Part II. Oyster Mushrooms

Chapter 3

Introduction to Oyster Mushroom

WHAT IS OYSTER MUSHROOM

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The principles of oyster mushroom growing follow the general characteristics described in 'What is Mushroom' in Chapter 1. In this article three main factors−spawn, substrate and environmental control−will be discussed again focusing on oyster mushroom cultivation. As a fruitbody of an edible white rot fungus, oyster mushroom belongs to *Pleurotus*, Pleurotaceae, Agaricales, Basidiomycota. In nature, oyster mushrooms appear in cluster on dead trees from late fall to spring, and are distributed almost all around the world (Jiyul Lee, 1993). Oyster mushrooms share all the fundamental characters of cultivated mushrooms.

Spawn

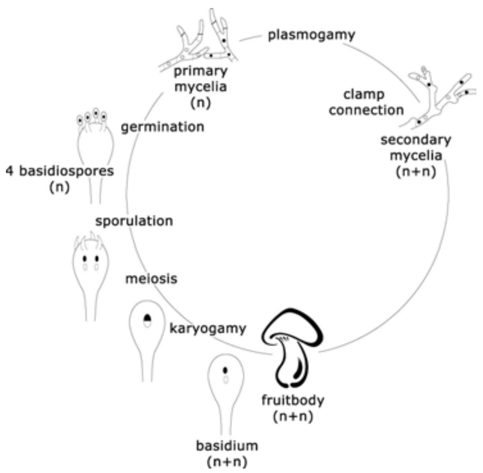

Figure 1. Lifecycle of oyster mushroom

Four basidiospores form at the end of each basidum on the gill of a fruitbody (Fig. 1). Each spore has one nucleus. Spores germinate to become primary mycelia, and then form secondary mycelia by plasmogamy. Chances are 25% that a primary mycelium will meet with a compatible one. Secondary mycelia of oyster mushroom can be distinguished by the clamp connections and each cell has two nuclei. Only secondary mycelia can produce fruitbodies under the proper conditions. In the basidia of a mature fruitbody, the two nuclei fuse into one, then pass through meiosis, and produce 4 haploid nuclei. The four haploid nuclei are then made into four new basidiospores.

Spawn suppliers usually make oyster mushroom spawn from isolated secondary mycelia by tissue culture. Growers can also make their own spawn by incubating the spores or tissue of fruitbody specimen, but highest level of sanitation is required. Tissue culture is recommended for mother culture production because genetic characteristics of the mushroom are preserved to the isolated mycelia. On the other hand, spore culture easily brings about variation of character manifestation due to recombination of genes. During spawn preparation, the first isolated generation (called mother culture) is usually inoculated to substrate and incubated, which is the second generation (called mother spawn). Fully colonized mother spawn is inoculated to another substrate and it incubated to be the third generation (called mushroom spawn). By repeating inoculation and incubation, more spawn can be produced from mother culture, but much repetition will lower the spawn's vitality. Most growers utilize the third generation spawn.

During propagation and storage, growers must be faithful to the principles not to decrease the vigorosity or increase the mutation or variations. There are several storage methods for mother culture including subcultures, liquid nitrogen and paraffin sealing. Most common for oyster mushroom is grain and sawdust spawn. Detailed information on characteristics of oyster mushroom strains and spawn production will be provided in chapter 4 (Spawn).

Substrate

Substrate can be understood as soil for plant providing necessary nutrition. Substrate mixture of oyster mushroom should supply specific nutrients required for oyster mushroom cultivation (Table 1).

Table 1. Nutritious materials for oyster mushroom

	Nutrients		Materials
organic	C-source	cellulose	humus materials such as wood, straw, leaf, etc.
		hemicellulose	〃
	N-source	protein	〃
		amino nitrogen	〃
inorganic			K, P, Si, Fe, Mg, etc.

(Source: *Oyster mushroom-cultivation technology and management* by Cha *et al.,* 1997)

The main nutritional sources for oyster mushroom are cellulose, hemicellulose and lignin. C/N ratio is important factor for optimal substrate composition for oyster mushroom. Oyster mushroom requires much carbon and less nitrogen source than button mushroom (*Agaricus bisporus*) but most of main substrate materials such as cereal straw, cotton waste, sawdust need supplementation of nitrogen source such as wheat and rice bran to reach optimal C/N ratio for oyster mushroom. Inorganic materials are usually included in substrate materials and need not additional supplement. And amino nitrogen is used during spawn run, but it is not fit for fruiting, therefore, growers commonly do not need additional apply of amino nitrogen during mixing (Cha *et al.*, 1997).

Oyster mushroom growers have wide range of substrate materials as oyster mushroom can utilize various agro-wastes with its enzyme. That is to say, oyster mushroom is a white rot fungus that uses lignin and cellulose together as its carbon source and turns the host into white. Therefore, any type of organic matters containing lignin and cellulose can be used for oyster mushroom substrates, and this includes almost all agricultural wastes. Possible substrate materials are sunflower seed hulls, rice/wheat straw, bean, sugarcane bagasse, rubber tree sawdust, groundnut shells, cotton waste, cottonseed hulls, coco lumber sawdust, coffee pulp, corncobs, paper, water hyacinth, water lily, cocoa shell waste, coir and others. Various utilizations of substrate materials for oyster mushroom are introduced in Chapter 5 (Substrate).

It would be impossible to say the single best mixing formula of substrate that will perfectly satisfy all growers since different materials are available at different prices in different regions. The same supplementation could increase yield in temperate area but contamination in tropical area. Growers' tastes also affect the selection of substrate materials. Above all, it is strongly recommended that each grower find his own best substrate mixing formula by trial and error based on standard substrate mixing formulae.

In choosing a growing method, growers should consider labor availability and the provision of substrate materials. Mushrooms from log cultivation are commonly assumed to be of the best quality. But the recently developed skills of shelf, bottle and bag cultivation seem to have bridged the quality gap. Log cultivation takes a long time for one flush and shows a low rate of productivity in spite of its intensive labor demand. As the most widely performed method, bag cultivation provides stable yield with relatively few failures. Shelf cultivation seems to be more risky than either bottle or bag cultivation because contamination once occurs, can rapidly spread through the whole substrate mass on the shelf. Bottle cultivation can be automated and requires a high investment. In choosing the ideal substrate material, growers should consider the long-term availability, expense and productivity of the materials.

A. Bag cultivation B. Shelf cultivation C. Bottle cultivation

Figure 2. Fruitbodies of oyster mushroom from various cultivation modes

Environment

Environmental factors include temperature, relative humidity, light, carbon dioxide and acidity of substrate, which alter together in their co-dependant relationships. As the growing room temperature is raised, relative humidity decreases. A higher temperature promotes fruitbody metabolism, which in turn, increases their respiration rate and results in high carbon dioxide production. Oyster mushrooms also need different environmental conditions at each growing stage. During incubation, appropriate relative humidity is 65-70% and water content of substrate is 65%. Optimal temperature for mycelial growth is 20-25℃, but some thermophilic strains reach optimal growth at 25-35℃. Mushroom mycelia are quite durable to high concentration of carbon dioxide during incubation.

Upon the completion of incubation, pinning induction follows. Pinning induction is made by worsening the environment in order that the mycelia cannot keep on with their vegetative growth and will therefore convert to a reproductive growth mode, which initiates fruitbody formation. Pinning induction includes cold shock, watering and lighting. Once the pins come out, growers stop pinning induction and maintain environmental conditions that are favorable to fruiting. Carbon dioxide concentration should be less than 800 ppm in its reproductive growth though the number differs according to strains. Fruitbody formation also requires high relative humidity up to 80-95% and lower temperature than optimal mycelial growth by 10℃. In addition, some strains also need light of 50-500 lux for primordial formation. Growers then harvest the resultant fruitbodies.

Growers can choose a suitable strain for their own natural environment. Each *Pleurotus* species needs different environmental conditions for fruitbody development (Table 2).

Table 2. Environmental parameters for fruiting of oyster mushrooms

Species	Temperature (℃)	Relative humidity (%)	CO_2 (ppm)	Light (lux)
P. citrinopileatus (Golden Oyster Mushroom)	21-29	90-95	< 1,000	500-1,000
P. cystidiosus (Abalone Mushroom)	21-27	85-90	< 2,000	500-1,000
P. djamor (Pink Oyster Mushroom)	20-30	85-90	500-1,500	750-1,500
P. eryngii (King Oyster Mushroom)	15-21	85-90	< 2,000	500-1,000
P. euosmus (Tarragon Oyster Mushroom)	21-27	90-95	< 1,000	750-1,500
P. ostreatus (Tree Oyster Mushroom)	10-21	85-90	< 1,000	1,000-1,500 (2,000)
P. pulmonarius(Phoenix or Indian Oyster Mushroom)	18-24	85-90	400-800	1,000-1,500 (2,000)
P. tuberregium (King Tuber Oyster Mushroom)	30-35	85-90	< 2,000	

(Source: Stamets, 1993)

The other key component in environmental control is pest and disease management. The routines of pathogenic invasion are evident. It is obvious that virus infected or bacteria contaminated spawn will cause problems to the whole inoculated crop. Insufficient sterilization cannot remove all pathogenic organisms in the substrate. During inoculation, pathogenic fungi and bacteria can invade via dirty tools, shoes, clothes and hands. During incubation, they also come into the room through the door opening and windows.

It is not easy for even skillful growers to completely prevent contamination. But considering that mushroom marketing emphasizes the nutritional and medicinal effects of mushrooms as a natural food, even when mushroom diseases occur, growers should avoid using chemicals. This is of course totally up to the choice of the growers. The best means of pest management are good preventative practices. Environmental control and pest & disease are discussed further in Chapter 6 (Growing Houses) and Chapter 8 (Pest and Disease Management).

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