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Fresh produce food safety risks and their mitigation

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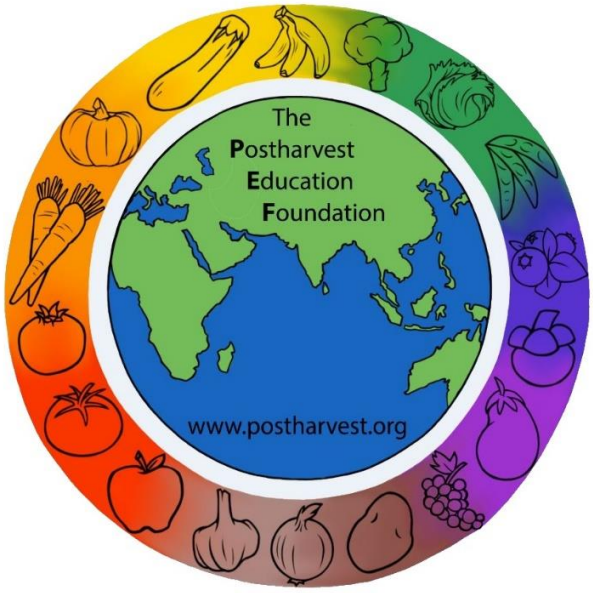

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Introduction

Food safety risks can be broadly defined as:

1. Biological contamination and particularly microbiological contamination: bacteria, viruses and parasites that cause human illness.
2. Chemical contamination: naturally occurring toxins, pesticide residues that exceed maximum residue limits (MRL), pollutants and heavy metals.
3. Physical contamination: foreign elements that can cause injury, such as glass, stone, metal, wood splinters or other materials.

Food safety outbreaks have often occurred as a result of microbial contamination from bacteria (e.g. *Salmonella,* shiga toxin producing *Escherichia coli* (STEC); *Listeria monocytogenes, Shigella*), viruses (e.g. Norovirus, Hepatitis A) and parasites (e.g. *Cyclospora, Cryptosporidium*).

The maximum residue levels (MRL) of applied pesticides is specified in Codex Alimentarius by FAO/WHO. Exceeding these tolerances or applying unregistered pesticides are typical examples of chemical contamination in fresh produce.

Food safety in agricultural commodities is managed by applying sound production and handling practices. Specifically, good agricultural practices (GAP) during production and harvest, and good manufacturing practices (GMP) during handling in the packhouse. This PEF white paper has been developed using available published documents (hot links are provided in the reference list) and is provided for our e-learning trainees and postharvest network.

Good Agricultural Practices

Planting materials

- Healthy, disease-free planting material (e.g. seed, seedlings, cuttings, bulbs) should be used.

Fertilizer use

- Organic fertilizers, such as animal manure, should be composted correctly before use to reduce the risk of contamination by microorganisms such as *E. coli*, *Salmonella,* and *Listeria*.
- Composting should take place at least 50 m away from the fields or orchards.

- Manures should be applied no later than 120 days before harvest.
- Human sewage should never be used as a source of fertilizer.
- Only approved and good quality fertilizers should be used.
- The amount and timing of fertilizer and compost applications must be documented.
- Soil analyses should be taken regularly and tested for heavy metals as well as for nutrients.
- Fertilizers must be stored separately from crops, seeds or other agro-chemical products to prevent cross contamination.
- The storage area should be clean, dry, well-ventilated and appropriately covered to protect inorganic fertilizers, such as powder, granules or liquids from sunlight, rain, humidity, and other atmospheric factors.

Irrigation and water use

- If irrigation is used, the source of water and the delivery system should be documented.
- Accurate irrigation records must be kept.
- Water sources should be inspected for potential sources of contamination.
- Water samples should be tested for contamination by heavy metals and microbial quality (usually total coliforms and generic *Escherichia coli*).
- Ground water should be tested at least once a year and surface water should be tested every three (3) months.
- Contaminated water cannot be used for irrigation without remediation treatment by filtration or sanitizers e.g. chlorine.
- Foliar sprays must be applied with potable water.

Pest and disease management

- Only those pesticides registered for use can be used and at their labelled rate.
- The trade name and common name, active ingredient, rate/dosage used, method of application, date of application, frequency of application and name of applicator must be documented.
- The minimum time, between spraying and harvest, as specified on the label, must be followed.
- Crop samples must be taken to measure pesticide residues to demonstrate that the MRL (maximum residue limit) has not been exceeded.

- The applicator must be trained and use the appropriate personal protective equipment (gloves, boots etc.) when applying pesticides.
- Pesticides must be stored in a separate and locked store room.
- Empty pesticide containers should be washed three times and disposed of according to label directions.

Harvesting and product handling

- Harvested product must be handled hygienically and not be placed on the soil.
- Containers used for harvesting must be cleaned and sanitized at least weekly, and more often if they are dirty.
- Injured produce should be removed in the field whenever possible.
- Fruits/vegetables should be packed in clean containers for shipping to markets.
- If produce is washed after harvest the wash water must be treated with a sanitizer to prevent cross contamination. Not that washing produce does not sanitize the produce itself.
- A typical wash water sanitizer is sodium hypochlorite at about 150 ppm free chlorine and maintained at a pH of 6.5-7.5.
- This must be measured and documented at the start of the day and every hour thereafter.
- The water must be changed at least daily.

Equipment and tools

- All machinery, equipment, tools and vehicles should be well maintained and cleaned regularly.
- Equipment, reusable harvesting containers, and harvesting tools should be made of non-toxic materials that are easy to clean and disinfect.
- A cleaning and disinfection procedure and schedule should be documented.

Site history and land use

- Growers should consider the former use of the site, as well as assess the impact of present use of adjacent sites on potential risks.

- Contamination with heavy metals (e.g. lead, chromium, arsenic, zinc, cadmium, copper, mercury, and nickel), other chemical contamination, sewage systems, or proximity to animal production increases the risk of contamination.
- Wherever possible, all animals including dogs and wildlife, should be excluded from the field to prevent microbial contamination and reduce the transfer of pests and diseases.
- There should be a buffer zone between animal facilities and production fields.
- Any risk of water draining from manure piles, animal production sites, sewage, storm drains or contaminated water requires action, either by re-routing or containment.

Worker safety and hygiene

- Workers must have toilets and hand washing facilities, and these should be maintained in sanitary conditions.
- Field toilets must be constructed and maintained so as to prevent ground water contamination**.**
- If gloves are used they must be kept clean.
- Good staff hygiene is required to prevent the spread of illness.
- Workers that have diarrhoea or other illnesses that could impact food safety should not be in contact with the produce.

Traceability

- Growers must guarantee that produce can be traced back at least to the farm, and preferably to the individual field.
- Each box must be identified with a code that indicates harvest date, packing date, grower code or packer

Recordkeeping

- Growers must document every aspect of production and handling, including their own training and the training of any helpers or staff.
- These records must be accessible and will be audited for GAP certification.

GAP certification and GlobalGAP

- There are many forms of GAP, including USDA GAPs, and recommendations from FAO.

- GlobalGAP is one of the most widely used of these and is often required by importers.
- The GlobalGAP organization has developed local standards for many countries specifically for their internal markets (LocalGAP) which are less stringent.
- Producers need to follow the recommendations set by these standards and be audited by a recognized third party in order to have their compliance certified.

Successful adoption of GAP require a commitment from the grower and all staff to regular training, strict adherence to the practices, and systematic record keeping. GAP certification involves the direct cost of certification and auditing, plus the indirect costs of providing the sanitation and storage facilities, improvements to the packhouse, and record keeping.

Training

- Workers (family members, day laborers and hired staff) must be properly trained in the use of tools, equipment and chemicals, and the training must be documented.

GMPs – Good Manufacturing Practices for packinghouse operations

All packing and processing facilities should be managed by Good Manufacturing Practices (GMP). GMP includes the principles of HACCP (Hazard Analysis Critical Control Points). The HACCP process involves identifying the biological, chemical and physical hazards for the specific facility and developing a plan to monitor and control these hazards. When an issue is detected corrective actions must be put in place documented. A good HACCP program manages the risks so that there are very few Critical Control Points (CCPs). For example, all light sources must be protected to prevent broken glass from contaminating the produce and thus prevent this from becoming a CCP. Typical CCPs for sanitation are free chlorine levels and pH in wash water.

Specific considerations for GMP include:

General sanitation requirements

- Typically packinghouses that are handling raw agricultural commodities (i.e. not involved in processing) do not have to be enclosed although some private standards require that the facility should at least be covered in netting to exclude animals and insect pests.
- More stringent certification standards specify a fully enclosed packhouse with linear flow.

- The packhouse should be designed so that finished product is shipped from a different entrance to that used for receiving product from the field.
- All packing facilities should have documented procedures, and these should be based on HACCP principles.
- Packing houses and the equipment in the packing house should be clean and well maintained, and any surfaces or equipment that touch fresh produce must be cleaned and sanitized.
- Routine cleaning and sanitizing procedures (sanitation standard operating procedures or SSOP) must be established and documented.

Wash water use and sanitation

- Any water used to wash produce must be potable and subject to microbial tests.
- Dump tanks must be cleaned regularly and the water should be changed daily.
- Water that is to be reused, including in dump tanks, must be sanitized.
- Wash water sanitizers cannot sanitize produce, but are used to sanitize water and prevent cross contamination.
- The most common wash water sanitizer is sodium hypochlorite (chlorination). The wash water must be maintained at least 150 ppm free chlorine and the pH 6.5-7.5 for chlorination to be effective and this must be measured and documented at the start of the day and every hour thereafter.
- Other wash water sanitizers include peroxyacetic acid, aqueous chlorine dioxide and ozone. These must be used at the labelled rate and monitored regularly.

Culling of injured/damaged produce

- Injured, soft, decayed, or damaged produce should be removed during handling and should not be included in the final product.

Packhouse staff hygiene

- Sanitary toilets, and hand washing facilities must be provided. These facilities must not lead directly into the packing house.
- Staff inspecting and handling produce must be trained in, and practice good hand washing and sanitizing procedures.

- If gloves are used they must be cleaned or changed regularly.

Pest control and animal exclusion

- No animals, including dogs, are permitted in areas where produce are being packed or handled.
- The packing area must be free of insects, rodents and birds.

Storage

- Produced that is packed for market must be stored separately from incoming produce.
- The storage area should be clean and, if possible, cooled.

Chemicals in the packhouse

- Any chemicals used in the packhouse must be authorized for postharvest for use and applied according to the label.
- All chemicals must be stored in a locked, clean room.
- As in GAP, any chemical usage must be documented.

Transportation

- Any vehicle used to transport fresh produce should be clean before loading.

Recordkeeping

- Records shall be maintained for product packed, shipped, handled, transported and stored, as well as for SSOP, sanitation, corrective actions, and staff training.

Identification and Traceability

- All packed containers of produce must be identified with a traceable code as described in GAP regulations.

HACCP

Awareness of food-borne illness is increasing and concern throughout the industry is driving the use of HACCP and HACCP based certification programs (22000-Tools.com). Design and

implementation of the Hazard Analysis Critical Control Points (HACCP) system involves the following basic steps:

1. Identify possible food safety hazards
2. Determine critical control points
3. Establish preventive measures
4. Monitor the manufacturing process to detect hazards
5. Plan corrective actions
6. Prepare a method to verify that the HACCP plan is working
7. Document the HACCP system by maintaining records.

It is highly recommended that date packing and processing plants establish and consistently implement a HACCP program to assure safety of their products to the consumers.

HACCP follows these seven principles:

1) Conduct a Hazard Analysis

Start by evaluating your processes and identify where hazards can be introduced. Hazards can be physical (i.e. metal contamination), chemical (i.e. can a cleaning product contaminate the product, are there toxins that could contaminate the product?) or biological (at what points could bacteria or virus contaminate your product?). Make sure that you have the expertise to make an accurate evaluation of the hazards. This means that if you do not have sufficient expertise in your organization you will need to identify external resources that you can use to perform the hazard analysis.

The hazard identification is done in two steps, first the identification of hazards, then an evaluation of the hazard. The hazard evaluation is a determination of the degree of risk to the user from the identified hazard. Once the hazard is identified and evaluated the team must identify critical control points. These are points where the hazard must be controlled or it will present a risk to the end user.

2) Identify the Critical Control Points

At what steps in your process can controls be applied to prevent or eliminate the hazards that have been identified? These are your critical control points. For each critical control point you will

identify the preventive measure. How will you prevent the hazard? Use of specific Temperature, pH, time, procedures?

Establish a maximum or minimum limit for temperature, time, pH, salt level, chlorine level or other processing characteristic that will control the hazard. This is the critical limit for the CCP. If this limit is ever exceeded corrective action must be taken, and all affected product controlled.

3) Establish Critical Limits

The next step is to establish criteria for each critical control point. What criteria must be met to control the hazard at that point? Is it a minimum temperature? Are there regulatory limits that you must meet for this control point?

4) Establish Monitoring Procedures

What will you measure and how will you measure it? You need to monitor the process at the critical control point and keep records to show that the critical limits have been met. Can you do continuous monitoring of the control point? If not, how often will the measurements need to be performed to show that the process is under control?

The monitoring that takes place at the critical control points is essential to the effectiveness of the HACCP program. The monitoring program will be made up of physical measurement or observations that can be done in a timely manner, to provide the information in a time frame that allows you to take action and control product if an out of control situation occurs.

5) Establish Corrective Actions

Establish what actions need to be taken if a critical limit is not met. This will be identified ahead of time for each CCP. The action must make sure that no unsafe product is released. There must also be an evaluation of the process to determine the cause of the problem and an elimination of the cause.

The action or actions taken have two purposes, to control any nonconforming product resulting from the loss of control, and to identify the cause, eliminate it and prevent the situation from reoccurring. By identifying the corrective action before an out of control situation occurs, you are prepared to take action quickly if and when it does occur.

6) Establish Record Keeping Procedures

Determine what records are needed to show that the critical limits have been met, and the system is in control. Address regulatory requirements and include records from the development of the system and the operation of the system.

7) Establish Verification Procedures

The HACCP plan must be validated. Once the plan is in place, make sure it is effective in preventing the hazards identified. Test the end product, verify that the controls are working as planned. Perform ongoing verification of the system. Are measuring and monitoring equipment in control? What are corrective actions showing? Are records being maintained as required?

Sanitation standard operating procedures (SSOPs)

SSOPs are specific procedures that allow the packinghouse or processing plant to achieve sanitary process control in its daily operations.

These sanitary control procedures include:

- Safety and purity of the water used in all operations
- Cleanliness of utensils and equipment
- Prevention of cross-contamination
- Hand washing and toilet facilities
- Protection of food from contaminants
- Labelling and storage of toxic compounds
- Monitoring employee health and not allowing sick employees to touch the food
- Pest control.

References

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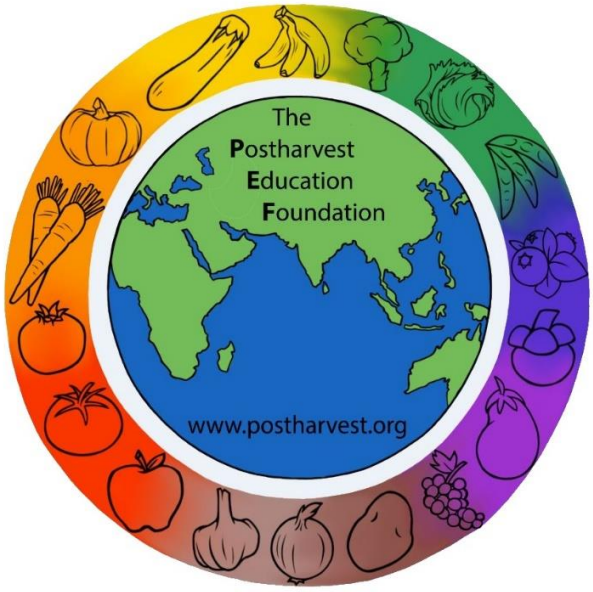
General resources:

General resources on GAP including training and videos
www.gaps.cornell.edu

GlobalGAP – for export and perhaps some high end markets
https://www.globalgap.org/uk_en/documents/#fq=gg.subscope:(%22fruit%22)&fq=con_locales:(%22en%22)&fq=gg.document.type:(%22checklist%22+OR+%22regulations%22+OR+%22cpacc%22)&fq=gg.standard.gg:(%22ifa5%22)

LocalGAP – a version of GlobalGAP developed for emerging farmers
https://www.globalgap.org/uk_en/documents/#fq=con_locales:(%22en%22)&fq=gg.standard.lg:(%22v3%22)&fq=gg.document.type:(%22checklist%22+OR+%22cpacc%22)&fq=con_locales:(%22en%22)

FAO Guidelines. Good Agricultural Practices
http://www.fao.org/3/a-a1193e.pdf
http://www.fao.org/3/ag130e/ag130e12.htm



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