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Presents:

BEGINNER'S GUIDE TO OYSTER MUSHROOMS CULTIVATION AT HOME

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1. INTRODUCTION

- **The Cultivation of Oyster Mushrooms**

Species belonging to *Pleurotus* spp. (Basidiomycetes) resemble wood inhabiting mushrooms presenting wood-rotting abilities, degrading wood as saprophytes or facultative parasites growing on living or dead wood substrata on which produce a white rot. *Pleurotus* is more likely growing on deciduous trees and is rather rare on conifers.

Fruitbody morphological aspect: oyster shelf like cap 5-15(20) cm in diam of flesh like consistency with an eccentric-lateral stem of fibrous consistency. The cap color is variable, ranging from a species to another, and may be: white, cream, yellow, pink, reddish, grey, brown or dark grey.

Totally, there are known more than 20 worldwide well known oyster mushroom species.

Growing oyster mushrooms at home is very easy (known as the easiest to cultivate from all cultivated species). It grows on a wide range of substrates such as: paper, straw, leaves, and cotton residues, sawdust, etc which are rather present in rural areas.

Oyster mushrooms are rich in proteins (about 10-30%, fat, vitamins, minerals, etc), they have a therapeutic effect with a major impact on human health (0% cholesterol, polysaccharides with antitumoral, anti-inflamatory, anti-bacterial, anti-viral, anti-oxidant and immunomodulating effects). In addition they are delicious and worldwide famous.

1.2. Some of the most important cultivated oyster mushrooms

I will briefly present some of the most worldwide cultivated oyster mushroom species. An important aspect worth considering here is that some *Pleuortus* species are thermophilic (they love higher temperature ~30-32 °C / 86-89.6 F) while some other species are chriophilic (lower temperatures such as ~8-15 °C / 46.4-59 F are more suitable for their development). Taking into account this, we may choose what species to cultivate and in what season. Another important aspect is the sensitivity level of the mushroom; therefore we have more or less sensible species to the environmental factors present in the grow room. One thing is certain, these factors influence the mushroom developmental process, and are composed of biotic (e. g., competitive molds, flies, nematods, or other competitive mushrooms for the same substrate), while a-biotic factors refer to developmental conditions such as: temperature, humidity, ventilation, and light.

Fig. 1. Oyster mushroom fruitbodies (Photo credits: google.com)

Species of Cultivated Oyster Mushrooms:

1. *Pleurotus citrinopileatus* (golden oyster mushroom)
2. *P. djamor* (flamingo, salmon or pink oyster mushroom)
3. *P. eryngii* (king oyster mushroom)
4. *P. ostreatus* (oyster mushroom)
5. *P. florida* (the Florida oyster)
6. *P. pulmonarius* (the lung oyster, Phoenix mushroom)
7. *P. cornucopiae* (branched oyster mushroom)
8. *P. columbinus*
9. *P. cystidiosus*
10. *P. flabellatus*

1.2.1. Pleurotus citrinopileatus (Golden Oyster Mushroom)

The golden oyster mushroom is an impressing edible mushroom species especially because of its unique flavor and beautiful color: a light yellow pleasant to the human eye. This species has also a medicinal value and currently is subject to further scientific investigations. In spite of its qualities, this mushroom is more sensitive, has a lower productivity rate and is a thermophilic species compared to *Pleurotus ostreatus* which rather loves cold weather.

Fig. 2. *Pleurotus citrinopileatus* fruitbodies (Photo credits:fungiforum.com)

1.2.2. Pleurotus cornucopiae

This species may be characterized by a cap which in the young state is cream colored ant then becomes yellowish-ochraceous, at maturity turns darker ochraceous-dark brown. The cap is funnel shaped while the inner flash is white, thin with a pleasant odour and mild taste. There is a variety very similar to that of the golden oyster mushroom (*P. citrinopileatus*) often being confused with the latter. On the market may be seen a lot of hybrids some of them between *P. ostreatus* and *P. cornucopiae* bearing characters of both species; however, in some cases hard to distinguish, therefore experimented mushroomers are talking about *Pleurotus* without mentioning the species name but referring only to its genus.

Fig. 3. *Pleurotus cornucopiae* fruitbodies (Photo credits*:google.com*)

1.2.3. Pleurotus djamor (Flamingo or Pink Oyster Mushroom)

This beautiful oyster mushroom species is native to the tropical and subtropical areas and unlike *P. citrinopileatus* (the golden oyster mushroom) this species has an exotic look especially because of its pleasant color. Its morphological characteristics resemble *P. ostreatus* and include a complex of varieties such as: var. *cyathiformis* (with a white cap), var. *djamor* (white cap), var. *fuscopruinosus* (pruinose dark-colored cap), var. *fuscoroseus* (brownish-pink cap), var. *roseus* (pink colored cap), and var. *terricola* (white cap). Above all these varieties, *P. djamor* var. *roseus* is the most appreciated among mushroom cultivators especially because of its spectacular presence showing a color similar to that of the salmon flesh color. Unlike most oyster mushroom species it may be

cultivated very easily whereas its mycelium has a better substrate colonization rate and a higher productivity rate than other oyster mushroom species. In addition, this species is thermotolerant and therefore suitable to be cultivated in warm weather.

Fig. 4. *Pleurotus djamor* fruitbodies (Photo credits:google.com)

1.2.4. Pleurotus eryngii (King Oyster Mushroom)

Few of the cultivated oyster mushrooms are so appreciated because of their flavor as this species. Easily cultivated, this mushroom has also a therapeutical utility whereas in terms of productivity is less productive than other types of cultivated oyster mushrooms, therefore experimented mushroomers at inoculation use more mycelium than in other species. In addition, to stimulate fruitbody production they use nutritive supplements such as wheat or rye grains.

Fig. 5. *Pleurotus eryngii* fruitbodies *(Photo credits:leucoprin.ca*)

1.2.5. Pleurotus ostreatus (Oyster Mushroom)

The commonly cultivated oyster mushroom, *Pleurotus ostreatus,* as I know is the second worldwide cultivated mushroom after champignon (the white button mushroom). The latin word '*pleurotus*' originally comes from the greek word *'pleura*' = side and '*otus*' = ear and refers to the lateral or eccentric position of the stem on the mushroom cap. The word '*ostreatus*' as a whole comes from '*ostrea'* which means oyster and refers to the cap morphological aspect. In the wild this species has an affinity for beech wood, while when cultivated, may be grown on a wide range of substrata. It is very easy to grow and lots of productive strains are

available from this species. *P. ostreatus* may be grown in any season since it develops well at low temperatures as 8-14 °C (46.4-57.2 F) or high temperatures as 30-32 °C (86-89.6 F).

Fig. 6. *Pleurotus ostreatus* fruitbodies

1.2.6. Pleurotus florida (The Florida Oyster Mushroom)

Originating from Florida, this oyster mushroom variety is a thermophilic species (loves heat) suitable to be cultivated in warm and moist weather. From a taxonomical point of view it's name as a species doesn't exist although it is widely used across the world. Unlike *Pleurotus ostreatus* this variety is easy to grow and comparable with *P. ostreatus* when thinking about mycelium colonization rate of random substrata; however, according to some mushroomers is somewhat less productive.

Fig. 7. *Pleurotus florida* fruitbodies

1.2.7. Pleurotus pulmonarius (Phoenix Mushroom)

The latin word '*pulmonarius*' means lung and this mushroom resembles the color and shape of the human lungs. This species includes o complex of varieties such as: var. *juglandis*, var. *lapponicus* and var. *pulmonarius*. The *juglandis* variety may be encountered in the forests growing on *Juglans* spp. trees, while the other varieties grow on other hardwoods and conifers across temperate and subtropical areas. This species is often confused with *P. ostreatus* and *P. sajor-caju* other cultivated oyster mushrooms.

Fig. 8. *Pleurotus pulmonarius* (Photo credits:google.com)

Note: Of all the presented species and varieties here, the beginner cultivator should choose *Pleurotus ostreatus* especially because this species doesn't need strict environmental conditions in order to develop. Therefore cultivation mistakes are allowed especially for the beginner cultivator. It is important to get familiarized with what means the cultivation of oyster mushrooms and then you may start by cultivate other oyster mushroom species as well.

1.3. The mushroom mycelium: What is it? And where can it be purchased?

Once you know exactly what species of mushroom you will cultivate, the next step is to procure mycelium (spawn or mushroom seeds). However, before purchasing mycelium you should know few things:

- Check the provenience of the mycelium. A pure mycelium is the result of

its preparation in laboratory conditions; therefore you should purchase it from companies that you trust;

- Make sure that your mycelium is fresh (it has a warranty of about 2 months);
- Another important aspect refers to transportation: this should be made in proper temperature conditions (2-4 C / 35.6-39.2 F);
- Do not accept damaged bags of mycelium;
- Make sure that you've got the best strain, this will influence your mushroom production.

Fig. 9. Bag filled up with mushroom mycelium

(Photo credits:google.com)

Where do we get the mycelium from?

You can get mycelium from various sources of producers or cultivators.

There are several supliers out there. Best is to find local supliers.

Just in case that you would like to make your own mushroom spawn feel free to checkout the Low-tech Spawn Making Course at: www.mushroomclasses.com

How much mycelium should you purchase?

As a beginner cultivator you should purchase a small amount: 3-5 kilos /6.6-11 lbs are sufficient for the inoculation of 20 substrate bags each one of them weighting 5 kilograms /11 lbs.

Note: Once purchased mycelium should be kept in the fridge and taken out with up to 24 hours before usage.

2. THE OYSTER MUSHROOMS CULTIVATION PROCESS

2.1. Preparing the mushroom cultivation chamber

In order to avoid future culture contamination with various molds or insects the cultivation chamber obligatory has to be cleaned up. This procedure is necessary for the success of the cultivation process. The principle is simple: a clean product left in a place filled up with germs, has a high rate of contamination with germs; therefore a clean environment is necessary if we want to obtain success in our mushroom cultivation process. Therefore you should wash the floors with water and soap, paint the walls and use germ killing substances such as: chlorine, or alcohol mixed up with water [100ml (0.0246 US gal) of chlorine to 10l (2.642 US gal) of tap water] that will be sprayed all over in the grow room. This treatment has to be applied before and after each mushroom cultivation cycle just to be sure that possible contamination from previous mushroom culture won't affect future cultures.

The cultivation chamber may be any space destined for this purpose able to keep a high humidity level; however most chambers fail to keep humidity and this may result in dry substrates and poor mushroom fruitbody production. Since this

cultivation method is classical and made without equipment the mushroom cultivation chamber should have some other requirements such as:

- if possible to be a place able to keep a constant temperature;
- a place able to allow a natural ventilation (e.g., by opening a window or a door);
- a place able to allow sunlight entrance (e.g., through a window) or if this is not possible then this may be substituted by electrical lights;
- the floors should be made out of concrete or any other material except wood.

Fig. 10. *Pleurotus ostreatus* developing under a plastic cover
(Photo credits:google.com)

Basements are ideal for growing mushrooms especially because they do not fail in offering proper development conditions for mushroom fruitbody formation.

Anyway, you may use any space that you have available for mushroom cultivation, just keep in mind the above mentioned.

Note: If you opt for an open space to grow mushrooms then you may use a plastic foil cover (as seen in the picture above) to avoid substrate water loss and mushroom fruitbody dryness. However, in spite of all these measures it is possible to grow mushrooms outside in open air if the outside environmental conditions are proper for this.

2.2. Material and tools needed for home mushroom cultivation

In order to cultivate mushrooms we will need to use the following:

- substrate ingredients (see substrate recipes) or the so called compost ingredients: straw (wheat, rye, or barley), woody materials (chips, sawdust, etc), paper (cardboard, newspaper, books), corn (corncobs, cornstalks), cotton wastes, coffee grounds, nut shells, dry leaves, hay, or any other type of agricultural wastes;
- mycelium (spawn or mushroom seeds);
- a fire source;
- tap water source;
- a pot, a metal barrel or any other recipient. This will be covered up with a lid;
- (a recipient built up by using a wire mesh-as seen in Fig. 12);
- (a customized table -as seen in Fig.13: will be used for filling up the plastic bags with compost);
- a plastic foil;
- trash bags or customized column shape plastic bags;
- gypsum;
- water sprayer;
- disposable gloves.

Note: 1. Newspaper or books are not recommended as substrate ingredients since oyster mushrooms; particularly *Pleurotus ostreatus* has the ability to accumulate polluted substances and heavy metals into its fruitbodies

2. The beginner mushroom cultivator may leave out of this list the wire mesh recipient or the customized table since these is not obligatory for the cultivation process.

Fig. 11. Fire source and metal barrel needed in the substrate pasteurization process
(Photo credits:fungiforum.com)

2.3. Main ingredients of the mushroom cultivation compost

Oyster mushrooms generally grow on a wide range of agricultural waste materials of which they decompose. Such waste materials may be easily found in our house backyard, in our own kitchen or in the paper and wood industry. It can be used any material that is consisting of cellulose and lignin, two basic constituents of wood and plant organisms.

Many woody materials consist also of resins and polyphenolic compounds

(such as found in the conifer wood) that inhibit mycelium growth in some mushrooms.

Fig. 12. Wire mesh recipient used for substrate pasteurization
(Photo credits:fungiforum.com)

Therefore for oyster mushroom cultivation is not recommended to use as main grow substrate coniferous wood. By contrast, *Pleurotus* species grow on deciduous wood such as: beech, poplar, oak, birch, maple, and other such wood types. Other largely used substrates include: straw (wheat, barley, rice, etc), cotton hulls, corn stalks, leaves, paper or other agricultural wastes.

For those living in the city oyster mushrooms can be grown on cardboard, nut shells, (e.g., peanut, sunflower), coffee grounds, hay, or dry leaves. All of these substrates are rich sources of nutrients for mushrooms and are readily available as

wastes in our own yard or kitchen. Why throw them out? We have the chance to turn them into food.

Fig. 13. Customized table used for filling up plastic bags with compost (Photo credits:fungiforum.com)

Things to consider when choosing substrate material:

- I recommend you to use fresh materials (not older than 1 year);
- the material shouldn't be moldy or wet because of improper storage;
- the material should not have any color other than its native color;
- the material should be clean without any alien particles such as rocks or glass pieces;
- the substrate dimension is an important feature and is strongly connected with the spawn (mycelium) run through compost. For example the straw should be chopped into small pieces (1-1.5 cm/0.4-06 US in) or wood should be used as wood

chips. Keep in mind: the bigger the substrate particle is, the slower the decomposition rate by mushrooms gets and this results in a longer time until mushroom fruitbody formation.

Fig. 14. Shell types available in the kitchen of the city mushroom cultivator

Note: If you don't have any chopping machine around, no problem use the material as it is (for example use straw as it is). Wood may be also used as whole logs. If you want to learn how to grow mushrooms on logs check out www.mushroomclasses.com

2.3.1. Adding nutritional supplements to the substrate

The intake of protein, carbohydrates, vitamins and mineral supplements increases the rate of substrate colonization by the mushroom mycelium and has a direct effect on the final mushroom production from a quantitative and a qualitative

point of view. Among the best sources of protein I will list here: soy (added to substrate as grain or flour), wheat germ, or yeast. Sources rich in carbohydrates are the following: seeds of wheat, barley, oats, corn and rice.

Fig. 15. Straw ready for pasteurization (Photo credits:fungiforum.com)

Supplements are usually added to the main substrate at a rate of 3-25% and are not a mandatory component in preparing the compost that will be used as food for mushroom fruitbody formation. One aspect worth considering here is that using supplements improves productivity but encourages fungal contamination of the substrate by other competing species such as molds or bacteria.

Note: I recommend to the beginner mushroom cultivator to not use nutritional supplements in his first mushroom cultivation trials. Such productivity enhancing nutrients should be added to the substrate when the beginner mushroom cultivator is already familiarized with the cultivation process.

If you still want to use nutritional supplements than better would be to ground them and administrate them as flour, this may avoid seed sprouting in the substrate during incubation. However, when seed sprouting occurs, this results in rising the substrate temperature above 26 ºC / 78.8 F and determinate the so called 'self-ignition' of the substrate, when the mycelium is destroyed and the future mushroom culture compromised. In order to avoid this is recommended to decrease room temperature by 2-3 ºC / 35.6-37.4 F during incubation when in the substrate there are nutritional supplements added.

2.3.2. Adding other supplements to the substrate

The pasteurized and sterilized substrate and inoculated with mushroom mycelium, under incubation conditions after a certain period of time begins to ferment, at this point the substrate becomes acid (the pH within the substrate drops down). To prevent this phenomenon to the substrate is added gypsum, lime or calcium carbonate (chalk forage) at a rate of 5%. By using only one of these ingredients the substrate is maintained at neutral levels (between acid and alkaline).

Adding such supplements also improves the physical structure of the substrate by increasing porosity thereby facilitating gas exchange in the substrate.

Note: The addition of such supplements is not mandatory in the cultivation of oyster mushrooms, but their use is recommended because of the benefits mentioned.

2.3.3. Substrate recipes

I recommend to the beginner mushroom cultivator in his first trials of oyster mushroom cultivation to use a simple substrate recipe: composed of a single ingredient (e.g., wheat straw -the first recipe). Once familiar with the culture of mushrooms the beginner cultivator may play with a wide range of ingredients, including nutritional supplement additions. Finally through failure and success he or

she will understand how the whole process works and will develop a real experience in time.

I will expose here some substrate recipes for oyster mushrooms cultivation from which you may choose:

- **wheat straw 95% + gypsum 5%**
- **sawdust (beech, poplar, oak, walnut, horn-beam, maple,..) 95% + gypsum 5%**
- **straw 60% + corn-cobs 35% + lime 5%**
- **corn-cobs 90% + barley grain 7% + gypsum 3%**
- **soybean stalks 60% + corn-cobs 36% + gypsum 4%.**

2.4. Compost making for oyster mushrooms

The first step in compost making is to select a substrate or a compost formula. As a beginner for your first mushroom cultivation trial you should chose the following formula: **wheat straw 95% + gypsum 5%.**

Next the material has to be chopped into pieces (if possible). In principle for a 100kg/220 lbs of substrate you will need about 30-60 kg/66-132 lbs of dry material. The material is going to be soaked into water therefore its final weight will be around 100kg/220 lbs.

Note: Weighting the material is not mandatory only if you want to know exactly the substrate quantity that you are going to process. Usually this is a necessary step when you estimate the overall mushroom production.

2.5. Compost heat treatment

After weighting the material it can be soaked into water for several hours (recommended) or it can be directly sent to heat treatment.

There are several methods of heat treatment but here I will show you only two of them because they are widely used in the household system:

- **Direct flame heating (as shown in fig. 16):** The material is placed into a container (usually a metal barrel, or an improvised boiler) half filled with water and it is soaked by using a grill placed on the top of it which

is designed to keep the material under water, then everything is covered up with a lid for an appropriate heat treatment.

- **Scalding the material into hot water:** the same procedure as described above should be used here too.

Fig. 16. Substrate pasteurization on direct flame
(Photo credits:fungiforum.com)

Heat the content of the barrel until the temperature reaches 80-85 ºC / 176-185 F and try to maintain this temperature for about 2 to 4 hours. If the treatment temperature is lower, then allow more time for heat treatment process. This way occurs the so called 'substrate pasteurization' and this step is important because kills competing fungi and bacteria present into the substrate mass. However this temperature doesn't kill some bacteria species useful for the mushroom cultivation process.

Note: Another heat treatment procedure is to sterilize the material by boiling it for several hours or rising the temperature to 121ºC / 249.8 F for about 30 minutes to 1 hour. However, this procedure is not suitable for backyard mushroom cultivation.

2.6. Preparing the compost for inoculation

The house backyard mushroom cultivation is a concept based on ideas and lots of improvised tools in order to make the whole process easier.

Fig. 17. An improvised wire mesh container filled up with straw
(Photo credits:fungiforum.com)

One of such improvised tools is the wire mesh container which is filled up with material and soaked under water during heat treatment. This has the advantage that allows water flow immediately after heat treatment. Thus through a rope system it can be lifted up from the boiler and kept in the air while water is licking away (see Fig. 17). It also has the advantage of removing all material from the barrel after heat treatment.

All operations that we undertake from now on (draining, inoculation, weighing, etc) should be performed in clean conditions in order to avoid substrate infection with molds, germs and bacteria; otherwise all of our work until now could be compromised. This is why containers and all tools that the pasteurized material enters in contact with should be clean enough to ensure mushroom cultivation success.

A first step is to clean up container surfaces with 90º alcohol or some other germ killing substances (however, these should be oyster fungus friendly substances designated only against competing fungi or bacteria).

Wash hands with soap and water then spray them with alcohol or use a pair of gloves.

After pasteurization, allow material to cool down preferably on a clean concrete surface covered up with a clean plastic wrap, or a specially designed table for this purpose (see Fig.18). Disperse the material on the table in a layer of 20-30 cm / 7.9-11.8 US inch thick in order to cool quickly.

Check the substrate before inoculation:

- The material when squeezed into our hands should not show any water drops;
- The smell should indicate a freshly humidified substrate and should not have any sour odor indication the start of decomposition process.

Note: How will you know if you did the right thing so far?

Water should not accumulate at the bottom of the plastic bag that is going to be introduced in (waste bag, customized plastic bag, etc).

When the substrate temperature drops down to ca. 20-25 ºC / 68-77 F the material is cool enough to be weighted and inoculated with mushroom mycelium (spawn).

In order to know the exact quantity of compost, it is recommended to weight materials in a wet state separately and then to mix them up.

Fig. 18. Material left to cool down on an improvised table designed solely for this purpose

(Photo credits:fungiforum.com)

2.7. Adding supplements and mycelium to the substrate

- Immediately after mixing up the substrate ingredients we will add to the substrate mixture gypsum at a rate according to the chosen formula (usually 4-5%) mix well and we are ready to go further with the inoculation step.
- Now take a pair of disposal gloves on your hands and carefully take the mycelium out of the jar or bag. Care should be taken not to damage the hypha of mycelium surrounding the grain kernels or other support on which it is growing. Mycelium is a living organism, therefore if damaged the mycelium won't be able to spread throughout the compost and this will result in low mushroom yield.
- Now weight the mycelium and use the desired quantity (usually 2-3% = 2-3 kg / 4.4.-6.6 lbs to 100kg /220 lbs of compost)
- Next add the weighted mycelium quantity to the readily pasteurized and cooled substrate that has been mixed up with gypsum (see Fig.19). Mix everything together and disperse the mycelium in the whole substrate mass.

Fig. 19. Adding mycelium to the straw based substrate
(Photo credits:wildbruncmushrooms.com)

Remarks:

a) If you will increase the amount of mycelium added to the substrate from 1.25% to 5% automatically the mushroom production will increase by about 30-50%. In addition this will reduce the time necessary for spawn to colonize the substrate during incubation and will prevent contamination by competing molds, bacteria or insect occurrence in the substrate.

b) If you won't take into consideration the first remark, the competing species might take control of part (10-20%) of your bags filled up with inoculated substrate. When this happens, the oyster mushroom mycelium stops or reduces its

development. However, such situations occur, even if you did everything right, so there's no need to panic if you find 10-20% of your bags are infected with molds or such contaminants. Don't get discouraged, but try to think of what did you do wrong or how could you improve your mushrooming experience. From time to time even the experienced mushroomers are dealing with such situations.

2.8. Preparing the compost bags for incubation

Once prepared the compost mixture is inserted into trash bags or column type customized bags (about 4-10kg / 8.8-10 lbs of material in each bag). The bags are then bound to their end by using a rope.

Note: Preferably use transparent polyethylene bags for a good visibility. This is important because you can easily detect any infection in time. In case of contamination remove the bag out of the incubation room. Another advantage of the transparent plastic is that you can observe the spawn run through the compost mass.

Next take the bags and make wholes on their surface with a diameter of 1-2 centimeters / 0.4-0.8 in and distribute them in zigzag at distances of 10-15 cm / 3.9-5.9 inches one from another. Make rounded wholes or cross shaped wholes. The latter variant is superior to the first one because it reduces the chances of compost to lose humidity especially in the warm season.

The mycelium hypha in order to grow requires nutrients, moisture, temperature, oxygen and pathways for elimination of metabolic substances resulted from their development process such as carbon dioxide and metabolic water. Therefore the role of the holes is to allow gas exchange in the substratum.

Note: The size of the bag also has its significance. A good habit is to think about balance: a small and narrow bag will quickly dehydrate (especially in summer), on the opposite, a big and thick bag prevents good ventilation. Having in mind this simple principle most mushroomers are using bags measuring 40-50 cm /15.7-19.7 inches in diameter and 70-80 cm 27.6-31.5 inches long.

Fig. 20. Inserting the inoculated compost into polyethylene bags
(Photo credits:fungiforum.com)

The term of 'compost incubation' is assigned to the period of time from inoculation until mushroom fruiting. At *Pleurotus* this usually lasts between 17 and 27 days.

Incubation is usually done in the same room where mushroom fruiting occurs or may be done in a separate room especially designed for this purpose. The latter variant is even better since it reduces the contamination of your mushroom growing room with alien organisms.

To avoid the possible contamination of the bag and its extension to other bags as well and to facilitate gas exchange within the bags is important to:

- place the bags at 10-15 cm distance one from another;
- avoid overlapping the bags, this can increase the substrate temperature during spawn run;
- do not wet the bags.

Fig. 21. Inserting the inoculated compost into column-type polyethylene bags (Photo credits:fungiforum.com)

To ensure the mycelium development during incubation it is necessary to create an environment similar to that found in nature which is specific for every mushroom species.

Further you should focus on:

Temperature: should be constant (if possible). You should also keep in mind that temperature requirements are variable for thermophilic and criophilic mushroom species (see table 1)

- **Humidity:** It is recommended to keep humidity at optimum levels (75-80%) by watering the grow room floors and walls from time to time.

- **Humidity:** It is recommended to keep humidity at optimum levels (75-80%) by watering the grow room floors and walls from time to time.

- **Ventilation:** A continuous ventilation ensures air circulation and gas

exchange in the grow room. Without equipment this may be achieved by forming a passive air current throughout the grow room.

- **Light:** At this stage is not mandatory.

Table.1. Optimal grow room conditions for oyster mushroom fruiting and development (valid only for equipped grow rooms).

		Pleurotus ostreatus	*P. ostreatus* f. *florida*	*P. citrinopileatus*	*P. eryngii*
Inoculation	Mycelium quantity/substrate:	2%	2%	2%	3%
Incubation	Temperature : °C	(10)20-24	20-22	22-29	23-25
	Temperature: F	(50)68-75.2	68-71.6	71.6-84.2	73.4-77
	Substrate temp.: °C	25-30	25-30	27-32	25-28
	Substrate temp.: F	77-86	77-86	80.6-89.6	77-82.4
	Time:	12-14(22) days	12-14 days	10-14 days	(12)14-18 days
Pinhead Formation	Temperature: °C	(8)10-15(20)	15-20	15-25(30)	10-18
	Temperature: F	(46.4)20-59(68)	59-68	59-77(86)	50-64.4
	Relative Humidity:	90-95%	90-95%	90-95%	90-95%
Fruitbody Conditions	Temperature : °C	(10)13-20(25)	(11)13-20(28)	(13)17-22(28)	14-18(21)
	Temperature: F	(50)55.4-68(77)	(51.8)55.4-68(82.4)	(55.4)62.6-71.6(82.4)	57.2-64.4(69.8)
	Relative Humidity:	85%	85%	85%	82-85%
	Concentration of CO_2:	< 1000 ppm	< 1000 ppm	< 1000 ppm	< 1500 ppm
	Light:	800-1500 lux	800-1500 lux	800-1500 lux	800-1500 lux
Watering	No. times/day:	2-3	2-3	2-3	2
	Period:	7-10(14) days	7-10 days	7-10(14) days	7-14 days
	Relative Humidity:	90%	90-95%	90-95%	90%
Production Cycle	Period:	2-3 months	2-3 months	2-3 months	2-3 months

Note: The beginner mushroom cultivator may ignore some of the requirements presented in table 1. Since we are discussing backyard mushroom farming, the notes above are rather concerning equipped grow rooms able to offer optimal environmental conditions for mushroom development. Oyster mushroom cultivation is very easy and do not requires much attention.

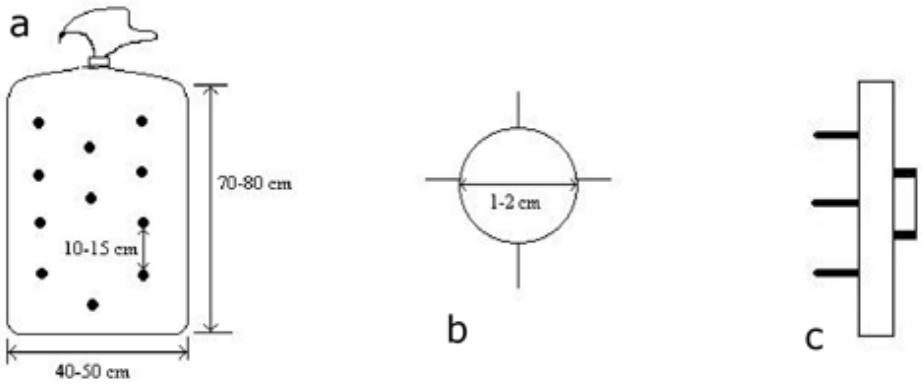

Fig. 22. Preparing the bags for incubation: a) bag dimensions; b) cross-shaped hole; c) hole making device.

Observation: After 3-4 days from inoculation the mycelium growth may be seen. The mycelium hyphae are slowly expanding their surface covering up the substrate. The incubation phase ends with the induction of mushroom primordia formation (pinhead formation). In this moment the mycelium has already covered up the whole compost surface.

2.10. Mushroom fruitbody formation & development

The mushroom fruitbody formation occurs across the bag surface where we made holes through the plastic film. At first, they appear as small dark colored pinheads that gradually develop and get lighter in color. If you placed the sack on the ground and the room temperature is rather optimal you may untie the bags at the end and leave them wide open. The fruitbody formation lasts between 4 to 10 days depending on the species, strain and microclimate conditions. However, at this stage you should consider the following aspects:

Humidity: Now is the moment when the growing mushrooms should be watered through the use of a pressure pump. They should be sprayed 2 to 3 times/day until harvest. If the mushrooms are stagnant in their growth or are

getting dried the watering is insufficient.

Fig. 23. Hanging column bags incubating in the grow room
(Photo credits: www.fungiforum.com)

Temperature: Should be constant if possible.

Ventilation: To prevent fungus drying avoid strong and dry direct airflow in the grow room.

Light: It is indispensable at this point for mushroom development, therefore this is very important. If the grow room is a basement and it doesn't have any natural light, then you should use artificial light: neon tubes preferably blue fluorescent of 40W power placed at 2-3 meters / 78.7-118.1 inches above or along the sides of the grow room. Leave them to light up the room from 8 to 12 hours per day.

Note: Light intensity is important and has direct effect on fruitbody development. A less intense light affects the mushroom stem making it longer while the cap is getting poorly developed.

Fig. 24. Oyster mushroom primordia formation
(Photo credits:fungiforum.com)

2.11. Harvest

Mushrooms are harvested after 3-5 days once pinhead formation has occurred. Mature oyster mushrooms consist of well developed fruitbodies lighter in color and with the mushroom cap margin nearly flat. At this point harvest oyster mushrooms by hand twisting the whole mushroom bunch or by cutting the mushroom stem base with a knife.

Note: Mushrooms not harvested in time lose their quality.

After the first round of mushrooms has been harvested the plastic foil

covering the bag may be removed if environmental conditions (especially humidity and airflow) allow this.

The harvest is followed by a time gap of 8 to 10 days until the next round of mushrooms; however, this is not a rule because sometimes they appear in a single round.

Fig. 25. Oyster mushroom pinhead formation
(Photo credits:fungiforum.com)

How many mushroom production rounds are there?

Well, there may be 3 to 5 rounds of mushrooms to be harvested (when you have equipment that provides proper environmental conditions for fruitbody development) or 2 to 3 rounds when you don't use such equipment.

The life-cycle of the whole culture should last 1 to 2 months (the case of classical mushroom cultivation).

Fig. 26. Oyster mushroom pinhead formation close up

(Photo credits: www.fungiforum.com)

Fig. 27. Fruitbody development by using artificial light

(Photo credits:fungiforum.com)

Fig. 28. Oyster mushroom fruitbodies
(Photo credits:fungiforum.com)

To prevent respiratory system allergies caused by spore formation in the grow room it will be necessary to use a mask covering up your nose and mouth and a dressing suit only used for this purpose. Billions of spores are released when mushrooms reach the state of maturity. These spores spread all over the grow room and affect the lungs of the unprotected personnel when harvesting

mushrooms. In order to avoid air load with spores in the grown room before each harvest you should spray all over with water.

Fig. 29. Harvested oyster mushrooms (Photo credits: www.fungiforum.com)

2.12. Few Words about oyster mushroom production

On the market there are many excellent strains; however, it is hard to know which one is the best as long as you do not make a mushroom strain evaluation. Productivity depends on a complex of factors (microclimate conditions, type of substrate used, mushroom species, strain, etc) some of them difficult to take into account. In another course I intend to discuss in detail what factors influence productivity and how some of them can be controlled. Info on how to set up a low-tech small-scale mushroom farm you'll find at www.mushroomclasses.com

What can you do with waste material used in mushroom production?

The remnants may be used for animal feed, as an organic fertilizer for soil or simply as fuel for fire.

Fig. 30. Fruitbodies of *Pleurotus eryngii* (nameko)
(Photo credits:google.com)

3. OTHER CONSIDERATIONS

3.1. Oyster mushroom cultivation problems

Here I will briefly summarize some of the most important things to keep in mind when starting the oyster mushroom cultivation process:

- Excessive humidity damages and undermines the mushroom mycelium;
- Heat treatment failure leads to substrate infection with competing molds, bacteria or insects;
- Low intensity light or the lack of light in the grow room during fruitbody formation results in inhibition of fungal growth and development;
- Excessive temperature (greater than 35 °C / 95 F) inhibits and destroys mycelium;

- Excessive concentration of carbon dioxide in the grow room inhibits the development of mycelium;
- Substrate inoculation with a low quantity of mycelium increases the risk of infection by competing organisms for the same nutrients, increases the incubation time, and decreases the mushroom crop.

3.2. Oyster mushroom culture pests

Pests may be divided into two categories: pathogens and competitors. Pathogens are fewer than competitors and have a devastating effect on the mushroom culture. They are: molds, bacteria, viruses, or insects. Competitors refer to those pests that cause competition with the inoculated oyster mushrooms mycelium for the same type of nutrients found in the compost. However, not all contaminants are considered pests. There are certain bacteria or fungi that are rather important for oyster mushroom mycelium development and have a direct effect on the mushroom crop.

Such organisms belong to the following genera: *Humicola*, *Torula*, *Actinomyces*, *Streptomyces*, and some species of *Pseudomonas* or *Bacillus*). For this reason it is recommended to pasteurize the substrate (80-85 °C / 176-185 F) and not to sterilize it. In addition, through sterilization the substrate is predisposed to infection at a higher rate through exposure to air.

Here I will briefly present you some of the most common pests:

A. Trichoderma viridae (the green mold)

It is very common and appears as green masses of moldy areas infecting the substrate partly or integrally. It is characterized by a rapid growth and acts as a parasite on the oyster mushroom mycelium and may inhibit the occurrence of mushoom pinheads or mushroom fruitbody development. It was shown that *T. viridae* prefers a more acidic substratum (4-6 pH) and this is also the reason why you should use gypsum in your substrate formula. *Trichoderma* spores stick to anything, therefore insects when occur may function as a contamination vector that can spread the local contamination to the whole mass of substratum.

Fig. 31. *Trichoderma viride*

(Photo credits:biogardenorganic.com)

Note: Substratum contamination may occur also when using infected mushroom mycelium at inoculation. This is why your mycelium should be bought from a clean source that you trust. If *Trichoderma* occurs in the substrate take the bag outside of the grow room and lower the substrate pH by adding baking soda or salt.

Correct heat treatment of the substrate, clean grow room before incubation phase, reduce moisture level in the grow room during incubation, reduce carbon dioxide level in the grow room by frequent ventilation (if possible), use clean tools, use gypsum at an optimal rate.

B. Contamination because of insects (nematods, flies, mites, etc)

Mainly the flies are insects able to invade the mushroom culture and infect it with various pathogens. They are attracted by the smell of the decomposing substrate. Flies are laying eggs near mycelium while hatched larvae consume it.

What can you do against flies, nematods or mites?

- Add a mesh at each window, this will have good results in preventing flies entering the grow room;
- Use UV lights, the blue color will attract insects;
- Apply a proper heat treatment to the substrate (if not, possibly you will see mites walking in the substrate);
- Avoid excess moisture in the substrate (if not, you will see nematods developing in your substrate);
- Use clean tools during mushroom cultivation.

Fig. 32. The common mushroom fly (*Lycoriella* spp.)
(Photo credits:google.com)

Fig. 33. Nematod (Photo credits:google.com)

C. Other mushroom species (e.g., *Coprinus* spp.)

This mushroom belongs to the family of *Coprinaceae* and it is characterized by a characteristic outline with the cap when mature dissolving and turning into a black ink. This mushroom may be quite often seen growing into the substrate destined for oyster mushroom cultivation. The causes may be the lack of oxygen into the substratum due to the lack of porosity or lack of gypsum in the substrate. The latter situation raises the pH in the substratum offering ideal conditions for species of *Coprinus* to develop.

Fig. 34. *Coprinus* spp. growing among *Pleurotus* fruitbodies
(Photo credits:google.com)

There are several species of *Coprinus* that may appear in your substrate: edible (*C. comatus*, *C. atramentarius*, etc) or non-edible (*C. micaceus*) or even toxic. If you encounter them in your substrate I highly recommend you the following: do not eat them! Not even the edible oyster mushrooms that you see developing among them!

End Note

I hope you enjoyed this eBook and that was useful for you to understand what's with oyster mushroom cultivation. If you're interested to discover even more on how to grow mushrooms checkout the course:

Low-Tech Mushroom Growing For Beginners:

https://mushroomclasses.com/mushroom-growing/

This course is about 15 hours long and contains video leactures, instructional movies, quizzes, articles, projects and Q&A support