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MUSHROOM TECHNOLOGY

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MUSHROOM TECHNOLOGY

INTRODUCTION

Mushrooms are fleshy, spore bearing fungi. These spores germinate under favorable conditions to microscopic filaments which branch to form a mycelium. Fusion of compatible mycelia gives rise to fruiting bodies. Nutritionally, mushrooms are called saprophyte and obtain their food from non-living matter. Carbon and nitrogen sources including other elements available in the substrates support vegetative growth and fruiting development of the fungi.

The fast-growing mushrooms are good source of delicious food with high nutritional attributes like proteins, essential amino acids, fats, vitamins, carbohydrates and fibers, and some have medicinal values as well.

The art of mushroom propagation has advanced dramatically in the past decades due to the techniques of spawn preparation, wide selection of low cost materials and availability of agro-industrial wastes used as growing substrates.

Technical information on mushroom growing and brochures demonstrating the cultivation of commercial species like *Volvariella volvacea* (straw mushroom), *Agaricus* sp. (white button mushroom), *Pleurotus* species (oyster and abalone mushrooms), *Auricularia* species (*tainga ng daga*) including the medicinal *Ganoderma lucidum* are now available at the Institute.

Table 1. Mushroom Species Cultivated in the Philippines

CLASSIFICATION (As to temperature)	SCIENTIFIC NAME	COMMON NAME	INCUBATION TEMP.	FRUITING
TROPICAL	*Volvariella volvaceae*	Straw	37◦C	28-30◦C
SEMI TROPICAL	*Pleurotus sajorcaju*	Oyster	28-30◦C	26-28◦C
	Pleurotus cystidiosus	Abalone	-do-	-do-
	Auricularia Sp.	Jews Ear (Tainga ng daga)	-do-	-do-
	Lentinus edodes	Shiitake	-do-	-do-
	Agaricus bitorquis	Button Hot Champignon	-do-	-do-
TEMPERATE	*Agaricus bisporus*	Button Cold Champignon	22-25◦C	-do-

GENERAL CONSIDERATIONS FOR THE ESTABLISHMENT OF MUSHROOM FARMS/ GROWING HOUSES

1. Criteria for the selection of a site
   - There should be a sufficient space for expansion
   - Fresh water should be available
   - Temperature range of the area should be suitable for the specific mushroom to be produced
   - Availability of transportation/proximity to market
   - Not too windy area for the *Volvariella* species

2. Criteria for the selection of raw materials
   - Availability/continuity of supply at reasonable cost
   - Good quality of raw materials

3. Basic requirements
   - Water source
   - Available space for expansion
   - Labor source
   - Availability/continuity of good quality spawn
   - Capital investment

4. Operational plan

5. Cultivation/technology

PRODUCTION OF TROPICAL MUSHROOM (Straw Mushroom)

Preparation of Potato-Dextrose-Agar (PDA)

Raw Materials

Fresh good quality potatoes	200	g
Dextrose powder	20	g
Agar bar (*gulaman*)	20	g
Distilled water	1	L

Procedure

1. Wash, peel and dice the potatoes. Place 200 g in a casserole where water has started to boil and allow to boil until potatoes are soft enough for the pallate.
2. Strain the broth (decoction) through cheesecloth. Restore the volume of decoction to 1 L and put back into the casserole.
3. Add the agar (chipped) and the dextrose powder. Heat while stirring occasionally until the agar dissolves.
4. Dispense 30 mL in each flat rhum bottle and plug the mouth with the bottle cotton.
5. Sterilize the medium in a pressure cooker at 121◦C or 15-lb. pressure for 15 minutes. Immediately after sterilization, slant the test tubes at an angle of 20 to 25 degrees, making sure that the agar does not touch the cotton plug.
6. Lay the bottles flat on the table until the agar congeals.

Isolation of the Pure Culture (by Tissue Culture Method)

Tissue Culture Method (*Volvariella volvaceae)*

1. Select a good, young, healthy and fresh mushroom (button stage for straw mushroom). Disinfect with 70% rubbing alcohol using a cotton swab.
2. Cut vertically and horizontally half portion of the button stage mushroom.
3. With a sterilized scalpel, cut approximately 1- cm cube to the tissue between the cap and stem and place on the middle of the plated agar.
4. Incubate for 5 to 7 days at ordinary temperature. This is termed as pure tissue culture.
5. Transfer the pure culture into agar slants.
6. Incubate for 5 to 7 days at ordinary temperature. This is now termed as sub-culture.

Preparation of Spawn Substrates

1. Place chopped dried substrate; i.e., rice straw, banana, leguminous leaves in a suitable container and add water until completely submerged. Place something heavy on top to avoid floatation.
2. Ferment substrate anaerobically in water with urea (3 grams per gallon of water) as follows:

chopped, dried tobacco midribs	- 3 days
chopped, dried *kakawati* leaves	- 5 days
chopped, dried *ipil-ipil* leaves	- 5 days
chopped, dried rice straw	- 3 days
chopped, dried water lily	- 2 days
chopped, dried banana leaves	- 3 days

3. Wash the substrate with tap water three times or until objectionable odor is removed.
4. Mix with sawdust at a proportion of two parts substrate to one (2:1) part sawdust.
5. Add rice bran (Class A) at 20% of the major substrate.
6. Readjust the moisture at 65% to 70% (damp moisture).
7. Place substrates in polypropylene bags (PP) and 500 g/bag. Use 6x10 PP bags and pull-end of the bag, pass thru a PVC pipe ring (1" long x 1" dia.) Plug with used cotton, cover with scratch paper and tie with a rubber band.
8. Sterilize at 15-lb. pressure for 1 to 1½ hours or steam for 4 hours in a drum.
9. Cool, inoculate with pure culture.

Inoculation of the Spawn

1. Sterilize the inoculating needle in the flame of an alcohol lamp.
2. Lift from the inoculum about 1.5 cm^2 and transfer into the bagged substrate.

3. Flame the lip of the bag as well as the lip of the rhum bottle containing the inoculum before lifting a portion for transfer.
4. The inoculum substrate is now termed spawn and is ready for planting into beds after two weeks.

Backyard Planting of Straw Mushroom

Materials

Mushroom spawn of good quality
Bedding materials (rice straw/banana leaves)
Urea (fertilizer)
Plastic sheet (5m/3 m bed)
Soaking vessels
Benlate (fungicide)

Procedure

1. Gather good quality substrates (dried rice straw and dried banana leaves).
2. Arrange the substrates, bundle with plastic straw in the middle to about 4" diameter. Have the substrate cut to 18" length.
3. Soak the bundled substrates in clean, tap water for a considerable period of time. Rice straw requires 3-4 hours soaking while banana leaves require 10-12 hours soaking. This procedure renders the substrate pliable. It allows sufficient water supply required for the growth of mold during its incubation period. **Do not oversoak the material.**
4. While the material is being soaked, prepare the bed foundation. This could either be made of soil, wood or concrete. Most economical and practical is soil foundation. This is done by making a foundation similar to a garden plot which should be east-west oriented under a partially shaded area.
5. Prepare the fertilized paper (old newspaper) soaked in 3g urea/gal of water for 10-20 minutes.

6. After the completion of the required soaking period, haul the materials from the soaking vessel and allow excess water to drain freely.
7. Lay the substrates on the bed foundation and make up 3 to 4 layers during the dry season and 5 to 7 layers during the rainy season. Make the first layer by closely laying enough soaked substrates side by side until the whole length of the plot is covered.
8. Distribute pieces of half-squeezed fertilized paper only along the edges of the laid substrates.
9. Distribute spawn (300 g) to the layers of a 3-m bed. Place a thumb-sized spawn on the top of each piece of distributed fertilized paper. Keep a 2-3" distance between spawns.
10. Repeat the preceding procedure as you make the second, third and succeeding layers.
11. Cover the entire bed with plastic sheet to assure temperature build-up and to retain the moisture required for the mushroom mold to ramify. This should be left intact for 5 days (dry season) or 7 days or more, depending on the existing climatic conditions (cool, rainy months).
12. Aerate the bed on the 5th or 7th day after the incubation period by removing the plastic cover. This will allow the release of toxic gases which may affect the growth of mushroom. In cases of storm, heavy rain or too windy a place, raising the plastic sheet for less than an hour in the morning is sufficient.
13. Return the plastic sheet cover, but never allow this to touch the pinheads to avoid spoilage of mushroom.

Care and Management

High yielding mushroom beds depend on three interrelated factors: good quality spawns, preparation of bed and care and management. More tips follow:

1. Keep the surrounding clean.

2. Keep the bed moist if necessary. Do this by spraying with clean water making sure that it does not exert pressure to avoid breaking the thread-like structures spreading on the substrates.
3. **DO NOT WATER THE BEDS WHEN PINHEADS APPEAR**. This will give way to early decomposition of fruits.
4. Picking up mushrooms would be realized on the 14th and 21st day depending on the prevailing environmental conditions. When picking/harvesting, do not use any sharp tools to remove the fruit from the substrate. Hold the base of the mushroom with bare hands and apply a simple twisting motion.
5. In case the bed is infected with other kinds of molds or infested with insects, take the harvestable mushroom before applying the prescribed fungicide/insecticide and do this by spot spraying.
6. Maintain the temperature of the bed at 32° to 35°C during the fruiting. No mushroom will fruit if temperature drops to 20°C. Mushrooms grown at higher temperature will be smaller and lighter in weight.
7. After a lapse of one month, discard used substrates (spent bed).

PRODUCTION OF SEMI-TROPICAL MUSHROOM (Oyster Mushroom)

Preparation of Potato-Dextrose -Agar (PDA)

Follow the preparation of PDA as discussed in the production of tropical mushroom.

Preparation of Substrates (Fruiting bags)

1. Mix the following materials thoroughly:

Sawdust, dried sieve	-	78%
Rice bran, class A	-	20%
Calcium carbonate	-	1%
Refined sugar	-	1%
		100%

2. Add tap water sparingly until the mixture reaches approximately 65-70% moisture. When a handful of the mixture is pressed in the palm of the hand and no water runs off in between the fingers and will stay in form after the release of pressure, the 65-70% moisture is reached.
3. Pile and pack the substrate in pyramidal form.
4. Cover with plastic sheet and incubate for 5 days. Re-pile on the 3rd day.
5. On the fifth day, aerate the piled material by spreading the material thinly in a shaded area to remove the toxic gases produced during the fermentation period.

   Note : Do not spread the material under the sun

6. Pack 1 kg of the material in PP bags after 2-3 hours aeration. The smell of the toxic gas is removed and its moisture is re-adjusted to 65-70% level.
7. Collect the upper part of the plastic bag and pass it thru PVC pipe ring (1" dia. x 1" length), then pull the plastic thru this pipe. Hold the free end of the plastic bag with a rubber band.
8. Plug the bag with cotton and provide with paper to lessen moisture uptake during the sterilization process.
9. Sterilize the packed mixture at 15-lb pressure for 1 – 1½ hours.
10. Cool the substrate. This is now ready for inoculation with Pl sp mold grown on PDA or sorghum grains.

Propagation of the Mushroom Mold

1. Inoculate the PDA with young and pure culture of the *Pleurotus* mold.
2. Incubate the pure culture at 25°C for two weeks or until the full ramification of mycelium is observed. (This is now termed as subculture.) This is now ready for the inoculation of mother spawn.

Preparation of the Mother Spawn

1. Wash the sorghum grains thoroughly under running tap water.
2. Place in a casserole, cover with water at about 2" above grain level.
3. Bring to a boil with occasional stirring to test the grains.
4. Stop boiling when grains are just about to burst (*malabo/maligat* stage).
5. Immediately strain water to prevent grains from becoming overcooked. Use fine screen or cheesecloth for the purpose.
6. Cook briskly. When grains are merely damp, distribute in empty flat rhum bottles. One kilo will make 10 bottles.
7. Plug bottles with absorbent cotton, support with a piece of paper and rubber band. Sterilize at 15 psi for 15 minutes. Then cool.
8. Inoculate with 15-day old pure culture of the mold. (parent-tissue culture).
9. Incubate at 28-30°C until the whole medium is fully impregnated with the mushroom mold (normally 10-15 days).

These are now the mother spawns, one of which will be good for 25 to 30 spawn bags.

Inoculation of Substrate with Grain Spawns

1. Sterilize the inoculating needle in the flame of the alcohol lamp.
2. Scrape the fully ramified grain spawn with the use of the inoculating needle.
3. Flame the tip of the fruiting bag as well as the rhum bottle containing the grain spawn before transfer.
4. Inoculate the sterilized/cooled substrate with fully ramified grain spawn.

5. Incubate the above at 25 -28ºC for 30-45 days.
6. Ramify the mold in the substrate.
7. Open the ramified substrate for fruiting.

Fruiting

WHERE TO PLACE THE FRUITING BAGS

- Place the bags in a clean and cool area of the house (temperature approximately 25° to 28°C).
- Leave the bags there for at least 4 days to allow acclimatization before opening the bags.

  Space under the sink can also serve as growing area but make sure that it is clean and safe from insects and rodents.

  A bench atop a pan of water can also be used to hold the bags.
- Watch out for the fruits. Development usually starts 3 to 4 days after opening.

HARVESTING

- Do this with bare hands. Gently hold the stem and pull out the mushrooms.

CARE AND MAINTENANCE OF BAGS

- Spray water gently on the surface of the bags if they dry up. Never do this when pinheads appear. This will cause heavy decay of the mushroom fruit bodies.
- Cut the opposite end of the bags to allow for more fruiting.
- Scrape the exposed areas from where mushrooms have been harvested using a sharp knife. Do this after each harvest.

NOTE: Fruiting bags last for three months with approximately 8 harvests/flushes provided proper care and management have been applied to bags/growing houses/chambers.

PRODUCTION EQUIPMENT*

QTY	UNIT	PRODUCTION EQUIPMENT	UNIT COST (P)	TOTAL COST (P)
1	unit	cooking casserole (2-li cap)	400	400
1	unit	cooking casserole (4-li cap)	600	600
1	unit	chopping board	150	150
1	unit	working table, SS made 4"x8"	5,000	5,000
1	unit	top balance (100-gram cap)	1,800	1,800
1	unit	gas stove, 3 burners (with tank)	3,000	3,000
2	units	wood ladle	100	200
1	unit	pressure cooker (41 qts.)	30,000	30,000
1	unit	isolation chamber (fabricated)	3,500	3,500
1	unit	scalpel blade	120	120
2	pcs	inoculating needle	120	240
1	unit	shovel	300	300
1	pc	stapler	350	350
20	m	hose w/ nozzle	40	800
2	units	garden scissor	500	1,000
1	unit	siever	15,000	15,000
1	unit	weighing scale (50-kg cap)	5,000	5,000
4	units	weighing scale (10-gram cap)	1,200	4,800
1	unit	drum (90-100 bags)	1,200	1,200
4	yds.	cheesecloth	100	400
1	unit	alcohol lamp	100	100
1	pc	scalper holder	350	350
				74,310

* Estimated Cost