GROWING OF SHIITAKE MUSHROOM (Lentinus edodius) ON WATTLE SAW DUST AND/OR PROCESSED WATTLE BARK

ABSTRACT

Shiitake Mushroom is consumed widely in Asia where it is prized for its flavour and health promoting benefits. 'Shiitake' name is taken from 'Shii' tree (oak - Quercus) on which it grows naturally.

Increasing demand for Shiitake has resulted in the expansion of cultivation to areas outside its natural habitat. This has created a need to adapt and modify traditional cultivation techniques in order to develop new methods for growing Shiitake.

Actual cultivation of Shiitake originated in China (960 - 1127). Traditionally, Shiitake has been cultivated on freshly cut logs, usually from the oak family. Live trees are cut during the dormant season when their sugar content is high. Within two months the logs are inoculated with actively growing pure culture spawn. The spawn usually consists of sawdust or wooden plugs which have been permeated by Shiitake mycelium.

After inoculation logs with spawn are placed in stacks and left for mycelium to colonize the wood. Process take 18 to 24 months depending on conditions during the incubation i.e. amount of spawn used, the Shiitake variety and environmental conditions.

After the logs are fully colonized with the mycelium they are induced to produce mushrooms. Rains or watering will usually induce mushroom formation. Depending on their size and number of fruiting per year, logs can produce mushrooms periodically up to five years, with biological efficiencies from 20 to 33%, on initial dry weight of substrate to fresh weight of mushrooms. Oak trees usually takes 25 to 30 years to grow.
Producing Shiitake mushrooms on sawdust is becoming more advanced in view of its rapid production.

The novel method using wattle (Acacia Mearnsii) saw dust and/or tannin extracted bark blended with proteinous ingredients can produce Shiitake mushrooms in three months (see the description). With biological efficiencies from 40% to 60% within three months of harvest. Production cycle is reduced to six months compared to five years in traditional method i.e three months of incubation and three months of harvest.

Wattle trees take 8 to 10 years to grow having other major commercial uses as to produce tannin extract for leather and adhesive industries. Wood having other uses as firewood, charcoal and production of activated carbon.

Advantages of using wattle saw dust and/or tannin extracted bark as a substrate growing Shiitake mushrooms are:-

a) Rapid production of Shiitake mushroom starting within three months.

b) Beneficial environmental effects i.e to avoid deforestation as wattle industry is well established industry for more than seventy years, with re-planting forests in cycles of production requirements.

c) Use of by-products and waste materials to produce mushrooms, such as wattle sawdust and extracted bark can greatly reduce pollution with added advantage of food production.
DETAILED DESCRIPTION

MATERIALS AND METHODS

Traditional process involves cutting of oak trees during dormant season when sugar content is high. Log moistures are usually 35% to 55%.

Holes are drilled on the logs every 6 to 10 inches (15-25 cms) along the row in Diamond pattern. Depth of the holes usually 5/16" deep for plug spawn or 12 mm for sawdust spawn.

Plug spawn consists of wooden dowels grown with Shiitake mycelium and sawdust spawn is a mixture of sawdust and bran(4:1) colonized by Shiitake mycelium.

Holes are sealed after placing the spawn and sealed with wax to avoid other contamination.

Logs are incubated at 22 - 25 deg.C(72 deg. to 77 deg.F). Log moistures (between 35 to 55%) can be regulated through irrigation. Ventilation is needed to dry the bark surface to prevent contamination by other moulds. Logs are stacked and incubated for approximately 12 to 18 months depending on the size of the log.

Induction and pin formation starts when mycelium responds by shifting from its vegetative phase to the production of fruiting bodies. Light, temperature, moisture in the logs and humidity levels, all having variable effects on quality of fruiting bodies.

Fully colonized logs follow a cycle of fruiting and with periodical resting over two to five years. During this period Shiitake continues to decay the wood and continues producing fruiting bodies.

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The maximum biological efficiency of Shiitake production is about 33%. BE is a ratio of the fresh weight of the Mushrooms to the initial dry weight of the substrate, expressed as a percentage.

**Detailed Description of new method**

More specifically, the process involves collection of wattle sawdust from wood and bark after extraction of wattle (tannin) extract. Extraction of tannin from wattle bark is done through leaching with steam and water. This is a well-established industrial process.

Unlike logs, mix of components in this substrate can be adjusted to increase the nutrients availability for Shiitake growth.

Substrate preparation have following formulation:

- **a)** Sawdust from wattle wood or all dried wattle - 70% by weight
  - bark (3mm to 5mm size) obtained after extraction of tannin (waste material from tanning extract factory).
- **b)** Wheat or Triticale or Rye grain - cooked - 15% by weight
  - to 40% moisture.
- **c)** Chopped wheat or Triticale or Rye Straw - 15% by weight
  - (2 to 5 cms in size).

All ingredients are mixed thoroughly and soaked in water for 12 to 24 hours. Excess water drained and 1% lime (calcium carbonate) with 0.5% Gypsum added to the mixture.

Analysis of the substrate should have 55 to 65% moisture and 5.5 to 6.0 pH.
Mixed substrate is then filled into heat resistant high density polythene bags. Ideal weight should be 2 kilograms per bag but up to 5 kilograms can be filled.

A small amount of air exchange is needed during the spawn run therefore after filling, the neck of the bag is pulled through a heat resistant plastic ring and folded back to create an opening. This opening is then plugged with a cotton or foam plug which allows air exchange. Instead of ring a plastic (flexible) tie can be used to hold the plug.

After the sawdust mix has been prepared, it is heat treated to eliminate populations of competing organisms present in the substrate.

Heat treatment usually is done with steam in the retort or autoclave at 121 deg. C for 2 hours. Following the heat treatment substrate is cooled down to 25 deg. C - 26 deg. C (75 deg. - 77 deg. F).

Spawn made from Grain permeated by Shiitake mycelium, is used to inoculate the substrate. Spawn made from sawdust can also be used. Spawn can be obtained from many reputable spawn making companies. Suitable warm weather or cold weather strains is used.

Bags are opened up in sterile environment from the top removing plug and spawn is added and pushed into substrate. After inoculation bags are closed and stoppered again with cotton wool or foam plug.

Spawn rate is calculated to about 8% on weight of wet substrate.

Alternatively, substrate is prepared in glass bottle.
sterilized as per polythene bags and spawned in sterile environment, mixed and decanted or transferredaspectically in polythene bags and stoppered with cotton or foam plug. In this manner spawn can be distributed throughly in the substrate.

Inoculated substrate contained in bags, is then transferred to incubation room for vegetative growth at 24 deg.to 26 deg.C for 60(sixty) days. Incubation room should be equipped with air circulation system and washed periodically with disinfectant usually chlorinated water or phenolic compounds or Lysol(Trade name).

Cool white fluorescent light is required for better fruiting quality before Shiitake is able to fruit. Oxygen is needed during spawn run because Shiitake is aerobic.

After colonisation the substrate appears totally white and sawdust or bark particles are no longer visible. As the mycelium matures, lumps of mycelium appear on the substrate surface. Clear or brownish metabolic fluid may also appear in the bags. Areas on the surface may turn brown, especially where the substrate receives light.

The browning phenomenon is an oxidation caused by polyphenol oxidases, reacting to light and oxygen. Outer brown skin acts as a moisture barrier and a defence against invading organisms.

Fully grown mycelium substrate is then transferred to growing rooms for induction.

Outer polythene cover is removed and induction is initiated by shifting from warm incubation temperatures (25°C) to cooler temperatures (16 deg.C). Soaking the blocks in cold water(24 hours) can also provide this stimulus. Following the water soak, .../5
the blocks are placed under fruiting conditions in growing house.

Growing house should be adequately covered, either by a permanent structure or a greenhouse type structures with shelves covered with polythene sheets. Lights are fitted along the shelves as fruiting body responses to light for colour development, a quality requirement or could have transparent roof.

High carbon dioxide levels inhibit pinning (fruiting). Therefore, to promote pinning, substrate surface must be exposed to air through fans. 80% (relative) humidity is needed for maintaining adequate moisture in the substrate and to avoid substrate drying out. Watering floors and substrate is therefore essential. This can be done everyday provided adequate ventilation is provided.

Light exposure for 12 hours would produce dark and better quality. Lights can be provided through the fitted fluorescent tubes along and on the shelves or fitted transparent roof on growing house.

After first flush and harvesting mushrooms, resting period of 10 to 15 days followed for further vegetative growth, with slightly elevated temperature of about 20 to 22 deg.C.

Logs are then either watered heavily or soaked again for fruiting. 3 to 4 cycles are followed in the same manner. Within three months of harvest more than 40% biological efficiencies are achieved. Mushrooms are then sold as fresh or dried.

Main drawback in the old process (oak logs) is the time factor and lower biological efficiencies. Two years to produce mushrooms is uneconomical and deforestation of oak forests also
becomes environmental threat. Handling of the logs and production of substrate form all wood is also another negative aspect.

This novel process using wattle sawdust and/or extracted blended with other ingredients saves in use of wood, 70% compared to 100% in log cultivation. Wattle industry is already in existence since last 70 years for producing wattle extract, for leather tanning industry. Therefore, substrate materials already in existence and can be utilized effectively.

10 Replanting of wattle trees in rotation, and in systematic manner, which takes only 8 to 9 years compared to 25 - 30 years of oak trees, poses no threat to environment due to deforestation.

Biological efficiencies is higher than oak log cultivation with production in shorter duration i.e within three months compared 18 to 24 months in log cultivation. Easier handling in controlled conditions is added advantage economically. Use of extracted wattle bark also eliminates pollution threat with benefits of producing extra food.

20 Process is arrived at with the aim of using available wattle wood and extracted bark, which presently is used only as firewood and charcoal production and bark as a waste material. Wattle wood was compared with oakwood (natural forests) as a growing substrate (hard wood). Blending with other nutrients is to increase the yields in shorter time and reduce the use of sawdust.
CLAIM

We claim that method of growing of Shiitake mushrooms (Lentinus Edodes) using 70% of wattle (Acacia mearnsii) sawdust and/or blended with 15% proteinous ingredients such as wheat or triticale or Rye grains or wheat bran with chopped wheat straw 15%, as explained in detail above.

We also claim that this novel process is better economically, simpler, produces higher yields in shorter duration and is environmental friendly compared to existing process on oak log cultivation.

We claim that this process is utilizing existing available waste materials with blended nutrients to produce Shiitake mushrooms as a food source and uses less woody mass compared oaklog cultivation.

[Signatures]

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