

## Mycelium growth and yield of wild strains of *Pleurotus ostreatus* (Jacq.:Fr.) Quel. cultivated on waste materials from the textile industry

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### ABSTRACT

The objective of the experiment was to compare mycelium growth and the yield of wild strains of *Pleurotus ostreatus* derived from natural sites and of a cultivated HK35 strain. Mycelium growth was investigated on substrates prepared from the sawdust of deciduous trees, wheat and rye straw as well as by-products from the textile industry: flax and hemp shives. Irrespective of the applied substrate, the cultivated HK35 strain was characterised by the fastest growth, whereas amongst the examined wild strains, mycelia designated as U18/5, S12/3 and B17/4 were found to grow best. Substrates prepared from wheat and rye straw and flax shives turned out to be the best for mycelium growth of the tested strains of *P. ostreatus*. The yield of oyster mushroom depended on the type of applied substrate. Higher yields were recorded on substrates from flax shives and a mixture of wheat straw and hemp shives than on wheat straw. The cultivated HK35 strain and the wild S12/3 strain gave the highest yields irrespective of the kind of substrate.

Key words: flax shive, hemp shive, oyster mushroom, sawdust, straw, substrate

### INTRODUCTION

Mushrooms from the *Pleurotus* sp. genus can be cultivated on different substrates, such as wheat, rye and rice straw or maize stalks (Stamets 2000), and there are many substrates used in the intensive cultivation of oyster mushroom. According to Poppe (2004), there are over 90 potential substrates, primarily agricultural wastes, which can be utilised as substrates for the cultivation of mushrooms from the *Pleurotus* genus. Thanks to ligninolytic, xylanolytic and cellulolytic enzymes, mushrooms from the *Pleurotus* sp. genus can be utilised for

the delignification of waste materials developed in the course of agricultural production (Cohen et al. 2002). The usefulness of various cellulose- and lignin-containing materials for mushroom cultivation was confirmed by the research results of a number of researchers (Zervakis et al. 2001, Ozcelik and Peksen 2007, Rani et al. 2008, Akeviae et al. 2009, Dundar et al. 2009). The aim of this experiment was to assess mycelium growth and the development of wild strains of *P. ostreatus* on substrates from flax and hemp shives and compare the obtained results with the mycelium growth of

the above-mentioned strains on substrates from deciduous tree sawdust as well as wheat and rye straw commonly employed in the commercial cultivation of the oyster mushroom in our country.

## MATERIAL AND METHODS

Investigations were carried out at the Department of Vegetable Crops of the Poznań University of Life Sciences in 2009. The examined wild *P. ostreatus* strains were derived from the collection of cultivated and medicinal mushrooms of the Department of Vegetable Crops of the Poznań University of Life Sciences and were obtained by workers of the Independent Workshop of Cultivated Mushrooms of the Research Institute of Vegetable Crops in Skierniewice from natural sites of various regions in Poland (Tab. 1).

Two independent experiments were performed; one was carried out in a laboratory and the other was a cultivation trial. In the course of the laboratory experiments, we examined the mycelium growth of all *P. ostreatus* strains given in Table 1 grown on substrates prepared from rye and wheat straw, beech, oak and poplar sawdust, as well as hemp and flax shives. The experiments were conducted in glass test tubes measuring 4 cm wide and 16 cm long. Incubation was conducted at a temperature of 25°C and the measure of growth was the thickness of the substrate layer overgrown by the mycelium after 10 days of incubation. In the cultivation trial, yields of the tested *P. ostreatus* HK35, B17/4, S12/3

and 418/5 strains growing on substrates prepared from wheat straw, flax shives as well as a mixture of wheat straw and hemp shives (4:1 by weight) were compared. The cultivation was conducted using plastic foil bags of 5 dm<sup>3</sup> volume, which were filled with the appropriate sterilised substrate of 65% moisture content and inoculated with mycelium. Incubation and cultivation were carried out in accordance with the requirements for *P. ostreatus*. The yield was evaluated on the basis of the harvest obtained from the first flush. A detailed description of the method employed in both experiments can be found in the paper by Siwulski et al. (2010 a).

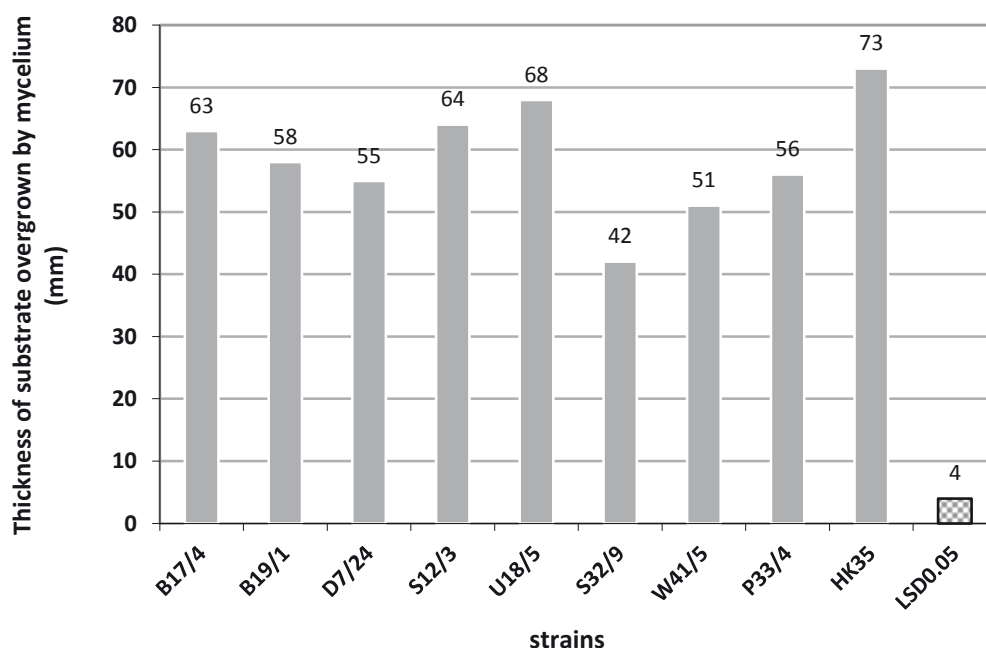
The trial was established in four replications in a random design in the case of the laboratory experiment, and three replications in the cultivation experiment. The obtained research results were subjected to the analysis of variance for two-factorial experiments using the Duncan test at  $p = 0.05$ . The results were described as average values of the two series in the laboratory experiment and two cycles in the cultivation experiment.

## RESULTS AND DISCUSSION

Wild strains of *P. ostreatus* as well as the HK35 cultivation strain differed with regard to the mycelium growth on the examined substrates. Mycelium of the HK35 strain was characterised by the best growth and the remaining wild strains exhibited a significantly poorer growth in comparison with the cultivated strain. From

**Table 1.** List of collected specimens of *Pleurotus ostreatus*

No	Collection date	Location of collection site	Collection site	Symbol of strain
1.	XII-I	Białystok Regional Directorate, Borki Forest District	trunks of birch	B17/4
2.	XII-I	Białowieża Forest District	lime trees	B19/1
3.	I-III	Szczecinek Regional Directorate; Drawsko Forest District, Czertyń Sub-district	beech trees	D7/24
4.	I-III	Szczecinek Regional Directorate; Świerczyna Forest District, Buczyna Sub-district	on beech trees	S12/3
5.	I-III	Szczecinek Regional Directorate; Ustka Forest District, Sycewice Sub-district	beech trees	U18/5
6.	XII-I	Łódź Regional Directorate; Skierniewice Forest District	<i>Aesculus hippocastaneum</i>	S32/9
7.	I-III	Katowice Regional Directorate; Kup Forest District; Winna Góra Sub-district	beech trees	W41/5
8.	XII-I	Poznań Regional Directorate; Miranowo Forest District, Piaski Sub-district	beech trees	P33/4
9.	<i>Pleurotus ostreatus</i> strain HK 35 from the collection of cultivated and medicinal mushrooms of the Department of Vegetable Crops of the Poznań University of Life Sciences			HK35



**Figure 1.** Mycelium growth of *Pleurotus ostreatus* strains on tested substrates

amongst the examined wild strains, U18/5 was characterised by the best mycelium growth. In comparison with this strain, significantly slower mycelium growth was recorded in the case of the S12/3 and B17/4 strains, followed by the B19/1, D7/24 and P33/4 strains. The mycelium of the W41/5 strain was characterised by an even worse growth, and strain S32/9 was found to exhibit the worst mycelium growth (Fig. 1).

The best mycelium growth of the examined *P. ostreatus* strains was determined on the substrates from wheat and rye straw and flax shives and then from poplar sawdust. A significantly worse mycelium growth was observed in the case of substrates from birch and oak sawdust. The poorest mycelium

growth of the examined strains was determined on the substrate from hemp shives (Tab. 2).

The observed interaction between the kind of substrate and the examined *P. ostreatus* strains was significant. The substrate from flax shives was overgrown fastest by the B17/4, B19/1, U18/5, S32/1, W41/5 and P33/4 as well as HK35 strain mycelium, whereas the S12/3, U18/5, P33/4 and B17/4, B19/1 as well as HK35 strains grew fastest on the substrate prepared from rye straw. Wheat straw was the best substrate for the cultivated HK35 strain as well as for the S12/3, U18/5, D7/24 and P33/4 strains (Tab. 2). The substrate from poplar sawdust was overgrown fastest by the B17/4, D7/24, S12/3 and U18/5 strain mycelium. Substrates

**Table 2.** Mycelium growth of *Pleurotus ostreatus* strains on different substrates (mm)

Symbol of strain	Substrates						
	rye straw	wheat straw	birch sawdust	oak sawdust	poplar sawdust	hemp shive	flax shive
B17/4	73	66	60	53	70	46	75
B19/1	62	60	58	50	56	50	68
D7/24	54	67	56	46	62	41	60
S12/3	75	74	59	51	70	47	70
U18/5	76	72	70	65	70	45	75
S32/9	47	53	40	33	45	30	46
W41/5	55	59	47	40	53	44	60
P33/4	69	61	53	47	58	43	64
HK35	78	81	72	68	75	58	77
Mean	65	66	57	50	62	45	66

LSD<sub>0.05</sub> for substrates = 4

LSD<sub>0.05</sub> for interaction = 7

Effect of strain = non-significant differences

**Table 3.** Yield of wild and cultivated strains of *Pleurotus ostreatus* on different substrates (g 100 g<sup>-1</sup> d.m. of substrate)

Strain	Substrate			Mean
	wheat straw	flax shive	wheat straw + hemp shive	
B17/4	53	60	59	57
S12/3	60	68	68	65
418/5	41	54	58	51
HK35	62	71	69	67
Mean	54	63	64	-

LSD<sub>0.05</sub> for strains = 5LSD<sub>0.05</sub> for substrates = 6LSD<sub>0.05</sub> for interaction = 8

prepared from oak and birch sawdust and hemp shives exhibited the slowest rate of overgrowing by mycelium of the examined *P. ostreatus* strains.

The presented results corroborated research results obtained earlier by Siwulski et al. (2010 b). The above-mentioned researchers demonstrated that the response of some mushroom species to the kind of substrate differed strongly. Mycelia of *Ganoderma lucidum*, *Hericium erinaceus* and *Lentinula edodes* grew better on sawdust substrate than on flax and hemp shives and straw, whereas the mycelium of such species as *Agrocybe aegerita*, *Pholiota nameko* and *Flammulina velutipes* showed the best growth on substrate prepared from flax shives. Zervakis et al. (2001) reported a very good growth of *Pleurotus* sp. mycelium on substrate from cotton waste.

Mycelia of the wild strains as well as of the cultivated *P. ostreatus* strain used in the experiments exhibited very good growth on substrates prepared from flax shives, which was similar to growth achieved on the substrates most frequently employed in commercial cultivation, i.e. from rye and wheat straw. It is also worth emphasising that the mycelium growth of the examined *P. ostreatus* strains was very slow on the substrate from hemp shives and was similar to their growth on the oak sawdust substrate.

The yield of *P. ostreatus* depended on the kind of substrate. Curvetto et al. (2002) and Obodai et al. (2003) reported differences in yields between *P. ostreatus* strains growing on different substrates. In their earlier experiments, the authors of this article reported the suitability of flax and hemp shives for the cultivation of two strains of oyster mushroom: K22 and P80 (Siwulski et al. 2010 b). Higher yields were obtained on substrates prepared from flax shives and a mixture of wheat straw and hemp shives in comparison with the yield obtained from the cultivation on wheat straw. The response of all

of the examined strains to the kind of the substrate was similar. *P. ostreatus* strains differed amongst one another with respect to the level of yields. The highest yields, irrespective of the kind of applied substrate, were recorded for the cultivated strain HK 35 and the wild S12/3 strain. Lower yields were recorded in the case of the B17/4 strain and the 418/5 strain had the lowest (Tab. 3).

## CONCLUSIONS

1. The kind of applied substrate affected mycelium growth and yield of the examined *P. ostreatus* strains. The best substrates for *P. ostreatus* mycelium growth included wheat and rye straw and flax shives. The most suitable substrate for cultivation from the point of view of the obtained yields was a mixture of wheat straw and hemp shives.
2. The responses of the examined *P. ostreatus* strains to the kind of substrate with regard to the examined traits were similar.

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#### WZROST GRZYBNI I PLONOWANIE DZIKICH RAS BOCZNIAKA OSTRYGOWATEGO *PLEUROTUS OSTREATUS* (JACQ.:FR) QUEL. NA MATERIAŁACH ODPADOWYCH PRZEMYSŁU WŁÓKIENNICZEGO

Streszczenie: W doświadczeniu porównano wzrost grzybni dzikich ras bocznika ostrygowatego *Pleurotus ostreatus* pochodzących ze środowiska naturalnego oraz rasy uprawnej HK 35. Wzrost grzybni badano na podłożach z trocin drzew liściastych, a także słomie pszennej i żytniej oraz odpadach przemysłu włókienniczego: paździerzach lnianych i konopnych. Najszybszym wzrostem, niezależnie od zastosowanego podłoża, cechowała się rasa uprawna HK35, a wśród badanych dzikich ras najlepiej rosła grzybnia oznaczona jako U18/5, S12/3 i B17/4. Najlepszymi podłożami dla wzrostu badanych ras bocznika okazały się słoma pszena i żytnia oraz paździerze lniane. Plon bocznika zależał od rodzaju podłoża. Większy plon uzyskano na podłożu z paździerzy lnianych i mieszaniny słomy pszennej z paździerzami konopnymi niż na słomie pszennej. Niezależnie od rodzaju podłoża, największy plon dała rasa uprawna HK35 i dzika rasa S12/3.

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