Cultivated Mushrooms

Introduction

- Cultivation of mushrooms as a research endeavor in U.S.A.
  - Only Penn. State a degree program: Mushroom Science
  - Common in Asian countries, in Horticulture departments.
- Will use term "mushroom" in a broad sense, again.

Introduction

- Consumption of mushroom probably occurred during prehistory, in hunting and foraging period.
- Unlike plants could not be cultivated at first and was be collected a long period of time.
- Even today, relatively few species of mushrooms can be cultivated.

History

- Mushrooms thought to be special and supernatural in origin.
  - 4600 years ago, Egyptians believed mushrooms to be plants of immortality.
    - Pharaohs decreed that only they could eat mushrooms.

History

- Mushrooms thought to be special and supernatural in origin.
  - Chinese and Japanese have utilized mushrooms for medicinal usage for thousands of years.
  - Romans thought mushrooms were the food of the gods.

History

- Many people presently collect mushrooms for the purpose of consumption, but…
- Many myths and false concepts still survive today concerning mushrooms.
- Many species have now been "cultivated", but……
- Relative to number of edible species, few cultivated.

History

- Different cultures cultivated different species.
- Cultivation of mushrooms in Western cultures first recorded in 1650.
  - ***Agaricus bisporus*** was first species cultivated, on compost.
- In Asia, specifically China and Japan, it is not known when cultivation began.
  - Several species of mushrooms cultivated, on wood.

Cultivated Species

- Will cover some examples of cultivated species in Eastern and Western Cultures.
- Will also go over some new possibilities.
- Will start off with ***Agaricus bisporus***.

Agaricus bisporus

- Also referred to as the **Button Mushroom**, most cultivated species.
- First species cultivated in Western culture, in Paris, France, around 1650.
  - First observed growing in melon crop compost.
  - For 160 years grown in open field.
  - Then moved underground into caves, excavated tunnels or quarries. Still used in France

Agaricus bisporus

- From France, method of cultivation learned by England.
- By 1865, United States began mushroom cultivation.
  - **Spawn** (=mycelium of mushroom) was initially imported from England.
  - United States did not develop its own spawn until 1903.
  - Initially, mushroom growing was a "backyard" endeavor.

Generating Spawn

- A medium in which to grow mycelium.
- "Autoclave" to sterilize medium.

Grain medium

Pressure cooker

Generating Spawn

- A source of mycelium.
  - Spores.

Spores in syringe

Wipe injection site with sterile swab

http://www.spiritgarden.co.uk/spawnbag.php

Generating Spawn

- A source of mycelium.
  - **Spores.**

Inoculate spores

http://www.spiritgarden.co.uk/spawnbag.php

Generating Spawn

- A source of mycelium.
  - **Tissue culture.**

Tear mushroom apart

Aseptically excise tissue

Generating Spawn

- A source of mycelium.
  - **Incubate**

Initial growth

Spawn grows throughout medium

http://www.spiritgarden.co.uk/spawnbag.php

Agaricus bisporus

- By 1865, United States began mushroom cultivation (continued).
  - By 1914, cultivation of button mushroom was becoming industrialized.
  - Southern Pennsylvania largest mushroom growers in U.S., 85% of mushrooms.
  - In 1970s and 80s, Penn. State improved yield of mushrooms, keeping U.S. competitive with rest of world.

Cultivating *Agaricus bisporus*

- Method for growing well known, but poorly understood.
- Substrate includes mostly horse manure, wheat straw, corn cobs, and several other waste plant products and animal waste.
- Mixed and allowed to sit and **compost**. Breakdown of complex compounds to simple compounds.

Cultivating *Agaricus bisporus*

- Will become very hot due to biological activities.
- When complete will have consistency of thick oat meal, when cooled.
- *Agaricus bisporus* spawn can then be inoculated into substrate and grow through substrate rapidly if maintained at 24 C.

Cultivating *Agaricus bisporus*

- **Casing Layer** is placed over substrate. Normally, clay soil. Critical phase!
- Bacterial activity, soluble salts and lowering temperature to 14-18 C, critical
- Mushroom "buttons" form just below casing layer.

Cultivating *Agaricus bisporus*

- **Compost pile:**

http://www.personal.psu.edu/mab568/AgaricusV2.htm

Cultivating *Agaricus bisporus*

- **Pasteurization:**

http://www.personal.psu.edu/mab568/AgaricusV2.htm

Cultivating *Agaricus bisporus*

- **"Spawning":**

http://www.personal.psu.edu/mab568/AgaricusV2.htm

Cultivating *Agaricus bisporus*

- **Casing:**

http://www.personal.psu.edu/mab568/AgaricusV2.htm

Cultivating *Agaricus bisporus*

- **Harvesting:**

http://www.personal.psu.edu/mab568/AgaricusV2.htm

Agaricus bisporus

- Genetic variants of *A. bisporus*.
  - **Portobello**.

  - Like white button mushroom, but expanded and brown.

Agaricus bisporus

- Genetic variants of *A. bisporus*. (continued).
  - **Crimini**.

  - Like white button mushroom, but brown.

Pleurotus ostreatus

- Prior to 1970s, *Agaricus bisporus* was only species cultivated in U.S.
- In early 1970s, some attempts to grow other species.
  - Pleurotus ostreatus (Oyster Mushroom).
  - Common on dead wood, in Europe and North America.

Pleurotus ostreatus

- Now commonly in U.S. supermarkets.
  - Cultivation first described at beginning of 20th Century.
  - Innovation in cultivation of mushroom growing on wood in late 1950s made cultivation of *P. ostreatus* possible.
  - By late 1970s, became common in supermarkets.

Lentinus edodes

- Many other species, but were from already cultivated species of Asia.
- Actual beginning of mushroom cultivation in Asia, unknown.
- Probably best known species is ***Lentinus edodes*** (=Shiitake) .
  - Mostly sold dried in U.S.

Lentinus edodes

- Since 1970s, has been cultivated in U.S. and now available, fresh, at supermarkets.
- Species originally cultured, in China, about 800 years ago.
- Now grown extensively in China and Japan.
- Research in Japan also claims mushroom has medicinal use, i.e., anti-tumor activity, rich in D2.

Lentinus edodes

- Cultivation of Shiitake.
  - Initially began by placing logs with fruitbodies near logs cut for cultivation.
  - Spores would eventually infect logs nearby.
  - To ensure fungus would infect logs, holes drilled in logs and wooden dowel with the mycelium placed in hole and sealed.

Lentinus edodes

- Cultivation of Shitake (continued):
  - Logs kept moist and in 6-9 months mushrooms will begin to form.
  - May continue to form for as long as several years.

Lentinus edodes

- Cultivation of Shitake (continued):
  - Difficulty in finding logs forced innovation of better method: placing sawdust and carbohydrate in polypropylene bag, which is sterilized.

Lentinus edodes

- Cultivation of Shitake (continued):
  - Polypropylene bag method (continued).

Lentinus edodes

- Cultivation of Shitake (continued):
  - Polypropylene bag method (continued).

Volvariella volvacea

- Also known as the Paddy Straw Mushroom.

  - Not available fresh in U.S., usually canned.

Volvariella volvacea

- Americans have had it in Chinese restaurants.
- Origin of cultivation uncertain, but believed to be as early as 1822.
- Became more widely dispersed in other areas where Chinese have migrated.
- Origin in Hawai'i likely during 19th. Century.

Volvariella volvacea

- Cultivation of Paddy Straw Mushroom:
  - Grown mostly on composted rice paddy straw, but also on other plant waste products.
  - Other products included dried banana leaves and oil palm waste.
  - Until 1972, with introduction of cotton waste, yield of mushrooms was very low.

Volvariella volvacea

- Cultivation of Paddy Straw Mushroom (continued):
  - Cotton waste made mass cultivation of mushroom possible.
  - Industrial production of mushroom now in Hong Kong, Thailand, Taiwan and Indonesia.
  - Cotton waste with 4% rice or wheat straw and 4-6% agricultural limestone allowed to compost for 2-3 days.

Volvariella volvacea

- Cultivation of Paddy Straw Mushroom (continued):
  - Turned at least once, pasteurized with steam.
  - Many countries still use lower yielding water material method.

Volvariella volvacea

- Cultivation of Paddy Straw Mushroom (continued):
  - Turned at least once, pasteurized with steam.
  - Many countries still use lower yielding water material method.

Auricularia Spp.

- Several species cultivated, but most common are *A. auricula* and *A. cornea (=A. polytricha)*

  - First species, temperate and other tropic to subtropic and occurs commonly in Hawai'i.

Auricularia Spp.

- *Auricularia cornea* was one of the edible fungi in ancient China
- First cultivation reliably reported in about 300-200 B.C.
- Now known to be cultivated in many South Pacific countries.
- Commonly called "ear fungus" regardless of where it is grown.
- Was commercially exported from Hawai'i, during 19th Century.

Auricularia Spp.

- Cultivation technique same as that of Shiitake and Oyster Mushroom.

Tremella fuciformis

- Also known as the **Silver Ear**.

- Long used as a herb, in China, for various ailments.

Tremella fuciformis

- Said to extend life expectancy, cure tuberculosis and good for treating high blood pressure. Also, grown for food as well.
- Prior to cultivation, only rich could afford to have this mushroom.
- Once believed to be a wood decomposer, but now known to be a **mycoparasite**.
- Occurs in Hawai'i.

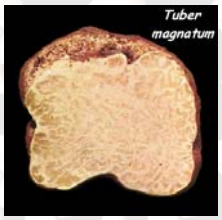
Flammulina velutipes

- Also known as the **Enoki**
- Small delicate mushroom.
- Cultivated on sawdust medium in a large, urn-shaped container.

- Available fresh in U.S., in supermarkets.
- Origin of cultivation obscured, but has been cultivated for several centuries.

Cultivation of New Species

- **Truffles**
- Several species "cultivated":



- Two of most popular are *Tuber melanosporum* and *T. magnatum*.

Truffles

- Have been collected as far back as 1600 B.C.
- Unlike other "mushrooms", truffles are subterranean and are Ascomycota.
- Cannot be "cultivated" in the usual sense because they form **mycorrhizae**, symbiotic relationship between roots of plant and fungus.
- Once believed to be a product of oak trees, as recently as 1903.

Truffles

- Because of inability to mass produce, one reason why price has been as high as $800/lb.
- Until after World War II, the only means of obtaining truffles was collecting them in wild.
- In 1972, idea of "growing" truffles, in an oak plantation. Requires up to 10 years before first truffles are harvested.

Truffles

- Harvesting truffles.

http://www.plantin.com/truffles/hunting.html

http://encarta.msn.com/media_461529942/Truffle_Hunting.html

Truffles

- Trees with truffle mycelium inoculated can be purchased.
- Some areas, other than Europe believed to have truffles, but never found, i.e. California.
- Numerous efforts have been made to grow oaks outside of native area have mostly failed, until 1987, when New Zealand attempted to grow truffles.

Truffles

- New Zealand was successful and it only took 5 years instead of 10.
- Why were they successful?.
  - It is believed that since oaks are not native to New Zealand, no competitive mycorrhizal fungi replaces truffle mycelium on the roots of trees.

Morels

- Numerous species of morels occur and all are equally edible.

Morchella esculenta
(Morel)

- Morels are also members of Ascomycota and have never been successfully cultivated, *commercially*.

Morels

- Very much sought after, but not as pricey as truffles.
- Numerous attempts have been made to cultivate morels.
- Mycelium could be grown and initially commercial interest attempted to sell mycelium.
- In 1980, Ron Ower grew the first morel, *Morchella esculenta*, but yield was very low.

Morels

- Gary Mills of Neogene Corporation, affiliated with Michigan State collaborated with Ron and seemed to successfully produce a high yield method, but only worked in Michigan.
- Attempts to use method elsewhere failed.

Medicinal Mushroom

- Many mushrooms cultivated for medicinal uses.

Lentinus edodes: In combination with AIDs drugs to boost immune response, chronic fatigue and induces antibody formation to Hepatitis B

Grifola frondosa (Maitake): Said to be a powerful antioxidant and can help to maintain a healthy immune system

Cordyceps sinensis (Winter Worm)*:* helps increase stamina, energy levels, and endurance, aphrodisiac, stimulate immune system, and lowers "bad"- raises "good" cholesterol.

Tremella fuciformis (Silver Ear)*:* Anti-aging, asthma, anti-tumor agent, and women's friend for skin, bone and weight control