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GROWTH AND YIELD PERFORMANCE OF DIFFERENT EXOTIC STRAINS OF EIGHT *PLEUROTUS* SPECIES CULTIVATED ON *TRIPLOCHITON SCLEROXYLON* IN GHANA

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Abstract: The mycelia growth rate, physical characteristics of first flush, number of flushes and biological efficiency of twenty three exotic strains of eight *Pleurotus* species grown on composted sawdust of *Triplochiton scleroxylon* K (Schum) were studied. The mycelia growth rate per week showed significant differences (P<0.05) among the strains for the first and third week of growth. *P. djamour* strain PDA-1, *P. eryngii* strain PEA-1, *P. ostreatus* strain POA-7, showed no mycelia growth and flushes within the study period. *P. solimoneo-stramineus* strain PSSC-1 and *P. citrinopileatus* strain PCC-1 showed very poor and patchy growth and the mycelium never fully colonised the substrate. This indicates that the different strains of the mushrooms utilize the given substrate at different rates. The heaviest cap weight was recorded for *P. ostreatus* strain POA-1 which ranged from 9.5-49.5 g for the first flush of mushrooms with its corresponding diameter ranging from 7.7-13.45 cm. With the exception of *P. sajor-caju* strain PSCA-1 and *P. citrinopileatus* strain PCC-1 which produced only one flush, all strains produced at least two flushes. *P. ostreatus* strain POA-9; the highest yielding strain produced four flushes. With all the strains flush 1 gave the highest yield of 98.5 g, and flush 4 the lowest yield of 2.36 g. In general, *P. ostreatus* strains recorded the highest yields and corresponding biological efficiencies (BE) whilst *P. solimoneo-stramineus* strain PSSC-1 produced the lowest. Significant differences (P<0.05) in the yield of the different species and strains were recorded. Further cultivation of *P. ostreatus* strain POA-9 will be encouraged among farmers since its BE values are comparable with *P. ostreatus* strain EM-1 currently on the Ghanaian market.

Key words: *Pleurotus* species, Growth, Utilization, *Triplochiton scleroxylon*.

INTRODUCTION

The Mushroom Unit of the CSIR-Food Research Institute has as one of its research activities, to collect and develop both indigenous and exotic strains of mushrooms for commercial cultivation on agricultural wastes available in Ghana. Over the years, the Unit has received several cultures from countries such as China, USA, Thailand, Japan, Mauritius, Malaysia and Belgium among others. To date a total of fifty five cultures are maintained in the Mycelium Bank. These comprise of edible mushrooms such as oyster mushroom (*Pleurotus*) species made up of *P. djamor*, *P. sajor-caju*, *P. ostreatus, P. tuber-regium*, *P. citrinopileatus* and *P. pulmonarius* also *Auricularia* spp. (woodear) among others. Medicinal mushrooms such as *Grifola frondosa* (Hen-of-the woods), *Hericium erinaceus* (Monkey head), *Lentinula edodes* (Shiitake) and *Ganoderma* spp. (Monkey seat). Other species of mushrooms available in the Bank are *Stropharia rugoso-annulata* (King stropharia), *Lentinus squarrosulus* and *Agaricus* spp. (Button mushroom).

Oyster mushrooms (*Pleurotus* species), the third largest commercially produced mushroom in the world (Van, 2009), are found growing naturally on rotten woody material (Phillips, 2006). They have a wide range of temperature adaptability (Bano & Rajarathnam, 1982), substrate utilization (Poppe, 2000), nutritional and medicinal properties (Garcha et al., 1993). Nutritionally, the mushroom has been found to contain vitamins B1 (thiamin), B2 (riboflavin), B5 (niacin), B6 (pyridoxine) and B7 (biotin) (Solomko & Eliseeva, 1988). Medically, *P. ostreatus* have been reported to decrease cholesterol levels in experimental animals (Hossain et al., 2003). The carpophore of the mushroom is also a potential source of lignin and phenol degrading enzymes (Fountoulakis et al., 2002). It is also used industrially as a bioremediator (Fountoulakis et al., 2002; Tsioulpas et al., 2002).

Ghana has since 1995, being producing these mushrooms in the country and is now one of the mushroom producing countries in West Africa. In 2007, the production of oyster mushrooms was 120 tons with a steady increase of 2.7% a year (Obodai, unpublished data). These mushrooms are cultivated on composted sawdust of *Triplochiton scleroxylon* supplemented with rice bran and lime (Obodai et al., 2002). Since the oyster mushrooms were introduced into the country it has gained popularity and have been accepted by the Ghanaian populace (Obodai & Johnson, 2002) for its taste, nutrition and medicinal claims of lowering cholesterol levels.

These mushrooms serve as a source of income for mushroom farmers. It is also important to note that not only must mushrooms be cultivated all year round but that the yields that arise should be high enough to cater for the demands of the market and for farmers to enjoy the benefits of their input. This study, therefore reports on the growth and yield performance of 23 different strains of *Pleurotus* species grown on composted sawdust of *Triplochiton scleroxylon*.

MATERIALS AND METHODS

Sources of cultures

The study was conducted between 6th July-28th August, 2010. Twenty three (23) strains of eight *Pleurotus* species were used for the study. The details of species and strains, codes and country of origin are listed in Table 1. The control culture was *P. ostreatus* strain EM-1, which is currently being distributed to commercial mushroom farmers in the country.

Table 1: Species and strains of oyster mushrooms used in the study.

***Pleurotus* species/strains**	**Original Strain (code)**	**New code**	**Country of Origin**
P. djamour	P10-no growth	PDA-1	USA
P. sajor-caju	P13 (1)	PSCA-1	USA
P. pulmonarius	P35 (AX) (8)	PPA-1	USA
P. pulmonarius	P15 (M53) (9)	PPA-2	USA
P. eryngii	P3 (KO2)	PEA-1	USA
P. eryngii	P13 (KO1) (10)	PEA-2	USA
P. ostreatus	P7 (TL) (18)	POA-1	USA
P. ostreatus	P12 (SL) (2)	POA-2	USA
P. ostreatus	P25 (Pearl) (3)	P0A-3	USA
P. ostreatus	P5 (Azul) (11)	POA-4	USA
P. ostreatus	P6 (012A)	POA-5	USA
P. ostreatus	P47 (HK) (12)	POA-6	USA
P. ostreatus	P25 (A8)	POA-7	USA
P. ostreatus	P15 (B soy 3) (4)	POA-8	USA
P. ostreatus	P31 (JB) (13)	POA-9	USA
P. ostreatus	P8 (Rh) (7)	POA-10	USA
P. ostreatus	P15 (B soy 5)	POA-11	USA
P. ostreatus	P8 (Rh) (7)	POA-12	USA
P. ostreatus	P9RL (15)	POA-13	USA
P.solimoneo-stramineus		PSSC-1	CHINA
P. citrinopileatus	P096 (14)	PCC-1	CHINA
P. sapidus	P969 (16)	PSC-1	CHINA
P. ostreatus (control)		EM-1	MAURITIUS

Culture maintenance and spawn preparation

All strains were maintained on Potato Dextrose Agar slants and were used to prepare sorghum grain spawn (Oei, 1991). Both the cultures and spawn were incubated at 26-28°C.

Composting of sawdust

Sawdust compost was prepared in accordance to Obodai et. al., (2002).

Mushroom Cultivation

Data recorded during mushroom cultivation included the weekly mycelia growth rate, mycelial density (taken by direct observation), the number of flushes per strain, weight and number of fruit bodies per flush, and the biological efficiency (BE). BE values were calculated in accordance to Royse et al., (2004).

B.E. = [Weight of fresh mushrooms harvested / dry weight of substrate] x100.

The mycelia growth rates and mean yields of the different strains were subjected to a one-way Analysis of Variance and the differences between means separated by Duncan's multiple range tests at $P \leq 0.05$ (Steel & Torrie, 1960), using Statistical Package for Social Scientists (SPSS) for Windows, v.16.0.

RESULTS AND DISCUSSIONS

Weekly mycelia growth rates

The results of the weekly mycelia growth rates (spawn run) and surface mycelia density are presented in Table 2. In three weeks of spawn run *P. ostreatus* strain POA-4, 9, and 10 and *P. eryngii* strain PEA-2 had completely colonized the substrate (Table 2). There were significant differences ($P \leq 0.05$) between the spawn run periods for the 1st and 3rd weeks. In the 1st week of growth *P. ostreatus* strain POA-2, 9, 11 and 12 and *P. eryngii* strain PEA-2 showed the fastest growth with *P. eryngii* strain PEA-1 and *P. citrinopileatus* strain PCC-1 showing no growth and the least growth respectively (Table 2). This trend was however not the same in the 3rd week: *P. ostreatus* strain POA-1 and 8 showed the least growth with *P.ostreatus* strain POA-5 growing the fastest. Twelve out of the twenty three (23) strains showed mycelia growing through the substrate with *P. solimoneo-stramineus* strain PSSC-1 and *P. citrinopileatus* strain PCC-1 showing poor patchy growth. These different growth rates and mycelial densities among species and strains clearly indicate that the mushrooms utilize the given substrate (*T. scleroxylon*) at different rates (Mueller et al., 1985) and strain specifications.

Mushroom Production

The total number of fruit bodies per strain within the period of study ranged from 4 to 42 (Table 3). The highest number recorded in the 1st flush was by *P. citrinopileatus* strain PCC-1 followed by *P. ostreatus* strain POA-9. It was interesting to note that strains of the species *P. ostreatus* produced both the second highest (14) and the least number (2) of fruit bodies (Table 3). These numbers are lower than that recorded by Shah et al. (2004) who had 7-22 fruit bodies for *P. ostreatus* cultivated on wheat straw, sawdust and leaves singly and in combination.

Although *P. citrinopileatus* strain PCC-1 produced the highest number of fruit bodies, its physical characteristics were lowest in all the strains studied, in terms of its cap weight**:** 1.5-2.5 g and diameter**:** 4.25-6.6 cm (Table 4). This mushroom is yellow in color and flushes in small clusters (Fig. 8). Figures 1-8 show the fruit bodies of some of the strains studied. The heaviest cap weight of mushrooms obtained for the first flush of mushrooms was produced by *P. ostreatus* strain POA-1 recording an average of 29.5 g (Table 4). The stipe weight and circumference showed varied weights even amongst the same species eg. in *P. ostreatus* (Table 4). Royse et al. (2004) and Mamiro and Royse (2008) have attributed the differences in mushroom size to type of substrate, spawn rate, type and level of supplements and type of mushroom species and strains.

Table 2: Weekly Mycelial growth rate of strains of *Pleurotus* species grown on composted *wawa* sawdust

Pleurotus species	1st week	2nd week	3rd week	[1]Surface mycelia density
P. djamour strain PDA-1		No growth		
P. sajor-caju strain PSCA-1	$4.57\pm0.46^{c,d,e,f}$	3.62 ± 0.47	$3.18\pm1.06^{b,c,d,e}$	++
P. pulmonarius strain PPA-1	$3.83\pm0.57^{a,b,c,d,e}$	3.55 ± 0.46	$1.95\pm1.13^{a,b,c,d}$	+++
P. pulmonarius strain PPA-2	$3.03\pm0.47^{a,b,c}$	3.58 ± 0.11	$3.13\pm1.05^{b,c,d,e}$	+++
P. eryngii strain PEA-1		No growth		
P. eryngii strain PEA-2	$5.26\pm0.23^{e,f}$	4.71 ± 0.38	Total colonization	++++
P. ostreatus strain POA-1	$3.65\pm0.41^{a,b,c,d}$	3.48 ± 0.49	$0.91\pm0.91^{a,b}$	++
P. ostreatus strain POA-2	$5.32\pm1.01^{e,,f}$	4.50 ± 0.30	$1.26\pm1.26^{a,b,c}$	++++
P. ostreatus strain POA-3	$4.47\pm0.29^{b,c,d,e,f}$	3.88 ± 0.36	4.68 ± 0.32^{e}	++++
P. ostreatus strain POA-4	$4.86\pm0.13^{d,e,f}$	3.97 ± 0.33	Total colonization	+++
P. ostreatus strain POA-5	3.88 ± 0.21^{abcde}	3.63 ± 0.50	4.71 ± 0.92^{e}	++++
P. ostreatus strain POA-6	$2.67\pm0.250.25^{a,b}$	3.06 ± 0.27	$4.11\pm0.51^{d,e}$	++
P. ostreatus strain POA-7		No growth		
P. ostreatus strain POA-8	$4.18\pm0.10^{b,c,d,e,f}$	3.68 ± 0.76	$0.80\pm0.08^{a,b}$	+++
P. ostreatus strain POA-9	$5.70\pm0.50^{e,f}$	4.45 ± 0.31	Total colonization	++++
P. ostreatus strain POA-10	$3.65\pm0.56^{a,b,c,d,e}$	3.03 ± 0.35	Total colonization	+++
P. ostreatus strain POA-11	$5.13\pm0.84^{e,f}$	3.81 ± 0.43	$1.03\pm1.03^{a,b}$	++
P. ostreatus strain POA-12	$5.32\pm0.16^{e,f}$	4.27 ± 0.50	$1.17\pm1.17^{a,b}$	+++
P. ostreatus strain POA-13	$3.00\pm0.82^{a,b,c}$	3.10 ± 0.35	$3.88\pm0.58^{c,d,e}$	++
P.solimoneo-stramineus strain PSSC-1	$2.95\pm0.52^{a,b,c}$	3.45 ± 0.24	$1.78\pm1.03^{a,b,c,d}$	+
P. citrinopileatus strain PCC-1	2.13 ± 1.30^{a}	2.07 ± 1.20	ND	+
P. sapidus strain PSC-1	$3.31\pm0.09^{a,b,c,d}$	2.78 ± 0.49	$2.71\pm0.97^{a,b,c,d,e}$	++
|*P. ostreatus* strain EM-1 (control)	$4.5\pm0.4^{d,e,f}$	5.8 ± 0.7	Total colonization	++++

[1]Degree of mycelia density when the mycelia fully colonises the substrate

++++ = Mycelium totally colonized bag; uniformly white   +++ = Mycelium totally colonized bag; not uniformly white

++ = Mycelium not fully colonized bag   + = Poor patchy growth

ND= No data available

The mycelium of *P. pulmonarius* strain PPA-2, *P. ostreatus* strain POA-3 and POA-4 could utilize the substrate during spawn run but were unable to produce fruit bodies. The utilization of the substrate by these mycelia could be exploited on since there is significant reduction in cellulose, hemicelluloses and lignin and increase in nitrogen. Further work can be done to ascertain the digestibility of this substrate for animal feed as has been carried out by Adamafio et al. (2009) using maize cobs. With the exception of *P. sajor-caju* strain PSCA-1 and *P. citrinopileatus* strain PCC-1 which produced only one flush, all the strains produced at least two flushes. *P. ostreatus* strain EM-1 (control) produced four flushes within the period of study with a yield and BE value of 210.0 g and 63.49% respectively. Strains comparable in yield and BE values to *P. ostreatus* strain EM-1 are *P. ostreatus* strain POA-9 and 13. The BE values ie the yield of mushrooms in relation to the dry weight of substrate at spawning, indicate how different strains utilize the substrate (Mueller et al., 1985). Thomas et al. (l998) reported that the yield of the mushroom is directly related to the spread of mycelium into the substrate. Across all strains the 1st flush produced the highest flushes and this decreased significant ($P\leq 0.5$) for subsequent flushes. This trend agrees with results obtained by other researchers (Obodai et al., 2003; Tisdale et al., 2006; Mshandete & Cuff, 2008) and demonstrates that the trend of steadily reducing mean yield per flush remains unchanged in spite of mushroom species/strain and the substrate. This reduction in yield has been attributed to nutrient depletion in the substrate being directly proportional to fruit bodies harvested in each flush (Stamets and Chilton, 1983). Tsang et al. (1987) have also demonstrated a reduction in cellulose, hemicellulose, lignin and other nutrient contents of wheat straw with the cultivation of four *Pleurotus* spp. including *P. ostreatus*. Some other forms of substrate modifications in terms of pH, moisture content, texture of substrate etc. could also contribute to this phenomenon. Ambient temperature changes may also account for the differences, since the fruiting of the mushrooms is temperature dependent, varying between 10 and 30°C (Oei, 1996).

On the basis of this study further work is being carried out to ascertain the utilization of *wawa* sawdust on selected strains at different times of the year in order to release comparable strains onto the Ghanaian market and thereby bringing diversity of strains on the Ghanaian market.

Table 3: Number of fruit body per flush

***Pleurotus* species**	**1st flush**	**2nd flush**	**3rd flush**	**4th flush**	**5th flush**	**Total number**
P. sajor-caju strain PSCA-1	4.0 ± 0.08^{abc}	0	0	0	0	4.0 ± 0.08^{a}
P. pulmonarius strain PPA-1	7.0 ± 0.58^{de}	15.0 ± 0.58^{h}	0	0	0	$22.0\pm1.00e^{d}$
P. eryngii strain PEA-2	7.0 ± 0.58^{de}	11.0 ± 0.58^{fg}	4.0 ± 0.33^{b}	0	0	22.0 ± 0.33^{ed}
P. ostreatus strain POA-1	3.0 ± 0.33^{ab}	3.0 ± 0.33^{b}	0	0	0	6.0 ± 0.67^{a}
P. ostreatus strain POA-2	9.0 ± 1.45^{f}	9.0 ± 0.67^{e}	3.0 ± 0.33^{b}	0	0	22.0 ± 2.33^{ed}
P. ostreatus strain POA-5	$5.0\pm0.67^{c,d}$	8.0 ± 0.33^{f}	0	0	0	14.0 ± 0.88^{b}
P. ostreatus strain POA-6	4.0 ± 0.00^{abc}	5.0 ± 0.33^{c}	11.0 ± 1.20^{e}	0	0	20.0 ± 0.88^{cd}
P. ostreatus strain POA-8	2.0 ± 0.33^{a}	2.0 ± 0.33^{b}	0	0	0	5.0 ± 0.58^{a}
P. ostreatus strain POA-9	14.0 ± 0.58^{g}	9.0 ± 0.33^{ef}	13.0 ± 0.58^{f}	6.0 ± 0.57^{c}	0	42.0 ± 0.33^{h}
hP. ostreatus strain POA-10	12.0 ± 0.33^{g}	$7.0\pm0.67^{d,e}$	7.0 ± 0.33^{c}	0	0	27.0 ± 0.58^{f}
P. ostreatus strain POA-11	3.0 ± 0.58^{ab}	3.0 ± 0.33^{b}	0	0	0	6.0 ± 0.68^{a}
P. ostreatus strain POA-12	$4.0\pm0.67^{b,c}$	12.0 ± 0.58^{a}	9.0 ± 0.33^{d}	0	0	$26.0\pm1.53^{e,f}$
P. ostreatus strain POA-13	8.0 ± 0.67^{ef}	11.0 ± 0.33^{g}	11.0 ± 0.88^{e}	5.0 ± 1.00^{b}	0	37.0 ± 1.16^{g}
P.solimoneo-stramineus strain PSSC-1	12.0 ± 0.58^{g}	12.0 ± 0.58^{g}	0	0	0	24.0 ± 1.00^{edf}
P. citrinopileatus strain PCC-1	27.0 ± 0.88^{h}	0	0	0	0	27.0 ± 0.88^{f}
P. sapidus strain PSC-1	9.0 ± 0.58^{ef}	9.0 ± 0.58^{e}	0	0	0	18.0 ± 1.00^{c}
P. ostreatus strain EM-1 (control)	9.0 ± 0.58^{ef}	7.0 ± 0.58^{d}	7.0 ± 0.58^{c}	6.0 ± 0.57^{c}	4.00 ± 1.52^{b}	33.0 ± 2.88^{f}

Table 4: Physical characteristics of fruit bodies for first flush of mushrooms

***Pleurotus* species**	**Cap weight (g)**	**Stipe weight (g)**	**Cap diameter (cm)**	**Stipe circumference (cm)**	**Stipe length (cm)**
P. sajor-caju strain PSCA-1	2.0-23.5	0.5-1.5	3.9-9.4	1.7-4.2	1.6-4.5
P. pulmonarius strain PPA-1	2.0-11.0	0.5-1.0	4.05-7.35	1.0-3.10	0.9-1.95
P. pulmonarius strain PPA-2	No flushes				
P. eryngii strain PEA-2	2.0-23.5	0.5-1.5	3.95-9.4	1.7-4.15	1.6-4.5
P. ostreatus strain POA-1	9.5-49.5	1.5-6.5	7.7-13.45	1.9-4.3	2.35-4.7
P. ostreatus strain POA-2	6.5-25-5	1.5-8.0	6.2-10.9	2.65-5.05	4.8-8.75
P. ostreatus strain POA-3	No flushes				
P. ostreatus strain POA-4	No flushes				
P. ostreatus strain POA-5	7.5-13.5	3.0-5.5	1.3-9.15	1.1-4.4	6.1-8.9
P. ostreatus strain POA-6	3.0-26	0.5-2.5	5.0-8-95	1.8-4.5	2.65-4.8
P. ostreatus strain POA-8	6.0-15.0	0.5-1.0	6.55-8.75	4.6-6.8	0.8-1.1
P. ostreatus strain POA-9	3.0-11.5	1.0-8.5	4.85-10.75	1.6-4.95	3.7-6.8
P. ostreatus strain POA-10	2.0-10.5	0.5-7.1	3.75-7.1	1.05-2.85	1.1-2.75
P. ostreatus strain POA-11	2.0-23.5	0.5-2.0	4.8-12.5	1.4-3.1	2.3-5.5
P. ostreatus strain POA-12	2.5-19	0.5-1.5	4.15-9.1	0.5-3.05	0.5-4.4
P. ostreatus strain POA-13	2.5-16.5	2.0-11	4.55-12.25	2.5-4.75	5.8-10.9
P.solimoneo-stramineus strain PSSC-1	2.0-6.0	0.5-3.25	5.1-7.15	1.0-2.3	0.9-2-2
P. citrinopileatus strain PCC-1	1.5-2.5	1.0-2.0	4.25-6.6	1.4-2.9	3.05-7.45
P. sapidus strain PSC-1	5.0-18.5	3.5-9.0	4.7-8.9	2.5-5.7	5.7-7.45
P. ostreatus strain EM-1 (control)	1.5-19.5	0.5-5.0	3.3-9.6	1.4-4.9	5.6-10.9

Table 5: Biological efficiency and yield of mushrooms per flush

***Pleurotus* species**	**1st flush**	**2nd flush**	**3rd flush**	**4th flush**	**5th flush**	**Total yield**	**Biological efficiency (%)**
P. sajor-caju strain PSCA-1	59.83±0.48	0	0	0	0	59.83±0.48^{ab}	18.13
P. pulmonarius strain PPA-1	36.16±0.57	21.66±0.46	0	0	0	57.82±0.44^{a}	17.52
P. pulmonarius strain PPA-2				No flushes			
P. eryngii strain PEA-2	59.53±0.23	45.33±0.38	0	0	0	104.86±0.26^{abcd}	31.77
P. ostreatus strain POA-1	28.33±0.41	21.00±0.49	0	0	0	49.33±0.43^{a}	14.94
P. ostreatus strain POA-2	75.50±1.01	58.16±0.30	8.33±1.26	0	0	141.99±1.20^{bcdef}	43.02
P. ostreatus strain POA-3				No flushes			
P. ostreatus strain POA-4				No flushes			
P. ostreatus strain POA-5	98.50±0.21	30.83±0.50	0	0		129.33±0.26^{abcde}	39.09
P. ostreatus strain POA-6	40.00±0.25	62.00±0.27	34.3	0	0	136.3±0.32^{abcde}	41.30
P. ostreatus strain POA-8	26.66±0.10	20.33±0.76	0	0	0	46.99±1.26^{a}	14.23
P. ostreatus strain POA-9	76.83±0.50	54.50±0.31	30.33±0.08	11.47±0.43	0	173.13±0.54^{ef}	52.46
P. ostreatus strain POA-10	25.66±0.56	59.00±0.35	34.16±0.53	0	0	118.82±0.63^{abcde}	36.01
P. ostreatus strain POA-11	53.73±0.84	36.16±0.43		0	0	89.89±1.61^{abc}	27.24
P. ostreatus strain POA-12	57.83±0.16	47.66±0.50	43.17±1.17	0	0	148.66±0.26^{cdef}	45.05
P. ostreatus strain POA-13	58.83±0.82	44.83±0.35	49.33±0.58	2.36±0.53	0	155.35±1.21^{def}	47.07
P.solimoneo-stramineus strain PSSC-1	25.33±0.52	22.83±0.24	0	0	0	48.16±0.36^{a}	14.59
P. citrinopileatus strain PCC-1	55.33±1.20	0	0	0	0	55.33±0.46^{a}	16.76
P. sapidus strain PSC-1	45.33±0.09	70.66±0.49	0	0	0	115.99±0.64^{abcde}	35.15
P. ostreatus strain EM-1 (control)	53.10±0.24	54.80±0.16	42.10±0.16	35.00±0.19	25.00±0.16	210.00±0.13^{f}	63.49

Fig. 1: *P. ostreatus* strain POA-10

Fig. 4: *P. ostreatus* strain POA-6

Fig. 2: *P. ostreatus* strain POA-13

Fig. 5: *P. pulmonarius* strain PPA-1

Fig. 3: *P. ostreatus* strain POA-12

Fig. 6: *P. solimoneo-stramineus* strain PSSC-1

Fig. 7: *P. ostreatus* strain POA-9

Fig. 8: *P. citrinopileatus* strain PCC-1

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