

# **Good Agricultural and Handling Practices for Grapes and Other Fresh Produce**



**P.L. Brady and J.R. Morris**

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Front and back cover photos courtesy of the University of Arkansas Viticulture and Enology Program; cover photo shows Sunbelt grapes developed by J.N. Moore, J.R. Morris, and J.R. Clark at the University of Arkansas. Sunbelt has characteristics similar to Concord, differing primarily in its ability to ripen more evenly in warm climates. Its juice quality is equal to or better than that of Concord.

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# **Good Agricultural and Handling Practices for Grapes and Other Fresh Produce**

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## Impact Statement

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Many owners of small- and medium-size farms in Arkansas and throughout the U.S. are finding it difficult to remain economically viable with traditional crops. Increasingly, these growers are exploring the potential for sustainability offered by the production of alternative crops such as grapes and other types of produce. However, recent nationwide outbreaks of foodborne illness linked to produce have demonstrated that these foods may be carriers of hazards, and, when this occurs, the effects can be devastating both for producers and consumers.

There are many activities that take place as grapes and other produce move from the farm to the consumer's table. These include activities related to production, post-harvest handling, packaging, transportation, and storage. Adequate food-safety precautions at each of these stages are absolutely necessary. Implementation of safety programs such as the Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) discussed in this publication is an important step in reducing possible hazards associated with produce throughout the production and distribution chain.

## Good Agricultural and Handling Practices for Grapes and Other Fresh Produce

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### Introduction

In recent years consumption of fresh fruits and vegetables has increased dramatically. This trend has increased the amount of produce being purchased at farmer's markets, road-side stands, and neighborhood markets since consumers say they feel that the direct contact with growers at these markets makes them better able to assess the quality and safety of the produce. This buying trend has opened new markets to small- and medium-sized farms, which sell at these local outlets.

Grapes, like a majority of fruits and vegetables eaten in the U.S., are wholesome and free of most microorganisms. However, since grapes and many other produce products are eaten without any cooking to kill potentially harmful organisms that might be present, the best approach to maintaining a safe product is for growers, processors, and others who handle the products to be aware of possible risks and to constantly take steps to assure that the produce they grow is safe. There are many activities that take place in the production, handling, and marketing of fresh fruits and vegetables. Each of these activities should be carefully assessed and appropriate steps taken to assure the safety and wholesomeness of the produce.

### Consumers and Produce Safety

The 2005 Dietary Guidelines for Americans recommended eating at least four and a half cups (9 servings) of fruits and vegetables a day. As a result of these Guidelines and other recommendations for improved health, Americans are choosing to include more produce in their diets. Grapes have been a popular choice for many Americans seeking to eat healthier since studies have shown they are high in many health-promoting components.

In addition to eating healthier, busy consumers want foods that can be prepared quickly and easily. Grapes and other fresh produce meet this requirement since most produce can be eaten without cooking. Like many fruits, grapes require very little preparation other than washing. Some fruits and vegetables may also need to be cut into pieces before serving. Many grocery stores are now making fruits and vegetables more convenient for consumers by offering fresh-cut produce that is ready to eat directly from the package.

As a final incentive to eat more produce, improvements in transportation and storage systems and greater numbers of imports from other countries have dramatically increased the variety of

fruits and vegetables available at reasonable prices year-round.

While fruit and vegetable consumption has been increasing, diseases transmitted by foods have become a major public health concern. Although a

relatively small percentage of all food-borne disease is caused by eating produce, there has been an increase in foodborne illness associated with fruits and vegetables. Growers and handlers of fresh produce must carefully control the factors that can affect the safety of their products. ■



### HAZARDS IN FRESH PRODUCE

A hazard is something that could cause harm to the consumer. There are three main types of hazards associated with fresh fruits and vegetables:

➔ Biological hazards result from microorganisms such as bacteria, viruses, and parasites as well as some fungi that produce toxins (poisons). These microorganisms can contaminate produce any time from when it is in the field until it is eaten.

➔ Chemical hazards arise from contamination of product with harmful or potentially harmful chemicals. This hazard may be due to chemicals naturally

in the produce. It may be due to chemicals used during agricultural production, to additives used in fruit handling and processing, or to materials used to extend storage life.

➔ Physical hazards are materials that are not supposed to be in the product. This might be stones, sticks, or other material accidentally picked up during harvest. Foreign material, like pieces of packing boxes, staples, metal slivers, etc., that get into the produce during handling or transportation are also physical hazards sometimes found in grapes and other fresh fruits and vegetables. ■



## **GOOD AGRICULTURAL PRACTICES (GAPs) FOR PRODUCE GROWERS**

The key principle to growing grapes and other produce safely is to remember that prevention of contamination is much more effective than corrective actions after contamination has occurred.

Good Agricultural Practices (GAPs) are scientifically based guidelines to reduce or eliminate microbial contamination of fresh produce in the field and in packing houses. Application of these guidelines along with practices to reduce other hazards can help minimize food safety hazards.

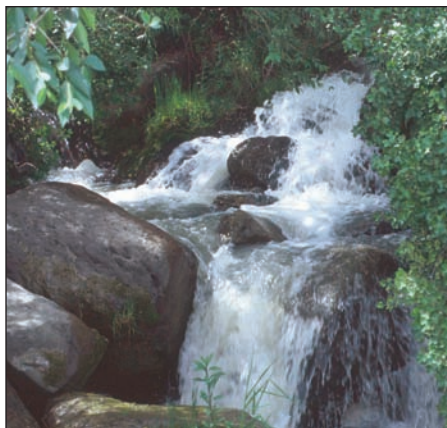
### **GAPs in Field Site Selection**

Selection of the appropriate site is critical to establishing a productive farm or vineyard. It is also the first step to assuring safe product. Previous use of the land, prior agricultural production practices, and the location of the site relative to potential hazards all can affect the safety of produce grown on the site.

Agricultural land that was used previously for activities other than growing food crops may be contaminated with disease-causing organisms or toxic chemicals. Land that was used for animal production may contain disease-causing microorganisms from the animals. The risk of contamination from prior use of the land is related to the time that has passed since the land was used for other activities.

Even when an investigation of the prior use of the land indicates that it was used solely for growing crops, prior production practices should be reviewed. Practices such as improper use of animal or chemical fertilizers can increase the potential risks.

### **GAPs for Water**



Water is used for many agricultural activities, including irrigation, pesticide and fertilizer application, cooling, and frost protection. Microorganisms in water used for these activities can contaminate fruits and vegetables. The severity of the hazard resulting from poor water quality depends on the type and number of microorganisms in the water and their ability to survive on the produce.

Although the trickle irrigation used in many vineyards limits the expo-



sure of the grapes to irrigation water, other activities still offer risk of fruit contamination if water quality is not maintained.

Growers should identify the source of all agricultural water and determine its potential contamination.

Agricultural water sources include surface waters such as rivers, streams, irrigation ditches, and open canals; impoundments such as ponds, reservoirs, and lakes; groundwater from wells; and, occasionally, public water systems.

It is generally assumed that ground water is less likely to be contaminated than surface water since surface water often flows through a variety of environmental situations that may expose it to contamination. However, care must be taken to assure ground water sources such as wells are designed and maintained so that water does not become contaminated.

Potential contamination sources for surface water include animal production areas, manure applied to land, industrial operations, and areas of concentrated human populations. Although there is little a grower can do about these sources, it is important that the grower be aware of potential problems from up-stream sources and take every possible step to minimize possible contamination.

Improperly managed human and animal wastes are important sources of contamination for agricultural water. Human contamination may occur from improperly designed or poorly managed septic systems, from sewage treatment discharges, and from sewer system and storm drain overflows.

The presence of coliform bacteria is an indicator that water has fecal contamination. The maximum contaminant level (MCL) for total coliform/*E. coli* in drinking water is zero. Although there are no defined standards for agricultural water, GAPs recommend applying drinking-water standards to agricultural water.

Water should be tested regularly to assure it is free of coliform contamination. Testing of open water sources should generally occur more frequently than testing of closed sources like wells.

In addition to microbial hazards, water also can contain chemical contaminants. Hazardous chemicals may get into water that flows through soils containing high levels of chemicals. Water washing over road beds, over fields and lawns

treated with pesticides, herbicides, or fertilizers, or through dump sites or other areas high in potentially hazardous materials can pick up chemicals that may contaminate grapes and other fruits and vegetables.

Water used for applications of pesticides and foliar fertilizers also can be a source of produce contamination. For this reason, only good quality water should be used for produce growing/processing.

The stage of development of the fruit or vegetable and the time between when the product is contaminated and harvest play important roles in determining the level of contamination. The risk of the contamination being carried over to the consumer is greatest if contamination occurs near or after harvest.

### **GAPs and Animals**

All animals are potential sources of contamination for produce since animals carry microorganisms both on and in their bodies. In addition, they are in constant contact with soil, manure, and water where they can pick up additional contaminants.

Grapes and other produce may be contaminated by animal wastes when farm animals are pastured in or near vineyards or other growing areas. Allowing

dogs and other pets in vineyards or cultivated fields also increases the possibility of product contamination. High concentrations of birds and other wildlife around growing produce are also potential sources of contamination on the farm. While it is not possible to keep all animals out of fields and vineyards, keeping out as much animal life as possible not only improves the safety of the product but also aids in preventing damage to the crop, which can lower market value.

Although poultry litter and animal manure are not used as fertilizer in vineyards, properly treated manure and litter can be effective and safe fertilizer for other crops. However, if untreated, improperly treated, or recontaminated after treatment, manure may contain microorganisms that can contaminate the crops it is used on and may even become a hazard for other crops in nearby fields. Therefore, use of animal wastes as fertilizer must be closely managed to limit the potential for produce contamination. Maintaining records of waste-handling procedures is important to verify that proper safety measures were followed.

Insects and rodents that are commonly found in production and handling areas can carry microorganisms that can contaminate produce. These pests also can damage pack-



aging materials, other supplies, and buildings. Since pests are attracted to areas where they have food, water, and materials for nesting, cleaning is an important step for controlling them. Minimizing the presence of waste piles, culled fruit, and other attractants will help reduce the numbers of pests. In addition to good cleanliness practices, it also is important to implement a pest control program.

### **Worker Health and Safety is a GAP**

Field workers have close direct contact with most produce and especially with grapes. In some cases, they are the last people to touch the produce before it reaches the consumer. Anything a worker touches can be transferred to the surface of the produce and, ultimately, to the consumer. A training program should be in place to assure workers know and follow appropriate sanitation practices to protect the product.

All workers should be taught appropriate techniques for hand washing and the importance of following these techniques should be constantly reinforced by growers, supervisors, and foremen. Workers should be taught to wash their hands after using the toilet, eating, smoking, or engaging in any other activity that could lead to hand contamination.

Employees should be provided with adequate sanitary facilities. Toilet facilities should be provided close to the field or vineyard but they should be

placed so that there is no risk of contaminating water, soil, or the fruit. Sanitary facilities should be maintained with adequate supplies of soap and disposable towels.

Employees should be provided with good quality water for drinking, hand washing, and sanitary needs. If gloves are used, employees must be taught that they are not a substitute for good hand sanitation and employees must be made aware of the safety considerations for their use.

Employees should be instructed to report any illness to their supervisors before beginning work. It should be clearly understood that workers with di-



arrhea or symptoms of other infectious diseases should not come in contact with fresh produce or produce-handling equipment. A policy for assigning infected workers to alternative work where they do not come in contact with the product should be in place to help assure the workers that reporting illness will not result in losing a day's pay. ■

## **GOOD HANDLING PRACTICES (GHPs) ARE CRITICAL TO ASSURE SAFETY OF GRAPES AND OTHER PRODUCE**

Efforts to assure safety do not end when grapes and other fruits and vegetables are harvested. In fact, studies have shown that the packing process is the point in the field-to-table chain where most fresh produce is at the greatest risk for contamination.

Good handling practices (GHPs) are sanitary procedures for the activities that move fruits and vegetables from the field to the consumer's table. The use of GHPs help reduce the risk of contamination of fresh produce during handling, packing, storage, and transportation.

While crops are in the field, soil, water, and air as well as humans and animals can contaminate surfaces with potentially hazardous microorganisms. During and after harvest many conditions come together that favor the growth of these organisms. Although there is very little that can be done during handling, processing, storage, and transporting of produce to reduce the numbers of contaminants present, care during these operations can keep contaminants from multiplying. In addition, appropriate handling will reduce the risk of increased hazards due to cross-contamination, temperature abuse, and elevated product respiration rates.

### **Harvesting and Handling**

Contamination of fresh produce, including grapes, can occur during harvest. Sources of this contamination include contact with field workers, environmental contaminants such as soil, water, and air, and unclean or contaminated equipment.

Harvest equipment including machinery, knives, containers, baskets, buckets, pallets, and lugs should be cleaned and sanitized before use, used appropriately, and kept as clean as possible. Containers and packing materials should be handled with care and kept clean and free from dirt and contaminants. Damaged or culled product should be removed from harvest equipment as soon as possible to avoid attracting pests.

### **Worker Health and Hygiene**

Workers who pick, process, or package produce can transfer contaminants to the product from their hands, clothing, or via coughs, sneezes, or open cuts or sores. Training workers about when and how to wash hands and the importance of good sanitation in all activities is as important to product safety and quality as product handling training.

Workers who are ill or have open wounds should not be allowed to contact the produce or produce-handling equipment. If workers are healthy enough and can safely do so, they may be assigned jobs that do not involve product contact.





### Post-Harvest Water Quality

Grapes are unique in that very little water is used in handling them after harvest. However, because water for post-harvest operations can be a significant source of contamination with most produce, it is important that all producers be aware of the ways water used in post-harvest handling can contribute to fruit and vegetable contamination.

For many fruits and vegetables, water is used in dump tanks to reduce injury to the produce when field containers are emptied onto the packing line. It also may be used for rinsing produce. Cold water may be used to remove field heat from the produce while hot water treatments can be used as a means of insect control for some commodities.

Water used for post-harvest operations should be free of disease-causing organisms. Therefore, it is recommended that all water used in produce processing meet EPA requirements for drinking water. Because contaminated water can

lead to product contamination, all equipment surfaces that the water contacts should be cleaned and sanitized to prevent contamination of the water.

Water used in produce-handling operations should be changed as often as necessary to maintain sanitary conditions. Microorganisms on the fruit can accumulate

in processing water and then be spread to other fruit. All recirculated water should be changed at least daily. It may need to be changed more frequently if the water becomes extremely dirty due to a buildup of waste matter from the produce.

Maintaining water quality for post-harvest handling of produce usually involves the addition of an approved sanitizer to the water. Chlorine is the sanitizer most commonly used in water for produce handling. Chlorine is available in a number of forms, including sodium hypochlorite, calcium hypochlorite, and liquid chlorine.

If chlorine is used as the sanitizer in water for use with fresh fruits and vegetables, it is important to monitor the free (unreacted) chlorine concentration in the water by taking water samples at least hourly to test for chlorine concentration. Local environmental codes should be consulted for rules pertaining to proper disposal of chlorinated water.

### **Cooling Considerations**

Good temperature management is a critical GHP for determining the ultimate quality of fresh produce. Post-harvest temperature control is vital to fruit and vegetable health. In addition, temperature influences the rate of growth of microorganisms which may be present on the product.

Temperature control for grapes begins at harvest. The general recommendation is to harvest grapes during the night or early in the morning when air temperature, and therefore fruit temperature, is lower. This is especially important when harvesting mechanically.

After harvest, all produce should be kept as cool as possible until it is removed from the field. Product waiting to be transferred to a packing facility, winery, or market should not be allowed to sit in the sun. Exposing picked fruits and vegetables to direct sun can result in a significant rise in their temperature. However, care should be taken to avoid contamination during shading. For example, boxes of grapes placed under vines for shading until they can be removed from the vineyard should be protected from insects and bird droppings.

Cooling fruit to storage temperatures as quickly as possible is another critical step for maintaining safety and quality. Rapid cooling is important because lower temperatures lead to less

multiplication of microorganisms and can lessen product spoilage by reducing the metabolic rate of the product and decreasing water loss. As a general rule, more quality is lost in one hour at 68°F than in 24 hours at 32°F.

Pre-cooling is the term commonly used to refer to any cooling treatment before shipping, storage, or processing. A number of methods are used for pre-cooling fruits and vegetables; however, the two most commonly used methods are cold air and cooling with water, i.e., hydrocooling.

Cooling of grapes should begin as soon after harvest as possible. Because post-harvest exposure to water may lower the quality of grapes, they are generally air-cooled using forced-air coolers to provide rapid cooling. Once cooled, grapes may be placed in storage rooms at 30°-32°F, 90-95% RH and moderate air flow to maintain quality until transfer to market. Some grapes destined for wine are destemmed, crushed, and the must cooled in the vineyard to preserve must quality for shipping to the winery.

Some produce is cooled or stored by packing it in ice. If this process is used, it is important that the ice is made from good quality water so it does not contaminate the produce. Water from melting ice should be removed in a way to prevent it from contacting and contaminating other produce.

## **Produce Cleaning and Treatment**

Washing and sanitizing fruits and vegetables are common methods to reduce surface contamination. However, some commodities with large surface areas that readily hold water, like strawberries, other berries, and grapes, have significantly reduced shelf life if they are washed prior to storage. For these products, air is the best cleaning method to remove dust and debris. With these commodities, prevention of contamination is the best way to control surface microorganisms.

Fruits and vegetables whose structures can tolerate water should be washed, since this reduces the numbers of microorganisms on the product and lowers the risk of foodborne illness associated with the produce. Reducing the number of organisms also helps decrease spoilage and improves appearance and nutritive value.

Water used to wash produce must be free of organisms that might cause disease. The initial wash to remove surface dirt can be with water alone or with water containing food-grade detergents or permanganate salts.

Equipment used for washing produce should be selected based on the characteristics of the produce. Soft produce is generally washed with a water spray as the product moves along on conveyor belts. More-solid fruits and vegeta-

bles may be washed in rotating devices or on flumes. Root crops are typically cleaned with brush washers that contain cylindrical rotating brushes. Regardless of the type of equipment used, all equipment should be cleaned and sanitized before use with fruits and vegetables and recleaned whenever dirt buildup occurs.

After produce is cleaned, a sanitizing step, generally using chemical agents, usually follows. Sanitizing means treating clean produce to destroy or substantially reduce the numbers of microorganisms of public health concern, without adversely affecting the quality of the product or its safety.

It is important that the sanitation step be applied only to produce that has already been washed. Dirt can interfere with the ability of sanitizing agents to reduce the numbers of microorganisms.

Chlorine is the sanitizer most commonly used with produce, but there are many other sanitizing agents on the market. The effectiveness of each individual sanitizer is influenced by factors such as water temperature, pH, contact time, organic matter in the sanitizer solution, and the surface structure of the fruit or vegetable. The instructions from the sanitizer's manufacturer should always be strictly followed when using sanitizers. When in doubt about proper sanitizer use or when considering a new sanitizer for use on produce, it is important to contact the sanitizer manufacturer for guidance on how to use it effectively.



## **Produce Packing and Storage**

Packing and storage facilities will vary depending on the produce being processed and the size of the operation. Since grapes do not receive a wash treatment, many growers prefer to pack grapes in the field, thus eliminating the extra step of transporting the fruit to a packing house. Field packing also is becoming common for some other products.

The packing house can be a small shed near the field or a large building with many processing and storage areas. Regardless of the size of the operation or the produce being handled, GHPs are essential to prevent the physical facility from becoming a source of produce contamination and to ensure consistent produce quality.

Whether packing occurs in the field or in a packing house, all equipment used for handling freshly harvested 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 are easy to clean and sanitize

and less likely to splinter or chip. All equipment should be placed so that it is easy to clean around it. When not in use, equipment should be stored so that it is not exposed to contaminants.

If product is washed, it is a good practice to color-code or label containers so that it is easy to distinguish between those used for transporting the product before washing and those used for clean product. Keeping unwashed and washed product separated is necessary to avoid re-contaminating the cleaned product.

Steps also must be taken to prevent contamination of produce with foreign materials that could cause harm to consumers. Produce handling equipment should not have loose bolts, knobs, or movable parts that could accidentally fall off into the produce. If the equipment has any paint on it, the paint should be approved for food-processing equipment and should be applied so it does not chip easily. All equipment should be maintained so there is no rust that can flake off onto the product. Only food-grade oil

and lubricants should be used on processing and handling equipment, and oil leaks and over-lubrication must be avoided.



Packing boxes and crates should be handled so they do not chip or splinter. Packing containers should not be closed with staples or nails since these may become contaminants in the produce.

A complete equipment cleaning and maintenance program should be established. Equipment malfunctions should be reported as soon as they start to develop, so that the necessary precautions can be taken before a small problem becomes something more serious.

### Storage of Fresh Produce

All fresh fruits and vegetables should be stored in clean locations using an organized system. Codes should be placed on boxes to identify the contents and provide information about packing. These codes can help assure inventory rotation to minimize the time that the commodity is stored. They also will assist in a recall, in case of problems during distribution and marketing.

Boxes of product should be placed on pallets to avoid direct contact with floors. Pallets should be placed away from the walls and from each other to allow air flow and to make it easier to clean and inspect for rodents and insects.

Chemicals, trash, waste, or odorous material must not be stored near fresh fruits and vegetables. Walls,



floors, and ceilings of storage areas must be systematically and periodically cleaned to avoid accumulation of dirt or other contaminants.

Fruit and vegetable storage areas should have accurate, recorded temperature and humidity control to prevent or delay microbial growth and to maintain produce quality. The proper storage temperature and relative humidity will vary considerably depending on the commodity and its specific requirements.

### Transportation GHPs

Proper handling of fruits and vegetables during transportation is critical to the safety of fresh fruits and vegetables. Fresh produce is generally hauled in trucks or trailers. Trucks containing mixed loads should be packed to avoid cross-contamination.

Ideally the transportation vehicle would be sanitized after each load. It is important to remember that these vehicles also may haul other materials. If the

previous load included animals, raw foods such as fish, meat or eggs, or chemical substances, the produce should not be placed in the vehicle until appropriate cleaning and sanitizing measures have been taken.

Trucks, trailers, and transportation containers must be free of visible filth and food particles. Odors are a sign that the transportation equipment needs additional cleaning since bad smells can be an indication of microbiological contamination and/or poor cleaning. ■



### Costs and Benefits of Added Safety

Growers and processors deciding whether or not to adopt additional safety practices for their operations must weigh the costs of the practices against their benefits. Costs include:

- investments in facilities to ensure safe water
- worker training and/or re-training
- upgrades to records to verify safety procedures
- possible use of third-party audits to verify compliance with GAPs during production and GHPs in packing and handling.

Benefits of adopting better safety practices include:

- higher prices for quality produce
- reduced safety risks
- avoiding lost sales, damaged reputations, and potential law suits that may result if contaminated produce is identified with the operation.

Since many retailers and food-service buyers are now requiring third-party audits as a condition of purchase, higher safety standards can open potential markets for product. ■

### **Further Reading**

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