Production and quality appraisal of mycelium of parasol mushroom
*Macrolepiota procera* (Scop. ex Fr.) Sing.

WANDA WOŹNIAK

Institute of Technology of Plant Origin Food
Poznań University of Life Sciences
Wojska Polskiego 31
60-624 Poznań, Poland

*corresponding author e-mail: wozwa@up.poznan.pl

**Summary**

The paper presents the production of mycelium of parasol mushroom *Macrolepiota procera*, an endangered mushroom species. Mycelium was produced in tissue culture, from which spawns were produced on five media. From the best production variant mycelium for consumption in highly processed foodstuffs was grown and analyzed chemically. Mycelium may also be used to produce mushrooms under natural conditions.

**Key words:** mushrooms, mycelium, parasol mushroom

**INTRODUCTION**

Obtaining mycelium biomass in our times is a crucial problem not only for the development of production of cultivated and wild mushrooms, but also in obtaining new biologically active compounds [1-3]. Human activity greatly affects the incidence of mushrooms. Due to the impact of economy the area of old primeval forest is shrinking, peat bogs are disappearing, we have fewer and fewer old trees, while the number and size of waste dumps, barren land and areas covered with concrete and asphalt are increasing. Numerous mushroom species are disappearing, while the area where others may still be found is decreasing [3-7]. For this reason in recent years growing interest has been observed in mycelium of wild growing large-fructification mushrooms grown on liquid media and in controlling mycelial metabolism [2, 8]. Obtained, expected properties of mycelium...
may facilitate its application in food production, as a flavour additive to highly processed products [9-11].

MATERIAL AND METHODS

The raw material was an endangered mushroom species, fruiting bodies of parasol mushroom *Macrolepiota procera* (Scop. ex Fr.) Sing. (fig. 1) [5-7]. Parasol mushroom is an edible mushroom, which is commonly picked in Europe, North America, northern Africa and Asia [12, 13]. In some countries it is the only gill mushroom readily picked for human consumption [14]. Parasol mushroom grows in small clusters or individually, it forms fruiting bodies from June to November in lighted position in forests, parks, gardens, on meadows and pastures. It prefers warm positions on calcareous and sandy soils.

![Figure 1. Parasol mushroom *Macrolepiota procera* (Scop. ex Fr.) Sing.](image)

In the first stage maternal mycelium was obtained from a fruiting body and from this mycelium spawns were grown on five agar media: carrot, potato, wheat, Hansen I and Hansen II. Mycelium growth on Petri dishes was analyzed by linear measurement of the diameter of medium surface covered by mycelial hyphae.

In the second stage mycelium was propagated using the submerged culture. In the propagation the medium was used in which mycelium exhibited the highest growth intensity. Experiments were performed in 16 replications for six series of trials. Mycelium to be used for consumption purposes was propagated on a potato medium at different shaking rates: 120 rpm and 90 rpm. Intensity of mycelium growth in solutions was determined by measuring the volume of medium occupied by mycelium. The manner in which hyphae were growing was evaluated visually.
In the third stage of the study an analysis was conducted on mycelium, which was propagated using submerged culture on a potato medium using sensory examination and physico-chemical analyses. Mycelium contents of protein compounds soluble in water, in 0.1M NaCl and 0.15% NaOH were determined by colorimetry using amide black 10B. Activity of red-ox enzymes was determined by colorimetry by calculating the amount of purpurogallin formed by pirogallol under the influence of the reaction of $H_2O_2$ with enzymes found in the analyzed mycelium of parasol mushroom. Dry substance content was determined by gravimetric using a WPS 30S moisture analyzed by Radwag, by drying at 95°C to constant weight. The mycelium rehydratation ratio was determined using Loeseck’s method. Moreover, sensory examination of mycelium was conducted in order to assess its potential use for human consumption.

RESULTS AND DISCUSSION

The effect of medium composition on dynamics of mycelium growth on Petri dishes was presented for maternal mycelium in fig. 2 and for four spawns in figs. 3–6. Mycelium was produced by submerged culture in potato medium with 1.2% extract and pH 5.5. Mixing intensity was 120 or 90 rotations x min$^{-1}$ (fig. 7). Mycelium shaking at 120 rpm was too rapid, as it caused damage of hyphae. Shaking of mycelium at 90 rpm was optimal for mycelium growth.

The effect of medium and successive reproduction on intensity of mycelium growth of parasol mushroom on agar medium

When comparing mycelium growth dynamics of parasol mushroom on solid media: carrot, wheat, potato, Hansen I and Hansen II media, it was found that for all media and all reproductions the growth time was similar (fig. 2-6). Mycelium of the first reproduction started to grow on the fifth day since its inoculation on potato and carrot media, while it was around day 10 on the other media; the end of growth was observed 39/40 days after inoculation (fig. 3). Mycelia of the first reproduction from carrot medium yielded markedly smaller increments. In case of the second, third and fourth reproductions the most intensive growth was observed on Hansen I medium (figs. 4-6). The end of mycelium growth increments depending on the medium was recorded between day 26 and 32 since inoculation. Mycelium produced on carrot medium was smaller. The biggest growth intensity was found for mycelium grown on potato medium from the first reproduction of tissue mycelium. A rapid, intensive growth and large thallus diameters were observed. Spawns of parasol mushroom were inoculated on five different solid agar media, they formed a large number of delicate thalli growing on the surface and into agar. Mycelia from synthetic media were white, while those cultured on natural media were cream-coloured. Despite a faster growth of spawn produced in Hansen I medium, it was rejected from production in liquid media due to the unpleasant sensory attributes and a lack of intrinsic mushroom aroma.
Figure 2. Growth of maternal mycelium of parasol mushroom on five agar media

Figure 3-6. Spawn growth of parasol mushroom on five agar media

Figure 3-6. Spawn growth of parasol mushroom on five agar media
Characteristics of mycelium of parasol mushroom produced on liquid potato medium by submerged culture

Mycelium at 120 rotations per minute grew uniformly, but very slowly (fig. 7). After 55 days it occupied 25% of medium volume. After 10 days the medium grew darker. Mycelium colour was dark brown, hyphae were loosely compacted and slight mushroom aroma developed as late as approx. 2 minutes after mycelium had been drained. After sensory examination it was found that such mycelium is not suitable for food processing purposes. Mycelium in potato medium at a shaking rate of 90 rpm grew uniformly and very fast (fig. 7). As early as at the sixth day mycelium occupied 80% volume of liquid in the flask. It was light-creamy in colour with delicate discolourings, hyphae were strongly compacted and the intensive mushroom aroma was perceptible immediately after draining. Throughout mycelium culture the medium was clear and light. After sensory examination it was found that such mycelium may be used for food processing, which was confirmed by physicochemical analyses (tab. 1). As it results from conducted analyses, mycelium of parasol mushroom from potato medium was characterized by a considerable content of dry matter, which was higher than that of the fruiting body.

![Figure 7. Mycelium growth of parasol mushroom in liquid potato medium](image)

Contents of soluble protein compounds were rather high, comparable with those in fruiting bodies of most mushrooms [11, 14]. Rehydratation ratio and the activity of redox enzymes in analyzed mycelium were high.
Table 1.

Chemical analysis of mycelium of parasol mushroom produced on liquid potato medium

<table>
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<th>globulins</th>
<th>prolamins</th>
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<table>
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<tr>
<th>activity of redox enzymes [mg purpurogallin/100 g d.s.]</th>
<th>2726.18</th>
<th>66.46</th>
<th>2.44</th>
</tr>
</thead>
</table>

| rehydratation ratio | 2.78 | 0.24 | 8.44 |

CONCLUSIONS

1. Mycelium produced in the laboratory on liquid potato medium scale is suitable for food processing purposes, particularly in highly processed products.

2. The biggest growth intensity on solid agar potato medium was found for mycelium of parasol mushroom from the first reproduction of tissue mycelium.

3. Mycelium growth rate of parasol mushroom in liquid medium depended on the shaking rate, with slower rotations considerably accelerating mycelium growth.

4. Mycelium produced in potato medium at 90 rotations per minute grew very intensively and was characterized by light cream colour, intensive mushroom aroma and high nutrient content in comparison to mushrooms.

REFERENCES

WANDA WOŹNIAK

Instytut Technologii Żywności Pochodzenia Roślinnego
Uniwersytet Przyrodniczy
ul. Wojska Polskiego 31
60-624 Poznań

*autor, do którego należy kierować korespondencję: e-mail: wozowa@up.poznan.pl

Streszczenie


Słowa kluczowe: grzyby, grzybnia, czubajka kania