Comparison of mycelium growth and yielding of selected strains of *Hericium erinaceus* (Bull. Fr.) Pers. on sawdust substrates with the glucose addition

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S u m m a r y

The aim of the studies was to determine the effect of sawdust substrates and their enrichment with glucose on the mycelium growth and yield of three *Hericium erinaceus* (Bull. Fr.) Pers. strains. The subject of the studies was strains of *H. erinaceus* designated as 'H1', 'D5' and 'D9'. Pine and beech sawdust supplemented with glucose in the amount of 1%, 2% and 3% were used as cultivated substrates. It was found that the tested strains differed in mycelium growth rate. The 'D9' strain was characterized by the fastest mycelium growth. The mycelium grew more rapidly on substrate with glucose addition, regardless from its amount, in comparison with substrate without glucose addition. The 'H1' and 'D5' strains gave the bigger yield than 'D9' one. The biggest yield was recorded on beech sawdust substrate with 3% addition of glucose.

Key words: *Hericium erinaceus, substrate, glucose, mycelium growth, yield*

INTRODUCTION

Hericium erinaceus (Bull. Fr.) Pers. is a cultivated mushroom of well-appreciated taste value. The species can be found on dying or dead trunks and branches of deciduous trees. The natural range of *H. erinaceus* stretches from China and Japan to North America and Europe [1]. In Poland, it rarely occurs in its natural habitats and, therefore, it is under complete legal protection. Carpophores of this mushroom contain many salubrious substances [2-4]. The principal constituent of the substrate in *H. erinaceus* commercial cultivations is sawdust from various deciduous trees [5]. Croan [3] maintains that it is also possible to employ for this purpose shavings obtained from coniferous trees of *Pinus* species. Other materials such as: wheat and rice straw [6], cotton chaff [7], maize cobs [8] were also used for the cultivation of this mushroom. In addition, substrates are often supplemented by various additives, including: cereal bran or grains, wastes from sugar cane production, bone and soybean meal, maize cob rachises as well as saccharose in order to increase the quantity and quality of yield [6, 9-11].

The aim of the performed experiments was to determine the impact of two sawdust substrates obtained from native tree species and their treatment with glucose on the growth of mycelium and yield of three *H. erinaceus* strains.

MATERIAL AND METHODS

Experiments were conducted in 2008 at the Biology Laboratory of the Department of Vegetable Crops of the Poznań University of Life Sciences. Investigations were carried out in two stages. During the first stage, the growth of mycelium was studied, while in the course of the second stage – yield of *H. erinaceus* carpophores were assessed.

Three strains of the *H. erinaceus* designated as H1, D5 and D9 were employed. The substrate was prepared from a mixture of beech and pine sawdust which was additionally supplemented with wheat bran in the amount of 20% in relation to the substrate dry matter. The substrate prepared in this way was also enriched with 1%, 2% and 3% addition of glucose. Substrate without glucose supplementation was considered as control. The experimental substrates were wetted with tap water to the moisture content of 70%.

In the experiments on mycelium growth, the substrates were placed in glass test tubes and sterilised at the temperature of 121°C for half an hour. After cooling down to the temperature of 21°C substrates were inoculated with grain mycelium. The mycelium was placed on the surface of the substrate in a layer of 1 cm. Test tubes were placed in a thermostat. The incubation was conducted at the temperature of 25°C and 80–85% air relative humidity. The growth of mycelium was estimated on the basis of the thickness of the layer covering the substrate by mycelium after 21 days of incubation.

The experiment on mycelium growth was designed as a random, three factorial trial in six replications and two series.

The cultivation experiment was conducted in polypropylene bottles of 1 dm^3 volume. Each bottle was filled with 450 g of the substrate in which a whole 10 cm deep and 1 cm in diameter was made. The bottles were closed with covers equipped in filters and then sterilised at the temperature of 121°C for an hour. Once the substrate cooled down to the temperature of ambient air (21°C), inoculations with grain mycelium were carried out by placing 10 g of mycelium in the earlier prepared wholes. Then the bottles were closed with covers with filters and transferred into the incubation chamber. The incubation was conducted at the temperature of 25°C and 80–85% air relative humidity until the substrate became completely covered with mycelium. Next, bottles with the substrate and with removed covers were placed in a cultivation chamber in which the temperature was maintained at 25°C and air relative humidity – at 85–90%. The cultivation was additionally lighted with fluorescent light of 500 lx intensity 12 hours a day. Carpophores were harvested successively as they matured. The carpophores were twisted off the bottles and bottom parts of their stipes were cut off in order to remove substrate residue. Yield included carpophores together with the cut stipes. Yields were calculated as the mass of carpophores obtained from 100 g of the substrate dry matter (DM).

The cultivation experiment was designed as a random, three-factorial trial in four replications. Two cycles of cultivation experiment were conducted. The results were described as average values of the two cycles.

In both stages, when comparing experimental results, the analysis of variance for factorial experiments was applied using Duncan's test at the level of significance $\alpha=0.05$.

RESULTS AND DISCUSSION

It was observed that the examined strains of *H. erinaceus* differed significantly with regard to mycelium growth rates. Strain D9 was characterised by the fastest growth. Mycelium of H1 strain grew more slowly than D9, while D5 strain was characterised by the slowest mycelium growth (fig. 1). In their experiments on the impact of sawdust substrates on the rate of *H. erinaceus* mycelium growth, Pawlak et al. [12] also reported differences in the growth of mycelium of different strains. The above researchers showed that D9 mycelium covered sawdust substrates faster in comparison with the mycelium of H1 and D5 strains. Fast mycelium growth in the cultivation substrate is a desirable characteristic in mushroom cultivation because it reduces the risk of contamination with competitive microorganisms and speeds up harvesting [5, 13].

The results of the performed experiments failed to confirm differences in rates of mycelium growth on substrates derived from pine and beech sawdust. However, the growth of *H. erinaceus* mycelium was influenced by the addition of glucose to the substrates. The examined mycelium was found to grow faster on substrates supplemented with the addition of glucose in comparison with the substrate without the addition of this compound. Mycelium growth on substrates enriched with the addition of 1%, 2% and 3% glucose was similar (fig. 1).

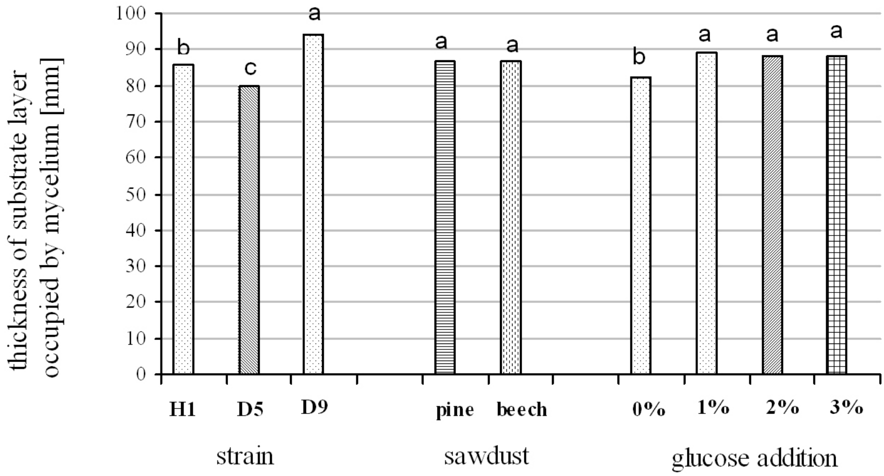

Figure 1. Mycelium growth of three *H. erinaceus* strains on sawdust substrates with the glucose addition

It was found that the examined strains differed with regard to yield levels. In comparison with the D9 strain (20.5 g · 100^{-1}g DM of substrate), strains H1 and 'D5' (27.0 and 25.5 g · 100^{-1}g DM of the substrate) yielded higher levels of carpophores. Similar results were reported by Siwulski et al. [14] in experiments carried out earlier on the usefulness of the above-mentioned strains for the cultivation on sawdust of several species of deciduous trees.

The performed cultivation experiment revealed that the type of the applied sawdust influenced yield levels. In comparison with the employed pine sawdust, carpophore yield harvested from the substrate derived from beech sawdust were higher. The carpophore yield obtained from the beech sawdust substrate amounted to 28.2 g · 100^{-1} g DM of the substrate and was by 7.7 g higher in comparison with the yield harvested from pine sawdust substrates (tab. 1). Eisenhut and Fritz [13] also considered substrates from beech sawdust enriched with 20% addition of wheat bran as the best for the cultivation of the discussed mushroom species. On the other hand, Ping and Chapman [15] found substrates made up from 80% sawdust from coniferous trees, 18% wheat bran, 1% calcium sulphate and 1% saccharose as suitable for the cultivation of *H. abietis* and *H. erinaceus*.

It was found that the addition of glucose affected yield levels. Increased glucose supplementation of substrates from beech and pine sawdust increased *H. erinaceus* yields, irrespective of its strain. The highest yields were recorded in the treatments when beech sawdust substrates were supplemented with 3% and 2% glucose addition, respectively, 30.2 and 29.7 g · 100^{-1} g DM of the substrate. Lower yields were recorded on substrates from beech sawdust enriched with 1% of glucose and without any addition of this compound. Yield on the substrate from beech sawdust without glucose addition did not differ statistically from the yield obtained on the pine sawdust substrate supplemented with 3% glucose. It was found that yield obtained on pine wood sawdust substrates declined together with lowering of the glucose dose. The smallest yield (16.6 g · 100^{-1} g DM of the substrate) were observed when no glucose was added to the substrate from pine sawdust (tab. 1). Siwulski et al. [14] also reported high carpophore yields of *H. erinaceus* from substrates derived from beech and oak sawdust. The obtain results confirm better suitability of sawdust from deciduous trees for *H. erinaceus* cultivation in comparison with sawdusts derived from coniferous trees. Worse suitability of the pine sawdust for *H. erinaceus* cultivation could have resulted from the presence of resin substances as well as from poor nutrient resources in comparison with the beech wood sawdust. The addition of 3% glucose to the pine sawdust increased carpophore yield of *H. erinaceus* mushrooms by 43% in comparison with yield recorded on the sawdust without supplementation.

Table 1.

Yield of three *H. erinaceus* strains cultivated on sawdust substrates with the glucose addition (g · 100^{-1} g D.M. of substrate)

strain	beech sawdust				pine sawdust				mean
	glucose addition [%]				glucose addition [%]				
	0	1	2	3	0	1	2	3	
H1	28.4	29.4	32.2	32.6	18.2	23.1	25.2	27.1	27.0 a
D5	27.3	28.3	29.8	30.2	19.4	20.9	22.7	25.3	25.5 a
D9	20.1	25.1	27.3	27.7	12.3	14.8	17.2	19.4	20.5 b
mean for addition quantity	25.1 c	27.6 b	29.7 a	30.2 a	16.6 f	19.6 e	21.7 d	23.9 c	-
mean for kind of sawdust	28.2 a				20.5 b				-

Data marked with the same letter do not differ significantly at $\alpha=0.05$.

CONCLUSIONS

1. The examined strains differed with regard to mycelium growth rates. 'D9' strain was characterised by the fastest growth rate of mycelium.
2. The type of sawdust used as substrates failed to influence the growth of *H. erinaceus* mycelium.
3. Supplementation of sawdust substrates with glucose, irrespective of its quantity, exerted a positive influence on the growth of *H. erinaceus* mycelium. Mycelium was found to grow faster on the substrate with the addition of glucose than without such supplementation.
4. The examined *H. erinaceus* strains differed with regard to yield levels. 'H1' and 'D5' strains were characterised by similar yields which were higher in comparison with 'D9' strain.
5. The type of sawdust and the amount of glucose added to the substrate influenced carpophore yield of *H. erinaceus*. The highest carpophore yields were obtained on the substrate from sawdust supplemented with 2% and 3% addition of glucose.

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PORÓWNANIE WZROSTU GRZYBNI I PLONOWANIA KILKU ODMIAN SOPLÓWKI JEŻOWATEJ *HERICIUM ERINACEUS* (BULL. FR.) PERS. NA PODŁOŻU Z TROCIN Z DODATKIEM GLUKOZY

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Streszczenie

Celem badań było określenie wpływu podłoży z trocin i ich wzbogacania glukozą na wzrost grzybni i plon trzech odmian soplówki jeżowatej. Przedmiotem badań były odmiany soplówki jeżowatej H1, D5 i D9. Jako podłoży użyto trocin sosnowych i bukowych z dodatkiem glukozy w ilości 1%, 2% i 3%. Stwierdzono, że badane odmiany różniły się szybkością wzrostu grzybni. Najszybszym wzrostem grzybni charakteryzowała się odmiana D9. Wzrost grzybni był szybszy na podłożu z dodatkiem glukozy, niezależnie od jego ilości, w porównaniu do podłoża bez dodatku. Odmiany soplówki jeżowatej różniły się wielkością plonu owocników. Odmiany H1 i D5 wydały większy plon niż odmiana D9. Największe plony uzyskano na podłożu z trocin bukowych przy 3% dodatku glukozy do podłoża.

Słowa kluczowe: *soplówka jeżowata, podłoże, glukoza, wzrost grzybni, plon*