

## SECTION III

# GOOD MANUFACTURING PRACTICES FOR HANDLING, PACKING, STORAGE AND TRANSPORTATION OF FRESH PRODUCE \*



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## **SECTION III**

### **GOOD MANUFACTURING PRACTICES FOR HANDLING, PACKING, STORAGE AND TRANSPORTATION OF FRESH PRODUCE**

#### **Introduction \***

The aim of Good Manufacturing Practices (GMPs) is to reduce the risk of contamination of fresh produce during handling, packing, storage and transportation. In this Section, Modules 1 and 2 provide information on measures to prevent and reduce contamination on produce surfaces by proper cleaning and use of sanitizers and by implementing other GMPs during packing, storage and transportation of the produce. Module 3 discusses measures to clean and sanitize equipment that comes in contact with fresh produce.

#### **Module 1 Produce Cleaning and Treatment**

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##### **Learning Outcomes**

- *Participants should be aware of recommended cleaning procedures for fresh produce.*
- *Participants should understand safety considerations for water used in produce cleaning operations.*
- *Participants should be familiar with the use of sanitizing agents and new technologies for reducing levels of microbial contamination on fresh produce.*

##### **Practical**

- *Experiment/Demonstration: Water as a Contamination Agent*
  - *Experiment/Demonstration: Chlorine and Water Quality Management*
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This Module addresses cleaning and treating produce with sanitizing agents to reduce contamination. It is important to note, however, that once produce is contaminated with human pathogens there are currently no available agents or

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processes, other than thorough cooking, that can ensure complete elimination of pathogens. This is why preventing contamination in the first place is so important.

Microbes are everywhere in the growth environment of produce. Even though produce operations may have in place and conscientiously employ good agricultural practices, it is inevitable that fresh fruits and vegetables will have microorganisms on their surface.

As discussed previously, surface microorganisms of fresh produce vary widely and are highly dependent on the type of commodity and the agricultural practices used. Natural microflora on fresh produce include species of *Pseudomonas*, *Alcaligenes*, *Flavobacterium*, *Micrococcus*, and lactic acid bacteria. These natural microflora are mostly harmless. However, soil, water, sewage, air and animals in the field can contaminate the external surfaces of produce with pathogenic organisms. Microorganisms from these sources compete with the natural flora.

In many instances the outgrowth of microbiological contaminants does not take place until conditions are appropriate. During and after harvesting many conditions come together that can favor the growth of microorganisms. Some of these include handling, cross contamination, temperature abuse, and increases in product respiration rates leading to heat production.

The reduction of pathogens on produce is important to reduce foodborne illness, to decrease spoilage, and to improve appearance and nutritive value. Washing and sanitizing fruits and vegetables is a common practice to reduce surface contamination. However, the application of such treatments is dependent on the ability of the commodity to tolerate water. The shelf life of some delicate produce is reduced after they get wet. This is especially true for commodities with large water-adhering surface areas, like strawberries, other berries and grapes. Another cleaning media, air, may be preferred for removal of dust and other debris from these delicate products.

Visual III.1-1

**A four-step procedure is recommended for cleaning fruits and vegetables**

1. Remove surface soil by dry cleaning (brushing or vacuuming).
2. Initial water wash to remove surface dirt
3. Washing with a sanitizing agent (chemical agent generally)
4. Final rinsing

Before the washing step, and with commodities that cannot tolerate wetting, it is essential to remove surface soil by dry cleaning, brushing air blowers or vacuum (if the item will physically tolerate it). Subsequent washing steps then reduce

remaining surface dirt. A thorough spray wash with chlorinated water or multiple washes are generally more effective than one soaking wash.

Water used for produce washing must be potable and free of pathogenic organisms. Clean wash water is critical since organic matter in the water can react with many sanitizing agents and decrease their decontamination efficiency. The initial wash to remove surface dirt can be with hot water alone or with water containing food grade detergents or permanganate salts (Beuchat, 1998).

The characteristics of the commodity will determine the selection of wash equipment. Soft fruits are generally washed on conveyor belts using water sprayers. More solid fruits like citrus, apples, and pears may be washed in rotating devices or by fluming. Root crops are typically cleaned with brush washers which contain cylindrical rotating brushes. Brushes must be cleaned and disinfected often because they can become a vehicle for spreading contaminants. Air cleaning may be effective for removing debris, loose soil or other foreign material from very delicate commodities.

#### Visual III.1-2

Sanitize means to treat clean produce by a process that is effective in destroying or substantially reducing the numbers of microorganisms of public health concern, as well as other undesirable microorganisms, without adversely affecting the quality of the product or its safety for the consumer.

A sanitizing step, generally with the application of chemical agents, follows washing. To sanitize, means to treat clean produce by a process that is effective in destroying or substantially reducing the numbers of microorganisms of public health concern, as well as other undesirable microorganisms, without adversely affecting the quality of the product or its safety to the consumer (FDA, 1998). It is important to remove dirt prior to sanitation, since dirt can hinder contact between the sanitizing agent and the microorganisms. A chlorine solution is the most common sanitizer, but there are many new sanitizing agents on the market. These will be discussed in more detail later in this Section.

#### Visual III.1-3

- Sanitizing agents currently available can reduce microbial contaminants but cannot eliminate them completely.
- New technologies that can further reduce and eliminate foodborne pathogens on fresh fruits and vegetables are under active investigation.

It is important to note that sanitizing agents currently available can only reduce microbial contaminants and cannot ensure they are completely eliminated.

New technologies are currently being researched to further reduce and eliminate pathogens from fresh produce but these are not yet available.

For QUALITY purposes a common industry practice is to wash and sanitize produce in cold water. Low temperatures slow the respiration rate of fresh commodities and retard the changes in texture and other quality factors.

From a SAFETY point of view, the use of cold water can be an important issue. As was discussed in the cooling module (Section II, Module 5), placing some warm produce in cool water results in a pressure differential. This creates a suction effect that can cause surface contaminants or contaminants in the water to be drawn into the flesh of the commodity where they are protected from subsequent disinfecting treatments (Bartz and Showalter, 1981).

Maintaining the water temperature 5°C above the internal temperature of the produce will help prevent this suction effect (Zhuang et al., 1995). A further precaution would be to use an initial air-cooling step prior to washing or sanitizing to minimize the temperature differential between the fruit flesh and the water temperature. Produce that is more dense (i.e. carrots) is less likely to have this problem.

For those commodities that cannot be exposed to water, prevention of contamination is critical and GAPs and GMPs become the only way of controlling microorganisms on the surface of the fresh produce. This is the case for some berries and other commodities that cannot get wet.

### **Sanitizing Agents**

Sanitizing agents should be used on clean produce. Soil must be removed from the produce prior to the application of a sanitizing agent. Dirt and debris can protect the microorganisms from contact with the sanitizer, or react with chlorine and other sanitizers reducing their antimicrobial activity. Water is the cleaning medium most frequently used for soil removal. This water must be clean since impurities in water can drastically alter the effectiveness of a detergent or a sanitizer. Water used for sanitizing should be potable and pathogen-free.

Sanitizers are chemical substances that can destroy or substantially reduce the numbers of microorganisms in wash and cooling water thereby reducing cross contamination. They may also reduce but not eliminate pathogens on the surface of produce. Sanitizers and chemical substances are not effective if the pathogens have become internalized.

The scope of action depends on the sanitizing compound. Their effectiveness varies with concentration since lower concentrations are needed for destroying vegetative cells than are required for spores. The effectiveness of each individual sanitizer is influenced by many factors including water temperature, pH, contact time, organic matter content and the surface morphology of the fruit or vegetable. Produce sanitizers can reduce the number of surface organisms but do not achieve commercial sterility. Manufacturer's instructions should always be strictly followed when using sanitizers. When in doubt about proper sanitizer use or for new applications of a product, contact the manufacturer.

Visual III.1-4

### **Sanitation vs. Sterilization**

- The application of chemical sanitizers can reduce the number of vegetative cells of bacterial pathogens but may not be effective for the destruction of the more resistant spores.
- Commercial sterility refers to the complete elimination of pathogenic microorganisms, including the spores of foodborne pathogens (i.e. *Clostridium botulinum*). This can be achieved through heat treatments such as canning but not through the application of common disinfectants.

The use of sanitizing agents should not be a substitute for the Good Agricultural Practices discussed Section II. Sanitizers should be used as an additional measure to minimize the risk of microbial hazards on fresh produce.

Visual III.1-5

### **Sanitizing agents used to treat fruits and vegetables include:**

- Halogens
- Ionic compounds
- "Active" oxygen
- New Technologies
- "Hurdle" Technology

A number of different agents/treatments have been used to sanitize fresh fruits and vegetables. These include halogens and halogen compounds, ionic compounds, active oxygen, new technologies and hurdle technology.

## Halogens and Halogen Compounds

### Visual III.1-6

Examples of halogens and halogen compounds:

- Chlorine
- Chlorine dioxide
- Bromine
- Iodine

### Chlorine

Chlorine is the most widely used sanitizer in the food industry. It is used for the treatment of drinking, processing and wash water, equipment and other surfaces. Recently, concerns have been raised about its use due to the formation of chlorinated by-products (Richardson et al., 1998).

The ability of chlorine to destroy microorganisms depends on the amount of free residual chlorine, i.e. the chlorine remaining after it reacts with organic matter, in the water (Gavin and Weddig, 1995).

### Visual III.1-7

Total chlorine = Chlorine demand + Free residual chlorine

Chlorine reacts with impurities in the water, such as minerals and organic solids from the commodities being washed. The amount of chlorine that reacts is generally called the “chlorine demand” of the water. Once the chlorine demand has been satisfied there is a break point where further additions of chlorine will exist as free residual chlorine. A commonly used analogy to explain this reaction is to suppose the chlorine solution is added to a sponge. The maximum holding capacity of the sponge would be equivalent to the chlorine demand of the wash water. After this point, further addition of chlorine would run through the sponge. This would be equivalent to the free residual chlorine. The sum of the two would be the total chlorine added. Disinfectant properties are provided by free chlorine only (Gavin and Weddig, 1995).

### Visual III.1-8

Using chlorine to treat fresh fruits and vegetables:

Chlorine is commonly used at concentrations of 50-200 ppm with a contact time of 1-2 minutes to sanitize produce surfaces.

To treat produce surfaces, chlorine is commonly used at concentrations of 50-200 ppm with a contact time of 1-2 minutes (CFSAN/FDA, 2001).

Visual III.1-9

Considerations for the use of chlorine solutions as sanitizing agents for fresh produce:

- Metal containers and processing equipment can suffer corrosion if the pH of the chlorine solution is too low.
- A pH of 6.0 -7.5 at 20°C (68°F) is a good compromise since there is enough HOCl available to sanitize the product but equipment corrosion can be minimized.
- Chlorine evaporates when the wash temperature is raised
- Chlorine loses its effectiveness when the wash water contains large amounts of organic matter or when the solution is exposed to air, light or metals. The amount of free chlorine can be monitored with automated units or with commercial kits that can be purchased at any swimming pool supply store.
- Because chlorine can cause skin irritation after extended exposure, the use of protective equipment is recommended.

Chlorine solutions contain molecules of HOCl (hypochlorous acid) and its ions  $H^+$  and  $^-OCl$  in equilibrium. Of these, the non-dissociated form of the acid HOCl is the form that exerts the lethal effect upon microorganisms. The equilibrium among these chemical forms is affected by pH. Chlorine sanitizers themselves change the pH. As the pH of the solution is lowered, equilibrium favors the lethal form of the acid (HOCl). Therefore, pH is an important factor in the sanitizing effect of chlorine solutions. However, low pH favors metal-corroding reactions, therefore, using these pH levels is harder on equipment.

Temperature control should be part of the Sanitation Standard Operating Procedures for the proper preparation and use of this sanitizer. Water pH should also be monitored - the optimum range is 6.0 to 7.5. When pH values are outside this optimum range they can be adjusted by the addition of organic or inorganic acids to lower pH. Typically chlorine gas is injected into a stream of water that passes through a bed of crushed oyster shells or other alkaline material which brings the pH up to near neutral. The water then passes into the mail reservoir after this pH adjustment has occurred. Other alkaline materials such as sodium bicarbonate or diluted lye (hydroxide) may also be used to raise pH.

Table III-1 Chlorine as a Sanitizing Agent

<b>Advantages</b>	<b>Disadvantages</b>
<ul style="list-style-type: none"><li>• Relatively inexpensive</li><li>• Rapid action</li><li>• Wide action against many microorganisms</li><li>• Colorless</li><li>• Easy preparation and use</li><li>• Easy to determine concentration</li></ul>	<ul style="list-style-type: none"><li>• Unstable during storage</li><li>• Affected by organic matter content (loss of germicidal effect)</li><li>• Viruses tend to be resistant</li><li>• Corrosive</li><li>• Efficacy is lowered when the pH of the solution increases</li><li>• Toxic at high levels</li></ul>

### Chlorine Dioxide (ClO<sub>2</sub>)

Chlorine dioxide has received a lot of attention in the last few years because its effectiveness is less affected by pH and organic matter content than that of chlorine. Another advantage is its high oxidative action, which has been observed to be 2.5 times greater than chlorine (Benarde et al., 1967). However there are some disadvantages also. These include its poor stability, virus resistance, and its tendency to explode at high concentrations. Chlorine dioxide decomposes at temperatures above 30°C (86°F) and when it is exposed to light (Beuchat, 1998).

Despite these disadvantages, use of chlorine dioxide has been increasing because of new technologies that permit shipment to areas of use instead of on-site generation. Concentrations should not exceed 5 ppm for treating unpeeled fruits and vegetables. Chlorine dioxide is approved as a wash treatment for uncut produce, and is being reviewed for approval as a wash treatment for pre-cut produce.

### Bromide

Bromide has had limited use in treating wash water. It may be used alone or in combination with chlorine, where a synergistic effect has been observed. Little information is available regarding the effectiveness of bromine alone or combined with chlorine as a fruit and vegetable sanitizing agent.

### Iodine

Iodine solutions are less affected by the organic matter content of wash water than chlorine, however they may stain equipment used to handle fruits and vegetables and react with starch to form a blue-purple color. For this reason their application in fruits and vegetables is limited to non-starchy commodities.

## Ionic Compounds

### Visual III.1-10

Examples of ionic compounds:

- Trisodium phosphate (TSP)
- Quaternary ammonium compounds (Quats)
- Organic acids

#### Trisodium Phosphate (TSP)

A wash solution of 15% TSP for a contact time of 15 seconds as been shown to be effective for the elimination of *Salmonella* in tomatoes (Zhuang and Beuchat, 1996) However, there is little information in the literature documenting TSP's effectiveness as a sanitizing agent under commercial conditions. Pathogens appear to vary in their resistance to TSP, with *Listeria monocytogenes* being resistant and *E.coli* O157:H7 being sensitive. More research is needed to learn about TSP's spectrum of action and effect on the quality characteristics of the produce being treated.

#### Quaternary Ammonium Compounds (Quats)

These compounds are generally used for the sanitation of walls, floors, drainage, equipment and other food-contact surfaces in fruit and vegetable processing plants. Although they are not approved for direct food contact, quats may have some limited usefulness in treating fresh fruits and vegetables that must be peeled before consumption (CFSAN/FDA, 2001). These compounds have several advantages, which make them interesting as sanitizing agents. They are not corrosive to metals and are stable at high temperatures. They are effective against yeast and molds and against *L. monocytogenes* but are less effective against coliforms, *Salmonella*, *E.coli*, *Pseudomonas*, and viruses.

Quats are relatively stable in the presence of organic matter. Since their effectiveness is greatest in a pH range of 6-10, their application is limited in highly acidic environments (Beuchat, 1998). A rinsing step is recommended after their application.

#### Organic Acids

Organic acids are produced from the natural metabolism of fruits and vegetables. Acetic, citric, succinic, malic, tartaric, benzoic and sorbic acids are the major organic acids that occur naturally in fresh produce. Their decontamination activity has been attributed to a reduction in bacterial cell membrane permeability.

Fruit and vegetable organic acids provide some natural protection against the growth of bacterial pathogens, since these organisms cannot grow at a pH below 4. However several pathogens can adapt to survive at lower pH and cause illness. Pathogens are able to grow in many vegetables and in fruits like melons, papaya, and mango that are not very acidic. The effectiveness of organic acids as sanitizing agents varies widely with the type of acid and the microorganism being inhibited. Their application may have negative effects on sensory properties such as flavor and aroma of the commodities being treated.

Although organic acids have had limited use with produce, washes and sprays containing organic acids have been used successfully to disinfect meat. Because the addition of organic acids directly or in washes can lead to reductions in pathogenic microorganisms, applying vinegar or lemon juice holds promise as an inexpensive treatment for decontamination of fresh fruits and vegetables (Castillo and Escartin, 1994; Zhang and Faber, 1996).

### **Active Oxygen Compounds**

#### Visual III.1-11

Examples of “active” oxygen compounds:

- Hydrogen peroxide
- Peracetic acid
- Ozone

#### Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>)

Hydrogen peroxide has shown promise as a sanitizer for fresh and cut produce (Sapers and Simmons, 1998). It has also shown positive results for the sanitation of cantaloupes, grapes, and some nuts. pH, temperature, and other environmental factors influence the sanitizing effects of hydrogen peroxide.

Hydrogen peroxide’s application as a sanitizing agent is limited for some fruits and vegetables due to the bleaching of anthocyanin pigments in commodities such as strawberries and raspberries and to the oxidation of mushroom phenolic compounds causing a loss of color.

#### Peracetic Acid

This acid is formed by the reaction of acetic acid and hydrogen peroxide with catalysts. It has been reported to be effective in reducing microbial counts in produce wash water and on fruit surfaces (Hei, 1998). Sanitizers using peracetic acid at 40-80 ppm significantly reduced *Salmonella* and *E. coli* 0157:H7 populations on cantaloupe and honey dew melon (Park and Beuchat, 1999),

Peracetic acid is approved in the U.S. for use either in wash water or for direct application to whole or cut fruits and vegetables.

## Ozone

Ozone destroys microorganisms much faster than chlorine due to its high oxidation potential. This allows it to be used at much lower concentrations (less than 1 ppm). It is highly effective for treating processing water, but has variable results when used as a sanitizing wash for fresh produce. The lethal effect of ozone on microorganisms is through its oxidative action. *Salmonella typhimurium*, *Y. enterocolitica*, *S. aureus*, and *L. monocytogenes* are sensitive to treatment in ozonated water at a concentration of 20 ppm (Restaino, et al., 1995). Many viruses and the cysts of protozoa such as *Cryptosporidium parvum* are also sensitive to ozone (Korich, et al., 1990). In addition, ozone has been shown to be effective for the prevention of decay in broccoli, carrots and pears.

It may be necessary to adjust the ozone dosage to prevent damage to the treated commodity. For example, maintaining a concentration of 25-30 ppm gaseous ozone has resulted in some undesirable physiological effects such as the appearance of black spots on bananas.

From a safety perspective there are many advantages to the use of ozonated water. There are some quality benefits as well, including prolonging the shelf life of oranges, strawberries, raspberries, grapes, apples and pears (Beuchat, 1998).

The high oxidizing power of ozone, which makes it very effective against microorganisms, can also cause some problems with its use. These include the corrosion of metal processing surfaces and ozone's reactivity with organic matter. Handling is also a major concern because of potential toxic effects.

## New Technologies

### Visual III.1-12

New technologies to treat fresh fruits and vegetables include:

- Irradiation
- Pulsed light
- Edible coatings

Many new technologies for treating fresh fruits and vegetables are currently under investigation and some are already available but are not yet used commercially.

## Irradiation

A treatment with ionizing radiation at doses up to 1 kGy can be applied to fresh fruits and vegetables. Irradiation is generally applied to inhibit post-harvest pathogens and to protect produce quality. Irradiation may be effective for eliminating pathogenic microorganisms from the surfaces of produce. An irradiation dose of 1 kGy has been reported to be effective for the destruction of *Listeria monocytogenes* on cut bell peppers. Unfortunately doses much greater than 1 kGy are necessary for destroying spores, viruses, yeasts and molds (Farkas et al., 1997) and these higher doses can cause softening and off-flavor development in fresh produce.

Additional factors to consider when using irradiation sanitation are the resistance of specific microorganisms to the treatment, other post harvest treatments, humidity, and produce temperature. A concern when irradiating produce in closed packages is that irradiation may lead to the elimination of competing microflora allowing germination of pathogenic bacterial spores.

## Pulsed Light

Pulsed light treatments (i.e. a combination of 25% ultra-violet, 45% visible and 30% infrared light) are effective when the light can penetrate food surfaces or transparent media such as clear juices. Shelf life extension of some fresh fruits and vegetables has been reported after treatment with pulsed light, however the effectiveness of the treatment is limited on produce with opaque and/or irregular surfaces (Dunn, 1996).

## Edible Coatings

Edible films can be made of many different polymers (pectin, proteins, oils, etc.) and there are many commercial brands of these films on the market. They are generally applied to fresh fruits and vegetables to improve appearance and to prevent moisture losses. They also can serve as a carrier for antimicrobial compounds such as organic acids (Beuchat and Golden, 1989), methyl jasmonate (Buta and Moline, 1998) and bacteriocins onto the produce surface. More research is needed to determine the effectiveness of films in controlling microbial growth. It also remains to be determined how microorganisms can mutate and adapt to the new environment created by the application of the film to the surface of the produce.

## Hurdle Technology

### Visual III-1.13

Hurdle technology uses a combination of treatments such as controlling pH, humidity, and temperature with preservatives to create multiple obstacles to microbial growth.

Hurdle technology uses a combination of treatments such as controlling pH, humidity, and temperature with preservatives to create multiple obstacles to microbial growth. In many cases, the multiple treatments have a synergistic effect enhancing the actions of each. Many of the treatments previously discussed can be applied in combination to fresh fruits and vegetable to maximize the treatment effects or to offer additional protection.

### **Summary**

1. Surface microorganisms of fresh produce vary widely and are highly dependent on the type of commodity and the agricultural practices used. Organisms present include both natural microflora and contaminants from soil, water, air, sewage and animals. During and after harvesting many conditions come together that can favor the growth of microorganisms. Some of these include handling, cross contamination, temperature abuse, and increases in product respiration rates leading to heat production.
2. The reduction of pathogens on produce is important to reduce foodborne illness and decrease spoilage and to improve appearance and nutritive value. Washing and sanitizing fruits and vegetables is a common practice to reduce surface contamination.
3. Before the washing step, and with commodities that cannot tolerate wetting, it is essential to remove surface soil by dry cleaning, brushing air blowers or vacuum (if the item will physically tolerate it).
4. A washing step reduces surface dirt. Water used for produce washing must be potable and free of pathogenic organisms. Impurities in water can drastically alter the effectiveness of a detergent or a sanitizer.
5. A sanitation step, generally with the application of chemical agents, follows washing. Sanitation involves the reduction of microorganisms of public health concern, as well as other undesirable microorganisms, without adversely affecting the quality of the product or its safety to the consumer.
6. The effectiveness of each individual sanitizer is influenced by many factors including water temperature, pH, contact time, organic matter content and the surface morphology of the fruit or vegetable. Chlorine is the most common sanitizer, but there are many other sanitizers on the market including chlorine dioxide, bromide, iodine, trisodium phosphate, quaternary ammonium compounds, organic acids, hydrogen peroxide, peracetic acid, and ozone. New technologies such as pulsed light, irradiation, and edible coatings are also proving useful in sanitizing produce. For many types of produce, the use of hurdle technology, multiple procedures that supplement and enhance each other, has been most effective in reducing microbial contamination.

## **Module 2**

### **Packing, Storage and Transportation**

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#### **Learning Outcomes**

- *Participants should understand recommended practices for maintenance of packing and storage facilities and equipment and for proper trash and waste handling*
- *Participants should be aware of considerations for safety during produce transportation*

#### **Practical**

*Laboratory Exercise: Experiments with Artificial Germs – Germs and Produce*

#### **Additional Resources**

*Part V – Storage Conditions for Fruits and Vegetables*

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Many of the sanitation considerations discussed for the production field can be extended to the packing facility. While a discussion of these may seem repetitive, this discussion is included to point out that there are steps in the packinghouse process that require implementation of monitoring procedures. During packing it is important to consider Good Manufacturing Practices for packing and storage facilities, equipment, containers, trash handling, worker health and hygiene, and storage of produce and packing material.

#### **Packing Facilities**

Visual III.2-1

##### **Sanitary Construction Considerations for Packing and Storage Facilities**

- Facilities should be designed and constructed for easy cleaning and sanitation.
- Buildings should be well screened with barriers designed to exclude vermin, domestic and wild animals, birds, and insects.
- Windows should be closed or covered with mesh.
- Walls, floors and ceilings should be in good condition, and easy to clean and sanitize.
- Lamps and bulb lights should be covered so that, if they should break, the product and the work area will not be contaminated with broken glass.
- The floor should be constructed with a slight slope to avoid water accumulation in production areas.
- The sewage system should be constructed to prevent water accumulation in packing and storage rooms.

Packing and storage facilities will vary depending on the produce being processed and the size of the operation. The packinghouse can be a small shed near the field or a large-scale building with many different processing and storage areas. Regardless of the size of the operation, good manufacturing practices are essential to prevent the physical facility from becoming a source of microbial, physical or chemical contamination and to ensure consistent fresh produce quality.

Visual III.2-2

**Additional recommendations for the proper maintenance of packing and storing facilities include:**

- All chemical agents, such as fuels, additives, fertilizers, pesticides, sanitizers, etc. must be packed in durable containers, properly labeled, and stored in dry, clean, closed places, separated from food products and packing material. These supplies must be handled only by authorized personnel and should never come in direct contact with the fruits or vegetables.
- Packing and storage areas should be separated and, ideally, different personnel should handle separate tasks to avoid cross-contamination.
- Comprehensive Sanitation Standard Operating Procedures (SSOP's) and maintenance programs should be implemented.
- Pest control and monitoring should be in place.

Packing and storage areas should be separated. Ideally, different personnel should handle tasks in each of the areas to avoid cross-contamination. It is important to keep all packing and storage areas free from chemicals, trash, machinery, harvest residues and waste materials to discourage pests and prevent produce contamination. Comprehensive Sanitation Standard Operating Procedures (SSOP's) and maintenance programs should be implemented and pest control and monitoring should be in place.

## **Equipment**

### Visual III.2-3

#### **Sanitary Considerations for Equipment**

- All equipment and containers that come in direct contact with produce or ingredients should be stainless steel or plastic, if possible, since these materials can easily be cleaned, disinfected and hygienically maintained.
- Equipment must have smooth surfaces and be placed in locations that can facilitate adequate cleaning.
- Equipment should not have loose bolts, knobs, or movable parts that could accidentally fall off.
- If equipment has any paint on it, the paint should be approved for food processing equipment and it should not chip easily. Rust should be removed so it will not flake off onto the product.
- Oil leaks and over-lubrication must be avoided. Only food grade oil and lubricants should be used.

All equipment used for washing and sorting of fresh produce should be designed for easy cleaning and maintained properly to prevent contamination. If possible, all equipment and containers that come in direct contact with produce or ingredients should be stainless steel or plastic since these materials can easily be cleaned, disinfected and hygienically maintained. Equipment should have smooth surfaces and be placed in locations that can facilitate adequate cleaning. There should be no loose bolts, knobs, or movable parts that could accidentally fall off and, if the equipment has any paint on it, the paint should be approved for food processing equipment and it should not chip easily. Rust should be removed so it will not flake off onto the product. Oil leaks and over-lubrication must be avoided. Only food grade oil and lubricants should be used.

### Visual III.2-4

#### **Additional considerations for packing equipment:**

- A complete equipment cleaning and maintenance program should be implemented to prevent hazards to the operator and the consumer.
- Equipment malfunctions should be reported as soon as they start to develop, so that the necessary precautions can be taken before a small problem can become something more serious.
- It is a good practice to assign a responsible individual to each piece of equipment so that person can become familiar with the equipment and its proper operation.

A complete equipment cleaning and maintenance program should be designed and implemented. Such a program prevents hazards to the operator and the consumer. Equipment malfunctions should be reported as soon as they start to develop, so that the necessary precautions can be taken before a small problem can become something more serious. It is a good practice to assign a responsible individual to each piece of equipment so that person can become familiar with the equipment and its proper operation.

## **Containers**

### Visual III.2-5

#### **Good Manufacturing Practices for containers:**

- Containers should be made of non-toxic materials and constructed so they can be cleaned and sanitized easily.
- Damaged containers should be discarded when cleaning becomes difficult or when the damage is such that they might break and pieces fall into the produce.
- Containers used for transporting produce should be cleaned and disinfected after each use.
- Containers that have been in direct contact with soil, mud, compost or fecal material should be properly marked and should not enter the receiving or packing facility at any time. A second set of crates can be used for produce entering the packing facility.
- Containers used for fresh produce should not be used to transport any other items including lunches, tools, combustibles, pesticides or any other materials. These practices can result in chemical or microbial hazards to the consumer.
- Within the packing facility, it is a good practice to color code or label containers that are used for transporting the product before and after washing and keep them well separated to avoid cross contamination.
- Pest control and monitoring of infestation should be considered during container inspections.

To prevent contamination of produce, containers used for fruit and vegetable harvesting, transportation from the fields and during packing or storage should be clean and sanitized. The integrity of the container is important since many of the physical contaminants in fresh produce are introduced from the containers being used (i.e. fibers, wood or plastic chips/pieces, etc.). Containers used for fresh produce should not be used to transport any other items including lunches, tools, combustibles, pesticides or any other materials. Within the packing facility, it is a good practice to color code or label containers that are used for transporting the

product before and after washing and keep them well separated to avoid cross contamination.

## **Trash and Waste Handling**

Visual III.2-6

### **Good Manufacturing Practices related to trash and waste handling:**

- It is important to designate a specific secure, confined area outside the processing facility for the temporary holding of trash and produce waste.
- The trash and waste collection center should be constructed to facilitate cleaning and to avoid accumulation of residue and bad odors. This area must be well outside the production perimeter. It is important to use closed containers and to consider dominant winds to avoid bad odors in the production and packing facilities and the surrounding neighborhood.
- Trash containers and wastebaskets used inside the production and packing areas must be conveniently located, properly identified, should be able to be tightly closed, and not easily overturned.
- Trash and waste material should be removed often. It is important to include a trash collection schedule in the daily cleaning activities.
- Separation of organic and inorganic waste material with appropriate recycling is recommended.

Trash and fruit or vegetable waste can be a source of microbiological contaminants. Decomposing organic matter can serve to spread microorganisms around the facility, produce offensive odors, and attract insects and other pests bearing pathogenic organisms. Trash and waste materials should be stored in designated sites and should be removed daily. The collection site should be constructed for easy cleaning, should use closed containers, and should be located so that winds do not blow odors into the production and packing facilities or the surrounding neighborhood. Separation of organic and inorganic wastes with appropriate recycling is recommended.

## **Storage of Packing Material**

Visual III.2-7

### **Selection of a packing material storage location:**

- The storage area must be clean, dry, and free from trash, insects, and animals.
- The ceiling should be checked for leaks before placing the material in the storage location.
- The storage location should be well separated from all chemical agents and from storage areas used for chemicals or other hazardous materials.
- Storing packing materials on pallets is a good practice to avoid direct contact of the packing materials with floors.

Packing material such as cardboard boxes, plastic bags, etc. must be stored in a place designated for this purpose. This area should be clean, dry, and free of trash, insects, and animals. The packing materials should be kept away from any contamination sources.

During packing operations it is important to avoid damage to containers. Boxes should not be stapled since staples can damage packages and may contaminate the produce. New boxes and bags should be used at all times. Plastic bags and food contact surfaces should be made of food grade plastics to prevent the migration of chemical contaminants to the fresh produce.

## **Produce Storage**

Visual III.2-8

### **Good Manufacturing Practices related to fresh fruit and vegetable storage:**

- All products should be stored in a clean location using an organized system. Codes and inventory rotation are important to minimize the time that the commodity is stored and to facilitate recall, in case of problems later in the food chain.
- Boxes of product should be placed on pallets to avoid direct contact with floors.
- There must be a minimum separation between pallets and walls of 45 cm (17.5 inches). Allow 10 cm (4 inches) between pallets and floors. Such separation allows adequate ventilation and facilitates cleaning and inspection for rodents and insects.
- Chemicals, trash, waste or odorous material must not be stored near products.
- Fruit and vegetable storage areas or chambers should have accurate, recorded temperature and humidity control to prevent or delay microbial growth. The proper storage temperature and relative humidity will vary considerably depending on the commodity and its specific requirements.
- Walls, floors and ceilings must be systematically and periodically cleaned to avoid filth accumulation.

As with all produce-handling areas, hygiene and temperature control in storage rooms are critical factors in minimizing contamination and maintaining produce safety and quality. There should be an established cleaning and sanitation schedule for all produce storage areas.

### **Transportation**

Proper handling of fruits and vegetables during transportation is critical to the safety of the produce. All of the time and effort taken to minimize microbial contamination and to monitor quality during field production, harvest, washing and packing will be wasted if the conditions for transportation are not appropriate.

Visual III.2-9

#### **Shipping Container Sanitation is Critical**

- It is important to ask the freight company to keep a detailed log of previous loads and to clean and sanitize containers between loads. This needs to be checked before fresh fruits or vegetables are placed in the unit.
- A complete inspection of the trailer or container should be performed before the product is loaded. Be aware of bad smells, visible dirt or traces of organic matter.

Fresh produce is generally transported in trailers or in overseas containers. It is important to remember that freight companies also transport other materials. In the best case scenario, shipping containers would be food grade, only used to transport the same food, and thoroughly cleaned and sanitized between loads. However, every producer should ask what type of food was previously transported in containers offered for their produce. Produce should not be transported in containers that have been used to transport fish, raw meat, eggs and other commodities that are significant sources of foodborne pathogens unless these containers have been adequately cleaned and sanitized.

In an ideal situation the transportation unit would be sanitized after each load. However, since transport companies have other priorities, they may be unaware of sanitation requirements for fresh produce. Sanitation frequency will often be dictated by previous load history, type of produce and type of package, among other aspects.

### Visual III.2-10

#### **Important considerations for fruit and vegetable transportation units**

- Trailers and containers must be free of visible filth, odors and food particles.
- Transportation units should not have any water condensation and should not be wet.
- Hermetic seals are highly recommended to avoid pest access and environmental contamination during transportation.
- If the fresh commodity requires refrigeration during transportation, refrigeration equipment should be functioning appropriately. Temperature monitoring devices should be used to monitor the performance of the refrigeration system.

If the previous load history indicates that the transportation unit has been used recently for transporting animals, raw foods, or chemical substances the produce should not be placed in the unit until appropriate cleaning and sanitizing measures have been taken. The trailer or container should be washed and decontaminated using procedures similar to those described for food processing equipment. Trailers and containers must be free of visible filth and food particles. Odors are a sign trucks additional cleaning is needed since bad smells can be an indication of microbiological contamination and poor cleaning practices. Many of the cleaning and sanitizing chemicals described for use in disinfecting produce can be used as long as they don't cause corrosion of the unit.

#### Refrigerated Transportation

### Visual III.2-11

- When products are stored at their optimum temperature, the shelf life is extended, appearance is more attractive and higher quality is maintained.
- In addition to these quality benefits, keeping a low temperature during transportation also can inhibit or greatly retard the growth of pathogens. The optimum storage and transportation temperature will depend on the sensitivity of the commodity to chill injury and on the reduced growth of pathogens at lower temperatures.

Storage and transportation temperatures that are too low can damage some tropical fruits and other highly perishable commodities (i.e. bananas and tomatoes). For these products, the industry uses storage and transportation temperatures between 10 to 15°C (50 to 59 °F). For non-chill sensitive commodities, the optimum temperature range is as low as possible, without causing freezing, usually from 0 to 5°C (32 to 41 °F). In addition to temperature, the relative humidity of the transportation unit should be considered to prevent either dehydration or condensate build-up. Recommended temperature and

humidity for storage of many produce products are provided in Part V of the Additional Resources. These recommendations also would apply to transportation conditions.

Visual III.2-12

**Additional GMPs for refrigerated transportation units:**

- Refrigeration and cooling systems should be inspected before each trip to ensure they are working properly. They should also be under a scheduled maintenance plan.
- Minimize staging time (time between removal from cold storage and loading into refrigerated containers). Consider turning on refrigeration units and cooling transportation container before loading.
- Allow for proper air circulation in the trailer or container by properly stacking, and not overloading the product.
- Temperature records should be maintained during transportation.
- Temperature recorders must be calibrated and tamper-proof to ensure that the proper storage temperature is being maintained.
- Refrigeration coils should be clean and should not drip condensate on the load.

Training of drivers and other transportation and handling personnel is important. They should be sensitized to the importance of temperature control and transit time on maintaining the safety and quality of the fresh commodity. Maintenance of trucks to ensure that they reach their destination without delay is also important. Temperature records during transportation help ensure the produce is maintained at the proper temperatures.

**Summary**

1. Regardless of the size of the production operation, good manufacturing practices are essential to ensure consistent fresh produce quality and to prevent the handling environment from becoming a source of microbial, physical or chemical contamination.
2. It is important to keep all packing and storage areas free from chemicals, trash, machinery, harvest residues and waste materials to discourage pests and prevent produce contamination in these facilities.
3. All equipment used for washing and sorting fresh produce should be designed for easy cleaning and maintained properly to prevent contamination.
4. To prevent produce contamination, any containers used for fruit and vegetable harvesting, transportation from the fields and during packing or storage should be clean and sanitized and maintained intact. Plastic containers should be of food grade plastic.

5. Trash and fruit or vegetable waste can be a source of biological contaminants. Trash and waste materials should be stored in designated sites and should be removed daily. The collection site should be constructed for easy cleaning, should use closed containers, and should be located so that winds do not blow odors into the production and packing facilities or the surrounding neighborhood.
6. Hygiene and temperature control in storage rooms is critical factors in minimizing contamination, reducing pests, and maintaining produce safety and quality. There should be an established cleaning and sanitation schedule for all produce storage areas.
7. Produce should not be transported in containers that have been used to transport fish, raw meat, eggs and other commodities that are significant sources of foodborne pathogens unless these containers have been adequately cleaned and sanitized. Refrigerated units should maintain proper temperatures for produce safety and quality.

## **Module 3**

### **Equipment Cleaning and Sanitation**

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#### **Learning Outcomes**

- *Participants should be aware of proper cleaning and sanitizing practices for equipment, containers, utensils and facilities in produce handling operations.*

#### **Practical**

- *Laboratory Exercise: Experiments with Artificial Germs:  
How Germs are Spread II  
Germs and Produce*
- 

To reduce the risk of contaminating fruits and vegetables, strict cleaning and sanitizing procedures must be followed on all equipment, utensils, containers and in handling facilities.

Visual III.3-1

#### **What should be cleaned and sanitized?**

- All facility equipment, containers, utensils and facilities.
- The same procedures should be applied for the sanitation of tools, containers and all surfaces that come in contact with the fruit or vegetable during production in the field, harvesting, field packaging or transportation.

#### **Cleaning Procedures**

Cleaning includes the use of both physical methods, such as scrubbing, and chemical methods like detergents, acids or alkalis to remove dirt, dust, food residues and other debris from surfaces. These methods may be used separately or in combination.

Visual III.3-2

#### **Detergent**

- Material that reduces surface tension of water increasing its ability to interact with organic and aqueous media.
- This property gives detergents the ability to remove and/or eliminate undesirable contaminating substances present on surfaces.

A detergent is a material that reduces surface tension of water. The reduction of water surface tension allows detergent penetration. This helps the detergent displace and suspend particles from processing surfaces and equipment. Water rinsing then moves particles away.

Visual III.3-3

<b>Characteristics of a Good Cleaning Agent (Detergent):</b>
<ul style="list-style-type: none"> <li>• Complete and rapid solubility</li> <li>• Non-corrosive to metallic surfaces</li> <li>• Good moistening action</li> <li>• Good dispersion or suspension properties</li> <li>• Good rinsing properties</li> <li>• Germicide action</li> <li>• Low cost</li> <li>• Non-toxic</li> </ul>

A good detergent should have complete and rapid solubility, be non-corrosive to metallic surfaces, have good moistening action and offer good dispersion or suspension, and rinsing properties, germicidal action and low cost. When selecting the proper cleaning product, it is important to know what surface material it will act on and which material(s) it will remove. The following visual offers recommendations for selecting of cleaning compounds based on the surface being cleaned.

Visual III.3-4

<b>TYPE OF SURFACE</b>	<b>RECOMMENDED CLEANING SUBSTANCE</b>	<b>FREQUENCY OF USE</b>
Stainless steel	Alkaline, not abrasive Acid, not abrasive	Daily Weekly
Metals (copper, aluminum, galvanized surfaces)	Moderately alkaline substances with corrosion inhibitors	Daily
Wood	Detergents with surfactants	Daily
Rubber	Alkaline Substances	Daily
Glass	Moderately alkaline substances	Daily
Concrete Floors	Alkaline	Daily

To prevent produce contamination, all equipment and utensils must be cleaned and sanitized following the guidelines and frequency established in the Sanitation Standard Operating Procedures (SSOPs), or when the circumstances require it.

#### Visual III.3-5

To clean effectively, it is necessary to use appropriate tools. Examples of common tools used to clean processing and packaging equipment and food processing facilities include:

- Sponges
- Brooms
- Scrapers
- Scrubs
- Pressure water guns

Cleaning tools can be a major source of biological hazards when not handled properly. Cleaning tools should be rinsed and sanitized after use, and replaced regularly to avoid the development of microorganisms on their surfaces.

Cleaning tools are necessary to clean effectively. However, cleaning tools can be a major source of biological hazards when not handled properly. Cleaning tools should be rinsed and sanitized after use, and replaced regularly to avoid the development of microorganisms on their surfaces.

Cleaning procedures cannot guarantee the reduction of microorganisms, however, they can minimize the formation of bio-films. To eliminate microorganisms, it is necessary to treat surfaces with chemical agents generally called equipment sanitizers or disinfectants.

### **Sanitizing Procedures**

#### Visual III.3-6

Sanitize food contact surfaces means to adequately treat clean food-contact surfaces by a process that is effective in destroying or substantially reducing the numbers of microorganisms of public health concern, as well as other undesirable microorganisms, without adversely affecting the quality of the product or its safety to the consumer. It means the application of cumulative heat or chemicals on cleaned food-contact surfaces that, when evaluated for efficacy, is sufficient to reduce populations of representative microorganisms by 99.999%.

To sanitize food contact surfaces means to adequately treat clean food-contact surfaces by a process that is effective in destroying or substantially reducing the numbers of microorganisms of public health concern as well as other undesirable

microorganisms, without adversely affecting the quality of the product or its safety to the consumer. It means the application of cumulative heat or chemicals on cleaned food-contact surfaces that, when evaluated for efficacy, is sufficient to reduce populations of representative microorganisms by 99.999% (U.S. Public Health Service, FDA, 1997).

Sanitizing is not a substitute cleaning procedure. Organic and inorganic matter affects the germicidal action of many sanitizers therefore cleaning to remove dust, dirt and food residues should always be done before the application of a sanitizing agent. Good manufacturing practices also can prevent the formation of bio-films which bacteria may develop to protect themselves from the action of sanitizers.

Visual III.3-7

**Factors to consider when selecting a sanitizing agent**

- Type of equipment and kind of surface being sanitized
- Water hardness
- Sanitizing equipment available
- Effectiveness against important pathogens associated with the types of products being processed or to the processing environment
- Effectiveness under practical conditions

The selection of a sanitizer for produce handling equipment will depend largely on the target microorganism, the type of produce being processed and the material of the surfaces that come in direct contact with the produce. Other important considerations are the type of water and the cleaning procedure being used.

A sanitizing agent with a broad action spectrum is recommended for the destruction of pathogenic microorganisms on different equipment surfaces. For some sanitizing activities it is necessary to use alternate agents. Developing a rotation schedule for cleaning and sanitizing agents should lessen the likelihood of pathogens developing resistance to a specific sanitizing agent.

Visual III.3-8

**Common Agents Used for Equipment Sanitation Include:**

- Chlorine and chlorinating agents, including hypochlorite compounds
- Quaternary Ammonium Compounds (Quats)
- Strong acids and alkali

Sanitizers and their use on produce were discussed in Module 1. The following discussion identifies some special considerations when using sanitizers on processing equipment.

### Chlorine and Chlorine Compounds

When properly used, these substances can be considered among the most useful equipment sanitizing agents. However, pH, temperature and organic load dramatically affect the activity of chlorine. Chlorinating agents have a rapid effect over a large variety of microorganisms and are relatively inexpensive. This group of disinfectants is highly corrosive to metals and can also bleach equipment therefore, rinsing equipment surfaces immediately after the proper contact time is strongly recommended.

#### Visual III.3-9

##### **Free Residual Chlorine**

The amount of free residual chlorine is very important for plant sanitation since the rate at which bacteria are killed is proportional to the residual chlorine concentration.

The amount of free residual chlorine is very important for plant sanitation since the rate at which bacteria are killed is proportional to its concentration (Gavin and Weddig, 1995). As discussed in Module 1, sanitation waters must be chlorinated to a point where free residual chlorine concentrations of significant germicidal power exist. Sanitizers containing a concentration of 2-7 ppm free residual chlorine are considered to have significant bactericidal power. These can be applied to conveyor belts and equipment using continuous/intermittent sprayers or by flooding. Solutions of higher concentration (20-50 ppm) can be used for equipment and cleanup.

The length of contact time, pH and temperature of the sanitizer are also important considerations in achieving effective sanitizing. Increasing the temperature of the chlorinated water can cause considerable depletion of chlorine unless the solution contains organic nitrogen to interact with the chlorine to form chloramines, which have germicidal power.

Many operations inject chlorine gas into the water to prepare sanitizing solutions. When this is done, it is important to consider the water temperature as this affects the solubility of the chlorine gas (Gavin and Weddig, 1995).

### Iodine Compounds (Iodophores)

Iodine compounds are widely used to sanitize food processing equipment and surfaces. The most commonly used are ethanol-iodine solutions, aqueous iodine

solutions and iodophors, which are combinations of elemental iodine with anionic surfactants of nonyl-phenol ethoxylates or carriers such as polyvinylpyrrolidone.

At concentrations of 6-13 ppm of free iodine (pH 6.6- 7.0) for a contact time of 3-15 seconds the population of vegetative bacterial cells can be reduced 90%. Bacterial spores are more resistant to iodine than vegetative cells (Beuchat, 1998). For cleaning equipment surfaces, a solution with 25-50 milligrams of iodine per liter (ppm) at a pH 3-4 is normally recommended.

Iodophors are the iodine compounds most frequently used in the food industry (Gorny, 2001). They have a wide spectrum of action, are effective against yeasts and molds and are very convenient if an acid cleaner is needed. Their effect is fast and they have wide antimicrobial activity. Iodophors have the advantage of being less corrosive than chlorine at low temperatures. However, they vaporize at temperatures above 50°C (122°F) where they can be highly corrosive and their effectiveness is reduced at low temperatures (Beuchat, 1998). Iodophors are most effective in a pH range of 2-5 but they can remain active under mildly alkaline conditions depending on other conditions.

Iodophores lose their effectiveness in the presence of organic material and at pH 7 or greater. It is possible to visually observe the efficacy of iodophores, since they lose their color when residual iodine reaches ineffective levels.

Depending on solution composition and the nature of the surface to which it is applied, iodophores at high concentrations may have a corrosive action on metals. For this reason, it is important to thoroughly rinse treated surfaces with water after iodophore application. For surfaces that don't damage easily, iodophores can be applied without a final rinse.

#### Quaternary Ammonium Compounds (Quats)

Quats have good detergent characteristics. They are colorless, have relatively low corrosiveness with metals, and are non-toxic. Quats are good sanitizers although they are selective for some types of bacteria (i.e. not effective against *E. coli* and *Pseudomonas aeruginosa*). Because of this selectiveness, an occasional chlorine treatment is useful to maintain adequate plant sanitation.

Quaternary ammonium solutions should be used at levels between 200-1200 milligrams per liter. When hard water is used, higher concentrations are needed. Quats are not affected by organic matter but also are not compatible with soaps or anionic detergents. Quats tend to adhere to equipment surfaces, thus it is necessary to rinse thoroughly with potable water after their application.

Because of their low corrosive nature, quats are generally used to sanitize floors, walls, ceilings and other parts of refrigerated compartments. However, they have

the unfortunate limitation of inactivation by wood, cotton, nylon, cellulose sponges and some plastics (Gavin and Weddig, 1995).

### Other Sanitizing Agents

In addition to having detergent properties, strong acids and bases possess considerable antimicrobial activity. When these materials are applied to processing equipment it is important to avoid contamination of foods since the acid or base can harm the consumer. All treated surfaces must be rinsed with abundant amounts of water after treatment.

Ultraviolet light (UV) has some applications as a surface sanitizer. However, because of its low penetration power, it is mainly used to kill airborne microorganisms especially mold spores in air circulation systems, above packaging areas, in cool rooms, etc.

Ozone has some use as a plant sanitizer. It is used to treat water and storage rooms. Ozone is effective against microorganisms in cold water and in recirculated water systems.

### Water Quality and Sanitizers

Water is the main component of sanitizing solutions and it can be a factor in the effectiveness of the sanitation procedures. Water used to mix sanitation solutions, must be of good quality. Organic load, turbidity, and presence of pathogens in the water used in sanitizing solutions can alter the effectiveness of sanitation procedures.

### Handling of Sanitizing Substances

Visual III.3-10

#### **Recommendations for the safe handling of sanitizing agents:**

- When using alkaline or acid substances employees must wear goggles and protective clothing.
- Sanitizers must be stored in a separate facility, away from fresh produce and packaging material.
- The specific handling and usage instructions for each product must be carefully followed.
- Sanitizing agents are classified as pesticide chemicals therefore they are subject to usage and disposal regulations, specific for each country.

Legally in the U.S. sanitizers intended for use on semi-permanent or permanent food contact surfaces (other than food packaging) are “pesticides” and must be registered with the Environmental Protection Agency (Gorny, 2001). Residues

that remain on the food contact surfaces are pesticide chemical residues that are subject to EPA tolerance regulations.

The recommendations for handling chemical pesticides discussed in Section II, Module 3 apply to the use of sanitizing agents. Protective equipment such as gloves, boots, goggles and, in some cases, masks, should be used. Operators must be trained on the proper handling and preparation of sanitizing solutions.

Visual III.3-11

**Dangerous mixtures of sanitizing agents**

- To avoid abrupt neutralization reactions, alkaline and acid sanitizing products should not be mixed (e.g. chlorine mixed with ammonia is extremely dangerous).
- Acid products should not be mixed with hypochloric solutions since they can produce chlorine gas, which can be toxic

Different sanitizing substances should not be mixed because dangerous reactions may occur. To avoid abrupt neutralization reactions that can result in splattering and/or noxious fumes, alkaline and acid sanitizing products should not be mixed (e.g. chlorine mixed with ammonia is extremely dangerous). Acid products should not be mixed with hypochloric solutions since they can produce chlorine gas, which can be toxic.

**Summary**

1. To reduce the risk of contaminating fruits and vegetables, strict cleaning and sanitizing procedures must be followed on all equipment, utensils, containers and in handling facilities.
2. Cleaning includes the use of both physical methods, such as scrubbing, and chemical methods like detergents, acids or alkalis to remove soil and many surface contaminants. These methods may be used separately or in combination. When selecting the proper cleaning product, it is important to know what surface material it will act on and which material(s) it will remove.
3. The selection of a sanitizer will depend largely on the target microorganism(s), the type of produce being processed and the material of the surfaces that come in direct contact with the sanitizer. Common agents used for equipment sanitation include chlorine and chlorinating agents, including hypochlorite compounds, iodine, quaternary ammonium compounds (Quats), and strong acids and alkali.

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