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PLEUROTUS SPP. CULTIVATION ON WHEAT STRAW*

Summary. Mushrooms from the genus *Pleurotus* are tasty and rich in proteins, fibres, carbohydrates, vitamins and minerals. According to several authors, their nutritional value is due, mainly, to protein quality, one of the most important factors for the nutritional evaluation. Among various mushrooms there are some basic differences due to genetic nature and their metabolism, typically heterotrophic, which influence the way the substrate nutrients are used. So, when new wastes are applied in mushroom culture, as substrate, it is very important to study and know the chemical composition of the fruit bodies formed. *Pleurotus* mushrooms productivity and their ability to grow on different organic waste materials, can promote and increase commercial production. Thus, for a successful culture some factors must be considered, namely: environmental conditions control and simple cultivation techniques. *Pleurotus ostreatus*, commonly designated by oyster mushroom, is one of the most cultivated mushrooms. Nowadays, other species are also very appreciated, as *P. cornucopiae* (Paulet Pers.) Roland, *P. pulmonarius* (Fr.) Quél. (= *P. sajor-caju* (Fr.: Fr.) Singer) and *P. eryngii* (DC Fr.). The aim of this investigation was to evaluate the yield, biological efficiency, fresh weight and morphological characteristics of *P. eryngii*, *P. sajor-caju* and *P. ostreatus* (Jacq.: Fr.) Kummer, when grown on a sterilized substrate composed of wheat straw, to determine the most productive species.

Key words: mushrooms, yield, culture, substrate

Introduction

Mushrooms have been a part of human diet since the time no-one can remember. They were used, as food, before man understood the use of other organisms. Recently mushrooms consumption has increased, not only for their flavours, but also for the wider

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knowledge of high nutritional and medicinal values of some species (QUIMIO 2004). Nowadays, it is well known, that they are a very important contribution to human nutrition. Their popularity is based, not only on their food value (levels of protein, carbohydrates, fat, vitamins and nucleic acids), but also mostly on their exotic taste and their gastronomic properties, eaten alone or combined with other foods (BONONI 1999). Among all mushrooms, approximately 2000 species are edible, however, only 25 are commonly used in food, still lower is the number of species commercially cultivated (PASCHOLATI et AL. 1998).

Mushroom cultivation has a long tradition, with *Auricularia auricularia-judae* (Bull. ex St. Amans) Wettst., however for *Agaricus bisporus* (Lange) Imbach culture there are some references only from XVII century, in France (SÁNCHEZ and ROYSE 2001). In Europe and the United States of America the edible mushrooms cultivation started with *A. bisporus* ("champignon de Paris") and in Canada with *Lentinula edodes* (Berk.) Pegler (shiitake). Recently, other species, such as those of the genus *Pleurotus* have been used.

Although very similar, the *Pleurotus* species present, however, differences regarding the shape, size and colour. These mushrooms are considered very interesting, not only for their easy adaptation and maintenance, resistance to pests and diseases, fast growing, but also for the low cost of cultivation, allowing a rapid return on investment (RAJARATHNAM 1992, POPPE 2000).

Pleurotus spp., saprophytes mushrooms require nitrogen, inorganic compounds and carbon sources as cellulose, hemicelluloses and lignin. Thus, organic wastes containing cellulose, hemicelluloses or lignin can be used, however, demanded amount of each nutritional sources differs, according to mushroom species (CHANG and MILES 1989).

The culture system, in controlled environment, allows the mushrooms availability during all the year, with short cycles production, high productivity, quality and yet the economically valourisation of some agricultural and agro-industrial wastes (KONG 2004).

The main purpose of the present study was to evaluate the mushrooms production and quality, through yield, biological efficiency, fresh weight and morphological characteristics of *P. eryngii*, *P. sajor-caju* and *P. ostreatus* when cultivated in sterilized wheat straw, as culture substrate growing and determine the most productive species.

Material and methods

Pleurotus species cultures (*P. eryngii*, *P. sajor-caju* and *P. ostreatus*) were obtained from INRB L-INIA culture collection. Stock cultures mycelia were grown and maintained on potato dextrose agar (PDA) (Oxoid) at 4°C. All cultivation process was performed according to the steps shown in Figure 1.

Spawn was prepared from hydrated oats seeds. Four hundred grams of grains (wet weight) were placed in polypropylene bags, and sterilized at 121°C for 1 h. After being cooled, each bag was inoculated with *Pleurotus* species mycelia and incubated at 24°C in the dark, until mycelia had completely colonized the oat grains. Wheat straw was used as substrate growing. For each species were made seven sample replicates, in order to undertake the analyses.

Dry wheat straw was cut into 1 to 3 cm fragments with an electric thresher and then hydrated during 12 h. The moisture excess was allowed to run off until moisture content of 60% was reached. Polypropylene bags with straw substrate (1 kg) were sterilized

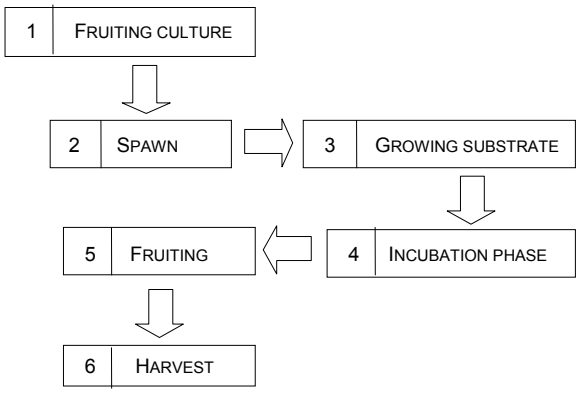

Fig. 1. Steps of mushroom culture (adapted from RAMOS et AL. 2004)
Rys. 1. Etapy uprawy grzybów (według RAMOS i IN. 2004)

at 121°C, during 1 h, by three times. Each bag was inoculated with 100 g of spawn and incubated at 24 ±2°C in complete darkness. After total colonization, the bags were placed, without their plastic covering, in controlled environmental conditions favourable for fruiting: temperature 20 ±2°C, relative humidity 85 ±5% and daily illumination 12 h (Fig. 2).

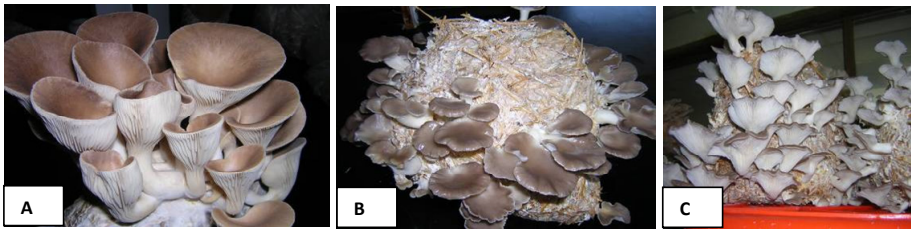

Fig. 2. *Pleurotus* species: A – *P. eryngii*, B – *P. sajor-caju*, C – *P. ostreatus*
Rys. 2. Gatunki rodzaju *Pleurotus*: A – *P. eryngii*, B – *P. sajor-caju*, C – *P. ostreatus*

Only mushrooms from first flush were used. Mushrooms were harvested before they showed slightly curled edges.

To determine the most productive species the following parameters were assessed:

- yield (Y) – relationship between fresh mushrooms and fresh substrate (%),
- biological efficiency (BE) – relationship between fresh mushrooms and dry substrate (%),
- fresh weight (W) – fruit bodies weighed immediately after harvest (g),
- fruit body number (N) – counted for each bag/substrate growing,
- height (H) – measured from the base to the stipe of the pileus (cm),
- pileus diameter (d) – measured from one edge of the pileus, across the stipe, to another (cm).

Results and discussion

The yield results (Fig. 3 A) showed no major differences among all three species. However in the *P. eryngii* substrate it was the most productive (41.0%) followed by *P. sajor-caju* and *P. ostreatus* (38.4% and 38.5%, respectively).

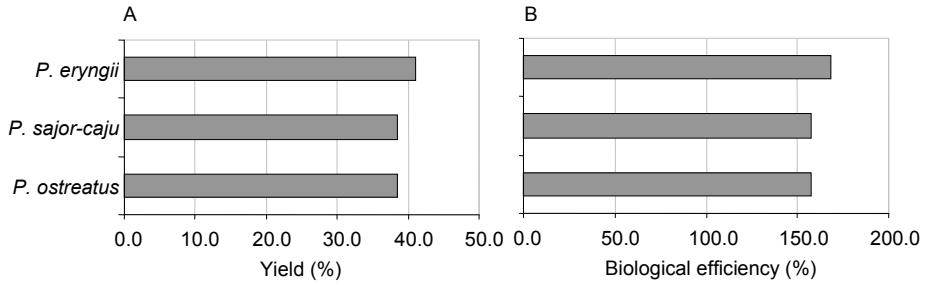

Fig. 3. *Pleurotus* species production quantification: A – yield, B – biological efficiency
Rys. 3. Ocena produktywności gatunków rodzaju *Pleurotus*: A – plon, B – efektywność biologiczna

The biological efficiency evolution was similar to the yield. The values depended only on the mushrooms fresh weight because the dry matter substrate value (24.4%) used in the BE determination was the same for the three species. Thus, it was *P. eryngii* that showed higher biological efficiency (168.3%), followed by *P. ostreatus* (157.9%) and *P. sajor-caju* (157.6%) (Fig. 3 B).

The harvested mushrooms/block number, whose values are shown in Figure 4 A, show a considerable difference. *Pleurotus eryngii* produced a very small number, when compared with the other species (10 to *P. eryngii*, 76 for *P. sajor-caju* and 81 for *P. ostreatus*).

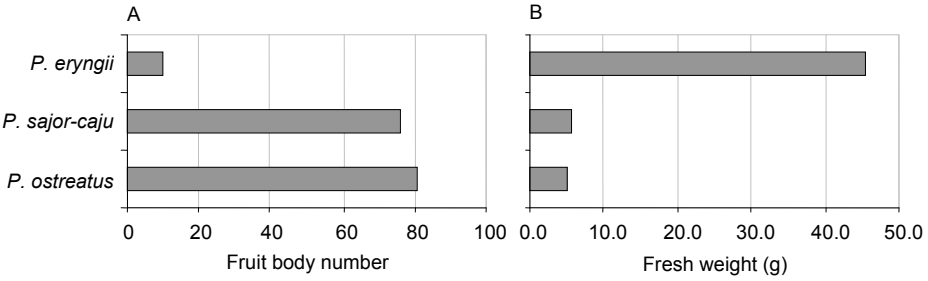

Fig. 4. *Pleurotus* species fruit bodies quantification: A – fruit body number, B – fresh weight
Rys. 4. Ocena owocników gatunków rodzaju *Pleurotus*: A – liczba owocników, B – świeża waga

In Figure 4 B it can be observed that *P. eryngii* (45.3 g per mushroom) presented a greater mass, when compared with the other species, namely 5.5 g for *P. sajor-caju*

and 4.9 g for *P. ostreatus*. Concerning mushrooms size, including pileus diameter and stipe height (Fig. 5 A and B), it was *P. eryngii* that produced the largest ones (6.7 cm and 4.2 cm, respectively), followed by *P. ostreatus* (5.9 cm and 2.1 cm) and *P. sajor-caju* (4.8 cm and 1.7 cm).

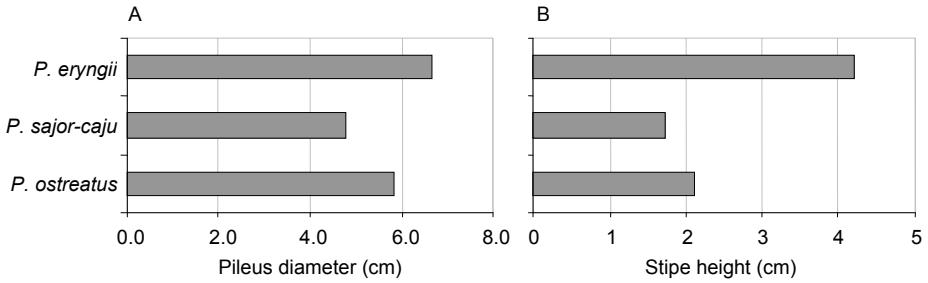

Fig. 5. *Pleurotus* species fruit bodies characterisation: A – pileus diameter, B – stipe height
Rys. 5. Charakterystyka owocników gatunków rodzaju *Pleurotus*: A – średnica kapelusza, B – wysokość trzonu

Conclusions

According to the results obtained in this study, we can conclude that wheat straw is a good substrate for *Pleurotus* species cultivation. *Pleurotus eryngii* are characterised by producing the largest mushrooms. So if the culture aim is quantity of mushrooms both *P. ostreatus* or *P. sajor-caju* will be recommended. However, if the cultivation purpose is to satisfy the market demand for larger mushrooms, less fragile and with high post-harvest resistance it will be better to produce *P. eryngii*.

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UPRAWA *PLEUROTUS* SPP. NA SŁOMIE PSZENNEJ

Streszczenie. Grzyby rodzaju *Pleurotus* są smaczne i bogate w białka, błonnik, węglowodany, witaminy oraz składniki mineralne. Według niektórych autorów ich wartość odżywcza, głównie dzięki jakości białka, jest jednym z najważniejszych czynników oceny żywieniowej. Pomiędzy różnymi gatunkami grzybów istnieją pewne podstawowe różnice, spowodowane ich budową genetyczną oraz metabolizmem (głównie heterotroficznym). Cechy te wpływają na sposób przetwarzania przez nie składników substratu. W związku z tym istotne jest, aby po zastosowaniu dla kultury grzybów podłoża o nowym składzie przeanalizować, jakie związki chemiczne zostały wytworzone w owocnikach grzybów. Produktywność grzybów rodzaju *Pleurotus* oraz ich zdolność wzrostu na podłożach organicznych o różnym składzie wpływa na możliwość ich produkcji na skalę przemysłową. Aby uprawa taka była zadowalająca, należy mieć na uwadze kilka elementów: kontrolę warunków środowiskowych oraz proste zabiegi uprawowe. *Pleurotus ostreatus*, czyli boczniak ostrygowaty, to jeden z najczęściej uprawianych gatunków. Obecnie również bardzo docenianymi gatunkami są *P. cornucopiae* (Paulet Pers.) Roland, *P. pulmonarius* (Fr.) Quél. (= *P. sajor-caju* (Fr.: Fr.) Singer) oraz *P. eryngii* (DC Fr.). Celem niniejszej pracy było wyznaczenie najbardziej produktywnego gatunku spośród *P. eryngii*, *P. sajor-caju* oraz *P. ostreatus* (Jacq.: Fr.) Kummer w uprawie na sterylnym substracie ze słomy pszennej poprzez ocenę takich parametrów, jak: plon, efektywność biologiczna, świeża waga i cechy morfologiczne.

Słowa kluczowe: grzyby, plon, uprawa, substrat

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