

Oyster Mushroom Cultivation

Part I. Mushrooms

Chapter 2

Mushroom Growing for a Living Worldwide

MUSHROOM GROWING IN NORTHERN THAILAND

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Introduction



Figure 1. Rural community people taking mushroom growing lessons

Thailand is a particularly good place for future growers to learn how to grow tropical mushrooms. Thailand has ideal environmental conditions for mushroom cultivation and a long history of mushroom growing. Thai people, who knew that mushroom growing required low cost materials and technologies while offering a high and quick return on their money, have long grown a variety of mushrooms. Up to date, young rural people are eager to learn how to grow mushrooms using materials readily available to them to improve their living (Fig. 1, 2).

In addition the warm climate favorable for mushroom growing, well-established growing practices and their will to pave their way for a better life, the long & successful mushroom production in Thailand are owed to the sincere efforts and considerable support made by the Kingdom of Thailand and Thai government to enhance Thai people's life by encouraging mushroom growing. The kingdom initiated Royal Mushroom Projects aimed at promoting rural development in Thailand (Fig. 3, 4, 5, 6, 7). The government runs loan programs for rural communities, some of which adopt a mushroom production cooperative. More mushroom production at the community level is expected, enriching rural people.



Figure 2. Rural community people taking mushroom growing lessons



Figure 3. Where Royal Mushroom Project is being Implemented



Figure 4. A mushroom growing house for Royal Mushroom Project



Figure 5, 6, 7. *Auricula Auricularia*, *Ganoderma lucidum* and *Hericium erinaceus* grown by Royal Mushroom Project

Table 1. Commercially cultivated mushrooms in Thailand

Common name	Latin name	Thai name	Market price (THB*/ kg)
Button mushroom	<i>Agaricus bisporus</i>	Hed Kradum	80-120
Black poplar mushroom	<i>Agrocybe cylindracea</i>	Hed Yanagi	250-300
Wood ear	<i>Auricularia auricula</i>	Hed Hu-noo	30-50
Inky cap	<i>Coprinus atramentarius</i>	Hed Muerk	120-160
Enokitake	<i>Flammulina velutipes</i>	Hed Khemthong	
		Hed KhaemNgern	150-200
Reishi	<i>Ganoderma lucidum</i>	Hed Lin Juer	1,000-1,500
Lion's mane	<i>Hericium erinaceus</i>	Hed Hua ling	1,000 (dry)
Shitake	<i>Lentinula edodes</i>	Hed Hom	160-180
Parasol mushroom	<i>Macrolepiota gracilentia</i>	Hed Nok Yoong	400-500
Golden oyster mushroom	<i>Pleurotus citrinopoleatus</i>		150-200
Abalone mushroom	<i>Pleurotus cystidiosus</i>	Hed Pao-hue	70-80
King oyster mushroom	<i>Pleurotus eryngii</i>	Hed Nanglom Luang	200-250
Oyster mushroom	<i>Pleurotus ostreatus</i>	Hed Nanglom Khao	30-40
Silver ear	<i>Tremella fuciformis</i>	Hed Hu-nu-Khao	300-350
Straw mushroom	<i>Volvariella volvacea</i>	Hed Fang	90-120

* THB (Thai Baht, THB1 = USD0.0258 in Feb 2004)

Growing House

Mushroom growing houses can be classified into two types: those built for temporary use or those erected for long term use. A typical mushroom house (Fig. 8) is made of thatch and bamboo or other kinds of wood poles and shading net. Growers use different dried grasses and leaves which are most readily available or thought to be the best available. Depending on the durability of the roof and wall material (1-5 years), growers should replace with a new roof and walls on a regular schedule. Some button and straw mushroom growers have brick houses with two rows of shelves inside. These houses are highly tolerant to subsequent, severe heat treatment during *in situ* pasteurization. Being secondary decomposers, button and straw mushrooms need compost and it should be pasteurized to be the selective medium for mushroom. See the steam pipes on the wall (Fig. 9).



Figure 8. Typical mushroom growing houses made of thatch and wooden poles



Figure 9. Steam pipes on the brick wall

Mushrooms Cultivated in Shelf

Straw mushroom

Straw mushroom (*Volvariella volvacea*) is a high temperature mushroom and the most popularly grown in Thailand. Thai farmers have grown the mushroom since the 1940s. Thailand has a temperature range that is very favorable for the mushroom's growth (30-37°C). Straw mushroom spawn is easily available for local farmers and that mushroom is cultivated on shelves, unlike other mushrooms, which are grown in bags except button mushrooms, whose spawn is not that easy to obtain here.

Here is a simple way of growing straw mushroom: A bale of straw inoculated with straw mushroom spawn is left in the bag and days later, mushrooms come out (Fig. 10). Traditionally, rice growers also grew straw mushrooms in their rice fields after harvest. They made rows of mushroom mounds with rice straw and other agro wastes in the harvested fields, using a wooden frame. Today, rice growers still produce straw mushrooms in their fields from December to April, using the growing method as described above. But the yield is as low as 20% and so is the price, THB20 (USD0.52)/kg, with comparison with modern growing methods.



Figure 10. Straw mushroom growing in a simple way

Indoor cultivation of straw mushroom is performed all through the year. Being a secondary saprophyte like button mushroom (*Agaricus bisporus*), straw mushrooms grow well in organic compost, where the ingredients are partially decomposed or highly degraded. When the compost is completed, it is placed on the shelf and steam is blown into the house with the temperature maintained at 60°C for 4-6 hours. When the room temperature cools gradually down to 35°C with the door closed, spawn is laid about 2cm deep into or on top of the compost. Indoor cultivation using compost achieves much the higher yield of 50-60%. Produced mushrooms are sold fresh in retail markets at THB30 (USD0.77) or to canneries at THB12-16 (USD0.31-0.41)/kg.

Straw mushroom growing is a handsome income source for rice growers as well as commercial straw mushroom growers. A grower makes a net profit of about THB5,000 (USD129) per month, greater than from other produce. Even better, the mushroom has a short production cycle, which means a fast return on investment. Further, the mushroom is rich in protein and can be grown with agro wastes, even on the spent mushroom substrate of inky cap, but the protein content of straw mushroom is much higher than that of inky cap.



Figure 11. Composting



Figure 12. Straw mushroom on the shelf

Button mushroom

Button mushroom (*A. bisporus*) is not the second most grown mushroom, nor is it a tropical mushroom. Thus, production of button mushroom is seasonal, usually in the cooler season from November to January. As mentioned above, it requires organic compost and is grown on shelves indoors. The brick house (Fig. 9) is a typical button or straw mushroom growing room. Button mushroom growing methods employed in Thailand are similar to traditional button mushroom growing in other parts of the world and include outdoor composting (Phase I) (Fig. 13), *in situ* pasteurization (Phase II), spawning, spawn-run (Fig. 15), and fruiting. Wood logs or other fuel resources are used as fuel for the boiler to steam the growing room with compost inside.

This farm produces 1 ton of mushroom per year in the 2 rows of 4 tier shelves with a total growing area of 144 (2 rows \times 4 tiers \times 2m wide \times 9m long) square meters. Another farm we visited uses two 5-tier shelves 9m long, 1.7m wide with a yield of 13kg/m². The farm produces 200kg per crop. Yields have not been “satisfactory” yet. Local mushroom demand from fast food restaurant chains like Pizza Hut and McDonald's are met by imported mushrooms from Holland and Australia. And it sells at around THB52 (USD1.3) per kg. Farm sanitation practices are required for high yields of quality mushroom production.



Figure 13. Outdoor composting



Figure 14. Filling



Figure 15. Spawn run
(8 days after spawning)

Mushrooms Cultivated in Bags

Oyster mushroom, abalone mushroom, yanagi and shiitake are commonly cultivated in bags in Thailand. Some large farms are equipped with machines and tools like ribbon mixers, bagging machines and compacting machines (Fig. 16), steam boilers and ventilation fans. They not only produce their mushrooms but also supply ready-to-fruit mushroom bags to neighboring farms. Common bag preparation methods are as follows:

- Mix sawdust (rubber tree) + rice bran (20%) + other additives (gypsum, lime, calcium sulfate (CaSO_4) or magnesium sulfate (MgSO_4))
- Adjust the water content of the mixture to 60-65%. (A rule of thumb is squeezing the mixture in the palm of your hand. When a droplet or two barely escapes, the mixture has a proper water content.)
- Fill the bags and compact
- Pasteurize the bags in the cooker for 3-4 hours from the time temperature reaches 90-100°C.
- Cool them to 25°C and inoculate

They commonly use a plastic ring to make a “bottle neck” for easy handling. They put a plastic ring on the bag end, pull out the bag end through the ring, fold down the pulled out part, tie it with a rubber band and plug with cotton, paper or cotton-topped plastic plug (Fig. 17).



Figure 16. Compacting Machine



Figure 17. Plugging



Figure 18. Traditional oil-drum sterilizer



Figure 19. Metal grate for oil drum sterilizer

Substrate bags are sterilized either in a commercial autoclave at 15-20 psi for 1 hour or in an oil drum sterilizer (Fig. 18, 19) around 100°C or higher for 3-4 hours. How to use the oil drum sterilizer is as follows. The sterilizer is first filled with water a foot from the bottom, heated and maintained at 90-100°C for 3-4 hours. Bags for mushrooms with a long cultivation period should be sterilized above 100°C with pressure. When the bags are cooled to the ambient temperature, inoculate them with spawn in a clean, sterile if possible, room (Fig. 20). Sorghum seed is the most commonly used material for a spawn carrier in Thailand.



Figure 20. Inoculation



Figure 21. Mushroom bags at incubation

Oyster mushroom and abalone mushroom

Being easy to grow, oyster mushroom is favored by more and more growers in the world, especially by those who want simple growing. All the mushroom bags are stacked atop the other bags on the A-frame shelf.

The farm we visited produces oyster mushroom for 6 months per crop and sells them at THB20 (USD0.52)/kg in wholesale markets and THB25 (USD0.65)/kg in retail markets. When the fruiting starts, they harvest mushrooms every day but not from all the bags. Growers can harvest up to 500g from a high quality 1kg bag in a crop. In average, they produce 200-300g from a bag. They also grow oyster mushrooms from Hungary, whose spawn costs THB2-3 (USD0.05-0.08) per kg bag.



Figure 22, 23. Oyster mushroom and abalone mushroom bags in the shelf

In the meantime, abalone mushrooms are harvested once a week and the production cycle takes a year. The average yield is 500g/kg a year. The mushrooms sell at THB40 (USD1.03)/kg in wholesale markets and THB50 (USD1.29)/kg in retail markets. As a new item, they fetch relatively high prices compared with oyster mushrooms.

But you should take a note of the productivity. Each mushroom produces 500g from a 1kg bag in one crop. But the crop span of oyster mushroom is half that of Abalone mushroom. That means productivity of the latter is half of that of oyster mushroom, while the price is the other way around. The choice is up to growers.



Figure 24.25. Oyster mushroom in cold storage and in the market

Figure 26. Packaging (Yanagi matsutake)

Yanagi matsutake

Yanagi matsutake (*Agrocybe cylindraceae*) is relatively easy to grow but less easy than oyster mushroom, since the mushroom is said to be more prone to contamination and it requires a longer time before the first harvest (1-1 1/2 months). The mushroom (called Yanagi matsutake in Thailand) is a new item in Thai mushroom markets. Its high demand, thanks to their marketing and promotional efforts, brings a handsome income to growers. The mushroom sells at the price of THB100-120 (USD2.58-3.10)/kg. A mushroom growing bag made of sawdust, rice bran (7.5-10%), CaCO₃ (2%), sugar (1%) and gypsum (1%) costs THB6 (USD0.15) per kg bag. A production cycle has ten flushes, lasts one year and produces 150-200g/kg in total. The mushroom can be stored at 7°C for 7 days.

Shiitake

As grown in relatively low temperatures, shiitake (*Lentinula edodes*) can be cultivated mostly in the highland areas with cooler temperatures or at lower altitudes in the cool season. Shiitake is one of the most expensive edible mushrooms in Thailand because there exist relatively unfavorable conditions for cultivation of those mushrooms. To provide better conditions, mushroom growers cover the roof with a shade net and pour cold water through the roof for evaporative cooling. To induce fruiting, they use icy water. Unlike other mushrooms, shiitake require cooler temperatures and are cultivated on the floor. The floor is limed to prevent fungal contamination, especially from green mould. A 1kg substrate bag costs THB5-7 (USD0.13-0.18). Mushroom growers harvest 3-4 flushes or 7-9 flushes in a crop.



Figure 27. Mushroom growing bags at spawn run

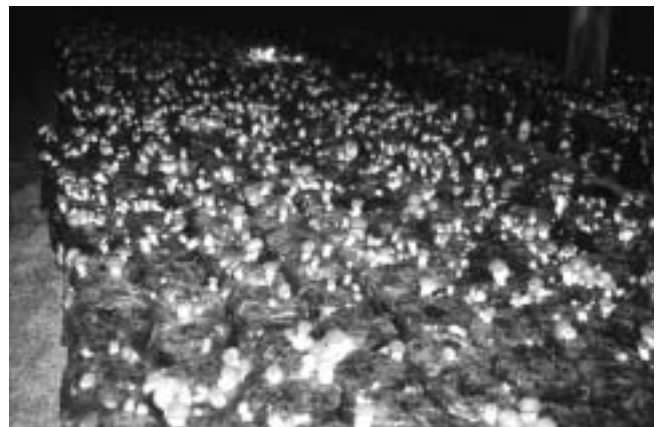


Figure 28. Shiitake grown on the floor

What Mushroom Growing means to Thai people's Life

Mushroom cultivation in Thailand means much more than growing other commodity crops. Most of the farmers involved with mushroom cultivation recycle agricultural wastes to cultivate mushrooms. Some 70% of rice farmers cultivate straw mushroom by utilizing straw or hay they already have. They don't need to buy basal substrate material. In a few years, straw mushroom cultivation brings them more money than rice. Inspired by the large income from mushroom growing, the Thai government encourages poor rural people to grow mushrooms. Moreover, mushroom growing provides a quick return on investment. Straw mushroom cultivation takes just 3 weeks and other mushrooms like abalone, oyster and ear mushroom 3-4 months to bring money to farmers. And the 10-30% profit is high enough for farmers to continue growing.

Lately medicinal mushrooms such as reishi (*Ganoderma lucidum*) and lion's mane (*Hericium erinaceus*) were introduced to the country. That brought about a great interest not only in reishi but also other medicinal mushrooms, even in Thai traditional medicines among Thai people. Now *Ganoderma* mushroom and dried lion's mane fetch the highest prices ever, THB1,000-1,500 (USD25.8-38.7) and THB1,000 (USD25.8)/kg, respectively, 25-50 times the price of oyster mushroom. Growing these medicinal mushrooms is like producing 'golden eggs'.

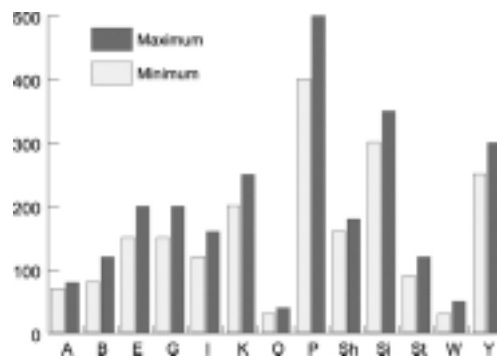


Figure 29. Prices of mushroom cultivated in Thailand

A : Abalone M. (*Pleurotus cystidiosus*)

E : Enokitake (*Flammulina velutipes*)

I : Inky Cap (*Coprinus atramentarius*)

O : Oyster M. (*Tremella fuciformis*)

Sh : Shiitake (*Lentinula edodes*)

St : Straw M. (*Volvariella volvacea*)

Y : Yanagi (Black Poplar)

B : Button M. (*Agaricus bisporus*)

G : Golden Oyster M. (*Pleurotus citrinopileatus*)

K : King Oyster M. (*Pleurotus eryngii*)

P : Parasol M. (*Macrolepiota gracilentia*)

Si : Silver Ear M. (*Tremella fuciformis*)

W : Wood Ear M. (*Auricularia auricula*)

M. (*Agrocybe cylindracea*)