (prior to stage 3). After this point more aggressive chemicals and mechanical action may be required for their removal, which will result in damage to the surface being cleaned and make it more vulnerable to biofilm formation in the future.
- ✔ Clean before you sanitize: Clear the surface of debris, and clean with detergent using mechanical action. Then, rinse with water before applying sanitizer. Select the appropriate chemicals and follow the supplier's instructions on concentration, application, temperature, contact time, and health and safety information. If equipment teardown is required for manual cleaning, fully submerge individual parts in water while scrubbing or scraping. This helps prevent droplets from contaminating other locations.
- ✔ During manual cleaning, select the right tools to ensure effective biofilm removal. Bristle quality and type matters: Don't use very stiff bristles as they may scratch delicate equipment surfaces and spread droplets of the biofilm and contaminate other locations. Very soft bristles may not be effective at removing biofilms. Also, use a pipe brush of the right diameter to clean hollow pipes or you risk damaging the surface or not effectively cleaning them.
- ✔ Routine cleaning and sanitizing may not be sufficient to remove all biofilms. Periodic deep cleaning, where equipment is stripped down before cleaning and sanitizing, is recommended to minimize the risk of biofilm formation.
- ✔ In line with FSMA requirements and other food safety regulations and standards, selection, care, and maintenance of cleaning equipment and tools are necessary to maintain sanitary conditions in food facilities.

How can Remco help you?

Remco provides specialized solutions and products including color-coded tools for cleaning and material handling where hygiene and safety are critical. We are Vikan's exclusive presence in the United States and Canada, giving us access to the global leader's hygienically designed products and vast wealth of knowledge. Our combined experience and focus on hygienic design make it a natural partnership and strengthens our ability to provide comprehensive solutions to food processors.

We can help you with the proper selection, storage, care, and maintenance of tools and equipment that are required to clean or effectively remove biofilms from contact surfaces and handle food safely by minimizing cross-contamination incidences, and thus preventing chances of biofilm formation within food facilities.

Our library of white papers and articles are designed to help you find the right solutions to your food safety challenges. Download our white papers and read our articles at the Remco Knowledge Center, <https://remcoproducts.com/knowledge-center/>. To learn more about developing a robust biofilm control and proactive contamination prevention strategies, please read the following:

1. *Cleaning Tool Maintenance*: <https://remcoproducts.com/cleaning-tool-maintenance/>
2. *The Hygienic Design of Food Industry Brushware*: <https://remcoproducts.com/ust-white-paper/>
3. *Selection, Care, and Maintenance Guide for Food Contact Tools and Equipment*: <https://remcoproducts.com/white-paper-selection-care-and-maintenance-guide/>
4. *Color-Coding Toolkit for Food Processing Facilities*: <https://remcoproducts.com/toolkit/>

By making information on the latest safety news, regulations, and best practices accessible via our social media and our website, we hope to provide the industry with the support it needs. If you require any technical assistance and additional information about our products and services, kindly contact us at cs@remcoproducts.com.

Selected References

- Bridier, A., Sanchez-Vizueté, P., Guilbaud, M., Piard, J. C., Naitali, M., & Briandet, R. (2015). *Biofilm-associated persistence of food-borne pathogens*. Food microbiology, 45, 167-178.
- Gibson, H., Taylor, J. H., Hall, K. E., & Holah, J. T. (1999). *Effectiveness of cleaning techniques used in the food industry in terms of the removal of bacterial biofilms*. Journal of applied microbiology, 87(1), 41-48.
- Moorman, E., & Jaykus, L. A. (2019). *Impact of Co-Culturing with Pseudomonas aeruginosa on Listeria monocytogenes Biofilm Physicochemical Properties and Sanitizer Tolerance*. In IAFP 2019 Annual Meeting. IAFP.
- U.S. Department of Agriculture, Food Safety and Inspection Service. (2015). *Best practices guidance for controlling Listeria monocytogenes (Lm) in retail delicatessens*.
- U.S. Food and Drug Administration. (2017). *Draft guidance for industry: control of Listeria monocytogenes in ready-to-eat foods*. Fed. Regist, 82, 4803-4805.
- Wang, R. (2019). *Biofilms and meat safety: a mini-review*. Journal of food protection, 82(1), 120-127.
- World Health Organization. (2009). *Codex Alimentarius: Food hygiene, basic texts.*, (Ed. 4).

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