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Evaluating and Managing Potential Risks Associated with Top-Iced Produce

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ABSTRACT

Top icing of produce is a practice used to preserve freshness and extend shelf life during transport and storage for some fresh produce items. However, there are concerns about possible food safety risks associated with this practice, especially regarding managing ice water and the potential for cross-contamination in distribution centers and warehouses. Food safety regulations such as the U.S. Food and Drug Administration's Preventive Controls for Human Food rule require distribution centers and warehouses to evaluate hazards and identify those that need a preventive control as defined in the rule. Here, we outline how to evaluate and manage risks associated with top icing. Each operation should assess potential hazards associated with the commodity, facility, and management practices to determine if they are adequately managed as Good Manufacturing Practices or require the implementation of preventive controls within a food safety plan. Facilities should assess risks of receiving, handling, and storing top-iced produce, including supplier programs, potential cross-contamination points, pallet stacking, and slotting procedures, among others. Risk-based measures can be implemented to reduce food safety concerns associated with top-iced produce. These measures include transitioning to iceless produce, maintaining cold temperatures, single stacking produce pallets, establishing dedicated wet rooms, implementing drainage systems, shrouding or adding liners under pallets, and implementing appropriate cleaning and sanitizing schedules.

OVERVIEW

Although topping some produce items with ice remains a common practice in the United States, there is limited industry advice regarding the assessment of risks associated with ice and melting water as well as options to manage melting ice water by supply chain members handling these products, including distributors and warehouses.

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Adding ice helps maintain freshness, extend shelf life, and prevent wilting and spoilage of some fresh produce items during transportation and storage *(16)*. The ice serves a dual purpose by maintaining the optimal temperature for product quality and preventing dehydration during distribution. Iced produce commodities often include broccoli, cauliflower, sweet corn, leafy greens, herbs, asparagus, and green onions. The growing and harvesting of some of these products are covered by the U.S. Food and Drug Administration (FDA) Produce Safety Rule (PSR) that includes standards for postharvest water. Others are "rarely consumed raw" and therefore not subject to the rule; however, they may be transported and stored alongside covered produce as products move through the supply chain.

The authors' personal communications with multiple retailers that self-distribute as well as independent wholesaler-distributors of fresh produce indicated that regulatory authorities, third-party auditors, and operators of distribution centers and warehouses handling top-iced produce have questions about managing potential food safety risks associated with this practice. Research has also shown that ice can serve as a vehicle for cross-contamination in fresh produce *(10)*. Specifically, concerns revolve around the management of melting ice water, given that it might come into contact with other products (i.e., stored below or adjacent) and non food-contact surfaces, such as wooden pallets or metal racks. One study *(10)* showed that ice could be a potential route for pathogen transfer to romaine lettuce via direct contact with contaminated melting ice or by melting ice water becoming contaminated due to contact with a contaminated surface. However, to the authors' knowledge, there has been no instance of a fresh produce outbreak caused by contamination from a warehouse or distribution center linked to topping produce with ice. In fact, ice is rarely cited as a contributing factor for foodborne outbreaks, with the exception of a Norovirus outbreak linked to contaminated ice cubes and a leaking air ventilation valve at a restaurant *(9)*.

All FDA-registered facilities, including distribution centers and warehouses handling fresh produce, must adhere to Good Manufacturing Practices (117 Subpart B) *(20)*. Unless exempt, registered facilities must conduct a hazard analysis and implement risk-based preventive controls if needed (117 Subpart C) *(20)*. The objective of this article is to provide recommendations to warehouses and distribution centers in evaluating and managing the potential risks associated with top-iced produce.

Regulatory landscape

Distribution centers and warehouses in the United States, including those that handle top-iced produce are subject to various federal regulations to ensure food safety. The FDA is the primary regulatory authority for produce distribution centers and warehouses. Even before the passage of the Food Safety Modernization Act, distribution centers and warehouses had to comply with Good Manufacturing Practices as registered food facilities, which included sanitation requirements (21 Code of Federal Regulations 110). Good Manufacturing Practices were updated with the issuance of the Preventive Controls for Human Food rule and include general requirements for designing, constructing, and operating food facilities, including warehouses *(20)*. Under the Preventive Controls for Human Foods rule, distribution centers and warehouses receiving, handling, and storing top-iced produce are required to perform a hazard analysis unless an exemption applies *(20)*. When evaluating if a hazard associated with top-iced produce is reasonably likely to occur and therefore necessitates the implementation of a preventive control, a company's internal data, such as environmental monitoring results, and factors outlined in this document can help inform the decision. Other regulations, such as the FDA Sanitary Transportation of Human and Animal Food rule *(23)*, may also apply. Although not regulatory, buyer-driven third-party audits may also include specific requirements for management of top-iced produce.

Although registered distribution centers and warehouses are not covered by the FDA PSR, produce they receive, handle, and store may have been grown by farms subject to the FDA PSR. The PSR requires that postharvest water directly contacting covered produce (e.g., ice used for top icing) meet the zero detectable generic *Escherichia coli* in 100-ml water standard, under 21 Code of Federal Regulations 112.44(a), and the water source and system must undergo an annual inspection *(21)*. Distribution centers and warehouses receiving iced produce from farms covered by the PSR or equivalent audit schemes may be at lower risk due to water standards for ice.

Identifying and assessing hazards

Even if the water used to form ice is of adequate microbial quality, melting ice may drip over contaminated surfaces, such as pallets and racking systems, making the melted water a vector for cross-contamination *(Fig. 1A)*. Containers, pallets, or other items that hold or transport fruits and vegetables, which are typically grown outside, may provide an entry point for organisms into facilities. Food residues from handling, packing, and repacking products may serve as a nutrient source for bacterial growth or support biofilm development *(4)*. Cases of produce often contain vents, providing a theoretical entryway for water. The example in *Fig. 1B* illustrates water accumulation in the wet room or wet aisle. Here, water is not the source of contamination; instead, the melting ice water fosters a favorable environment for the survival and growth of pathogens from the environment. Although not conducted at distribution centers and warehouses, prior studies have shown packinghouse surfaces that become wet or accumulate moisture are at greater risk of *Listeria monocytogenes* contamination *(2, 13, 15)*.

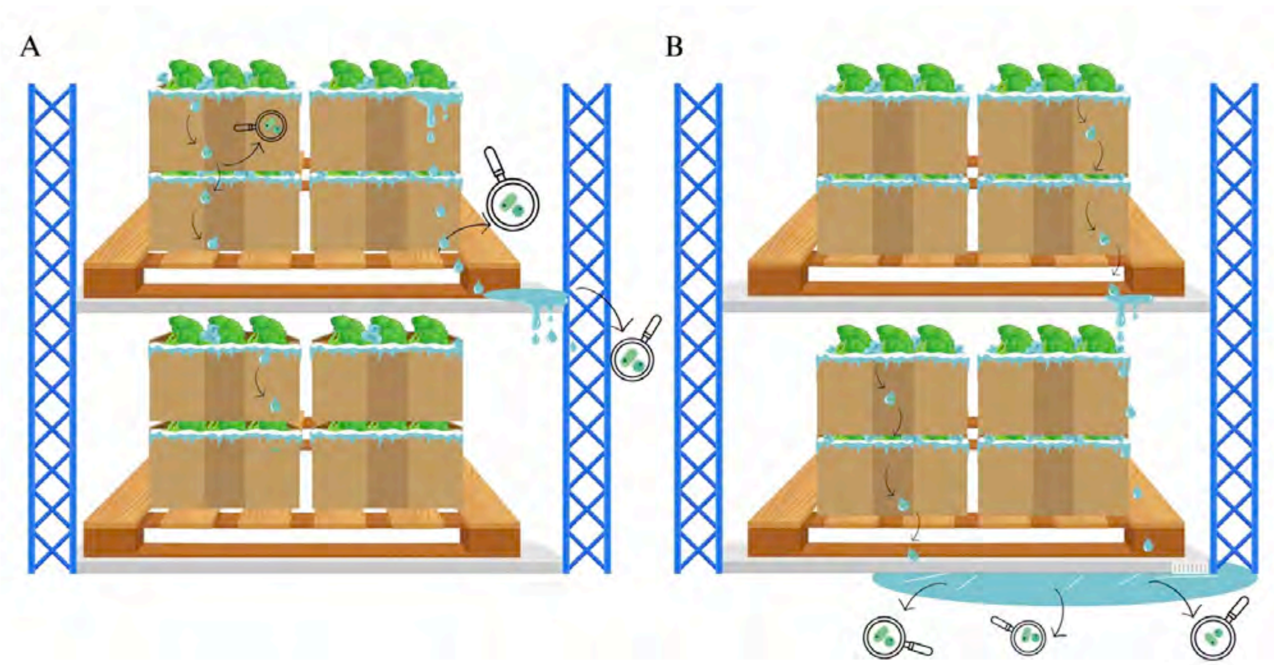

FIGURE 1. Representation of two contamination scenarios: A, melting ice and water becomes a vehicle for potential cross-contamination of a hazard. This can occur from contact with contaminated product, pallets, racks, other surfaces, or allergens (if stored in the same room). Contamination is shown as microbes in magnifying glasses. B, water accumulation in the wet room or aisle may foster a favorable environment for environmental pathogen contamination, with the potential for biofilm formation. Representation of water pooling under iced produce. Water accumulation in cold and wet environments is known to support microorganisms, and once in the environment (microbes in magnifying glasses), it may persist and move throughout the facility, potentially contaminating other exposed products.

Although several pathogens have been associated with produce outbreaks and recalls *(3, 16)*, one particular pathogen of concern for distribution centers and warehouses receiving, handling, and storing top-iced produce is *L. monocytogenes*. Several studies *(2, 5, 6, 13–15, 18, 26)* have observed *L. monocytogenes* on food and non food-contact surfaces in packinghouses, cold storages, warehouses, and distribution centers. Although not affecting produce, the *L. monocytogenes* outbreak and numerous recalls associated with Rizo Lopez cheese products highlight how environmental contamination of a facility and equipment by *L. monocytogenes* can result in long-term (over >10 years) food safety issues *(24)*, if not managed. Furthermore, produce is often stored under refrigeration to preserve quality and extend shelf life *(7, 12)*, and refrigeration also limits the melting of ice. *L. monocytogenes* can grow at refrigeration temperatures *(11, 25)*, while viruses, parasites, and many other bacterial pathogens do not grow at refrigeration temperatures. Viral and parasitic contaminations are primarily due to direct contact with humans (e.g., ill employees) *(3, 16, 17, 21)* and thus would be unlikely hazards with robust worker health and hygiene programs.

Factors to consider when assessing risks of top-iced produce

Several factors may be evaluated when assessing the risks of top-iced produce. This list is not exhaustive and is meant to stimulate discussion for food safety individuals.

1. Cross-contamination points: Identify potential areas in which cross-contamination may occur, not just with non food-contact surfaces but also within the stored produce itself.
2. Temperature, including fluctuations: Assess the ability to maintain consistently cold temperatures (without freezing) to reduce the rate of ice melting.
3. Packaging integrity: Damaged or compromised packaging can increase contamination risks by allowing water (and any contaminants it carries) to enter or exit a pallet, container, or package more easily.
4. Pallet stacking: Evaluate whether pallets are stacked and slotted correctly. Poorly stacked pallets may increase the risk of dripping. Improper pallet slotting may result in top-iced produce mixed with non-iced produce.
5. Employee training: Assess the level of training provided to employees involved in handling and storing top-iced produce and sanitation of wet rooms and aisles. Adequate training strengthens a company's food safety culture and ensures better procedure compliance.
6. Facility maintenance: Regularly inspect and maintain equipment used in storing top-iced produce, such as refrigeration units and drainage systems. Malfunctions or inadequate maintenance can contribute to safety concerns.

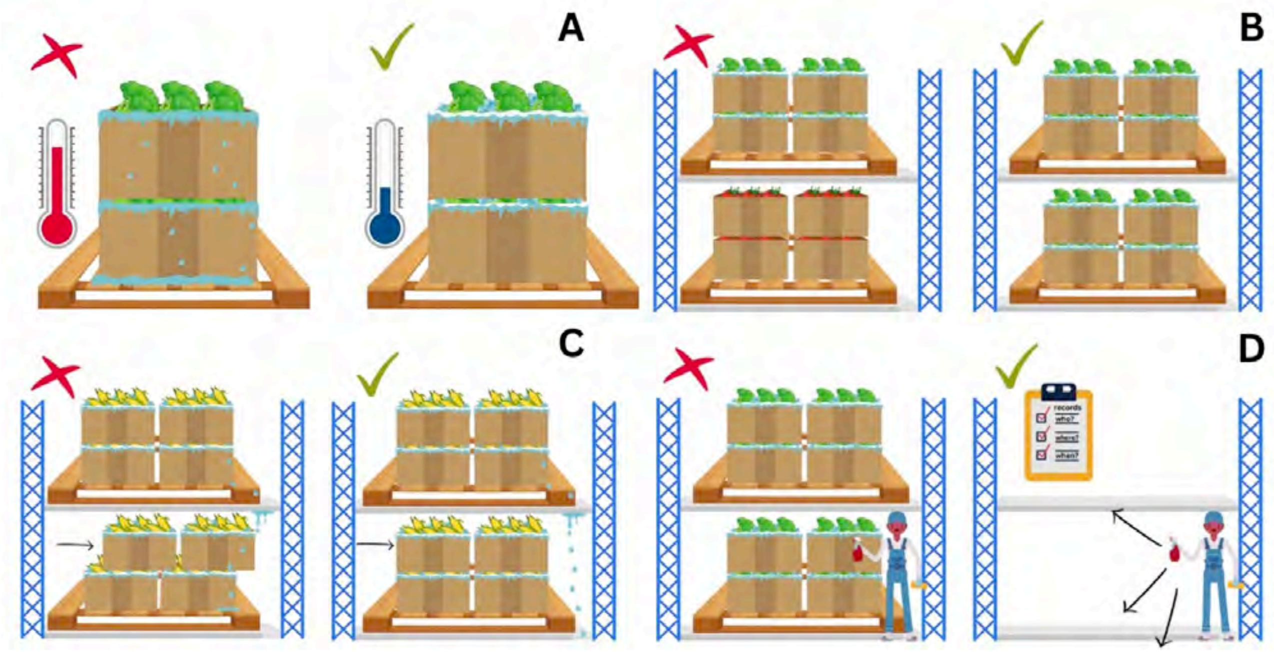

FIGURE 2. Visual representation of measures that can be applied individually or cumulatively, depending on the specifics of the operation, the potential hazards, and the assessment of risks. A, keeping it cold in wet rooms and aisles to minimize ice melting; B, dedicating areas to confine ice melting or avoiding storing top-iced produce above items that do not have ice; C, educating personnel to fix shifting, tipping, or unstable pallet loads to reduce inadvertent contamination from dripping iced products; and D, implementing sanitation schedules and clearing aisles and rooms for cleaning and sanitizing racks, walls, and floors to prevent microorganism harborage or biofilm development.

7. Supplier evaluation: Evaluate the practices of suppliers providing the top-iced produce to limit the likelihood that the product is contaminated and ensure the water used to make ice for produce contact is of adequate sanitary quality.
8. Data: Besides documenting observations, including pooling water and biofilm or slime buildup, facilities already implementing a *Listeria* environmental monitoring program in areas in which top-iced produce is stored should analyze these data for signals that could indicate the presence of the organism and should assess potential pathways that could compromise product safety.

Measures to reduce risks of top-iced produce

Protective measures can be applied individually or cumulatively, depending on the specifics of the operation, the potential hazards identified, and the assessment of risk. In some facilities, the factors previously mentioned may be well managed through prerequisite programs, aspects of which are listed in the following, and the facility may conclude that no hazards require a preventive control because the risk is low. In other situations, based on the risk identified in the hazard evaluation, a process preventive control or a sanitation preventive control could be implemented (e.g., to address *Listeria*). There are several ways that a facility can manage issues associated with top-iced produce, including but not limited to the following list.

1. Reduce or eliminate the use of ice in produce: Consider moving toward suppliers who use an alternative cooling approach, such as hydrocooling, forced air cooling, or vacuum cooling of produce to eliminate the need for ice. If ice is necessary, determine how much ice is necessary to maintain the desired quality. Using as little ice as necessary will minimize the amount of melted ice water *(8)*.
2. Keep facilities cold: Aim to keep wet rooms and aisles as cold as possible to minimize ice melting *(Fig. 2A)*. Warmer wet room or aisle temperatures will cause more ice to melt. Manage the flow of people and product into wet rooms or aisles to avoid unnecessary rises in temperature (e.g., exposure to warmer air when moving product from loading docks).
3. Single-stacked iced produce pallets: If possible, pallets should be placed directly on the floor, side by side, without stacking them on top of each other to prevent melted ice water from coming into contact with adjacent items *(10)*.
4. Segregate iced produce: Create dedicated areas within the distribution center or warehouse storage area to confine the melting process of iced produce. Do not store top-iced produce above items that do not have ice *(Fig. 2B)*.

5. Take care when moving iced produce pallets to prevent shifting boxes: Forklift drivers and other personnel should be instructed to fix shifting, tipping, or unstable pallet loads, as this may allow inadvertent contamination from dripping iced products *(Fig. 2C)*.
6. Implement drainage systems: Install effective drainage systems to channel melting ice water away from stored items and direct it to drains. Prior research has identified drains as a potential source or collection point for harmful microorganisms *(5, 14, 15)*. Sanitary or easy-to-clean drains are preferred. The drain should be in an easy-to-reach location for sanitation.
7. Shroud pallets or add liners between pallets for protection: Use pallet covers or shrouds (e.g., banana bags, plastic sheeting, plastic curtains) to shield top-iced produce from dripping ice water. If permanent barriers are erected (e.g., plastic, metal, or vinyl sheets that separate upper and lower pallets), ensure they are sloped to facilitate drainage to an appropriate location and cleaned and sanitized frequently so that they do not become a source of contamination.
8. Adhere to a robust cleaning and sanitizing schedule: Enforce a strict sanitation schedule to maintain hygiene standards within the storage environment *(19, 22)*. Clear rooms for complete sanitation of racks, walls, and floors, among other things *(Fig. 2D)*. When top-iced produce is present, consider sanitizer treatments (e.g., quaternary ammonium chloride based) on floors between racks.
9. Risk-based slotting or intended purpose: Categorize incoming top-iced produce based on risk or intended purpose, such as separating ready-to-eat items (e.g., cilantro, broccoli) from rarely consumed raw products (e.g., sweet corn). The FDA PSR also separates rarely consumed raw products and covered produce in the rule requirements *(21)*.
10. Remove excess or pooling water: Water accumulation can support the survival and growth of microorganisms. Consider adequate drainage systems, facility layouts (e.g., hygienic design), and employee training to support water removal *(14, 18, 19)*.
11. Environmental monitoring programs: Implement periodic microbial testing of non food-contact surfaces in wet rooms and aisles, where iced produce is stored to detect and address any potential microbial contamination. This proactive approach can help detect potential contamination of non food-contact surfaces before product contamination occurs *(1, 19, 22)*. This information should be used to adjust and optimize other mitigations, such as sanitation frequency and removing pooled water.
12. Prepare for crisis: Develop contingency plans and procedures for emergencies, such as power outages or equipment failures, which may disrupt temperature control. A robust emergency response plan ensures swift actions to protect ice from melting.

CONCLUSIONS

Overall, it is important to have knowledge and history of the hazards in your operation to evaluate them. For example, this could include reviewing the facility's environmental monitoring program, gathering information on commodities (such as historical evidence of outbreaks and recalls), and assessing management practices (sanitation regimens). The consensus from prior *Listeria* prevalence studies in different produce environments has emphasized sanitation programs to mitigate harborage and reduce the likelihood of resident *L. monocytogenes (2, 5, 13–15, 18)*. For some products, the hazard may be controlled later in the supply chain, for example, through cooking. Thus, distribution centers and warehouses must conduct a proper hazard analysis and, if necessary, implement risk-based preventive controls to ensure the safety of top-iced produce supplied by growers, packers, or shippers. By evaluating the factors and considering the suggested protective measures individually or cumulatively, facilities can effectively mitigate potential risks of top-iced produce and also continue to uphold regulatory requirements and third-party audit food safety standards.

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