How-To-Do-It

The Edibility & Cultivation of the Oyster Mushroom

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Fungi are among the most widely distributed and the most important, economically and ecologically, of all groups of organisms. Approximately 70,000 species have been described so far; and these represent only one-third to one-fifth of the total number that are believed to exist on Earth.

The vegetative stage of most fungi is in the form of a network of tiny thread-like structures collectively known as the mycelium. All of them reproduce asexually, and many of them sexually, in a variety of ways, usually by producing spores. In the ascomycetes and the basidiomycetes, spores resulting from sexual reproduction are typically produced in various types of fruiting bodies. Fruiting bodies that are soft and fleshy are commonly called mushrooms. There are more than 10,000 species of fungi that produce mushrooms, many of which are edible.

Mushrooms have been collected and used as food for thousands of years. There are references to the value of edible mushrooms as far back as about 500 B.C.

Mushroom Cultivation

The intentional cultivation of mushrooms for food goes back to about 600 A.D. when *Auricularia*, the wood ear, was first cultivated in China (Chang & Miles 1989). In recent years the number of successful attempts to cultivate additional species of mushrooms has increased as more has been learned about their life cycle requirements. World production of mushrooms has been increasing steadily, both in total amount and in number of species.

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At least 16 genera of mushrooms can now be cultivated, although about 98% of the total world production comes from six genera. *Agaricus bisporus*, the button mushroom commonly found in supermarkets, is by far the world's most widely cultivated mushroom, accounting for more than 68% of the total, with annual production in excess of one million tons per year. The U.S. produces almost 25% of the total and is the world leader (Chang & Miles 1989).

However, Americans are inclined to be mycophobes. We eat only one pound of mushrooms per capita each year. And we generally eat just one species, *A. bisporus*. The Chinese eat 22 pounds per capita each year. A single meal in a vegetarian restaurant in China may include a half-dozen mushroom species. Some are included for flavor, some for color, some for texture (Ingle 1988).

There are several reasons why there is an increasing interest in mushroom cultivation. Mushrooms could play an important role in helping to solve the problem of providing enough food for a rapidly growing human population. Mushroom cultivation can be used in the recycling of certain agricultural and industrial wastes. Also, the used substrate, following the harvesting of the mushrooms, is valuable as a fertilizer and a soil conditioner for the growth of plants.

Growing the mycelium of edible fungi is not very difficult. Getting the mycelium to produce fruiting bodies is the challenge.

The substrate for growing mushrooms must provide the nutritional requirements, including carbon, nitrogen, sulfur, phosphorus, potassium, calcium and magnesium, as well as the trace elements. All of these nutrients can be provided by organic waste products, including agricultural wastes. The main components of agricultural wastes are cellulose, hemicellulose and lignin. These substances are relatively resistant to biological decomposition. However, many mushroom-producing fungi have the necessary enzymes to degrade these materials.

In addition to providing the proper nutrients, the environmental conditions must be favorable in order for the mycelium to produce fruiting bodies. The most important factors include temperature, humidity, light (in some species) and aeration.

A relative newcomer to mushroom cultivation is *Pleurotus ostreatus*, the oyster mushroom. It was apparently first cultivated by Etter (1929) of the U.S. Department of Agriculture. It is now widely cultivated in Europe and Asia and to a lesser extent in the United States.

Several species of *Pleurotus* can be cultivated, including *P. ostreatus*, *P. ostreatus* var. *florida* (white oyster mushroom), *P. citrinopileatus* (golden oyster mushroom), *P. flabellatus* (pink oyster mushroom), *P. sajor-caju* (gray oyster mushroom) and *P. sapidus* (black oyster mushroom).

Characteristics, Flavor & Nutrition of Pleurotus

P. ostreatus is called the oyster mushroom because of the shape of the pileus (cap). The fungus lives saprotrophically on wood, such as tree trunks, stumps and logs (Figure 1). The mushrooms are produced in overlapping layers. They occur in various colors, most commonly white, gray or tan. The pileus is 5–30 cm across and has a short, lateral stalk, 1–3 cm thick and 2–4 cm long. It produces lamellae (gills) on the lower surface of the pileus. The flesh is soft in young fruiting

Figure 1. *Pleurotus ostreatus* growing on log.

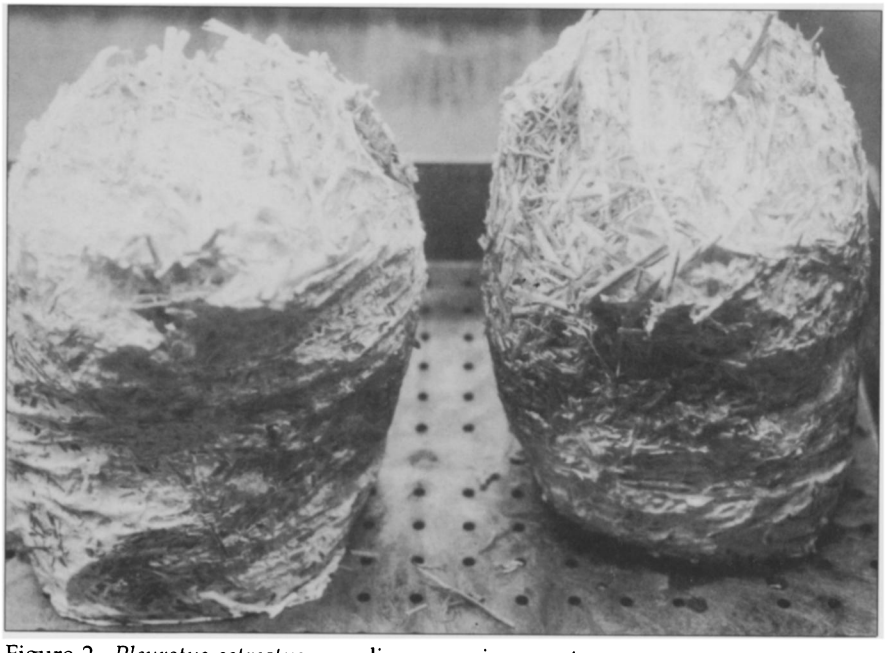

Figure 2. *Pleurotus ostreatus* mycelium growing on straw.

bodies and sometimes tough in older specimens.

Pleurotus mushrooms are gourmet favorites of many mycophagists (mushroom eaters). They are meaty with a soft texture and a delicate flavor. They may be sautéed in butter or used in omelets. Mushroom grower R.H. Kurtzman (1979) supplied a panel of tasters with cultivated *P. sapidus* mushrooms that had been sautéed. About 90% of the tasters gave them a good rating or better. Nearly 20% gave them the highest possible rating.

Although *Pleurotus* mushrooms are about 90% water, they are nutritious. On a dry-weight basis, they contain 10–30% protein. By comparison, rice is about 7%, wheat is 13%, and milk is 25%. In total amount of protein, they rank below meats, but well above most other foods (Chang & Miles 1989). The proteins contain all nine essential amino acids. They are especially rich in lysine, which is deficient in most staple cereal foods. They rank close to milk on the basis of essential amino acid content. They are also a good source of certain vitamins (thiamine, riboflavin and niacin) and minerals (potassium and phosphorus) (Chang & Miles 1989).

Table 1. Mushroom production and biological efficiency of *Pleurotus ostreatus* on various substrates.

Substrate	*Mass (g)*	*Biological efficiency*
Straw	450	57%
Soybean stalks	365	52%
Oak leaves	330	47%
Corn leaves	270	39%
Newsprint	155	22%
Sawdust	102	10%

Cultivation Parameters

One of the major advantages of growing *Pleurotus* instead of *Agaricus* is that it is not necessary to compost the substrate before inoculating it. The substrate needs only to be moistened and pasteurized.

Pleurotus can be grown in bags or containers on a variety of cellulose-rich materials, including many waste products. Of the various substrates we have used (Table 1), straw supported the greatest yield and highest biological efficiency (defined as the fresh mass of mushrooms divided by the dry mass of substrate).

Adequate ventilation during the fruiting phase is very important. Fruiting bodies cannot tolerate high CO_2 concentration. When the CO_2 concentration in the growing bags or containers exceeds 600 ppm, the stalk elongates and the pileus does not develop normally (Chang & Miles 1989).

Light is necessary for the initiation and development of fruiting bodies (although not for vegetative growth). They need light intensity of 50–500 lux and wavelength of about 440 nm. Most fluorescent bulbs produce light of that wavelength. Some instruction books (Stamets & Chilton 1983) recommend the use of Gro-lux®, but our results (Table 2) show that it is less effective than ordinary fluorescent lights, in addition to being much more expensive. Ordinary fluorescent lighting produces a higher yield as well as a more favorable mass ratio of cap to stalk. Both cap and stalk are edible, but the cap texture is more desirable.

Optimal temperature for develop-

Table 2. Effect of lighting system on mushroom production of *Pleurotus ostreatus*.

Type of fluorescent bulb	*Total Mass (g)*	*Ratio of cap mass to stalk mass*
Cool White Fluorescent	470	3.9
Warm White Fluorescent	440	3.4
Gro-Lux	360	3.2

ment of fruiting bodies is 10–28° C. The specific temperature optimum depends upon the species being cultivated.

The following procedures for growing *P. ostreatus* are based on those of Stamets and Chilton (1983) and Kurtzman (1979):

1. Chop or cut the dried substrate into small pieces (less than 5 cm).
2. Submerge the substrate in a water bath (70° C) for at least 30 minutes.
3. After draining, transfer the pasteurized substrate into a polyethylene bag with a microporous filter patch (which allows gas exchange).
4. Inoculate the substrate with 5% (w/w) of *Pleurotus* spawn. Thoroughly mix the spawn into the substrate with a clean (preferably sterile) rod.
5. Seal the bag with tape and incubate it in total darkness for 10–14 days at 25–30° C.
6. After the substrate is permeated with white mycelium (which should hold the substrate together), remove it from the bag (to prevent a build-up of CO_2) and place it in an environment where it will receive 50–500 lux of natural or fluorescent light for 12 hours/day and a temperature of 23–25° C (Figure 2).
7. Mist the substrate with a hand-sprayer once or twice daily.

Figure 3. *Pleurotus ostreatus* mushrooms growing on straw and ready for harvest.

In order to obtain a greater crop yield in a shorter period of time, the mycelium-permeated substrate (following Step 5) should be placed in a growth chamber so as to better control temperature, light and relative humidity (optimum is 90–95%).

Pinheads (mushroom primordia) should appear within 4–6 weeks after inoculation. Mature mushrooms will be ready to pick about a week later (Figure 3).

Several crops of mushrooms can be harvested at about 10-day intervals for 4–6 weeks. Average commercial yields for *Pleurotus ostreatus* are 1 kilogram fresh weight of mushrooms per kilogram dry weight of straw substrate.

The supplies required for *Pleurotus* cultivation are cheap and readily available. There are several commercial spawn producers in the United States. One reliable source is Fungi Perfecti (P.O. Box 7634, Olympia, WA 98507). The company also sells spawn of other species as well as extensive supplies, including the polyethylene bags referred to above.

In summary, cultivation of oyster mushrooms is an enjoyable and fascinating experience for anyone. It is especially useful for helping students better understand the biology and utility of fungi.

References

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