

# **Sanitation: The Key to Producing Safe Mushroom Products**

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The success of the mushroom industry in the last few decades can be attributed to consistent production of high quality and wholesome food products with tremendous consumer appeal. The growth of the industry has been accompanied by a dramatic shift in consumer preference away from processed products and toward fresh mushrooms. Today, fresh mushrooms account for 78 percent of total sales while only 22 percent are canned or frozen. Fresh market production now includes mushrooms that are washed, sliced, and packaged using new “fresh-cut processing” technologies. Because most mushrooms are not heat-treated to destroy microorganisms, the potential for contamination with harmful bacteria is now a more critical issue than ever before. As a result, the industry is increasingly faced with customer demands for assurances that mushrooms are grown, harvested, and handled under safe and sanitary conditions.

The key to producing safe mushroom products is to thoroughly consider the potential for product contamination from microbial, chemical, and physical hazards. Management at many companies does not always appreciate the benefits of an effective sanitation program. However, those companies that have made sanitation a top priority are not only producing safe products but also have gained in terms of product quality, productivity, morale, and customer satisfaction; all of which directly affect the company's bottom line.

The Food and Drug Administration has recommended the following eight key areas that should be considered when establishing a sanitation program: 1) Safety of the water that comes in contact with food or food-contact surfaces; 2) Condition and cleanliness of food contact surfaces; 3) Prevention of cross-contamination from unsanitary objects to food, food packaging material, and other food contact surfaces; 4) Maintenance of hand washing, sanitizing, and toilet facilities; 5) Control of employee

health conditions that could result in the microbiological contamination of food, food packaging materials, and food contact surfaces; 6) Protection of food, food packaging materials, and food contact surfaces from adulteration; 7) Proper labeling, storage, and use of toxic compounds; and 8) Exclusion of pests from the food plant. In this article, these important areas will be discussed with specific applications for mushroom growers, packers, and fresh-cut processors.

### ***Safety of the water that comes in contact with food or food-contact surfaces***

Water is extensively used in mushroom growing operations for preparation of compost and casing materials, irrigation, application of pesticides, and for general cleaning purposes. Post-harvest uses include facilities and equipment cleaning and sanitizing, mushroom wash treatments, and personal hygiene. Water can also be a vehicle for the spread of pathogenic microorganisms and chemical contaminants. It is essential, therefore, to be aware of the source and quality of water used throughout your operation. It is particularly important that water that contacts mushrooms or food contact surfaces such as equipment, containers, and packaging materials be free from harmful microorganisms and chemical contaminants.

Municipal water is considered the safest source of water because it must meet high chemical and microbiological standards, has been purified or treated, and is regularly monitored for the presence of contaminants. Well water is generally safe when obtained from properly constructed and maintained wells. However, it can become contaminated after heavy rains or floods, or from adjacent cesspools, septic tanks, or agricultural sites and should, therefore, be regularly monitored for the presence of microbial and chemical contaminants. Any water that does not meet current national standards for drinking water should immediately be treated with a disinfectant before use and the source of contamination determined. Untreated surface water from rivers, ponds, reservoirs, and lakes should never be used since its quality may vary unexpectedly over time.

Another way that harmful microorganisms have been known to enter a water supply is through faulty plumbing within a facility. Cross-connections in plumbing systems can allow potable water to inadvertently mix with a potentially contaminated

source, such as a wastewater or sewage line. A well-designed and maintained plumbing system that includes air gaps and vacuum breakers is the best defense against back flow problems. Older facilities should be checked for cross-connections and any modifications to plumbing systems should be made by a qualified plumber.

### ***Condition and cleanliness of food contact surfaces***

The federal government defines food contact surfaces as “Those surfaces that contact human food and those surfaces from which drainage onto the food or onto surfaces that contact the food ordinarily occurs during the normal course of operations”. Typical food contact surfaces in mushroom growing operations include utensils, knives, harvester hands or gloves, and containers. In mushroom packing and fresh-cut processing facilities, food contact surfaces include utensils, tables, prep areas, conveyer belts, washing and slicing equipment, packaging materials, and hands or gloves. The condition of these surfaces should be regularly monitored to assure that they are in good condition and are properly cleaned and sanitized.

The ideal food contact surface is made of non-absorbent and non-toxic materials that can easily be cleaned and sanitized. It should be resistant to corrosion and have smooth seams, corners, and edges. Stainless steel and durable plastic are the preferred materials for food contact surfaces while wood, ferrous (iron) metals, brass, and galvanized metals should be avoided. Equipment that contacts food should be designed to facilitate cleaning and sanitizing with surfaces that drain easily and do not trap soils. Crevices, cracks, and enclosed areas on equipment, utensils, or prep tables can prevent cleaners and sanitizers from reaching bacteria and thus result in rapid microbial buildup.

Detailed cleaning and sanitizing procedures must be developed for all food-contact surfaces (equipment, utensils, etc.) as well as for non-product surfaces such as: overhead structures, walls, ceilings, lighting devices, refrigeration units, heating, ventilation and air conditioning (HVAC) systems, and anything else that could affect food safety. A regular facility and equipment cleaning and sanitizing program is essential to remove food residues (nutrients) that bacteria need to grow and to reduce populations of harmful microorganisms to safe levels. A standard procedure for effectively cleaning and sanitizing a food contact surface is to 1) remove larger residual food particles by

sweeping or brushing, 2) pre-rinse with water to remove smaller particles and wet the surface 3) clean with an effective cleaning compound, 4) rinse off the cleaner with water, and 5) sanitize with an approved sanitizing compound. It is important that the cleaner be thoroughly rinsed off because the presence of residual cleaning compound can neutralize some sanitizers. Choice of cleaners will depend on the type of soil to be removed, the degree of mechanical force available, the quality of the water used, and cost. Sanitizers vary in their effectiveness against specific types of microorganisms, their capacity to penetrate remaining soils, and their residual effectiveness. Determination of which chemicals to use is best made in consultation with a reliable sanitation chemical supply company.

***Prevention of cross-contamination from unsanitary objects to food, food packaging material, and other food contact surfaces***

This sanitation area deals with employee practices to prevent contamination of products, physical separation of raw ingredients and finished products, and plant design to prevent cross-contamination. To effectively prevent contamination of mushrooms, potential sources of contamination from compost preparation to product shipping should be determined and corrective actions formulated.

A major cause of product contamination is unsanitary practices by people who handle food. Regular training should instill in employees an understanding that they can unintentionally contaminate mushrooms, food contact surfaces, water supplies, and even other workers and that they have a personal responsibility to practice proper hygiene.

Workers should wash their hands when beginning a shift, after breaks, after using the rest room, and after handling raw materials or unclean surfaces. Hands and exposed portions of arms should be thoroughly lathered and vigorously rubbed for at least 20 seconds and then thoroughly rinsed with clean water. Particular attention should be paid to areas underneath the fingernails and between the fingers. Hands should then be completely dried using clean disposable towels or hot air. Chemical hand sanitizers may provide additional protection against cross-contamination but are no substitute for good hygiene practices.

Many companies are now requiring food handlers to wear gloves. It is important to remember, however, that a contaminated glove is no defense against bacterial contamination. Employees should wash their hands each time they put on gloves and use them only for their designated use. Gloves should be removed whenever leaving a workstation and changed whenever a potentially contaminated surface is handled. Management must ensure that employees understand these principles and that an adequate number of gloves are available throughout the work-day to allow frequent changes as necessary.

There are many other employee practices that can contribute to microbial, chemical, or physical contamination. Cigarettes, pens, chains, earrings, watches, multiple rings or rings with many stones and other small items should be kept out of areas where mushrooms are handled. Fingernails should be kept trimmed and hair should be covered by hats or hairnets. Facial hair should be neatly managed and beards or mustaches kept trimmed and covered by beard nets. Eating food, chewing gum, drinking beverages, or using tobacco should not be permitted in areas where mushrooms may be exposed or where equipment or utensils are cleaned and sanitized. Such practices are easily managed by providing designated break and lunch areas that are physically separated from production and processing areas.

Additional protection against cross-contamination can be obtained by reviewing the design and operation of your facility. Areas where raw animal manure or un-pasteurized compost are stored should be clearly separated from mushroom growing, packing, and fresh-cut processing areas. Traffic patterns for employees and equipment should be established to avoid contamination of pasteurized compost, casing materials, and mushrooms with raw manure and un-pasteurized compost. It is good practice to confine workers and equipment involved in phase I compost preparation to that area so that they do not transfer bacteria throughout the facility. In cases where workers or visitors must move throughout the facility, hands and footwear should be properly cleaned and sanitized.

The condition and appearance of the outside of your facility has a direct impact on the potential for cross-contamination. Unused equipment, pallets, containers, and any other items that are stored outside should be kept at least 20 feet from buildings to prevent

entry of pests and permit regular self-inspections. Tall weeds or grass are ideal breeding places for pests that can spread microorganisms into your facility and should be regularly cut. It is especially important that areas adjacent to compost ingredient storage areas and phase I operations be regularly checked for pests and signs of pest infestation. Good drainage in these areas is essential to prevent standing water where insects can breed and microorganisms can grow. Seepage from manure or compost areas should be directed away from mushroom handling areas and roads, yards, and parking areas should be well maintained to prevent the spread of dust and litter. Trash should be stored in properly covered containers and regularly removed.

Proper design and maintenance of building interiors will further protect against cross-contamination. Buildings should be constructed and maintained so that floors, walls, and ceilings can be adequately cleaned and kept in good repair. Floors in packing and fresh-cut processing areas should be constructed of washable, nonporous materials, adequately sloped to allow drainage, and have removable grates or plugs on drains to prevent entry of pests. Walls and ceilings should be made of light-colored, washable, and nonporous materials. Because rodents are able to squeeze through very small openings,  $\frac{1}{4}$  inch for mice and  $\frac{1}{2}$  inch for rats, doors should be constructed with no more than a  $\frac{1}{4}$  inch gap between the jam and the door. Loading docks should be kept clear of debris and spilled products since these are excellent entry points for rodents and birds. Insects can be discouraged by the use of truck door seals, rapid open/close doors, and air curtains.

Aisles or working spaces between equipment and walls should be unobstructed and wide enough to allow employees to perform their duties and to protect against cross-contamination. At least 18 inches of clearance between equipment and walls is necessary to allow sufficient space for cleaning activities and pest inspections. Containers and packaging materials should not be allowed to directly contact the floor.

Interior light fixtures that are suspended above or near exposed mushrooms should be equipped with safety-type bulbs or guards that prevent contamination with glass. Recommended light intensities vary depending on activities but should be sufficient to allow continuous inspection of mushrooms for the presence of visual contaminants. Supplemental lighting may be necessary in packing and inspection areas

to reach appropriate levels. Exterior lighting should preferably be placed away from doors and windows since it can attract flying pests.

### ***Maintenance of hand washing, sanitizing, and toilet facilities***

This sanitation area deals with the location, condition, and maintenance of hand washing, hand sanitizing, and toilet facilities. As previously discussed, it is important to prevent cross-contamination by monitoring employee hygiene practices. However, it is also essential that management provide adequate facilities to meet hygiene objectives. Thus, both employees and management play important roles in assuring that workers do not become a source of contamination.

Hand washing facilities in bathrooms and hand wash stations if present in food handling and processing areas should be checked at least once per day to ensure that they are clean, working properly, and have the necessary supplies including hot water, soap, disposable paper towels, and a trash receptacle. Hand-washing sinks should be separate from sinks used for equipment cleaning and other operations. Toilet facilities must always be in good working order and cleaned and sanitized on a daily basis or more frequently if needed. If hand sanitizers are used, they should be conveniently located to encourage employees to use them and the amount and concentration frequently monitored.

### ***Control of employee health conditions that could result in the microbiological contamination of food, food packaging materials, and food contact surfaces***

This is the third sanitation area that addresses the potential for contamination of foods by employees and underscores the potential risk that occurs with hand contact of ready to eat foods. Employers do not have the time to become experts in the recognition of infectious diseases. However, they should be alert to symptoms that could lead to product contamination, i.e. diarrhea, fever, vomiting, or jaundice. Workers infected with a disease that can be transmitted through food should not be permitted to handle mushrooms. They should be sent home or reassigned and relocated to an area where mushrooms are not handled. Workers must be assured, however, that they will not be penalized or lose their jobs if they report an illness.

Similarly, workers with open wounds or lesions should not be permitted to handle food. Minor cuts and scrapes should be covered with a bandage and further protected with latex gloves. However major wounds that show signs of infection are not likely to be adequately protected by bandages and gloves and affected workers should be sent home or reassigned.

***Protection of food, food packaging materials, and food contact surfaces from adulteration; Proper labeling, storage, and use of toxic compounds***

Protection of food, food-packaging materials, and food contact surfaces from contamination with lubricants, fuel, pesticides, cleaning compounds, sanitizing agents, and other chemical physical, and biological contaminants is another key sanitation area. Because it is mainly concerned with chemical hazards, it is combined here with proper labeling, storage, and use of toxic compounds.

Federal law defines a food as adulterated if it “bears or contains any poisonous or deleterious substance which may render it injurious to health”. The use of unapproved food additives, pesticides, sanitizers, non-food grade lubricants, or improperly applied pesticides, cleaners, and sanitizers can result in chemical contamination of foods. Exposed mushrooms and nearby food contact surfaces should be covered during cleaning and sanitizing and care should be taken when using pressure hoses to prevent splashing or misting of harmful chemicals. Growers should use only approved pesticides because these compounds have been proven to be both effective and safe when properly used. Chemicals used in irrigation or wash solutions should be “food-grade” only and used at recommended concentrations. In all growing, packing, and fresh-cut processing areas, pesticides, cleaners, sanitizers, and other potentially harmful compounds should be properly labeled and kept in locked, secured areas away from mushroom handling and storage areas.

Original containers of chemicals should show the name of the compound or solution, the name and address of the manufacturer or distributor, and instructions for proper use. When a chemical is transferred to a new container or made into a solution, the working container should be labeled to show the name of the compound or solution

and instructions for use. Chemicals should never be prepared or stored in containers that are normally used to pack or hold mushrooms.

### ***Exclusion of pests from the food plant***

The final sanitation area to be addressed is the control rodents, birds, and insects. All are capable of transferring to food and food contact surfaces human pathogens contained in their feces or adhering to their feet. A three-phase integrated pest management program is favored in food handling areas. First, areas where pests find shelter or are attracted must be eliminated. Then, modifications to buildings and grounds as previously discussed must be made to prevent their entry into food handling areas. After these steps are taken, pests that have still managed to gain entry should be exterminated in a manner that does not risk contamination of food.

Employers may wish to hire an individual who is trained and certified in the application of restricted use environmental pesticides. However, contracting with a reputable commercial pest control operator who has experience with integrated pest management techniques in food plants can provide the latest in pest control strategies and technologies.

The guidelines in this article are offered as a useful framework for improving the sanitary conditions in your facility. However, establishing a sanitation program is an ongoing process that requires continuing education in the science and technology of product protection. Additional resources for increasing your knowledge of food safety and sanitation issues are provided below.

### ***Books***

Principles of Food Processing Sanitation. A.M. Katsuyama, ed. Food Processors Institute. 1993. 540 p.

Principles of Food Sanitation. N.G. Marriott. Aspen Publications. 1999. 364 p.

Essential of Food Sanitation. N.G. Marriott. Aspen Publications. 1997. 344 p.

Employee's Guide to Food Safety. J.J. Keller and Associates. 1998. 116 p.

### ***Web Sites***

Sanitation Check List for Food Processors.

[http://foodsafety.cas.psu.edu/sanitation\\_checklist.cfm](http://foodsafety.cas.psu.edu/sanitation_checklist.cfm) Give your operation a quick sanitation checkup with multiple links to online sanitation information resources.

Good Management Practices for Safe Growing, Harvesting, and Packing of Fresh Mushrooms. <http://www.americanmushroom.org/gmp.htm>

Developed by Penn State University and the American Mushroom Institute

The Penn State Food Safety Web Site. <http://foodsafety.cas.psu.edu/>. Over 1200 links to online food safety information including materials for growers and processors of fruits, vegetables, and mushrooms.

### ***Educational Programs***

The Penn State Sanitation Shortcourse – Prerequisites for Food Safety. Offered each year in State College Pennsylvania. Call Dr. Luke LaBorde at 814-863-2298 or visit <http://foodsafety.cas.psu.edu/sanitation.html> for this year's schedule.