

Horticulture

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Production and Handling of Fruits and Vegetables

It is important to maintain good sanitation throughout production and handling of fruits and vegetables. Growers and their employees must understand just how critical any food poisoning outbreak could be to their livelihoods. Pathogens can be transmitted by direct contact (infected employees or animals) or through contaminated water or soil. Once a fruit is infected, pathogens are difficult or impossible to remove. Only thorough cooking (or other similar treatment, such as pasteurization) will reliably neutralize pathogens. Fruits and vegetables that are field-packed without washing have a higher likelihood of reaching consumers with field contamination.

Preharvest Guidelines

Irrigation water

Application method affects water quality requirements. The more the water contacts the commodity directly, the cleaner the water must be.

- If overhead or furrow irrigation is used, water ideally should be tested for the presence of coliform bacteria.
- In a drip irrigation system, emitters under plastic mulch are not likely to transmit pathogens to fruit, so water sanitation is not as critical.
- Pumps and irrigation stations must be free of contaminants, such as scum buildup, animals, human/animal waste products, etc. If a pump is contaminated, all the water going through the pump and anything that the pumped water contacts can become contaminated.
- The longer the drying period between harvest and the last irrigation, the less likely any contaminating pathogens will survive.

Frost protection

Management of frost protection water is similar to that of irrigation. Ideally, water should be of drinking water quality (potable) if it makes direct contact with the edible portion of the fruit or vegetable.

Pesticide mixing

Since pesticide water does come into direct contact with fruit, this water should be from a potable source.

- Give preference to groundwater sources: they have a lesser chance of being contaminated by direct or indirect contact with humans or animals.
- Surface water quality may change from day to day and is subject to animal contamination.
- Municipal water is, of course, potable.

Animal exclusion

Most human pathogens are carried by other animals (fowl; reptiles; amphibians; mammals, such as dogs, cats, deer, raccoons, etc.). Exclude as many animals as possible from the fields.

- This is a recurring theme, from the field and irrigation, to harvest, to shipping and storage: *Animals can bring contaminants into contact with fruits and vegetables at any stage, from farm to fork.* Any animal materials (waste, carcasses, etc.) should be removed immediately from the field if possible (and practical).
- Carcasses should be incinerated or buried.
- Fruit near these areas should not be harvested. Workers who touch live animals, animal carcasses, or animal waste materials should wash their hands before they continue working.

- This includes any fruit or vegetable that may have been the bulls-eye of a recent bird fly-by. If a worker touches this fruit, the contaminated material can get on his/her hands and be spread to any other fruit or vegetable he/she touches.

Human hygiene

If pickers are in the field for more than 3 hours, OSHA requires that there be 1 portable toilet per 20 employees.

- These must be moved with the crews and be kept within ¼ mile of them at all times.
- They must never be emptied in the field or near surface water sources.
- Appropriate hand-washing facilities must be provided with portable toilets.

Soil contaminants

Animal manure applied as fertilizer must be composted unless it is incorporated into the soil not fewer than 90 days before harvest for crops that are not in contact with the soil. Fully composted manure should be handled in such a way that contact between the material and the edible portion of the crop is avoided.

- "Fully composted" means organic matter has been maintained between 131°F and 170°F for 3 days, using an in-vessel or static aerated pile system, or for 15 days, using a windrow composting system, during which period the materials must be turned a minimum of 5 times (National Organic Program Final Rule Sec. 205.203)

Biosolids (human waste) are strictly regulated (Code of Federal Regulations, Title 40 Part 503).

- They are best avoided outright.
- They may NOT be used in organic operations.

Be aware of land use near the fields. Avoid establishing berry fields near animal operations or waste-handling facilities.

Manure should never have an opportunity to come into contact with the fruit or vegetable. Fruit that falls to the ground, called "drops" or "windfalls," should only be harvested if the finished product receives a heat-kill step such as pasteurization.

Drops should never be harvested for fresh market.

Harvest and Packing

Pesticides

Pesticide labels are prepared for the safety of product, workers, and environment. It is critical that they be followed.

- Apply only those treatments *specifically* labeled for the crop.
- Apply pesticides only when and as directed by the label.
- Do NOT harvest until the label-designated time.
- Always remember: ***"The Label Is the Law!"***

Animal exclusion

Animals can easily transmit pathogens. *Minimizing animal contact in fields and packing facilities reduces the risk of contamination.*

- Keep domesticated animals out of the field at harvest.
- Keep children out of the field during harvest.
- Practice animal and insect control in and around harvesting equipment storage areas.

Culling

Evidence suggests that human pathogens proliferate more readily in injured and decaying produce. This makes it important that fruits showing bruises or decay symptoms be culled as a preventive measure.

Ideally, harvest workers should not handle culls in the field. This can spread infection from contaminated to healthy vegetables via the worker's hands. Culls should be removed by a separate worker, if possible, so as not to contaminate sound produce.

Container cleanliness

Containers used in the field, in packing houses, and for shipment should all be kept clean until used. If any of the containers are reusable, they should be cleaned regularly with frequent washings. Any disposable containers should be kept clean until use and discarded if they become soiled before use.

- Stored containers can easily become contaminated by rodents, insects, and other animal life. Check stored units for contamination and either replace or clean any that become soiled.
- Store empty containers separately from:
 - Those already filled with vegetables.

- Any potential chemical contaminants.
- Any other nonsanitary conditions (near waste receptacles, animal-infested areas, etc.).

Harvest containers should not be allowed to touch the ground in the field (or in storage), as this may transfer pathogens from the soil to the produce.

Any commodity that grows on or in proximity to the ground should have extra care taken to control soil contaminants, particularly at harvest time.

Packinghouse cleanliness

Practice animal and insect control in and around packing facilities.

Cleaning and sanitation of packingline equipment are critical. Just one source of pathogen introduction at any point can potentially inoculate all vegetables passing through the line.

- Clean with detergent and physical labor (such as scrubbing or pressure-washing, etc.).
- Use sanitizers of various types to kill microbes on clean surfaces. *Sanitation is most effective after a surface has been cleaned.*
- Here are key cleaning points to remember:
 - Remove debris accumulation from all surfaces.
 - Clean all surfaces that produce or employees may contact, including bench/table tops, drains, walls, cooler coils, ceilings, etc., as appropriate.
 - Use a top-to-bottom cleaning method to avoid re-soiling already cleaned surfaces.
 - Fumigate closed-in spaces for sanitation.
 - Never put fruit that has fallen from the line back into circulation.
 - Have waste receptacles available for employee use, and regularly empty and clean them.
 - Properly store all equipment after work ends.
 - Clean regularly.

Personnel Cleanliness

Exclusion of ill workers

It is important to recognize symptoms of illness to keep sick workers away from the commodity. Some symptoms may include fever, diarrhea, vomiting, sore throat, or jaundice (yellow skin and eyes).

Employees who display symptoms of illness should either have appropriate measures put in place to protect the fruit from exposure (gloves, a mask to prevent sneeze contamination, etc.) or, if this is not feasible, be disallowed from coming in contact with fruit or any equipment that will contact the crop.

- Workers who have recently had enteric (intestinal) disease should, if allowed to work at all, be utilized in a non-produce handling capacity.
- Sending sick employees home is, unfortunately, usually the best method of dealing with this.

Disease transmission and cross contamination

Probably the #1 source of foodborne illness is unsanitary worker conditions.

Most of the diseases transmitted via fresh produce occur as part of the "fecal-oral pathway." This is the movement of human pathogens from an infected individual's waste to material ingested by a healthy person. Most commonly, this occurs when the infected individual handles food without properly washing his/her hands.

Employee hygiene, including hand washing and proper facility use, is an important step in breaking the infection cycle.

Open wounds also may contain pathogens. Use of a sealed covering (rubber or latex gloves; just a bandage is not sufficient) is the only way to contain them. The best method of reducing contamination from open sores or wounds is by removing affected employee(s) from situations where they may contact produce, directly or indirectly.

Restrooms in packing houses must have appropriate hand-washing facilities:

- A place to remove aprons, smocks, and gloves and hang them outside the restroom.
- Hand-washing stations located outside restrooms. This can aid supervisors in ensuring employee hygiene.
- A fresh-water source (*not re-circulated water*).
- Soap.
- A non-reusable hand-drying system (disposable towels, air dryer, etc.).
- Possibly a sanitizing solution for use *in conjunction with, but not to replace*, proper hand washing

Employees can maintain good hygiene only if the proper facilities are available to them.

Storage and Transport

Cooling

Human pathogens tend to grow slowly or not at all below about 45°F. This is, therefore, the normal target for cooling systems. However, depending on the cultivar, growing region, maturity, treatments (such as temperature conditioning), etc., storage below 45°F may not be possible because of the potential for chilling injury. In such cases, fruits should be stored at the lowest safe temperature.

Cooler system coil maintenance and sanitation are also important (any pathogens growing in the air handlers of a forced-air cooler can be blown into the stored commodity, possibly infecting the entire store of products).

Storage room and vehicle cleanliness

Be sure storage rooms and truck trailers are clean. If a trailer previously hauled raw meat, there is great potential for contamination. Clean trailers if there are traces of odors or visible signs of foreign matter.

Reefer maintenance

Proper reefer (a refrigerated vehicle) maintenance should be done and details recorded to avoid possible mishaps due to inappropriate shipping temperatures. Occasional use of a data logger to track temperature and cooler functionality/accuracy during transit is also desirable.

"The Cold Chain"

To maintain "the cold chain" (the total refrigerated atmosphere), produce should never leave refrigeration, including loading/unloading docks. Once produce has been cooled to storage temperature, it must remain at that temperature to maintain an environment in which bacterial growth will be minimized. If, at any point in shipping or storage, fruits are removed from a cold environment and warmed to a level where microbial growth may begin, pathogenic cells may begin to multiply and will not be eliminated by a return to a cold environment.

Use the same good agricultural practices and sanitary guidelines in packinghouse operations as were used in field operations in terms of employee handling, loading, and unloading for product safety. This is particularly important if handlers directly contact fruit (culling, re-packing, etc.).

Unpacking and Display

Product quality

Even at the consumer level, the cold chain must be maintained. Removal of bruised and decaying produce while setting up and rotating displays reduces chances for human pathogen proliferation as well. Use sanitation procedures in the back room and display area as outlined previously to avoid cross contamination between different foods or contamination by workers.

Limit consumer handling

Consumer packs may be preferable to bulk displays because they avoid possible contamination of produce by consumers while selecting produce.

Record Keeping

Keeping records is important. It will help document adherence to good agricultural practices and identify potential problem areas.

- Keeping records helps allocate legal responsibilities in a trace-back situation.
- Keep track of microbial test results, reefer and storage room temperature levels, any and all cleaning and maintenance activities, etc.
- History has shown that, in a trace-back situation following an outbreak, responsibility is often pinned on those with the least- (or worst-) kept records.
- Self-check lists are available from several commercial auditing companies to aid in record keeping.

References:

- Good Agricultural Practices for the Production and Handling of Strawberry, Raspberry, Blackberry and Blueberry—USDA-CSREES National Integrated Food Safety Initiative Project Number 00-51110-9722
- Southern Regional Fresh Produce Food Safety Training Program