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EFFECT OF SPAWN DENSITY AND BED SUBSTRATES ON THE SPOROPHORE YIELD OF *LENTINUS EDODES.*

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Abstract

Edible mushrooms cultivation is one of the efficient ways by which residues can be recycled and also improve food supply with high food quality to the humans. Cultivation of shiitake mushroom has increased tremendously throughout the world because of its abilities to grow at a wide range of temperature and utilized various agro-based residues as well as its medicinal value. The present study was aimed to find out the optimum spawn density and suitability of various commonly available agro and agro-industrial wastes as substrates for shiitake cultivation. Data pertaining to evaluation of optimum spawn density indicated that the spawn density of 20 per cent level completely colonized the beds within 31.3 days.

Among the substrates, silver oak saw dust recorded shortest spawn run (32.5 days) with biological efficiency of 68 per cent followed by eucalyptus saw dust. Further, investigations were also made to find out the effect of combination of substrates with different concentration on the yield of *L. edodes*. The results revealed that the combination of silver oak saw dust +eucalyptus saw dust (1:1) recorded spawn run (30.1 days), browning period (52.2 days), sporophore yield (347.0g) with biological efficiency of 69.4 per cent.

Key words: *Lentinus edodes*, shiitake mushroom, bed substrates and biological efficiency

Introduction

Edible mushrooms have been widely used as human food for centuries and have been appreciated for texture and flavor as well as some medicinal and tonic attributes. However, the awareness of mushrooms as being a healthy food and as an important source of biological active substance with medicinal value has only recently emerged (Koertge *et al*., 2003). Globally, *Lentinus edodes* (shiitake) is the second most popular edible mushroom, its importance being attributed to both its nutritional value and medical applications (Hatvani, 2001). This mushroom has several health beneficial effects like anticancer, antidiabetic, hypotensive, hypocholesterolemic and antimicrobial activities (Khan *et al*., 2009). Also, it is important nutritionally because of its higher protein, dietary fibers and important mineral contents (Zhanhai yu *et al*., 2010). The commercial interest in the shiitake mushroom has increased in recent years, mainly because of its high value on the international market and an increase in dried mushrooms imports by some countries. This has occurred, not only because of its excellent aroma, flavor and nutritional profile, but also because of its medicinal properties (Rigoberto *et al.,* 2011). Shiitake is globally a well known cultivated species, but yet to find a place in Indian markets. Hence, in view of the potentials of Shiitake to find a place in Indian markets the present research has been carried out.

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Materials and methods

Effect of spawn density on the sporophore yield of *Lentinus edodes*

The ill filled paddy grain spawn was prepared and inoculated into the bed substrate @ 5, 10, 15, 20, 25 and 30 per cent levels on w/w basis following layer spawning method (Sivaprakasam, 1980). The beds were prepared with different levels of spawn densities and incubated at 25±2^{0}C. The observations on spawn run, pin head formation, number of sporophores, yield and biological efficiency were assessed and recorded following standard procedures.

Efficacy of bed substrates on the growth and yield of *Lentinus edodes*

Nine different locally available substrates *viz.*, paddy

straw, sugarcane trash, sugarcane baggase, coir pith, groundnut shell, various saw dusts *viz.*, silver oak, teak, eucalyptus and coconut were evaluated for their efficacy in enhancing the yield of *L.edodes*.

Substrate preparation

Paddy straw, Sugarcane trash and Sugarcane bagasse

Well dried chopped substrates *viz.*, Paddy straw, Sugarcane trash and Sugarcane bagasse @ 1 kg / bed, previously soaked in water for 12 hours, followed by steam sterilization (15 psi for 30 min.) were used for the preparation of cylindrical (polybag 60×30cm) beds similar to that of oyster mushroom bed preparation (Thiribhuvanamala *et al.,* 2005 a). At the time of bed preparation the moisture level of the substrates was maintained at 50 per cent.

Saw dust

The method enumerated by Royse (2005) and was followed for bed preparation. The various sawdust substrates obtained from *viz.*, silver oak, teak, eucalyptus and coconut were steam sterilized (15 psi for 30 min.) and used for the preparation of beds as described earlier. At the time of bed preparation, the moisture level of the saw dust was maintained at 50 per cent by assessing in such a way that upon squeezing no water trickles down the substrate but the palm is wetted.

Coir pith

Partially decomposed coir pith was steam sterilized (15 psi for 30 min.) and used for the preparation of beds as described earlier.

Groundnut shells

Well dried groundnut shells crushed into small bits were steam sterilized (15 psi for 30 min.) and used for the preparation of beds as described earlier.

After the preparation the beds were pressed gently and tied with polythene strip. The IFPG spawn of *L.edodes* was inoculated to the beds at 20 per cent level following layer spawning method. A temp of 25±2°C and relatively humidity 90% were maintained in the cropping room. After spawn running, when the browning process nearing completion, the polypropylene bag was removed and the beds were dipped in cold water (5°C) for ten min. so as to induce basidiocarp formation. Fully matured basidiocarps were harvested periodically and the parameters like number of days taken for spawn run, days taken for first harvest, total yield and biological efficiency were assessed and recorded.

Effect of various growth hormones on the yield of *Lentinus edodes*

The mushroom beds were laid out and incubated under identical conditions, plant hormones *viz.*, giberellic acid (GA), indole 3 acetic acid (IAA) and naphthalene acetic acid (NAA) at 50, 100 and 200 ppm. were prepared in double dist. water. Ten ml of plant hormones from each one of the conc. was applied with an atomizer on the sporophore initials appeared on beds. Similarly, sporophore initials of second and third crops were also sprayed.

Result and Discussion

Effect of spawn density on the sporophore yield of *Lentinus edodes*

Data pertaining to evaluation of optimum spawn density (table 1) indicated that the spawn density of 20 per cent level completely colonized the beds within 31.3 days and the same treatment recorded comparatively less number of days for browning and pin head formation. However an increase in the spawn density beyond 20 per cent level resulted in reduced yield. The spawn density of ten and five per cent levels recorded significantly lesser yield.

The fast mycelial growth observed in 20 per cent level of spawn density could be due to rapid colonization of the substrate which minimized the chances of contamination by the competitors and thus attributed to higher yields. Many workers have reported beneficial effect of increased rate of spawning (Pandey *et al.*, 2000; Nwanze *et al.,* 2005). However in the present study, it was also observed that the increase in the spawn density beyond 20 per cent resulted in decreased yield. This might

Table 1: Effect of spawn density on the sporophore yield of *L.edodes*

Tr. no	Spawn density (g/bed)	Spawn run (days)	Browning (days)	Pin head formation (days)	Soprophore (wt)	Sporophore number/bed	Yield (g/bed)	Biological efficiency (%)
1	5	36.8_{e}	74.8_{f}	96.50_{e}	15.3_{f}	14.1_{e}	216_{f}	43.2_{e}
2	10	35.4_{d}	72.3_{e}	92.00_{d}	16.4_{e}	17.5_{a}	287_{e}	57.4_{d}
3	15	32.9_{b}	71.0_{d}	88.0_{c}	18.3_{d}	16.9_{b}	309_{d}	61.8_{c}
4	20	31.3_{a}	57.8_{a}	83.1_{a}	21.1_{a}	15.9_{d}	335_{a}	67.0_{a}
5	25	32.5_{b}	60.7_{b}	85.3_{b}	20.2_{b}	16.0_{c}	323_{b}	64.6_{b}
6	30	33.1_{c}	64.3_{c}	87.2_{c}	19.1_{c}	16.7_{b}	318_{c}	63.6_{b}

Table 2: Effect of bed substrate on the growth and yield of *L.edodes*

Sl. No.	Substrates	Spawn run (days)	Browning (days)	Days for first harvest	Total yield (g/kg)	B.E %
1	Teak saw dust	35.2_{c}	65.2_{c}	104.3_{c}	296.25_{c}	59.2_{c}
2	Silver oak saw dust	32.5_{a}	57.5_{a}	95.2_{a}	340.10_{a}	68.0_{a}
3	Groundnut shell	37.9_{d}	71.2_{d}	112.0_{d}	279.80_{d}	55.7_{e}
4	Coconut saw dust	37.0_{d}	70.9_{d}	110.5_{d}	287.75_{d}	57.5_{d}
5	Coir pith	41.5_{g}	80.3_{h}	134.8_{h}	260.0_{f}	52.0_{g}
6	Eucalyptus saw dust	33.4_{b}	61.2_{b}	98.5_{b}	310.20_{b}	62.0_{b}
7	Sugarcane trash	39.7_{e}	76.3_{f}	126.8_{f}	269.50_{e}	53.9_{f}
8	Sugarcane baggase	38.3_{d}	74.4_{e}	122.7_{e}	273.40_{e}	54.6_{f}
9	Paddy straw	40.2_{f}	78.1_{g}	130.3_{g}	250.70_{g}	50.1_{h}

be due to the reason that the higher spawn density may have resulted in increase in temp., Co_2 conc. and decrease in the oxygen conc. of the substrate (Chitra arya and Arun arya, 2003).

Effect of bed substrate on the growth and yield of *Lentinus* edodes

The present study was aimed to find out the suitability of various commonly available agro and agro-industrial wastes as substrates for shiitake cultivation. The results on the influence of various substrates are presented in table 2 and 3. The substrates, silver oak saw dust recorded shortest spawn run (32.5 days), browning period (57.5 days), sporophore yield (340.10g) with biological efficiency of 68 per cent followed by eucalyptus saw dust.

Further, investigations were also made to find out the effect of combination of substrates with different concentration on the yield of *L.edodes*. The results revealed that the combination of silver oak saw dust +eucalyptus saw dust (1:1) recorded spawn run (30.1 days), browning period (52.2 days), sporophore yield (347.0g) with biological efficiency of 69.4 per cent followed by silver oak saw dust + eucalyptus saw dust (2:1) which recorded spawn run (31.5 days), browning period (53.5days), sporophore yield (343.10g) with biological efficiency of 68 per cent.

Table 3: Effect of different concentration to bed substrate on the yield of *L.edodes*

Sl. No.	Substrates	Spawn run (days)	Browning (days)	Days for first harvest	Total yield (g/kg)	B.E %
1	Silver oak saw dust	32.5_{c}	57.5_{c}	95.2_{d}	340.00_{d}	68.0_{d}
2	Eucalyptus saw dust	33.4_{d}	61.2_{d}	98.5_{e}	310.20_{e}	62.0_{e}
3	Silver oak + Eucalyptus (2:1)	31.5_{b}	53.5_{b}	93.2_{b}	343.10_{b}	68.6_{b}
4	Silver oak + Eucalyptus (1:2)	32.0_{c}	54.3_{b}	94.2_{c}	342.20_{c}	68.4_{c}
5	Silver oak + Eucalyptus (1:1)	30.1_{a}	52.2_{a}	91.2_{a}	347.00_{a}	69.4_{a}
6	Paddy straw	40.2_{e}	78.1_{e}	130.3_{f}	250.70_{f}	50.1_{f}

Traditionally shiitake mushroom has been cultivated in wood logs in several countries (Choi, 2004; Kadiri and Arzai, 2004; Ozcelik and Peksen, 2007). The wood (natural) log cultivation cycle usually takes six years with low biological efficiency (less than 33 per cent). In the last decades, indoor shiitake production has been introduced substituting wood logs by so called synthetic media, sawdust being the basic ingredient for substrate formula (Pryzbylowicz and Donoghue, 1998). The productivity of this system depends on the quality of the sawdust used as substrate (Song *et al.,* 1989). Sawdust is difficult to standardize because it is generally obtained from residues of different types of wood. Thus, the availability of low-cost and homogeneous substrate for production is an important factor for successful cultivation. However, a widely used standard substrate formula is 80 per cent hardwood sawdust and 20 per cent supplements on a dry weight basis (Royse 1985; Miller and Jong, 1987). Some formulation, with all ingredients based on oven dry substrate weight, consisting of 80 per cent sawdust and 20 per cent bran in Asia (Lizuka and Takeuchi, 1978); 80 per cent sawdust, 10 per cent bran and 10 per cent wheat or millet in USA (Miller and Jong, 1987) and 84 per cent sawdust, 5 per cent rice bran, 5 per cent wheat bran, 3 per cent soybean and 3 per cent lime in Taiwan (Kalberer, 1987), are commonly used for *L. edodes* cultivation as standard substrates. Swiss researchers reported that the mixture of 75 per cent spruce sawdust, 24 per cent wheat bran and 1 per cent lime could be used for the successful cultivation of *L. edodes*. The present findings are also in line with the above findings.

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