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Effect of different substrates and light exposures on yield performance of *Pleurotus sajor-caju* and *Lentinus edodes*

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The effect of different conventional and non-conventional substrates singly and in combined form on the sporophore production of *Pleurotus sajor-caju* and *Lentinus edodes* was studied. When the substrates used singly, the yield of *P. sajor-caju* and *L. edodes* was recorded to be highest in paddy straw and saw dust repectively. The spawn run period for fruiting was always higher in *P. sajor-caju* than that of *L. edodes* irrespective of the substrate used. The result further indicated that combined compost substrates increased the yield and biological efficiency of both the mushrooms. On the other hand, influence of different light exposures on spawn run period, yield and biological efficiency revealed that diffuse light and alternate dark period and light conditions showed more promising result in terms of average yield and biological efficiency in both the test mushrooms. However, continuous dark period reduced the spawn run period for fruiting in both *P. sajor-caju* and *L. edodes*.

Key words: Biological efficiency, compost, light exposure, *Lentinus edodes, Pleurotus sajor-caju.*

INTRODUCTION

Mushrooms often called as Queen of vegetables and table delicious since time immemorial (Ponmurugan *et al.*, 2007). Mushrooms have high contents of qualitatively good protein, crude fibre, minerals and vitamins but are poor sources of lipids. Apart from their nutritional potentials, they are also known to possess promising anticancer, immunostimulator, cardiovascular, hypocholesteromic and antibacterial effects (Oyetayo, 2008).

Commercial cultivation of an oyster mushroom, *Pleurotus sajor-caju* (Fr.) Singer and a shiitake mushroom, *Lentinus edodes* (Berk) Sing. is now gaining popularity in India due to their pleasant flavour, good taste and high calorie value. Compost substrate which supports the growth, development and fruiting of the mushrooms varies differently with different mushrooms. Carbon and nitrogen sources in the compost susbtrates and their C:N ratio, in particular, are the major nutritional requirements of mushroom mycelium (Chang and Miles, 1993). It has been reported that a number of agro-industrial bye-products and non-conventional plants including cotton wastes, cotton-seed hulls, waste tea leaves, water hyacinth etc. have successfully been utilized for growing oyster and other mushrooms (Singh *et al.*, 1989; Tandon and Sharma, 2006). Significant influence of light intensity on spawn run, primordial initiation and fruit body development in various mushrooms has been reported by earlier workers (Quadir *et al.,* 1983, Chang and Miles, 1993; Upadhyay, 1997).

In the present study an attempt has been made to find out the effect of various susbtrates on the yield performance of *P. sajor-caju* and *L. edodes* and also to study the influence of different types of light

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exposures on spawn run and yield of the mushrooms in terms of biological efficiency.

MATERIALS AND METHODS

Mycelial culture of *P. sajor-caju* was collected from Indian Type Culture Collection Centre, Indian Agricultural Research Institution, New Delhi (Accession No. ITC-GF-1725) and the same of *L. edodes* was procured from American Type culture collection, USDA, Forest product laboratory, Madison, USA (ATCC No. 4086). The cultures were maintained on PDA slant at 4°C.

The method was designed with a view to choice the preferential utilization of different agro-industrial wastes and also to study the average yield with biological efficiency (BE) by *P. sajor-caju* and *L. edodes.* Substrates used singly were paddy straw (Ps), wheat straw (Ws), sugarcane bagasse (Sb), mustard straw (Ms), paddy hulls (Ph), water hyacinth (Wh), waste of rice mill (Wr), *Sesbenia* leaves (Sl), dry *Azolla* (Da), fibreless jute stice dust (Js) and saw dust (Sd) of hard woods. These substrates were collected, sun-dried for one week and cut into small pieces (2-3 cm) where necessary. All the substrates were soaked in a molasses solution for about 18-24 hrs (Quadir *et al.,* 1983). The excess water from the substrates was drained off by spreading them in a thin layer over cemented floor. The pH and moisture content of the substrates were maintained appropriately by adding $CaCO_3$ and $CaSO_4$ at 6.2-6.5 and 70-85% respectively in case of *P. sajor-caju* and 6.2-6.5 and 50-65% respectively in case of *L. edodes.* Then the substrates were sterilized and kept in room temparature for over night.

During the study with the utilization of combined susbtrate, different agro-wastes and non-conventional plants in combination with conventional substrates were used. The substrates were prepared in a similar manner like the previous experiment. One individual set of substrate mixture was prepared taking all the aforesaid ingredients together in a cumulative combined form in equal proportions to make it 1 kg dry/wt bag.

Each type of substrate was filled in polypropylene bags (approximately 1 kg dry wt/bag) separately. Mushroom bags were inoculated with fresh spawns raised on wheat grains @ 3-15% on the dry weight basis of compost (Upadhyay, 1997). The open mouth of the bags was wrapped and the bags were kept in the spawning room at 25°C for spawn run. The polypropylene was removed when the substrate mixture get covered with white mycelium and finally kept in the cropping room where slight watering was done regularly. Biological efficiency was calculated as follows. Biological efficiency = Fresh weight of mushroom harvested/Dry weight of substrate used × 100

The average yield and biological efficiency were recorded regularly and the data were presented in Table 1 and Table 2.

The compost beds filled with cumulative combined form of compost substrate (sterilised paddy chaffs, hulls of paddy, boiled wheat grains, saw dust, wheat bran, fibreless jute stick dust, sugarcane bagasse and used tea leaves in combined form) were sterilized and spawned. The spawned beds were subjected to different light exposures viz., continuous light, continuous dark, diffused light and alternate dark and light for fruiting. The time required for spawn run, average yield and the biological efficiency were recorded (Table 3).

RESULTS AND DISCUSSION

The result (Table 1) showed that different substrates produced fructifications of the mushrooms with distinct grades. Since the spawn run period of *P. sajor-caju* required lesser time than the other mushroom, the average yield always remained high as compared to *L. edodes.* Significantly higher yield was recorded on paddy straw in case of *P. sajor-caju* and on saw dust in case of *L. edodes* over the other substrates. Wheat straw and sugarcane bagasse, however, responded well next to paddy straw in case of *P. sajor-caju* while sugarcane bagasse and water hyacinth showed similar responses next to saw dust in *L. edodes.* The time required for spawn run varied from 20 to 34 days in *P. sajor-caju* and from 55 to 75 days in *L. edodes* according to the nature of the substrates. Investigation of Ponmurugan *et al.* (2007) revealed that the cellulosic biomass may effectively be used as substrates for cultivation of mushrooms as the cellulosic substances are degraded very easily by mushrooms. On the other hand, Shukla (1995) stated that *L. edodes* grew best on different wood logs. Dhanda *et al.* (1995) also reported that

Table 1 : Effect of different substrates singly on fruit body production of *P. sajor-caju* and *L. edodes*

Substrates	Yield of mushrooms*									
	Pleurotus sajor-caju					*Lentinus edodes*				
	Time for spawn run (days)	Total flushes/ crop	Total fruits /bed	Av. yield (g / kg dry compost)	BE (%)	Time for spawn run (days)	Total flushes/ /crop	Total fruits /bed	Av. yield (g / kg dry compost)	BE (%)
Ps	25	5	20	280	28	65	2	8	100	10.0
Ws	22	4	22	250	25	62	2	9	110	11.0
Sb	20	4	20	240	24	60	3	10	130	13.0
Ms	25	5	28	220	22	64	3	10	110	11.0
Ph	34	2	10	90	9	75	1	5	55	5.5
Wh	20	5	21	230	23	60	4	12	125	12.5
Wr	30	4	18	200	20	70	2	7	90	9.0
Sl	28	3	12	100	10	65	2	5	80	8.0
Da	25	2	8	80	8	62	1	4	70	7.0
Js	20	3	17	220	22	58	3	10	120	12.0
Sd	22	2	10	100	10	55	4	12	150	15.0
SEM ±				6.0808						
CD at 5%				13.5481						
CD at 1%				16.8985						

*Data are the mean values of five replicates.

Ps = Paddy straw; Ws = Wheat straw; Ms = Mustard straw; Sb = Sugarcane bagase; Ph = Paddy hulls; Wh = Water hyacinth; Wr = Waste of rice mill; Sl = *Sesbenia* leaves; Da = Dry *Azolla*; Js = Fibreless jute stick dust; Sd = Saw dust; BE = Biological Efficiency.

Pleurotus spp are most efficient mushrooms having the capacity to degrade the lignocellulosic organic complex and concluded that they prefer unfermented and non-supplemented paddy straw for their proper growth. The choice of suitable compost on which mushrooms colonize depend on their capacity to degrade the complex organic components into their available simpler forms for nutrition (Eswaran and Thomas, 2003; Sangeetha and Theradimani, 2007).

It is evident from the result (Table 2) that single substrate when combined with other substrates by permutation and combination methods, the yield of the mushrooms was found to increase significantly. The combined compost substrate i.e. cumulative form also shortened the span of spawn run. Yield of *L. edodes* was observed to be significantly high in the comulative form of substrates (Ps + Ws + Sd + Sb + Ms + Js + Utl) which corroborates the findings of Royse (1995). *P. sajor-caju* showed highest B.E.(70) in combined cumulative form in compared to *L. edodes* which showed 45 B. E. in the same bed. Sangwan and Saini (1995) also recorded that the yield of mushrooms varies considerably with the chemical composition contained in the substrates on which they grow. Of these combinations, *P. sajor-caju* always preceeded first in its capacity to produce fructifications (700 g/kg dry combined compost) as compared to *L. edodes* where it gives the yield of 450 g/kg dry combined compost. Nivedita *et al.* (2009) also suggested that agro-forest wastes can be recycled by utilizing as susbtrate for aftificial cultivation of locally available *Pleurotus* spp.

It may be noted from the result (Table 3) that the intensity of light had profound influence on vegetative growth and associated fructification of the mushrooms. Diffused light and alternate dark and light exposure showed promising response in terms of average yield and biological efficiency of both the mushrooms. It is also clear that continuous light and dark do not have any stimulatory effect of fruit body production. However, continuous dark phase faciliated to shorten the spawn run period for fruit body production. Thus the result suggested that

Table 2 : Effect of different waste materials in combined form on the yield and biological efficiency of *P. sajor-caju* and *L. edodes*

Nature of compost	Agrowastes	Non conventional wastes*																							
		Wh + Wr				Wr + Sl				Wh + Sl				Wh + Da				Wr + Da				Wh + Wr + Sl + Da (equal proportion)			
		PS		LE		PS		LE		PS		LE		PS		LE		PS		LE		PS		LE	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Single	Ps	540	54	230	23	550	55	180	18	400	40	220	22	380	38	200	20	350	35	150	15	600	60	340	34
	Ws	450	45	300	30	500	50	240	24	380	38	280	28	370	37	250	25	350	35	150	15	550	55	360	36
	Sd	500	50	430	43	350	35	350	35	450	45	400	40	400	40	420	42	300	30	200	20	550	55	440	44
	Sb	450	45	280	28	400	40	200	20	380	38	250	25	400	40	240	24	300	30	160	16	540	54	400	40
	Ms	380	38	360	36	380	38	250	25	320	32	350	35	360	36	300	30	350	35	200	20	530	53	380	38
	Js	550	55	300	30	400	40	200	20	500	50	280	28	450	45	250	25	350	35	150	15	600	60	350	35
	Utl	360	36	220	22	260	26	150	15	290	29	190	19	350	35	180	18	250	25	120	12	520	52	310	31
Combined	Ps + Ws + Sd + Sb + MS + JS + Utl (equal proportion)	560	56	440	44	480	48	350	35	500	50	430	43	530	53	420	42	450	45	300	30	700	70	450	45

SEM ±	3.2991	3.8126	2.7370	2.4888	1.3093	2.0178
CD at 5%	7.8023	09.0168	6.4730	5.8861	3.0965	4.7721
CD at 1%	9.2605	10.7019	7.6827	6.9861	3.6752	5.6640

* Data are the mean values of five replicates.

1 = AV. yield g/kg dry compost; 2 = Biological efficiency

PS = *P. sajor-caju;* LE = *L. edodes*

Ps = Paddy straw; Ws = Wheat straw; Ms = Mustard straw; Sb = Sugarcane bagase; Ph = Paddy hulls; Wh = Water hyacinth; Wr = Waste of rice mill; Sl = *Sesbenia* leaves; Da = Dry *Azolla*; Js = Fibreless jute stick dust; Sd = Saw dust; Utl = Used tea leaves.

Table 3 : Influence of different light exposures on spawn run, sporophore development and biological efficiency of *P. sajor-caju* and *L. edodes*

Nature of light exposure	Time required/ spawn run period for fruiting (days)*		Total no. of fruits/crop*		Av. yield (g/kg dry) compost)*		Biological efficiency (%)*	
	PS	LE	PS	LE	PS	LE	PS	LE
Continuous light	30	80	50	40	500	400	50	40
Continuous dark	15	44	20	30	700	500	70	50
Diffuse light	25	55	40	32	1000	600	100	60
Alternate dark & light	28	60	45	35	950	550	95	55

PS = *Pleurotus sajor-caju;* LE = *Lentinus edodes*

SEM ± 75.0000

CD at 5% 238.6500

CD at 1% 214.5750

*Date are the mean values of five replicates.

diffused light in day length alternating with darkness may influence the primordial initiation in a better way followed by fruit body formation in both. *P. sajor-caju* and *L. edodes.* Chang and Miles (1993) and Upadhyay (1997) also provided strong evidence that exposure to such conditions faciliated the vegetative growth, primordial initiation and development of fruit bodies of different mushrooms.

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