

# Oyster Mushroom Cultivation

## Part II. Oyster Mushrooms

### Chapter 9

#### Post-harvest Management

## MUSHROOM STORAGE AND PROCESSING

**Byung Sik Kim**

MushWorld

The following paper is summarized from *Shiitake Growers' Handbook: The Art and Science of Mushroom Cultivation* by Paul Przybylowicz and John Donoghue and *Tropical Mushroom Cultivation* by Tricita H. Quimio.



Figure 1. Harvested oyster mushroom

Mushrooms continue to respire after harvest and they have a relatively high respiration rate compared to other fresh produce, the respiration rate of oyster mushroom being three times greater than most fruits for example. Respiration rate is a good indicator of storage life and respiration results in changes in mushroom texture.

Spoilage during storage can be caused by bacteria and fungi within the mushrooms. Bacteria and enzymes continue to increase during cold storage. This results in rapid deterioration when the mushrooms are removed from cold storage. The mushrooms' texture is altered as they lose their firmness and their flesh darkens. The water inside the mushrooms is

also favorable for bacterial growth.

Many mushrooms are white to gray in color while they are growing. Under certain storage circumstances, however, the enzymes react with oxygen and form brown pigments. Such discoloration seriously decreases the quality of mushrooms. Mushrooms are 85-95% water. There are no barriers to water loss from their surface. Water loss in the mushrooms after harvesting is influenced by the status of the mushrooms, the humidity, fresh air and atmospheric pressure. When mushrooms wilt and shrivel, the quality of fresh mushrooms is lowered.

Fresh mushrooms have a short shelf life. Therefore it is necessary that they are either marketed soon after harvesting or preserved with special care such as in cold storage or other controlled environment storage.

### Short Term Storage

The shelf life of fresh mushrooms may be extended by refrigeration at 1-4°C. Cooling the mushrooms result in lower rates of all the physiological process within the mushrooms. During the initial cooling there is a high cooling load. Once the mushrooms are pre-cooled, however, the cooling load is much reduced. The shelf life of mushrooms

may vary from 1 day to 2 weeks.



Figure 2. Trimming mushroom



Figure 3, 4. Trimming. Washing, Weighing and packaging



Preservation of mushrooms at cool temperatures generally results in effective short term preservation by retarding the growth of microorganisms, reducing the rate of post harvest metabolic activities of the mushroom tissues, and minimizing moisture loss.

The temperature of the mushrooms at harvest is equal to the temperature in fruiting area. Generally the metabolic temperature of mushrooms is 15-18°C after harvesting. Heat is generated by processes within the mushroom and is high during fruiting. If mushrooms were not rapidly cooled but were put into the boxes or covered by PVC film storage, their temperature would increase due to the metabolic processes and then spoilage during storage could be caused by bacteria and fungi within the mushrooms.

To stop this metabolic process rapidly, the mushrooms should be cooled to storage temperature of 0-2°C within five hours of picking.



Figure 5. Low temperature room for the storage of Mushrooms



Figure 6 Fresh mushrooms were packed by PVC film in the commercial refrigerator.

The best method for fresh storage of oyster mushroom is to keep them at 8-10°C in packed container wrapped in plastic film. It's called 'PVC film storage'. Wrapping mushrooms with such microporous or perforated plastic film can improve their storage life, as this reduces the moisture loss and preserves the quality of mushrooms. Carbon dioxide levels increase and oxygen levels decrease in wrapped containers due to mushroom respiration. The gas composition can be modified by the respiration of mushrooms inside the package.

## Long Term Storage

For long-term storage of mushrooms, canning, pickling and drying processes are employed. The quality of the preserved product is rarely comparable with that of fresh mushrooms, and these processes are not always suitable

for all types of mushrooms.

### Drying

Drying is a method of preserving edible mushrooms such as shiitake and wood ear mushrooms. It is not often used for button mushrooms or oyster mushrooms, but oyster mushrooms can also be stored and marketed in dried form. Drying preserves the mushrooms by removing enough water to inactivate the enzymes and microorganisms. Mushrooms preserved by drying have a good flavor and the drying prevents deterioration. Dried mushrooms are convenient for long-term storage and transportation. The moisture content of fresh mushrooms is 70-95% depending upon the harvest time and environmental conditions; that of dried mushrooms is near to 10%. There are several methods commonly employed for mushroom drying.



Figure 7, 8. Dried shiitake and white wood ear mushroom

### Sun drying



Figure 9. The mushrooms are put into the bags after drying.

In this drying method, mushrooms are spread on the shelves in such a way that the gills face upward and are directly exposed to sunlight. Drying time required will vary depending on the weather conditions. In general, the quality of sun-dried mushrooms is lower than that of the mushrooms that are dried by the thermal power drying or hot-air drying. The moisture content is also higher and this means higher susceptibility to molds and pests.

### Thermal power drying

The process of thermal power drying should begin with mushrooms at a relatively low temperature. Mushrooms should be dried during sunny days at an initial temperature of 35°C while mushrooms should be dried during damp days at an initial temperature of 30°C. After five hours of heat for mushrooms under sunny conditions and seven hours of heat for those during the rainy season, the temperature can be raised gradually and then kept at 40-60°C for 12-18 hours. In addition to preserving the product, drying can enhance the flavor and appearance of the mushrooms.



Figure 10. Ear mushrooms are dried in 60-80°C for 6 hours in firewood stove



Figure 11. Product of dried *Phellinus baumii*



Figure 12. Dried fruitbodies of *Hericium erinaceus*

### Hot-air drying



Figure 13. Hot-air drying of *Agaricus blazei*

In the hot air drying method, hot air is blown into the dryer and mushrooms on the shelves are exposed to hot air. The temperature and humidity of the air can be controlled to optimum conditions by use of heaters and recirculation vents. Mushrooms produced by this method have better quality with higher hygienic conditions and brighter color compared to the sun-dried mushrooms. The size of the drying chamber varies depending on the production scale. Usually 10-12 shelves are installed with the clearance of 15cm between shelves and mushrooms are placed on the shelves stem downward inside the drying chamber. The drying chamber should be heated up to 40-50°C prior to loading the mushrooms.

If the mushrooms are loaded at the beginning, it will take a longer time before the chamber reaches the effective temperature, and this will cause self-digestion of mushrooms by their inherent enzymes and will result in softening of texture and spoilage.

It is desirable to sort mushrooms according to the size before drying. This will ensure uniform drying and results in good quality products. The dried mushrooms are apt to absorb moisture from the air, so they should be properly stored. If the moisture content of the mushrooms reaches about 20%, the mushrooms will easily be infested by insects and molds. Therefore, the dried mushrooms should be put into polyethylene bags, sealed and kept in a dry, cool and dark place. For prolonged storage, the mushrooms should be packed in cartons or wooden boxes and kept at 2-5°C in a low temperature storage area.

### Canning and bottling

Canning is by far the most common process used for preserving mushrooms. The production of mushrooms by canning has become considerably more specialized in recent years. In general terms, canning is divided into seven basic operations: cleaning, blanching, canning, sterilization, cooling, labeling, and packing. This method is widely used by the industry.

Browning and blemishing of mushrooms can be reduced by trimming immediately after harvest. If mushrooms are not canned immediately, they should be refrigerated until processing starts. Color and texture are retained by storage and proper storage can also increase canning yield. At this stage, an appropriate level of sodium metabisulphite or ascorbate is incorporated for color retention. The mushrooms are then rinsed and blanched for two minutes. Blanching is used to reduce the activity of enzymes.

After blanching, the mushrooms are placed in cans containing 2.5% sodium chloride and 0.24-0.5% citric acid. The cans are then sealed and sterilized. Sterilization methods vary according to the type of equipment used. The

most commonly used method is the batch process in which the cans are placed in an autoclave and sterilized for one hour 120-130 °C. The cans are then rapidly cooled in the wash sink.



Figure 14. The mushrooms are put in the bottle with brine



Figure 15. Canned *Pleurotus nebrodensis*

The principle of bottling is the same as canning but requires much less instrumentation, and therefore bottling can be adopted by small-scale growers without difficulty. The procedure for bottling mushrooms can be summarized as follows: Mushrooms must be processed right after harvesting in order to maintain their quality. Spoiled mushrooms must be sorted out from the wholesome mushrooms. The mushrooms should then be sorted in terms of size and quality and then boiled in water containing 0.1% succinic acid and 1% salt for 4-6 minutes of blanching.

A stainless steel knife is recommended when progressing mushrooms in order to minimize browning. During blanching, a weight loss of 35-40% is likely. Brine should be prepared according to the salinity desired by the consumers. The bottles are filled with brine and the blanched mushrooms in a desired proportion. After closing the cap halfway in order to allow air to escape from the bottles the bottles are boiled for 30 minutes or more depending on the size of the bottles. The caps are then closed tight before the bottles are taken out and cooled.

### Pickling

Pickled products such as cucumber pickles are popular in many countries throughout the world. Mushrooms can also be successfully pickled and produce quite favorable products when the right pickling formula is chosen.

In this process, the mushrooms are sorted and washed. They can be sliced if desired. Then they are blanched with 3% salt water for three to four minutes in boiling water. After the water drained off, they are placed immediately in cold water to cool. They are then transferred to a jar or bottle, and brine (22% salt) is added with a little vinegar, sugar and other spices such as vitamin C or citric acid to give the mushrooms some fresher color. The jars are then loosely closed and steamed for one hour. The lids are tightened when cooled and the contents chilled before eating.



Figure 16. Pickled mushrooms in Chinese market



Figure Pickled mushrooms *Coprinus comatus*



Figure 18. Pickled mushrooms *Volvariella volvacea*