Oyster Mushroom Cultivation

Part II. Oyster Mushrooms

Chapter 1

Substrate

COTTONSEED HULLS

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Figure 1. Cottonseed hull

Cottonseed hull is one of the most efficient substrate materials for oyster mushroom cultivation. Cottonseed hull contains hot water extracts and alcohol extracts that mushrooms can easily utilize. Cottonseed hull is easy to dry, so can be stored for relatively long period of time. If the substrate is to be sterilized or pasteurized, cotton waste is suitable because it emits extra heat by itself.

However, cottonseed hull cannot absorb water thoroughly and it is difficult to remove extra water content if it is overwetted. During fermentation, concentrated gas cannot escape to the outer surface of the cottonseed hull. The control of gas and water is essential for successful cultivation using cottonseed hull.

Cottonseed hull (Fig. 1) is the coating of cotton seeds, the substance that remains after the cotton has been peeled off. As a waste material of the oil industry, it is about 32-40% of the total weight of cottonseed. In China the annual output of cottonseed hull is about 12 million tons. It generally contains 9.1% water and 90.9% organic matter that consist of 4% crude protein, 1.4% crude fat, 40.9% crude fiber, 34.9% soluble carbohydrate, and 2.6% ash. Its C : N ratio is about 59 : 1. This chemical composition shows how nutritious a raw material cottonseed hull can be when cultivating oyster mushrooms. Thanks to its soft texture, high water-holding capacity, and good physical structure, cottonseed hull is used worldwide as a good substrate for cultivated oyster mushrooms.

Treatment of cottonseed hull

Pre-wetting

Being fresh and contamination-free are the basic requirements for cottonseed hull that is to be used as substrate material. In the pre-wetting step, the amount of water should be carefully calculated rather than measured by eye. The water usually sinks to the bottom of the pile, so the cottonseed hull pile's surface still looks dry, which encourages growers to overwater. A graduated container is recommended to calculate the necessary water according to the amount of dry cottonseed hull. After being mixed well, the cottonseed hull should remain soaking

overnight. It is helpful to add 1% $Ca(OH)_2$ during the overnight soaking.

Supplementation

The nutrient content of cottonseed hull is enough for cultivating oyster mushrooms due to its high C/N ratio. However, 5-10% of rice or wheat bran is usually added as a supplement before sterilization, as this may produce higher yields. Many Chinese growers use non-sterilized substrates in autumn when the temperature drops.

Bagging and Sterilization

The plastic bag used here for growing P. ostreatus is 40-50cm in length and 25cm in diameter. A specially designed plastic ring is wrapped at the top end of the bag to form a bottleneck with a cotton plug in it (Fig. 2). After bagging, the bags are usually sterilized to reduce the risk of contamination. If the cottonseed hull is sterilized at normal pressure, it is necessary to add 10% bran or other kinds of nitrogen supplements to raise yields. 2% calcium carbonate and 1% $Ca(OH)_2$ is also added to adjust the pH of the substrate to 8-9. The cottonseed hull is sterilized at 100℃ for 10 hours (Fig. 3). Then, the pH changes to reach the optimum level of 6.5-7.0.

Some growers skip the sterilization of substrates to reduce their costs for heating and autoclaving. This method is frequently chosen by relatively poor Chinese growers in autumn and winter. If not sterilized, the substrate materials must be fresh and should be pasteurized for 2-4 days by sunlight before pre-wetting. In addition, no nitrogen should be supplemented in order to lower the risk of contamination, but 1% of calcium hydroxide ($Ca(OH)_2$) needs to be added.

Figure 2. Bagging of cottonseed hull mixed with corncobs

Figure 3. Boiler and autoclave

Spawning

During spawning, the spawn should cover the surface of the substrate to reduce the possibility of contamination during spawn run. 50-60g of spawn is inoculated to 1kg of substrate, so spawning rate reaches 5-6% of wet weight of substrate. Then the bags should be incubated at 25℃ until the mycelia grow fully. When sterilization is not available, an increased amount of spawn needs to be well mixed with substrate. After spawned substrate is put into each bag, a layer of spawn is placed on the substrate surface in the bag. The bags should be incubated at a relatively low temperature, about 15-20℃, in order to decrease the amount of contamination.

Laying the Growing Bags

After the mycelia have fully grown, the bags are then moved to the growing house for fruiting. We use a unique method of making walls with mushroom bags and soil. 1-meter wide ridges are made at 0.8-meter intervals and the space between the ridges is used for draining. Fully incubated bags are cut open at the bottom and laid on one side of the ridge with another bag on the other side of the same ridge (Fig. 4). The length of the ridge varies according to the width of the house. It is necessary to leave the 0.8-meter wide aisles for both drainage and pickers passing through.

Figure 4. The walls shown from above

Figure 5. The walls of bags Adhered by fertilized soil

Figure 6. Mushroom bag walls without soil

The unique characteristic of our method is the use of fertilized soil with urea as both cement for building the wall and a source for nutrients and humidity (Fig. 5). The fertilized and moistened soil is filled into the 20cm space between the two tiers of bags and is also layered 3cm thick on top of the growing bags. The proper quantities of urea or other kinds of inorganic nitrogen supplements are spread on this soil if necessary. Then, another layer of bags are put on top of the previous layers until the ridge height reaches 1.5m with the wall length and width gradually tapering (Fig. 5, 6) to prevent the wall from falling down. A layer of soil is placed to cover the top of the wall of bags (Fig. 4). The number of ridges is dependent on the dimension of the growing house.

By using this method, we can manage the bags easily and raise the yields. The mycelia of the mushrooms stretch into the fertilized and moistened soil and absorb the nutrients from it. Watering is necessary during the fruiting periods. Water is sprayed on the soil, not on the substrate or fruit bodies, in order to keep the mushroom pins from dying.

Cropping Management

After the wall of bags are finished, the plastic rings and the cotton plugs are usually removed and the mouths of the bags are pulled straight to let fresh air enter in order to stimulate pinning. Some growers don't cut off the plastic at the top end of the bags because this part can generate a small micro-climate where the relative humidity is high, and water is not directly sprayed onto the pins thanks to this part. However, the methods vary from province to province according to local climate conditions. Some growers leave the plastic rings on during fruiting (Fig. 7), while others get rid of the excess plastic (Fig. 8).

During fruiting, growers maintain proper temperature and 85% relative humidity by spraying water on the ground and soil. Usually, 5-6 flushes are harvested before the weather is no longer suitable for oyster mushroom growing. Biological efficiency has reached 150-200%.

Figure 7,8. Oyster mushrooms growing from the bag wall

Harvest

It is necessary to stop watering two days before picking. The mature fruitbodies are recognizable by their shape. The process of picking is very easy as growers simply pull out the fruitbodies by hand. It is not advisable to use knives to cut the fruitbodies at the base because some stumps will be left and these can cause the crops to suffer from infections.