



Good Agricultural Practices for the **Production and Handling** of Citrus Fruit

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Introduction

Maintaining good sanitation throughout production and handling of citrus fruit is important. It is vital that growers and, in turn, their employees understand just how critical any food poisoning outbreak could be to their livelihoods. Pathogens harmful to humans 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 by any means other than cooking or other similar treatment, such as pasteurization. However, such a treatment is not possible for fresh produce.

Good sanitation also reduces infection by plant pathogens and reduces decay during shipping and storage. This document focuses on how to best reduce contamination.

Preharvest

Irrigation water

Application method affects water quality requirements. Irrigation water usually does not contact fresh citrus and is not generally a major concern.

- ▶ In the rare case that overhead irrigation is used, water should be tested to make sure it is free of coliform bacteria since it will contact the fruit.
- ▶ For microjet, flood, or seepage irrigation systems, water is less likely to contact fruit, especially on skirted trees.
- ▶ Pumps and irrigation stations must be kept 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 the pumped water is sprayed on can become contaminated.
- ▶ Allow a drying period before harvest. The longer the period, the less likely any contaminating pathogens will survive.

Frost protection

Management of within- or above-canopy frost protection water is similar to that of irrigation if water makes direct fruit contact. Ideally, water should be of drinking water quality (potable) if it comes in contact with fruit.

Pesticide mixing

Since pesticide water does come into direct contact with fruit, this water should be from a potable source. Fresh produce has been contaminated by tainted water mixed with pesticides.

In any case where water quality is a concern, numerous factors can affect the microbial load. However, contamination potential can be minimized by following a few general rules:

- ▶ Give preference to groundwater sources. Compared to surface water, they have a lesser chance of becoming 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 by definition potable water.

Animal exclusion

Most human pathogens are carried by other animals (fowl; reptiles; amphibians; mammals, such as dogs, cats, deer, raccoons, etc.). Exclusion of as many animals as possible from the field and picking operations will decrease the likelihood of contamination.

- ▶ This is a recurring theme, from the field and irrigation, to harvest, to shipping and storage: *Animals can bring contaminants into contact with fruit 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 come in contact with live animals, animal carcasses, or animal waste materials should wash their hands before they continue working.

- ▶ This includes fruit 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 other fruit.

Human hygiene

If pickers are in the grove 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 grove 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 (such as citrus fruit) 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 grove. Avoid establishing citrus groves near animal operations or waste-handling facilities.

Manure should never have an opportunity to come into contact with fruit. 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

Pesticides

Pesticide labels are for prepared safety of product, workers, and environment. It is critical that they be followed. Remember these points not only when applying any pesticide, but especially regarding harvest and re-entry:

- ▶ Apply only those treatments *specifically* labeled for the commodity.
- ▶ 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 grove at harvest.
- ▶ Keep children out of the grove during harvest.
- ▶ Practice animal and insect control in and around harvesting equipment storage areas.

Bag, bin, and tub cleanliness

Wash containers and harvest bags before each use and store them so that they remain clean to reduce the chance of contamination.

- ▶ Contact with dirt (e.g., sand) in the container can cause microscopic wounds in the fruit where microorganisms can enter.
- ▶ Stored containers can easily become contaminated by rodents, insects, and other animal life. Regularly inspect containers for cleanliness, and avoid contact with the ground whenever possible.
- ▶ Store empty containers separately from:
 - Those already filled with fruit.
 - Any potential chemical contaminants (e.g., chemical storage areas).
 - Any other sites of potential contamination (near waste receptacles, animal-infested areas, etc.).

Soil on the rungs of harvest ladders may transfer pathogens. Avoiding hand contact with rungs helps limit opportunities for soil and soilborne microorganisms to transfer to fruit. Painting rungs red and informing crews to not touch red portions of the ladder can be one answer.

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

- ▶ Workers who have recently had enteric (intestinal) disease should, if allowed to work at all, be utilized in a non-fruit handling capacity.
- ▶ Sending sick employees home is, unfortunately, 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 come in contact with fruit, directly or indirectly.

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

- ▶ A place workers may remove aprons, smocks, and/or gloves and store 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.).
- ▶ 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.

Postharvest

Packinghouse and degreening room

The environment in a degreening room (warm temperature and high humidity) is ideal for the proliferation of microorganisms. Because of this, degreening rooms should be cleaned with each season, or more frequently if they become overly soiled. Points of water accumulation should be avoided. Do not store fruit under water dripping from a ceiling, for instance.

As in preharvest and harvest procedures, practice animal and insect control in and around packing facilities.



Cleaning and sanitation of packingline equipment is critical. Just one source of pathogen introduction, at any point, can potentially inoculate all fruits that pass through the line.

- ▶ Physically remove debris, biofilm buildup, and any other residuals from the line. Use 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.* This is true of packing lines, hands, bins, and anything else that may become soiled.
- ▶ Here are some key cleaning points to remember:
 - Remove debris accumulation from all surfaces.
 - Clean all surfaces that fruit or employees may contact, including bench/table tops, drains, walls, cooler coils, ceilings, etc.
 - 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, and empty and clean them regularly.
 - Properly store equipment after work ends.
 - Clean regularly.

Dump/soak tanks

If using a fungicide truck drench, bin drench, or dump-tank system, sanitizers (e.g., chlorine) or sanitation steps (e.g., heating) used to reduce fruit pathogens may help control human pathogens as well.

- ▶ Drain and clean dump tanks daily.
- ▶ Rinse out any cleaning solutions before re-filling the tank (residuals from quaternary ammonium solutions may produce toxic fumes when touched by chlorinated water). Such cleaning solutions are often not registered for direct fruit contact and may injure the peel.
- ▶ Follow the label on all chemical products.
- ▶ Fruit should not be allowed to sit in a dump tank for extended periods, such as during employee breaks.

Culling

Evidence from other fruits suggests that human pathogens proliferate more readily in injured and decaying fruit. Removing injured or decaying fruit as soon as possible will help reduce the potential for cross-contamination. Keep packed fruit separate.

Temperature

Human pathogens tend to grow slowly or not at all below about 45°F. This is, therefore, the normal target for cooling systems. However, storage below 45°F may not be possible because of the potential for chilling injury. In such cases, citrus fruit should be stored at the lowest safe temperature.

Cooler-system coil maintenance and sanitation are also important, as any pathogens growing in

the air handlers can be blown onto the stored commodity and contaminate it.

Vehicles

Be sure truck trailers are clean. If a trailer previously was used to haul raw meat, there is great potential for contamination. Trailers should be cleaned if there are traces of odors or visible signs of foreign matter.

Reefer maintenance

Reefer (a refrigerated vehicle) maintenance should be completed and details recorded to avoid mishaps from inappropriate shipping temperatures. Use of a data logger to track temperature and cooler functionality/accuracy during transit is also desirable. Reefer coils and air-handling ducts should be cleaned and sanitized on a regular basis.

“The Cold Chain”

After being pre-cooled, fruit should never leave “the cold chain,” an appropriately refrigerated atmosphere, even during handling at loading/unloading docks. This maintains the cold chain and helps to insure overall quality by keeping fruit in an environment that will minimize pathogen growth.

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 have any direct contact with the fruit.

Unpacking and Display

Product quality

Even at the consumer level, the cold chain must be maintained. Removal of bruised and decaying fruit 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 fruit by consumers while selecting produce.

Record-Keeping

Keeping records is important. It will help show adherence to good agricultural practices and identify.

- ▶ Keeping records helps assign legal responsibilities in a trace-back situation.
- ▶ Keep track of microbial test results, reefer and storage room temperature test levels, and cleaning activities.
- ▶ 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.

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