



Employee hygiene

Good employee hygiene is very important. Employee training, health screening, and constant monitoring of packinghouse sanitation practices (hand washing, personal hygiene) are important in reducing contamination by employees.

Packinghouse equipment

Packinghouse equipment should always be maintained in clean condition. The remnants of product left on belts, tables, lines, and conveyors could provide a source for microbial growth; therefore, cleaning by scrubbing to remove particles should be part of the cleaning procedure.

Sanitizing by spot-spraying with a chlorine solution should be carried out, especially on belt conveyors and equipment. Knives, saws, blades, boots, gloves, smocks, and aprons should be cleaned or replaced as needed.

Pest control

A pest control program should be in place to reduce, as much as possible, the risk of contamination by rodents or other animals.

Facility sanitation

Packinghouse facilities have the potential for developing microbial growth on walls, tunnels, ceilings, floors, doors, and drains. Scheduled

washdown and/or sanitizing of the facility will reduce the potential for microbial growth. The cooling system should be monitored and cleaned daily or as necessary, depending on the type of system.

Temperature control

Maintaining proper holdingroom temperature could promote product quality and reduce microbial growth. Temperature should be monitored in order to ensure established product temperature parameters.

Shipping

Vehicles

Trucks must be inspected for sanitary condition and optimum transit temperature before being loaded with produce. Check for visible cleanliness, odors, dirt, and/or other debris prior to loading. Any truck showing these conditions should be rejected. Check for pest infestation, physical condition and the presence of a properly aligned air chute before loading. Make sure a Ryan temperature recorder is present to monitor cold temperature during transit. Never load produce into a warm truck.



Good Agricultural Practices for the Production and Handling of Cabbage and Leafy Greens

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Introduction

Many leafy greens (including cabbage, collards, kale, mustard, and turnips) are cut by hand and packed directly in the field for the fresh market. Cabbage also may be cut by hand, loaded into a bulk container, such as a field wagon, and hauled to a packing shed for trimming, grading and packaging.

Field sanitation practices are very important to reduce the spread of disease among plants and to prevent the possibility of contamination by microorganisms that are pathogenic (cause illness) to humans.

Preharvest

Raw product safety

The principal food safety hazard from leafy greens is microbial contamination. Ensuring the safety of raw leafy greens begins with preventing hazards in the field. The best guarantee of a safe raw product is a proactive food safety program that has been designed and implemented to identify and prevent hazards during production and postharvest handling. Growers/shippers should familiarize themselves with safe production practices so they might be viewed as qualified suppliers among potential buyers.

Land-use history

Grazing animals on or near crop land can introduce bacteria harmful to humans into the soil. Growers should ensure that land has not been used for animal husbandry and that it is not close to animal feedlots or water runoff from grazing lands. Past improper use of pesticides can result in hazardous residues on raw product. If there is any doubt about the suitability of the soil, residual levels of pesticides and heavy metals should be determined before planting.

Fertilizer use

Incompletely composted organic fertilizers may contain bacteria harmful to humans from animal or human feces. If organic fertilizers are used, they must be properly and completely composted so pathogens are not

present. Inorganic fertilizers originate from nontoxic, synthetic chemicals, so the presence of pathogens is not an issue. Composted sewage sludge should not be used, as it may contain pathogens as well as heavy metal contamination.

Irrigation

Natural surface water (e.g., canal, lake, pond) provides enough organic matter to support the growth of bacterial pathogens. It may be used with caution for irrigation but should be tested for the presence of the bacterium *Escherichia coli* (*E. coli*), which is an indicator of fecal contamination. Groundwater is less likely to harbor human pathogens but should be analyzed for heavy metal and pesticide contamination.

Overhead irrigation is more likely to spread contamination to above-ground plant parts than is root-zone irrigation. Growers should document how water is stored, if animals are confined nearby, and if water is potable (safe to drink).

Pesticide usage

Growers must be able to answer the following questions: Do you oversee your pesticide-spraying program? Do you have record-keeping procedures to track all spraying of this crop? Do you or the state/federal government regularly test your crops for residue levels?

Harvesting and Handling

Leafy greens must be harvested at optimum maturity based on buyer specifications. Leaves of turnips, mustard, kale, and collards should be harvested when tender by feel and before they show thick, coarse stems. Cabbage heads should be harvested when they are dense and before the leaves show discoloration or begin to open.

Hand-harvest

Hand-harvesting using knives can wound produce, encouraging contamination from the soil. Hand-harvesting also may lead to pathogen contamination if field workers practice poor hygiene. Field crews must be trained and monitored regarding personal hygiene practices, and portable bathrooms and hand-washing facilities must be provided at convenient locations in the field.

Knives should be routinely sanitized to keep disease inoculum from building on their surfaces and infecting sound cabbage heads

or leafy greens. Workers' knives should be collected at the end of a harvest day and placed in a bucket of sanitizer (use one ounce of household bleach per gallon of water). For better protection, place buckets of sanitizing agents at the ends of selected rows in the field. This will allow workers to sanitize their knives at regular intervals and reduce disease buildup over the course of the production day. Fresh sanitizer should be introduced throughout the work day.

When harvesting cabbage or other leafy greens, field crews should exercise care to minimize bruise damage and leaf punctures. Cabbage is sometimes considered a "hardware" item, because it is thrown into bulk containers in the field or at the packing shed. Outer leaves break and heads sometimes burst when subjected to impact damage. Leaves of leafy greens are crushed if they are overpacked into field boxes. Improperly used cutting tools will puncture leaves. Cuts or breaks in the leaves or heads will cause excessive wilting and provide avenues for decay pathogens and human pathogens to contaminate the product.

Field containers

Containers for harvesting fresh produce should be constructed of nontoxic materials, be easy to clean, and be free of extraneous materials (e.g., nails, wood splinters, etc.) that can carry over into processing. They must be approved by the U.S. Department of Agriculture (USDA) or the Food and Drug Administration (FDA) for field use. After detergent cleaning, field bins, buckets, etc., should be sanitized by using a very strong sodium hypochlorite solution dispensed from a high-pressure sprayer.

Leafy greens should be cleaned in sanitized water (75 to 100 ppm free chlorine) before marketing. Bunches of collards and leaves of mustard, turnips, and kale tied in half dozen bundles are lain on a flatbed trailer and hauled from the field station. A straight-line packing belt conveys bunches beneath spray washers where sand and dirt are removed and greens are re-freshened to improve their appearance. Workers place bundles from the end of the belt onto racks and into a storage cooler. Direct field-packing of boxed leaves also may be done, without washing.

Postharvest Handling

Precooling and storage

Once harvested, leafy greens can lose moisture and crispness quickly if not protected from the sun. Leafy greens (including cabbage) are normally room-cooled since the season when they are harvested does not produce hot ambient temperatures. Most buyers also require icing for loose greens (kale, collards, mustards, and turnip leaves) to provide the moisture needed for crispness.

Following the field-boxing of leaves, the greens may be taken to the shipping location where a shovel of ice is added to each box. Washed bundles of greens are removed from cooling racks and bulk-loaded into trucks by being lain in rows, with top icing for each row. Icing is recommended at 2.2 pounds of ice for every four pounds of greens to maintain a temperature below 40°F. All leafy greens, including cabbage, should be cooled to 32°F with a relative humidity set at 90 to 95 percent.

Icing

Ice used to cool and preserve quality during transit can be a source of contamination. Steps should be taken to minimize ice exposure to workers, soil, and airborne dust.

Receiving

Harvest crews should remove as much soil and mud from the product as possible before the product leaves the field. An area in the receiving yard should be set aside so pallets can be cleaned before they are placed into bins or sent to cooling.

Water

Water used in cleaning and cooling should be chlorinated at a concentration of 75 to 100 ppm of free chlorine. Chlorination can be accomplished using a gas injection system, adding bleach, or using calcium hypochlorite tablets. Chlorination levels in the water should be monitored frequently during operation, through the use of a chlorine test kit. Water pH should be maintained between 6.5 and 7.5 to avoid having to use excess chlorine and in order to maintain recommended free chlorine levels. Excessive use of chlorine causes gassing off (which can lead to objectionable chlorine odor, irritation of workers' skin, corrosion of equipment, and increased sanitation cost).

