

## Facilities and Equipment for Substrate Preparation

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#### 1. Substrate bags

Unlike logs, which serve protection from competing fungi or microorganisms, sawdust substrates lack this protection. Therefore, you are to provide it for high yield. Usually, to save labor, mushroom growers favor bottles over bags as containers. However, shiitake growers opt for bags rather than bottles for the following reasons.

Shiitake mushrooms tend to grow on every side of the sawdust substrate. The tendency leads growers to remove containers. In addition, when larger mushrooms are traded at higher prices, bags are preferred for larger sawdust mix and large mushroom production.

Bag materials must have high heat-resistance. High density polyethylene can withstand autoclaving at temperatures up to 121C, but allow less gas movement than low density polyethylene bags. So high density PE bags need a closure which permits gas exchange. A Polypropylene bag, another most commonly used one, is most heat resistant up to 135C. Like high density PE, its lower gas permeability requires a breathable closure ("Shiitake Growers Handbook" 132).

Shiitake requiring more air exchange than other mushrooms needs bags with breathable closure letting air through but excluding contaminants. Filters are usually on the surface or on the opening of a bag.

#### 2. Sawdust Making Machine

Sawdust serves shiitake mycelia as an important nutrition source. For more production of high quality mushrooms, you need to maintain substrates in good condition as long as possible and select proper tree species and particle size. Sawdusts from trees like *Buna* (Japanese Beech Tree) and *Alnus japonica* (Japanese Alder Birch) are easily degradable but those from *Quercus acutissima* and *Quercus serrata* need time to be fully degraded (Kinoko Guidebook, 113).

Mushroom growers might want to use chip dust and coarse sawdust to offer more gas exchange. However, they have it in mind that too fine sawdust prohibits gas exchange in the medium. You can also use a sawdust making machine lest sharp pieces of wood chip should puncture substrate bags.

#### 3. Mixer and Conveyer

In substrate preparation process, the size and number of mixers are determined depending on management style and cultivation scale. If you use coarse wood chip, you need to wet it 2 or 3 days earlier before mixing. On the previous day you must blend coarse and fine sawdust together. When you mix all the substrate ingredients, blend sawdust and prepared supplements while dry for 30 minutes and then pour water to it and mix them for another 30 minutes (Kinoko Guidebook, 114~115).

Some growers use formulas with high supplementation levels, expecting high potential yield. Others use formulas with low supplementation levels, compromising high potential yield but reducing the risk of contamination. The substrate formulas vary according to types of cultivation.



Mixer



Conveyer

A conveyer transfers sawdust mix from a mixer to a bag filling machine. An automatic conveyer system sends a signal to a bag filling machine, opening doors of a mixer. (Kinoko Guidebook, 115). **4. Bag Filling Machine**

This machine fills the bag and then compresses the substrate. Some bag filling machines drill a hole through the middle of the substrate in the bag. This hole helps spawn's vertical distribution, speeding colonization and inducing more uniform flushes.



Bag Filling Machine

## 5.

## Tray

It is used to operate 3~4 substrate blocks at a time during sterilization and incubation process. For present, shiitake growers use heat-resistant containers for bottle cultivation as they have no containers designed for bag cultivation to use (Kinoko Guidebook, 116).

## 6. Sterilizer

[Table 1] Characteristics of Pressure Cookers

	Low Pressure Cooker	High Pressure Cooker
Pressure	0kg/cm <sup>2</sup>	1.0~1.2kg/cm <sup>2</sup>
Temperature	98~100 'C	115~120'C
Total Sterilization Time	8 hours	5~6 hours
Bacterial Sterilization	Imperfect	Perfect
Fuel Consumption	High	Low
Price	Low	High

(Source: Kinoko Guidebook 2001)

You can choose either type of sterilizer, taking into account their cultivation environments. You should remember that heat moves through wet sawdust faster than through air. Thus, you need to check the temperatures of both air and substrate each time.

## 1) Low Pressure Cooker



Low Pressure Cooker

It takes usually 150 minutes for the cooker of 8~9m<sup>3</sup> to reach 98 to 100°C (New Cultivation Techniques of Oak-Mushroom, 197). You must continue sterilization for more than 4 and a half hours. It dehydrates less and keeps the substrate soft, but costs more time for complete sterilization of thermophilic fungi and microorganisms.

## 2) High Pressure Cooker



High Pressure Cooker

It takes less time to sterilize the substrate than low pressure cooker, but kills fungi and microorganisms. That's why it is most commonly used in large scale mushroom farms. When the pressure inside the

cooker reaches 0.7kg/cm<sup>2</sup>, you should remove gas inside the autoclave for about 30 to 40 minutes before increasing pressure inside the cooker. When the pressure goes up to 1.0~1.2kg/cm<sup>2</sup>, the inside temperature will reach 121°C (New Cultivation Techniques of Oak-Mushroom, 199). The total cooking time including 40 to 90 minutes of sterilization at 121°C and steaming is approximately 6 and a half hours.

7.

## Cooler

The sterilized substrate must be taken out of a cooker right after sterilization to reduce moisture content and prevent contamination. Mushroom growers can cool the substrate either by using a cooler or by letting it to cool. The ideal substrate temperature for inoculation is said around 18°C (New Cultivation Techniques of Oak-Mushroom, 201).

## 8. Inoculation Room



Inoculator

The room should be clean, sterile, and sealed to limit air movement, with UV sterilization lamps on before inoculation. After inoculation, bags with filters on it can be heat-sealed 5 to 10mm wide. Newly developed automatic inoculators deal with all the process from conveying to heat-sealing sawdust substrate (Kinoko Guidebook, 117). Mushroom growers must wash the floor of the room and keep UV sterilization lamps on after inoculation.

### ► Reference

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Science of Mushroom Cultivation, Kendall/ Hunt Publishing Company.