# Effect of Selenium Source on Selenium Absorption by Mycelia of Nine *Pleurotus ostreatus* Strains

M STAJIĆ [1] I BRČESKI[2] S DULETIĆ-LAUŠEVIĆ[1] J VUKOJEVIC[1] S P WASSER[3] & E NEVO[3]

[1]Institute of Botany, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia and Montenegro; [2]Faculty of Chemistry, University of Belgrade, Studenski trg 3, 11000 Belgrade, Serbia and Montenegro; and [3]Institute of Evolution, University of Haifa, Mount Carmel, Haifa 31905, Israel.
E-mail: stajicm@eunet.yu

**Abstract:** The aim of our research was to investigate the influence of three different selenium sources [sodium selenite ($Na_2SeO_3$), sodium selenate ($Na_2SeO_4$), and selenium dioxide ($SeO_2$)] when added to medium in different concentrations (0.3 mg/l, 0.7 mg/l, 1 mg/l, and 1.3 mg/l) and to measure the ability of mycelia of nine *Pleurotus ostreatus* strains to absorb Se from these sources. For almost all the investigated *P. ostreatus* strains, when Se absorption and retention by mycelia was considered, $Na_2SeO_3$ and $SeO_2$ were good Se sources. Strain HAI 387 was the most efficient in Se absorption when it was present in the form of $Na_2SeO_3$. $Na_2SeO_4$ was the least optimum source. An extraordinarily high amount of Se was noted in strain HAI 234 when grown in medium containing 1.3 mg/l Se.

**Key words:** Selenium, absorption, retention, *Pleurotus ostreatus,* mycelia

## 1 Introduction

*Pleurotus ostreatus* is economically highly praised for its nutritional and pharmacological value. Its fruit bodies are rich in carbohydrates, dietary fiber, proteins, essential amino acids, vitamins, and minerals.[1] Biologically active substances, especially polysaccharides and lectins, isolated from *P. ostreatus* have hypocholesterolemic, antitumor, immunomodulating, antiviral, and antibacterial effects.[1-3]

Selenium (Se) is not an essential microelement because some organisms, i.e., yeast and plants, do not need selenoproteins,[4] but in some animals and humans Se plays an essential nutritional role. Selenium is an integral component of several enzymes and proteins,[5] and according to their roles it can be concluded that Se is an antioxidant, an antimutagenic agent, and prevents the malignant transformation of normal cells and the activation of oncogenes.[6] *P. ostreatus* has the ability to absorb Se from medium[7] and it may present itself as an excellent dietary Se source.

The aim of our research was to investigate the influence of three different Se sources added to medium in different concentrations on the ability of mycelia in absorbing Se from these sources.

## 2 Materials and Methods

The *P. ostreatus* strains investigated and their origin are presented in Table 1. These cultures are deposited in the culture collection of the Institute of Evolution, University of Haifa, Israel (HAI) and documented in the Catalogue of Cultures.[8]

Se was used in forms of sodium selenite ($Na_2SeO_3$), sodium selenate ($Na_2SeO_4$), and selenium dioxide ($SeO_2$), at the following concentrations: 0.3 mg/l, 0.7 mg/l, 1 mg/l, and 1.3 mg/l. A synthetic medium of the following composition: glucose, 10.0 $gl^{-1}$; $NH_4NO_3$, 2.0 $gl^{-1}$; $KH_2PO_4$, 0.8 $gl^{-1}$; $Na_2HPO_4 \cdot 7H_2O$, 0.75 $gl^{-1}$; $MgSO_4 \cdot 7H_2O$,

0.5 $gl^{-1}$; yeast extract, 2.0 $gl^{-1}$, pH 6.0, (50 ml per flask), was inoculated and incubated at room temperature (22 ±2°C), on a rotary shaker (180 rpm) for 28 days. A medium without Se was used as the control. Three repetitions for each Se source and concentration per strain were performed. After the cultivation period, mycelia were filtered and dried at 30°C during the night. For Se extraction, dry mycelia were treated with: 70% nitric acid, 70% nitric acid + 70% perchloric acid (3:1), and 6 M HCl (37%), in a mineralizator at 120°C. Se concentrations in mycelia were measured using a graphite furnace Atomic Absorption Spectrometer (Varian, Australia).

**Table 1. *Pleurotus ostreatus* strains investigated**

| Scientific name of species | HAI number of strain | Origin of strain |
|---|---|---|
| *P. ostreatus* (Jacq.: Fr.) Kumm. | 207 | Ukraine, Transcarpathian region, Beregovo district, village Ivanovka, on *Quercus robur* L. |
| | 221 | Israel, Atlit, park, on *Salix* sp. |
| | 234 | Cultivated strain, Hungary. |
| | 290 | Cultivated strain, England. |
| | 387 | Cultivated strain (HK-35), Serbia and Montenegro, HK-35. |
| | 493 | Cultivated strain, Hawaii, Nextlab |
| | 494 | Cultivated strain, Hawaii, Nextlab |
| | 495 | Cultivated strain, Hawaii, Nextlab |
| | 592 | KW, A. S. Buchalo. |

## 3 Results

### 3.1 The effect of different Se sources and concentrations on the ability of mycelia to absorb selenium

#### 3.1.1 $Na_2SeO_3$ as Se source

$Na_2SeO_3$ was a good Se source for absorption by mycelia of all the *P. ostreatus* strains examined, and for the incorporation of Se into cellular constituents. By increasing the Se concentration in the medium, the selenium content of mycelia also increased, except in the case of strain HAI 221 where Se concentration in mycelia increased only slightly in the presence of 1 and 1.3 mg Se/l of medium. At all other Se concentrations investigated, the Se content of mycelia was lower than in the control (Figure 1). This was especially evident in the mycelia of strain HAI 221 where, with a Se concentration of 0.3 mg/l in the medium, the content in mycelia was 4-fold lower when compared to the control. Conversely, *P. ostreatus,* strain HAI 387 was the most efficient in Se absorption when it was present in the form of $Na_2SeO_3$ (560 µg/g of dry weight, in medium containing Se in concentration of 1.3 mg/l).

#### 3.1.2 $Na_2SeO_4$ as Se source

In medium containing $Na_2SeO_4$ as the Se source, the results obtained varied significantly. In strain HAI 207, when Se was present at 0.3 mg/l, mycelia content slightly increased and afterwards started to decrease, compared to the control (Figure 2), while in strains HAI 234, 494, and 495, Se concentrations in mycelia increased





as the concentration was increased in the medium. In HAI 234, An extraordinarily high amount of Se (625 µg/g of dry weight) was noted in mycelium of HAI 234 at medium concentrations of 1.3 mg/l. In strains HAI 221 and HAI 387, only in medium with Se concentrations of 1 mg/l, and in strain HAI 493 in concentrations of 1 and 1.3 mg/l, an increase of its concentration in mycelia was noted compared to the control, while in other investigated Se concentrations, it was more or less lower, and in medium concentrations of 0.3 mg/l, in the HAI 221, it was absent in mycelium (Fig. 2). Strains HAI 290 and HAI 592 showed a slightly decreased Se concentration in mycelia with its addition to the medium.

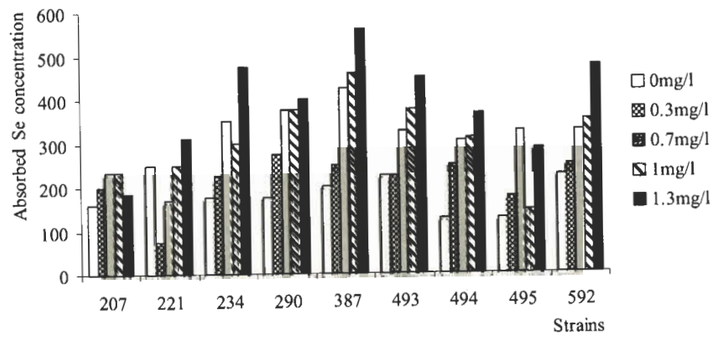


**Figure 1. Se content in mycelia (µg/g of dry weight) of *Pleurotus* strains cultivated in medium with $Na_2SeO_3$ as the Se source**

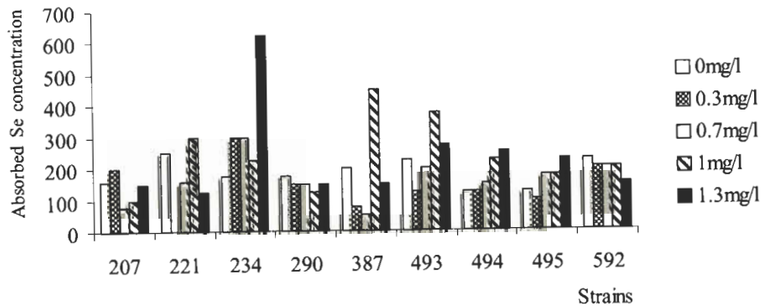


**Figure 2. Se content in mycelia (µg/g of dry weight) of *Pleurotus* strains cultivated in medium with $Na_2SeO_4$ as the Se source**

#### 3.1.3 $SeO_2$ as Se source

$SeO_2$ was also a good source for selenium absorption and retention by mycelia of all the *P. ostreatus* strains investigated. The Se content of mycelia of selected strains mainly increased with an increased concentration of selenium in the medium (Figure 3).

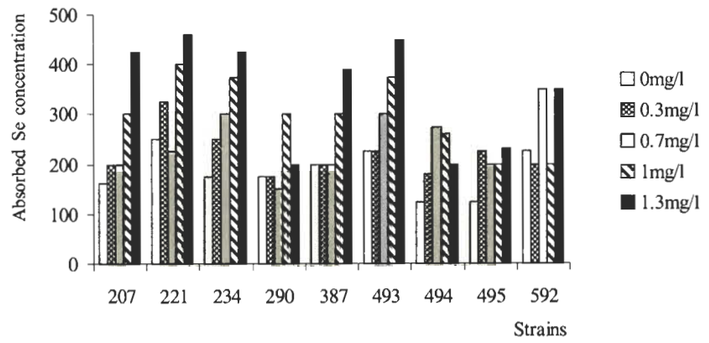


**Figure 3. Se content in mycelia (µg/g of dry weight) of *Pleurotus* strains cultivated in medium with $SeO_2$ as the Se source**

## 4 Discussion

The results obtained showed that the mycelia of the *P. ostreatus* strains investigated have different abilities to absorb Se from medium where it is present at different concentrations in the form of $Na_2SeO_3$, $Na_2SeO_4$ or SeO2. The strains also differed in their ability to retain Se in mycelia.

$Na_2SeO_3$ and $SeO_2$ were good Se sources for absorption by mycelia of almost all the strains examined, while in most of these strains, either no change or a slight increase in the Se content of mycelia was noted compared to controls after cultivation in medium Se-enriched with $Na_2SeO_4$. However, mycelia of some strains had a lower amount of Se after growth in Se-enriched medium compared with controls. These observations may be explained as follows:

(i) Increased Se concentrations in controls could be explained by using the wort agar medium for preserving the *P. ostreatus* cultures, because wort itself is rich in Se.[9]

(ii) All organisms can assimilate selenites and selenides, while only terrestrial plants and bacteria can assimilate selenates.[5]

(iii) The absorption of $Na_2SeO_3$ from aquatic environments is a passive process distinguished from the absorption of $Na_2SeO_4$.[10]

(iv) The resorption of Se from selenites is three times higher than that from selenates.[11]

(v) For Se incorporation into selenoproteins, the absorbed selenites or selenates need to be reduced to the selenide form. The selenide will then either be used in the biosynthesis of selenocysteine, which will be incorporated into selenoproteins, or undergo methylation to methaneselenol or dimethyl selenide, which leads to excretion or volatilization of Se.[12] On the other hand, synthesized selenoproteins are degraded after a certain period of time, and selenocysteine may enter one of three metabolic pathways: oxidative deamination; ß elimination; or selenoxidation.[13]

Unfortunately, our knowledge of Se metabolism, as well as the forms of Se that are present in filamentous fungi, is limited because investigations have only been done with yeasts. Shamberger[14] studied the effects of sodium selenite, sodium selenide, and sodium selenate on suppressing spontaneous mutagenesis on lysine and histidine loci in yeast. Contrary to selenite and selenide, which completely suppressed mutagenesis, selenate inhibited only mutagenesis at the lysine locus, which needed lower quantities of selenite and selenide compared to mutagenesis on the histidine locus.

The capacity for Se absorption by mycelia also depends on the type of medium. This was shown by previous experiments with *P. ostreatus,* strain HAI 387[7] and *Ganoderma lucidum* (Stajić et al., unpublished data). Se content in mycelia of both investigated species was significantly higher when cultivated on potato-dextrose Se-enriched medium with $Na_2SeO_3$ than in malt medium and especially in synthetic medium with the same Se





source. Further investigation should answer questions about the metabolic pathways of Se in mushroom hyphae.

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